Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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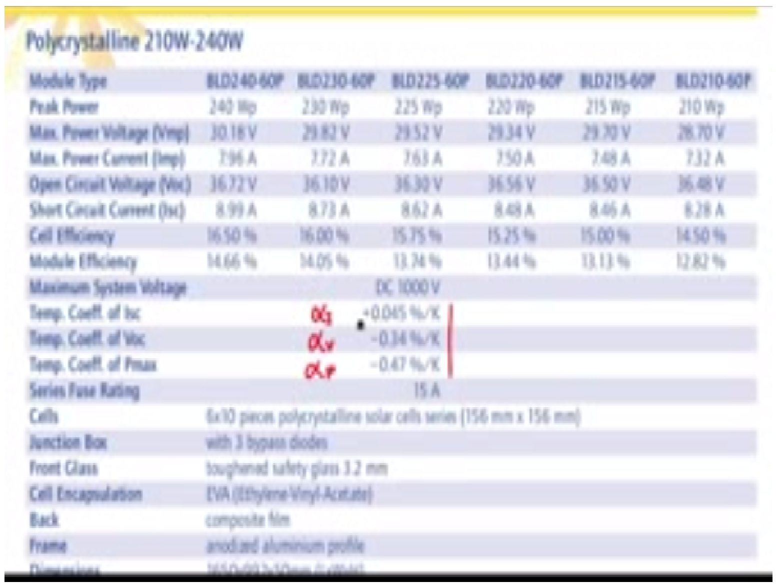

Polycrystalline 210W-240W

Module Type	BLD240-60P	BLD230-60P	BLD225-60P	BLD220-60P	BLD215-60P	BLD210-60P
Peak Power	240 Wp	230 Wp	225 Wp	220 Wp	215 Wp	210 Wp
Max. Power Voltage (Vmp)	30.18 V	29.82 V	29.52 V	29.34 V	29.70 V	28.70 V
Max. Power Current (Imp)	7.96 A	7.72 A	7.63 A	7.50 A	7.48 A	7.32 A
Open Circuit Voltage (Voc)	36.72 V	36.10 V	36.30 V	36.56 V	36.50 V	36.48 V
Short Circuit Current (Isc)	8.99 A	8.73 A	8.62 A	8.48 A	8.46 A	8.28 A
Cell Efficiency	16.50 %	16.00 %	15.75 %	15.25 %	15.00 %	14.50 %
Module Efficiency	14.66 %	14.05 %	13.74 %	13.44 %	13.13 %	12.82 %
Maximum System Voltage	DC 1000 V					
Temp. Coeft. of Isc	α_i +0.045 %/K					
Temp. Coeft. of Voc	α_v -0.34 %/K					
Temp. Coeft. of Pmax	α_p -0.47 %/K					
Series Fuse Rating	15 A					
Cells	6x10 pieces polycrystalline solar cells series (156 mm x 156 mm)					
Junction Box	with 3 bypass diodes					
Front Glass	toughened safety glass 3.2 mm					
Cell Encapsulation	EVA (Ethylene-Vinyl-Acetate)					
Back	composite film					
Frame	anodized aluminium profile					

Let us try to understand the temperature co-efficient better by doing some examples, but before that let us name the variables now the temperature co-efficient of ISC we will call that as αi the temperature co-efficient of VOC we will call that one as αv and the temperature co-efficient of peak power as αp for this particular example you see that the temperature co-efficient of current is 0.045% / degree Kelvin.

And temperature co-efficient of VOC is -0.34%/ degree Kelvin and that of the power αp is -0.47% / degree Kelvin, so what do these numbers mean and how do they effect the overall voltages currents and the power now that is what we would like to see now.

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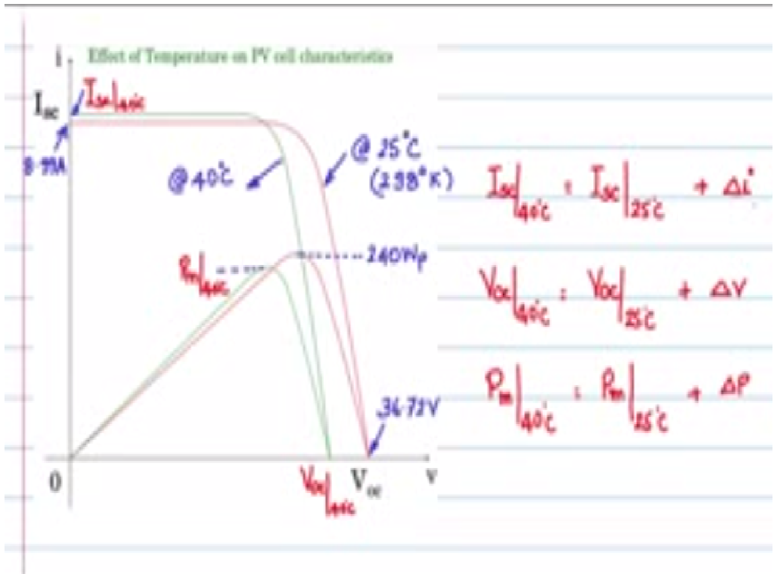

