Indian Institute of Science

Design of Photovoltaic Systems

Prof. L Umanand

Department of Electronic Systems Engineering

Indian Institute of Science, Bangalore

NPTEL Online Certification Course

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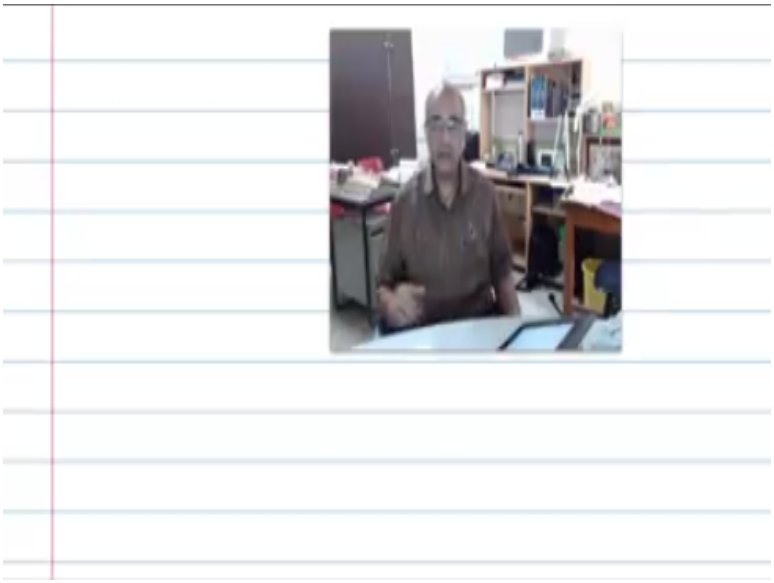

The PV cells are the solar cell if it has to be useful so that it can be made use of in our application., need to be amount in power which means the voltage has to be higher much higher than 0.6V the current has to be hired, so far bills the PV cells many PV cells need to be connected in series or paddle or a combination of both to arrive at a module now can this be done can we connect PV cells in series directly can we connect PV cells in paddles directly what happens if one set of PV cells.

Have different characteristics with respect to another set this is likely to happen due to shading if there is a shade or a shadow that falls on a part of the module then some of the PV cells will have less insulation compared to other parts of the module, so under such condition what happens to the certain characteristics IV characteristics or are these non identical cells being connected in

series of parallel having detrimental effect on the overall module or individual cell can we take any protective measures these are some of the issues that we need to discuss understand study and solve. So this is what we will be discussing right now so first let us take a connecting cells in series.

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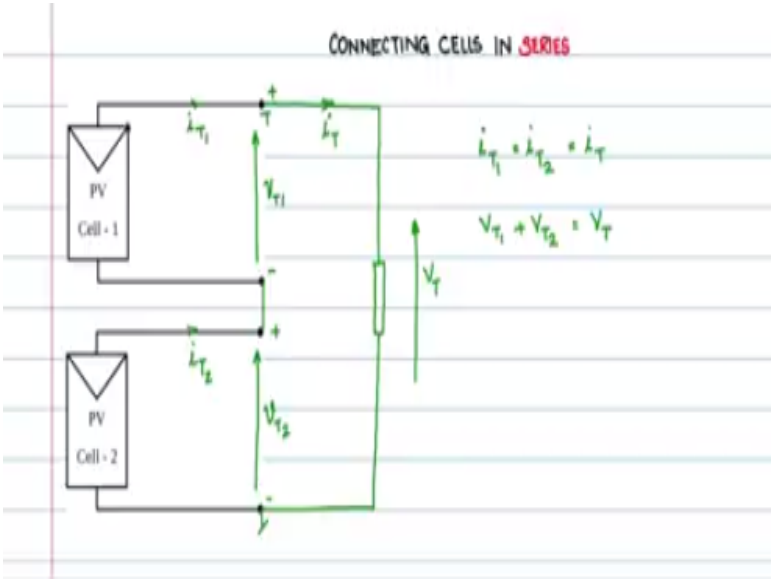

So connecting thousand series let us take just two cells and see how we go about connecting them in series, so we know that a pivotal B is represented in this fashion then you take cell one no take another cell two now these 2 cells if we are to connect them in series what we would do is connect these two terminals so this is + - for the first PV cell this is + and - for the second variation and of course you would connect an external load and I will just represent it as a simple resistive load for now it could be any node which is compatible here to the PVE cell.

So we would connect the load like this and we are interested in the terminal characteristics the resultant terminal characteristic no lattice is the resultant terminal voltage V_T and this is the resultant terminal current i_T that calls on as T, and let us say with respect to this so we have the individual cell having I will say V_{T1} and the second cell having V_T2 and when you connect it in series you observed that the current of both the cells will have to be the same and they have to be i_T, so the constraints here or that $I_{T1} = T_2$ which is equal to i_T.

Because they are connected in series now what is $i_{T1}$and i_{T2} so I will say that this is i_{T2} and I will call this one as i_{T1}, so as far as the currents are concerned they being in CDs I $i_{T1} = i_{T2}$ is equal to

i_{T1} with respect to the voltage $V_T1 + V_T2$ is equal to V_T, now these two are the constraints that get applied because of making that connection in between here so this will series connection of two PV cells, let us now try to replace these block pivotal symbols with an approximate model of the PV cell here so that we understand the play of currents and voltages are much more clearly.

