Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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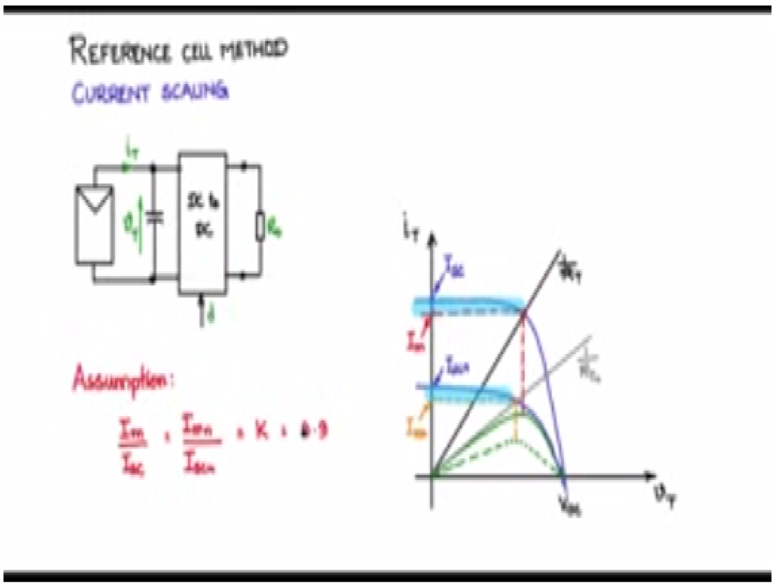

Let us now discuss the reference cell method instead of voltage scaling we will now look at current scaling. We will use this photovoltaic module system, this is the PV cell, there is this buffer capacitance and that across the terminals and DC to DC converter which is acting as the interface between the PV module and the load $R_{0.}$ DC-DC converter is having the control input D.

Now let us draw the IV characteristic for this PV system. Now here we have this IV characteristic, this is the IV characteristic and this is the PV characteristic. Let me draw a line so I have the peak power point and then this line intersecting on the IV curve is the operating point corresponding to the peak power point. Now a line which joins up like this, this is the load line 1/rt and this is the load line at which the operating point gives the maximum power.

Now from this operating point let me draw a horizontal line also, and let me indicate the important parametric point this is ISC, so I will mark it as ISC just like we had VOC here, this is an ISC point of IV characteristic. And then this point here the Y-intercept is IM, the IM is the current corresponding to the peak power point. Now just like we had a relationship between VM and VOC, we have a relationship between IM and ISC where we say that the ratio IM/ISC is constant.

Now suppose if the insulation varies, so we have the changed characteristic for a different insulation. So, the ISC point varies linearly whereas the VOC point varies logarithmically, and for this insulation the power curve I will draw dotted like this and you have the maximum power point somewhere here, and then when you take that up and draw the horizontal. So you will have IM new IMN, and this will be ISC new, ISCN. And the load line corresponding to peak power point for this insulation will pass through this like this, and this will be 1/RT new or RTN.

So this for the new insulation, so for any insulation you will have this type of set of curves what I would like to bring you are attention to is this the relationship between the IM and ISC of that particular set IMN and ISC of a particular set for the given insulation. So we will use the following assumption.

In fact, this assumption is much more stronger than the voltage assumption we have made IM/ISC which is equal to IM new/ISC new or any other IM and ISC pair is equal to a constant value K and its approximately equal to 0.9 given, once you chosen a PV panel from its data sheet you can as set time what is the value of this constant.

Let us say for now it is around 0.9 and you will find that IM/ISC ratio is much more constant than VM/VOC ratio. So probably the current scaling method may be much more accurate method.

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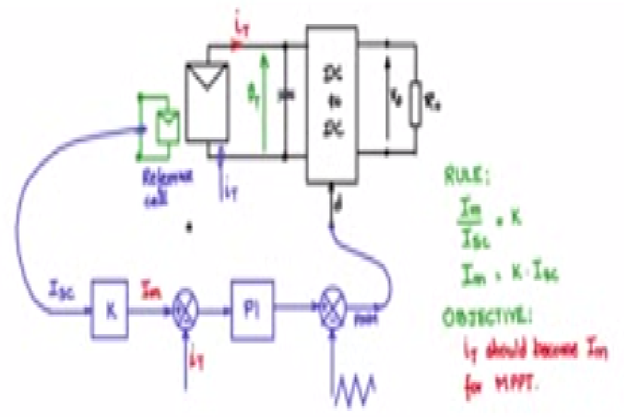

I have here for this PV system the duty cycle how it is generated, just like in the voltage scaling method I have a reference and I have a feedback, what is the reference and the feedback we will decide, the error goes to PI controller, the output of the PI controller is compared with the triangular carrier output of which will be a PWN that is connected to the duty cycle input, which will modulate RT for this particular system.

Now let us see what we want to give as reference and what you want to give as feedback signal. Consider the rule that we just discussed where IM/ISC is equal to a constant K or IM is equal to K times ISC. ISC is the short circuit current for the panel at a given insulation. Now what is the objective, what is it that we want to do we want to see that the current that is flowing through the panel should be set to the IM valve, for any particular given in solution.

The current that is flowing from the panel should correspond to the IM value for that insulation in such a case if IM value is flowing, then the operating point will be somewhere near or very near to the peak power point, and then the load line automatically that is presented to the PV is the load line corresponding to the maximum power point.

So therefore, we can say that IT the terminal current should become same as IM in value for MPPT in order to achieve maximum power point tracking. So using these two variables you can say that what I need to give as feedback is the current flowing through the PV panel. So I can say that I would like to have as feedback IT and as a reference I would like to have IM. The logic is that IM is the reference, IT is the feedback value which is supposed to try and follow or meet the reference value.

If there is any different, there is an error the PI controller will modulate this carrier and generate a PWM with the specific duty cycle which will modulate RT in such a way the error here goes to zero, under such condition IT will match IM. And that means that IT that is flowing here from the PV panel will correspond to IM value or the current corresponding to the peak power point meaning that implying that the panel is delivering peak power point to the load.

Now how do you get this IM? So first of course you need to measure the current IT, because this current IT has to be feedback and given here, this has to be feedback and given here. How do you measure IT? IT can be measured any current can be measured by putting a shunt resistor here and taking the voltage which is proportional to the current flowing through that and using that for feedback, or one can use a Hall sensor and sensed the current even the DC current flowing through the wire and given that one as feedback.

Now how to generate IM? So IM we know can be obtained from the knowledge of ISC short circuit current using this relationship. So ISC x K will be IM. Now this system will work provided you know what is ISC, ISC is the short circuit current which will keep varying depending upon insulation. So how to get the short circuit of this panel I cannot directly short circuit this panel, because in that case there will not be any power transfer to the load.

So therefore, we need to have a reference cell so I will put another small cell a reference cell which is in the neighborhood of this power delivering of PV array or PV module. Now this reference cell is not going to deliver any power it will be a small cell. Now this cell I am going to perform a short circuit you short the terminals and use this short circuited reference cell for obtaining the ISC.

If you sense the current through hall sensor or similar such method and connect it to ISC, and this ISC is supposed to represent the short circuit current of the main PV array if these two cells are at the same manufacture and similar data sheets. Now this ISC is scaled and becomes IM that give a reference for this control circuit and IT will ultimately try to match IM.

Now this supposed to give you a much better performance as compared to voltage scaling, because this relationship is much more accurate IM= K ISC is much more accurate than

VM/VOC = constant. So this method of obtaining maximum power point tracking is called the current scaling method reference cell method with current scale.