Consider the IV characteristic I have shown here let the IV characteristic which is in red represent the characteristic at temperature 25^0C or 298 ^{0} Kelvin. So this is the standard temperature and the one in green let us say it is at 40^0C now we know from the data sheet the open circuit voltages and the short circuit currents at standard temperature and in solution and this value from the data sheet is given as 36.72 volts and ISC is given as 8.99 amps all this from the data sheet.

Now we need to find what is VOC at the 40^0 curve and also ISC for the 40^0 current, the peak power for the curve at standard temperature and insulation is given as 240 volts peak for this particular cell in the data sheet we need to estimate what is the peak power value for the curve which represents the 40^0C temperature. Let me replace the question marks by meaningful variables.

So what we need to estimate is here the short circuit current at 40^0C the peak power at 40^0C and VOC at 40^0C, ISC short circuit current at 40^0C = the short circuit current at the standard temperature of $25^0C + \Delta i$ likewise VOC at 40^0C is VOC at 25^0C standard temperature + and Δv and the power max power or the peak power at 40^0C is given by the peak power at the standard temperature of 25^0C + a ΔP. We need to find what the Δi, Δv, Δp values are using the data sheet of a temperature co-efficient parameters.

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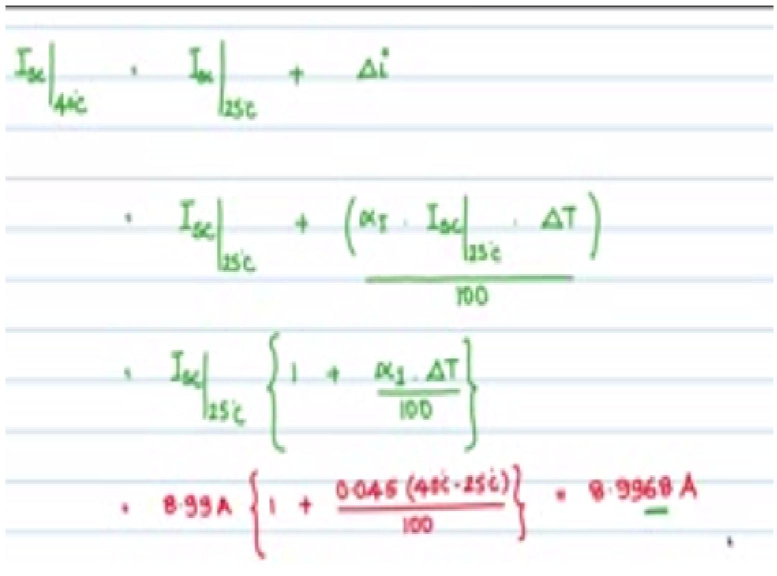

The temperature co-efficient of ISC αi is given as change in ISC/ ISC at standard temperature into 100 so which means that this whole thing is converted to a percent form/ degree change in temperature, so this is how it is defined as per the data sheet and this value for the short circuit current we saw is given as +0.045 % / degree Kelvin. Rearranging change in ISC which we shall denote as Δi is given as αi the temperature co-efficient of ISC x the ISC at standard temperature 25^0C x ΔT the change in temperature/100 times.

So this would be the change in ISC now substituting it in the ISC equation we find ISC at 40^0 C = ISC at 25^0C + Δi, the Δi can be replaced by this αi is a temperature co-efficient of ISC as given in the data sheet into ISC at 25^0C the reference temperature x ΔT difference in temperature/100.Now if you take out ISC at 25^0C out as a common factor you will get this particular term 1 + αi ΔT/ 100.

For the values given in the data sheet substituting for all this parameters here we can get the short circuit current ISC value at 40^0C. ISC at 25^0C 8.99 amps as given in the data sheet α is 0.045% / degree Kelvin temperature the standard temperature is 25^0C and the raised temperature is 40^0C/100 and that would give you a value of 8.9968, 0.0068 amps higher than the corresponding current value at 25^0C.

