SOLAR MODULE TESTING

- FACTORY TEST
- OUT DOOR TEST

MODULE TEMPERATURE RISE

$$T_{cell} = T_a + K \times G$$

T_{cell} = CELL TEMPERATURE FOR MODULE (°C)

T_A = AMBIENT AIR TEMPERATURE (°C)

K = CELL TEMPERATURE COEFFICIENT (°C/W-m²)

G = IRRADIANCE (W/m²)

NOCT – NORMAL OPERATING CELL TEMPERATURE

IRRADIANCE (G) = 800 W/m²

AMBIENT TEMPERATURE (T_A) = 20°C

WIND SPEED 1 m/s

LOAD = OPEN CIRCUIT

CELL TEMPERATURE COEFFICIENT (K)

$$K = \frac{NOCT - 20}{800}$$

CELL TEMPERATURE BASED ON NOCT

$$T_{cell} = T_A + \left(\frac{NOCT - 20}{800} \times G\right)$$

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A PARTICULAR MODULE HAS NOCT 49°C. WHAT IS CELL TEMPERATURE COEFFICIENT. WHAT WILL BE IT'S CELL TEMPERATURE IF AMBIENT AIR TEMPERATURE IS 35°C AND IRRADIANCE 65 W/m²

$NOCT = 49°C$

$$K = \frac{NOCT - 20}{800} = \frac{49-20}{800} = 0.03625$$

$T_{cell} = ?$ $T_A = 35°C$ $G = 65$

$$T_{cell} = T_A + \frac{NOCT - 20}{800} \times G$$

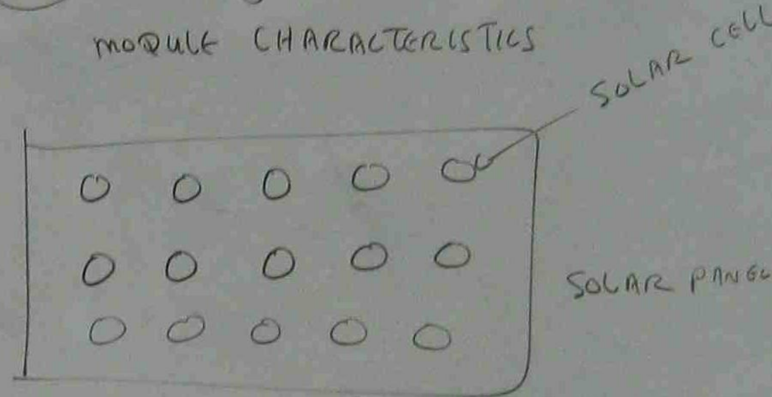
$$= 35 + \frac{49-20}{800} \times 65$$

$$= 37.35°C$$

MECHANICAL / CLIMATE / ELECTRICAL / THERMAL /

$\underbrace{\hspace{6cm}}$

MODULE CHARACTERISTICS



POLY CRYSTALLINE MODULES

36 CELLS IN SERIES

OPEN CIRCUIT VOLTAGE = 21V

SOME MODULES

32 → 33 CELL LOWER VOLTAGE

MAXIMUM POWER P_{mp}

CURRENT AT MAXIMUM POWER I_{mp}

SHORT CIRCUIT CURRENT I_{sc}

OPEN CIRCUIT VOLTAGE V_{oc}

TEMPERATURE COEFFICIENT OF SHORT CIRCUIT CURRENT (α)

TEMPERATURE COEFFICIENT OF OPEN CIRCUIT VOLTAGE (β)

TEMPERATURE COEFFICIENT OF MAXIMUM POWER (γ)

I_{SCT} - SHORT CIRCUIT CURRENT AT TEMPERATURE T°C (Amp)

I_{SC-SCT} - SHORT CIRCUIT CURRENT AT STANDARD TESTING

V_{OC-T} - OPEN CIRCUIT VOLTAGE AT TEMPERATURE T (°C)

V_{OC-STC} - OPEN CIRCUIT VOLTAGE AT STANDARD TEST CONDITION

P_{mp-T} - MAXIMUM POWER AT T°C

P_{mp-STC} - MAXIMUM POWER AT STANDARD TEST CONDITION (W)

$$I_{SCT} = I_{SC-STC}\left(1+\alpha\left(T_{cell} - T_{STC}\right)\right)$$

$$V_{OCT} = V_{OC-STC}\left(1-\beta\left(T_{cell} - T_{STC}\right)\right)$$

$$P_{mpT} = P_{mp-STC}\left(1-\gamma\left(T_{cell} - T_{STC}\right)\right)$$

POWER CONVERSION EFFICIENCY OF SOLAR MODULES

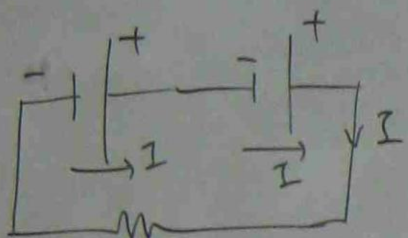
RATIO OF ELECTRICAL POWER OUTPUT AND INCIDENT SOLAR POWER AT STANDARD TEST CONDITION (STC)

