Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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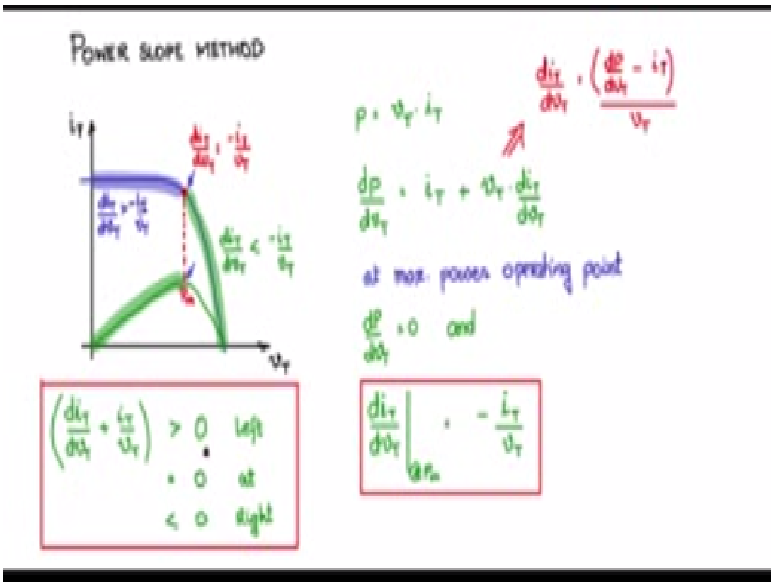

Another method for maximum power point tracking is called the power slope method. Here referring to the IV curve, I will draw this VT verses I T. the terminal volte and terminal current characteristic IV characteristic and this is the PV characteristic. And at the big power point, I will draw a vertical, and this point operating point is called peak power operating point. Now at T M at the peak power the slope of this power dp/dv is 0.

To the left of the operating point the slope of the power is positive, to the right of the operating point the slope of the power is negative. So this transition this is change in the slope of the power is used for tracking the peak power point or the maximum power point. So consider power P which is VT to IT and dp/dvt with respect to the X-axis dvt we have IT plus VT into dit/dvt.

So this is the relationship that you will arrive it. At the operating point corresponding to this maximum power point this maximum power operating point here, you have dp/dvt=0, the slope here is 0. And therefore, applying 0 here, you will see that dit/dvt at the peak power point is given by minus IT/VT, this is the constituting equation, for maximum power point tracking, which means that at maximum power point operating point, you will find that if you take the slope of the dit/dvt di/dv, if you take slope of this IV curve, that will be equal to - IT/VT minus of the ratio of I and V.

Now if you consider this equation rearrange it, dit/dvt =dpv/dvt-IT/VT consider this equation, now here on this region to the left of the peak power operating point you will that dit/dvt will be greater than – IT/VT. dp/dvt the slope here is positive, and this is positive – IT will give rise to dit/dvt, having a value greater than value – IT/VT. Now in this section of the operating point, dp/dv is negative, so therefore this will be more negative.

And therefore, dit/dvt is less than – IT/VT. So this is the logic that you could use to identify where the peak power point or the maximum power point lies. We shall bring – IT/VT to the left side and together we will have this parameter, dit/dvt + IT/VT, this can be used as the key for doing the MPPT logic. So if this parameter is greater than 0, then the current operating point is left to the left of the peak power point.

If this is equal to 0, then the current operating point is at the peak power point, if it is less than 0, then the current point is in this region, which is to the right of the peak power point. So this is the login that one can use, for achieving maximum power point tracking.

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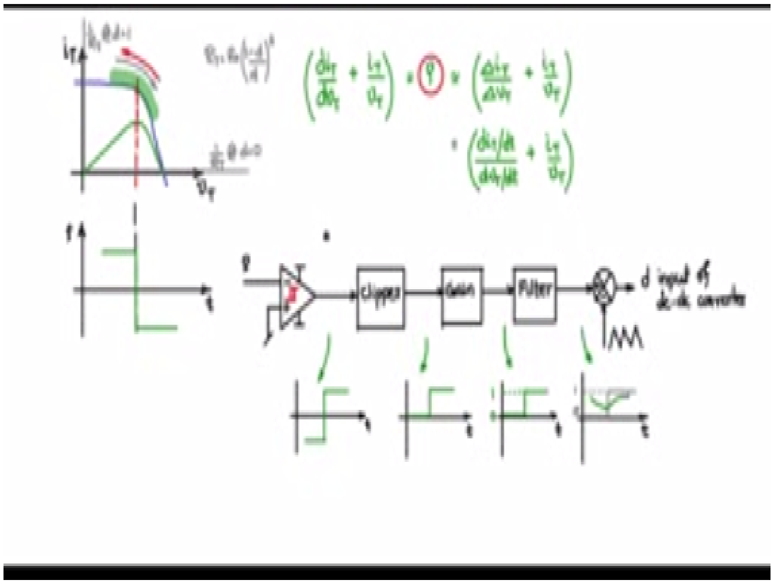

