Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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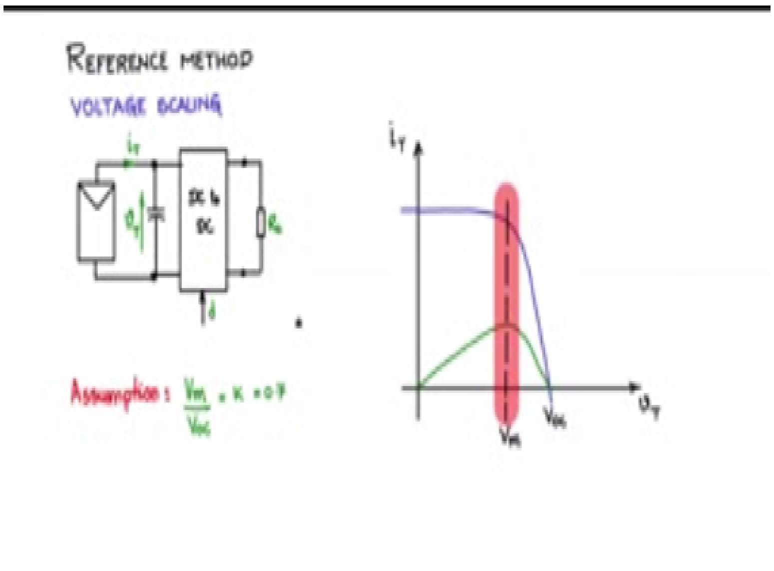

Let us now discuss the reference cell method and more specifically the voltage scaling type. So we know this block diagram topology you have PV cell connected to the DC-DC converter you have a capacitor buffer at the terminals of the PV cell, and then the load R0. So this is the DC-DC converter and we have terminal voltage V_t and terminal current I_t as shown like this. Then you have control input D and R_0.

Let me draw the V_t versus I_t curve this is the IV curve, and this is the PV curve. Now the maximum power point is occurring somewhere here in this region. So if the insulation varies there is variation in the IV characteristic you will see the IV characteristic changes, but the maximum power curve also will change the maximum power point value also will change, but it will be within up certain band it will be within the certain band like this.

And we can say more or less within this band the maximum power point, maximum power operating point lie in this zone. So we will call this as VOC point and we will call this as VM the maximum power voltage. So as a approximate solution we could say that if I choose VT the panel voltage to lie always within this band which means if I am having a load line which is in this band here.

If I have load lines in that band then more or less it is hovering around the maximum power point it may not exactly be at the maximum power point, but it will be near around at the maximum power point which is still very satisfactory in many of the application. So our literature has taken this approach that we make an engineering approximation, we make an assumption saying that VM/VOC that is this values divided by VOC value on the voltage access is a constant.

And let us say approximately if you say VOC is 100% VM is at around 70% point (70-90)% point but it will vary depending on the characteristic, once you choose a particular PV panel from the data sheet you can arrive at what this constant value is, let us say it is around point 7. So once you have made this assumption, now this becomes the rule given the panel and whatever may be the load R0 I will adjust the duty cycle such that the load line has seen from the PV panel will pass through in this range of slopes.

And thereby the operating point when the vertical is drop down on to the power curve will be more or less on the flat top, near the top of the hill and you can say near closed to maximum power transfer is happening. So this assumption is the bases for this voltage scaling method. Now let us see how we go about realizing this voltage scaling method.

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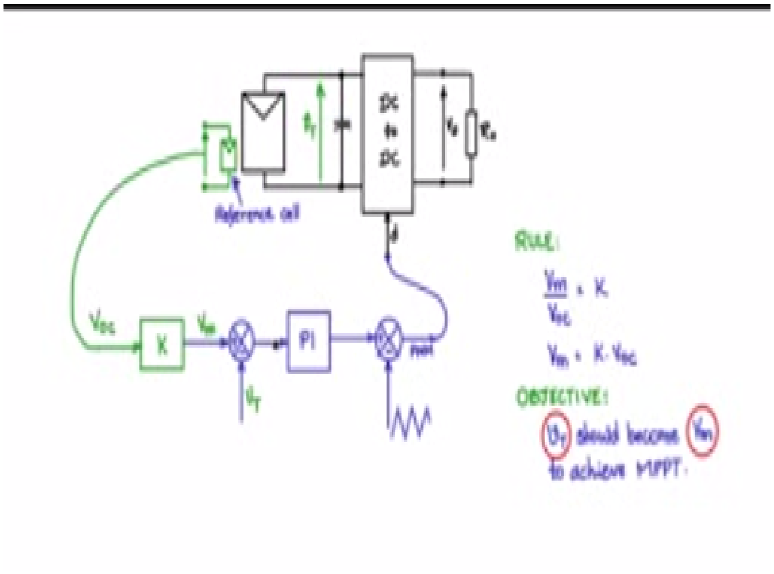

So to this PV system interfaced with DC-DC converter having the DS control input, let us see how we will give the control signals for this duty cycle input of the DC-DC converter to achieve maximum power point transfer using the reference cell voltage scaling method. Now let us understand the control block schema. Now there needs to be a reference, now this reference has to be compared with the feedback signal.