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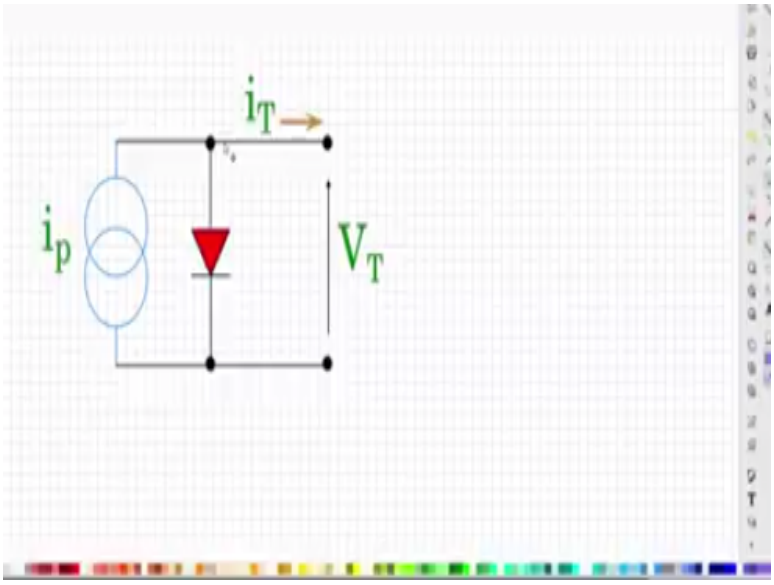

This is a PV cell model this is we T the terminal voltage variety the current that will flow through the terminal if there is a load connected across the terminal RS of the series resistance and R S H easy shunt impedance the shunt non ideality without loss of generality we can remove these two non idealities, so that understanding the series and parenting effect becomes much easier and therefore let us first try to remove these items this now becomes a more idealized model of the PV cell let us substitute this model of the PV cell into the PV cell symbolic block.

Which we have used and try to understand the series and the paddle curling effect of the T7now in this series R cubed let us replace the PV cell symbol with the ideal PV cell model replacing the symbol with this model you see that the PV cell 1 has been replaced and the circuit becomes like this, now if we replace PV cell - also with the model idealized model we have two circuit like this both the symbol being replaced by the idealized models now it will be much more easier to understand those seen in connection with this circuit configuration.

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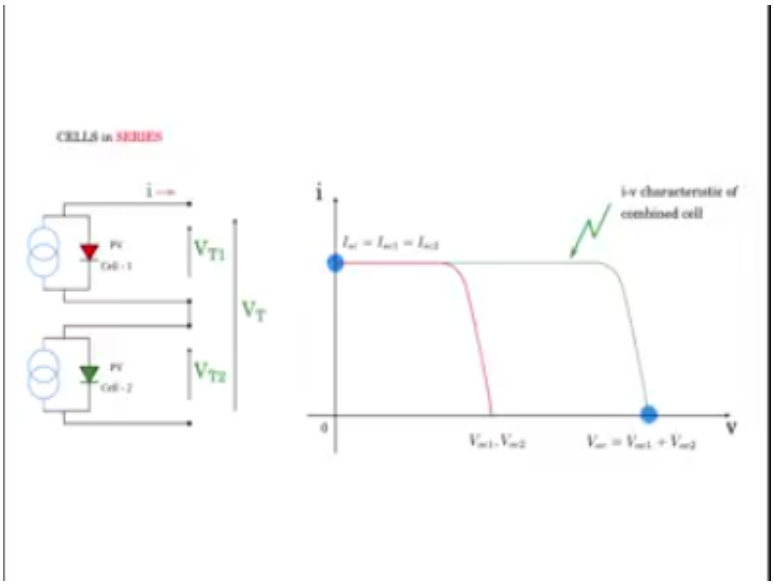

Let us see how the 2 series cells work and what will be the resultant iV characteristic of these 2 CD cells now this is the circuit that we just now discussed and we are interested in seeing the I versus V_T characteristic for this let us draw the x and y axis the x axis is the voltage axis of the V_T it is representing the terminal voltage across the combined system the y axis is the current axis so this IV axis represent the terminal current and the terminal voltage, now let us how characteristic like this which is having the iOC1 and is c1representing PV cell 1now another characteristic which is superimposed.

On the DV cell one characteristic is the PV cell 2 characteristic PV cell 2 characteristic is taken identical to that of PV cell 1characteristic which is having same $V_{OC1}$and $V_{OC\ 2}$ and the ISC2 is same as ise1 now these two cell characteristic PV cell 1 and PV cell 2 characteristic are to be combined to obtain the characteristic of the combined combination, now let us say that this is one operating point of the combined system and this is obtained by the constraint the voltage of the combination is equal to the sum of each individual.

That is PV cell 1 voltage plus PV cell 2 voltage so if you take the x axis there is an operating point we will see 1 and we will see to add it up and you will get this operating point likewise another operating point is as the current flowing through both the cells is the same this would be the one at the outer point is another operating point, so you have two operating points in a simple simplistic manner let us just combine these two operating points into the characteristic as shown here.

So this would be the green ocean would be the combined characteristic of the two PV cells in series and I should note that this is a trivial solution there are many problems the two PV cells will not have identical characteristic will never have identity identical characteristic and we need to see what happens in such cases.