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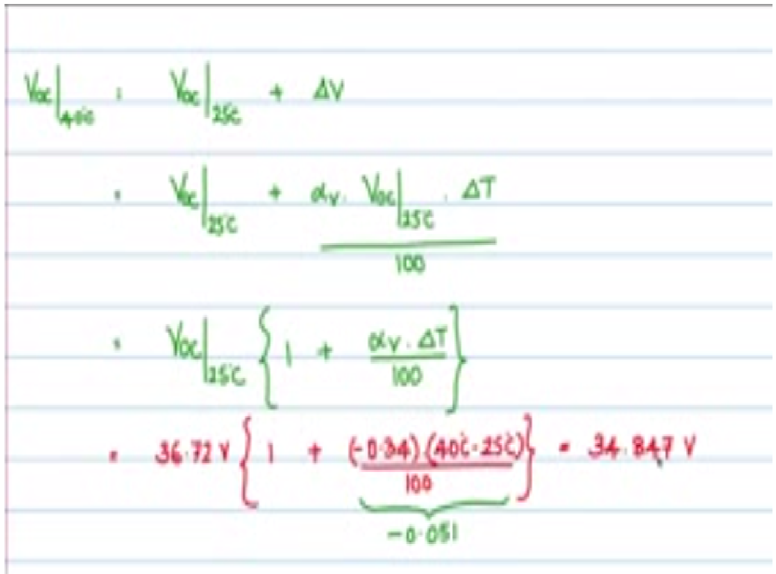

Along similar lines the open circuit voltage that 40^0C is given by open circuit voltage at the standard temperature of 25^0C + a change in voltage ΔV. Now this change in voltage ΔV can be obtained using the data sheet value of temperature co-efficient of VOC into the VOC at25^0C into the change in temperature/100. Bringing out the common factor the VOC at standard temperature into 1 + αv x ΔT/100.

So if we substitute the values from the data sheet values 36.72 volts for VOC at standard temperature αV for the VOC is given as -0.34 note the minus because the VOC decreases with increase in temperature a temperature rise of $40 – 25^0$ which is 15^0C/100. So this amount here amount from -0.051 which reduces pulls down the open circuit voltage to 34.847 volts, so as temperature increases the open circuit voltage will drop.

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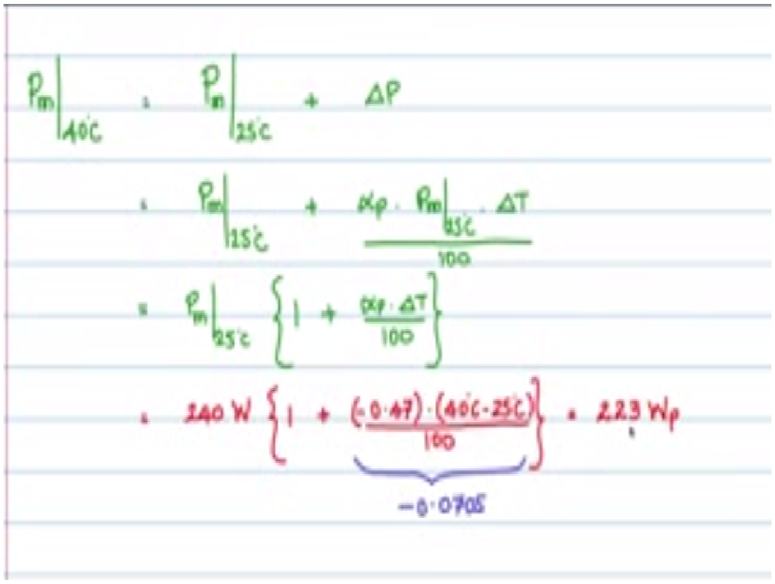

Similarly for the peak power value also PM at 40^0 C is given by Pm at 25^{0}C + at ΔP value, the ΔP value can be expressed as αp the temperature co-efficient of the power into PM at 25^{0}C x ΔT/100. Simplifying we have Pm at 25^{0}C to 1 + αp ΔT/100.Now if you substitute the data sheet values Pm at 25^{0}C is 240 at P 1 + α p from the data sheet is given as -0.47 x40-25^{0}C rise in temperature/100.

To this portion will become negative it is -0.0705 which will cool down the value of the peak power to 223 watt p therefore here again you will see observe that with rise in temperature the value of the peak power will come down.