So in any control system topology you will have a reference signal and feedback signal + and – and there will be an error signal. For now I am not going to tell what is this reference signal and what is the feedback signal we will come to that later. But this error signal what you have here I can process that, I will process it through a controller, and one of the most robust controllers is the PI controller proportional integral controller.

So I will use the proportional integral controller. The output of PI controller this will be a DC value. Now this has to be converted two times in order to get duty cycle signals. So we need to do a pulse with modulation. So depending upon the DC value there needs to be a voltage to conversion. So that involves a comparator like this, and to this comparator another input we will carrier signal at triangular carrier.

So when the DC signal in the triangle carrier are compared the output of the comparator would be a pulse wet module related signal, and that output is what is given to that D input and D input internally will drive the power semi conductors which within the DC-DC convertor. So this would be the schema. Now we need to see what are the values that you need to give and what variable you would want to give here.

Now let us go back to the voltage scaling rule which we just now discussed. The rule is we made assumption that VM/VOC is equal to constant K or VM is the voltage of PV panel at maximum power point or peak power point. So VM=K VOC, so we now we have a relationship of maximum power point with respect to VOC and a constant VOC is the open circuit voltage. Now what is the objective, what is that we want to achieve from this block schema.

What we want to do is that the voltage VT which is across the terminals of the PV panel should be set equal to so if I go to this IV characteristic the voltage VT should be hovering in this band if it is hovering in this band, then the operating point is somewhere here and what is the power drawn from the PV panel will be hovering around this region so it will be closed to the peak power point.

So we need to see that VM is as close to VT the terminal voltage across the panel is as close to the VM value as possible, VM value in terms of VOC. So that is what we would like to implement VT the terminal voltage across the panel should become VM to achieve MPPT. So therefore, now I have VT and VM these two important variables which we will use here. Now VM is the reference we want VM here to be the reference and VT is the feedback signal.

So we can sense the terminal voltage across the panel and give it as feedback and ultimately VT should become same as VM in such a case when this error is zero VT is same as VM and in such a case you will see that maximum power is being transferred to the load. So let us say for example that VT is not same as VM, let us say VT is less than VM then error is positive higher VI controller the output of this increases.

Once the output of this increases there is this duty cycle a pulse with modulation wave form coming in here, because this DC compares with this carrier and use a duty cycle. Now this duty cycle will change by going from 0 to 1 or 1 to 0 depending upon which type of converter and appropriately modulate the input resistance seen from the PV panel which will appropriately position the load line.

And therefore, change the value of VT. So the value of VT will keep changing and try to reach VM such that error here becomes zero. The job of this controller is to always see that the error here becomes zero, the error here is zero VT will be same as VM. And then you have achieved maximum power point tracking, but how to get VM because we know this rule. So we will add a block let us say that is K, and then we will submit as input VOC.

So we provide VOC gets multiplied scaled by K and you have VM this becomes the reference, this is your reference section VT which is measured gets compared with VM the error is controlled by this VI controller, and the pulse with modulated signal is provided here which will modify RT and the RT will change VT, and VT will keep changing till this become zero under such conditions when under such conditions VT = VM error is zero, then you have maximum power point tracking.

But here you have only one problem how to get VOC we do not have a VOC value, because if you measure this voltage this is a terminal voltage under loaded condition, how to get the unloaded open circuit value of the voltage across the panel it will change from panel to panel, it will change from insulation to insulation. Therefore, how to get this value of VOC. Once we have VOC then we know that the entire control scheme will work.

In the neighborhood of this panel which is delivering power to the load we will place a small cell called the reference cell, and that reference cell is kept open circuited there is no load connected across the reference cell. So this cell which is placed in the neighborhood of PV panel wherever this is placed on the roof top, you place this reference cell also as a small cell voltage across that is always going to give you always open circuit value of this cell.

And we will take this cell open circuit value to be same as this cell provided this cell and this cell is also same make, same date sheet aspect. So you choose the reference cell such that it is from the same manufacturer. And then you start to obtain the open circuit voltage. Now this open circuit voltage is given as input to this scaling block, and this scaled value will provide BM and this will become the reference for making the VIT of this try to reach VM, and thereby achieve maximum power point tracking. So this is the voltage scaling method reference cell method of maximum power point tracking.