Consider this IT, VT curve, and consider this region, let us say the operating point is moving from here to here, or it moving from here to here. So in the operating point is on this side, the parameter that we just defined dit/dvt +IT/VT that will be positive here, it will 0 at this point and it will be negative here. Let well call it as a ρ, we will give it as a symbol, while implementation it would as a digital domain you can do it as ΔIT/ΔVT + IT/VT.

So this would be approximately same as this, or the analog domain you can differentiate IT separately and differentiate VT separately, divide them and + IT/VT. So in this you can this parameter ρ. Now let us say if I place this ρ and make a way form for ρ with respect to time remember this with respect to time, ρ with respect to time. So let we take at some instant when it is crossing, when the operating part is crossing this peak power point. ρ

So here during this time, during the time period, when the operating point is here, ρ is positive and during the time when the operating point is here, ρ is negative, and then it is transfer from positive to negative here, so you will get a time wave shape one thing like this. Now let us say how we process this, let me will comparator ρ is given to one of the input to comparator, this is the parts of line, -PCC and this - PCC and VCC.

Now this comparator, can consider it as the 0 crossing detector here, will have a shape at the output here like this. So when this is high this will become low, and when this is low that becomes high. And this will go to from - VCC to + VCC. Now follow this comparator with the clipper, I want to remove the negative portion, I want to make it 0 to VCC. So if you clipper circuit using diodes you will get at the output of the clipper 0 gets clipped the negative portion gets clipped, and the positive remains at + VCC.

Then I would like to now scale this way form size that it is from 0 to 1, I do not want from 0 to VCC, let say we kept it from 0 to 1. So follow it up by a gain circuit scalar, scaling circuit and at the output of the gain circuit, what you expect will be something like this 0 to 1. So the gain will adjust such that it is 1/VCC, so that you will get 0 to 1. Now this let be pass it through filter, imagine a RC filter, or it could be an open filter.

At the output of this filter, the wave shape will look something like this, now let me draw this first, what is at the input, this is at the input 0 to 1. And the output the filter during this time this filter will start going toward 0, and then during this time the filter will start going up t o 1. Now this we can compare it with a triangle way form, a triangle carrier, and generate a pulse with modulated wave shape, this will be the D input to our DC-DC converter which is interfacing the PV panel.

So what is happing, now let us say that the operating point was here, this was high, so this becomes low. So once this becomes low the clipper has clipped it 0, the gain here that would also be 0, and the output of the filter is moving towards 0, it will keep on moving towards 0, which means the duty cycle is decreasing. Consider the DC-DC convertor is a buck boost converter. We have the extreme to the load line to the buck boost convertor 1/RT this is one extreme at D =0.

On the other extreme , 1/RT at D=1, the load line will be along the vertical. This is coming from $RT = R0(1\text{-}D/D)^2$ this is the resistance input output relationship for the buck boost convertor. So now consider that the operating point is somewhere, here to left of the maximum power operating point. And we saw that it was the duty cycle somewhere here and the duty because of the filter, the duty cycle is decreasing towards 0, because the input is 0 here.

Now as it is decreasing, duty cycle decreasing means from 1 to 0 it is decreasing the load line is shifting like this, the load line is shifting such that the operating point is shifting in this fashion along this arrow like this. And once it crosses the peak power point, there is a transient in the ρ, variable once the ρ becomes low this becomes positive, this becomes high, here also this becomes high and gain makes this = 1, and the filter output changes direction.

It will start to move towards 1, which means duty cycle is increasing the duty cycling that you are feeding to the DC-DC convertor is increasing. So from here again it is increasing, so which means it will start moving back, the operating points starts, moving back in this direction. So it moves back again it cross the 0, then again there is a change in direction, so duty cycle keeps moving in such a way that operating point keeps shifting back and forth around the maximum power point.

You can narrow down this back and forth movement as much as possible by setting an appropriate hysteresis for this hysteresis convertor, if you give a small hysteresis band, then this will be hovering very much near to the operating point. If you give a wide hysteresis band then the variation here will be wider. So in this way this particular power slope method can do maximum power point tracking.