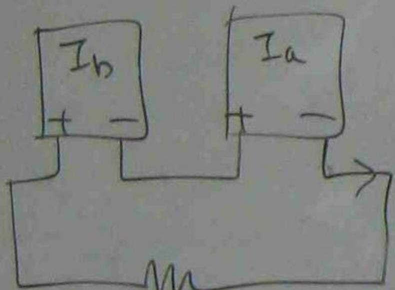
P_{PV} = TOTAL POWER IN LIGHT INCIDENT ON MODULE SURFACE AREA

G = IRRADIANCE (W/m^2)

A = MODULE AREA (m^2)

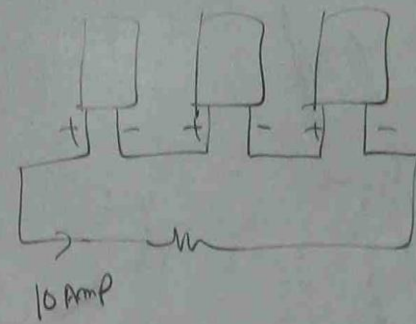
MIS MATCH LOSSES

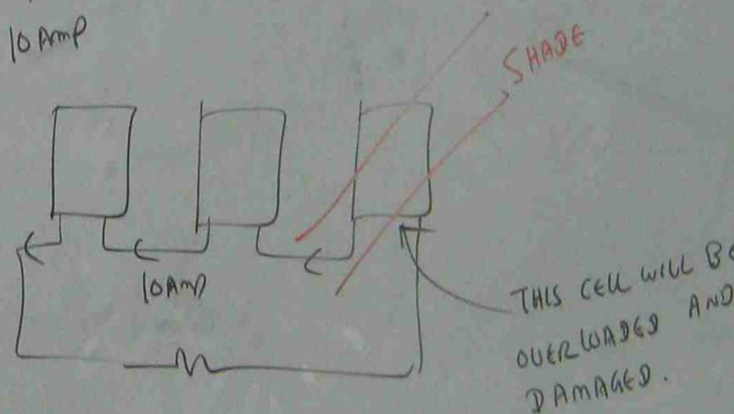




$$I = \frac{I_a + I_b}{2}$$

THE OUT PUT OF EACH SERIES STRING OF CELLS OR MODULE IS LIMITED TO THE WEAKEST ONE.





SHADING AND POWER DISSIPATION

WHEN PART OF A GROUP OF SERIES CONNECTED MODULE IS SHADED, THE UNSHADED CELLS IN EACH OF THE MODULE WILL BE TRYING TO DEVELOP A HIGHER CURRENT THAN THE SHADED CELLS ARE ABLE TO DEVELOP.

TO AVOID OVERLOADING, SHUNT CONNECTED DIODE SHOULD BE APPLIED.

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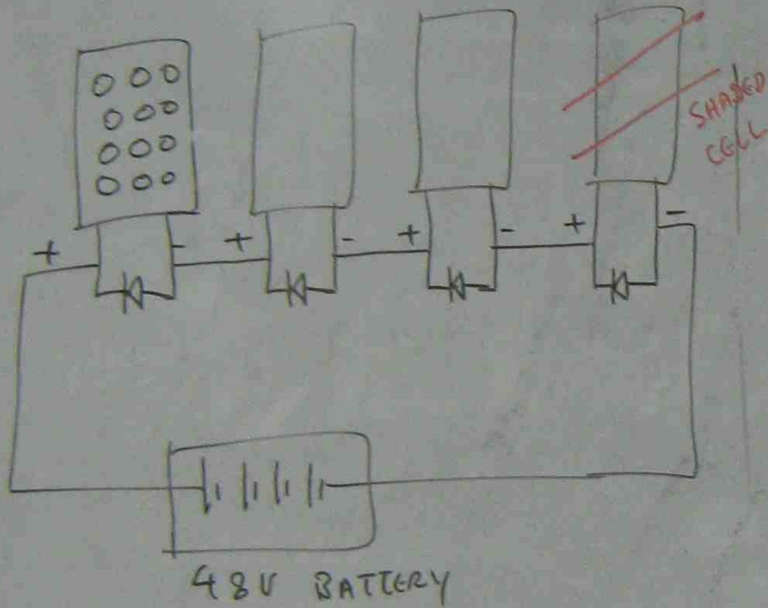

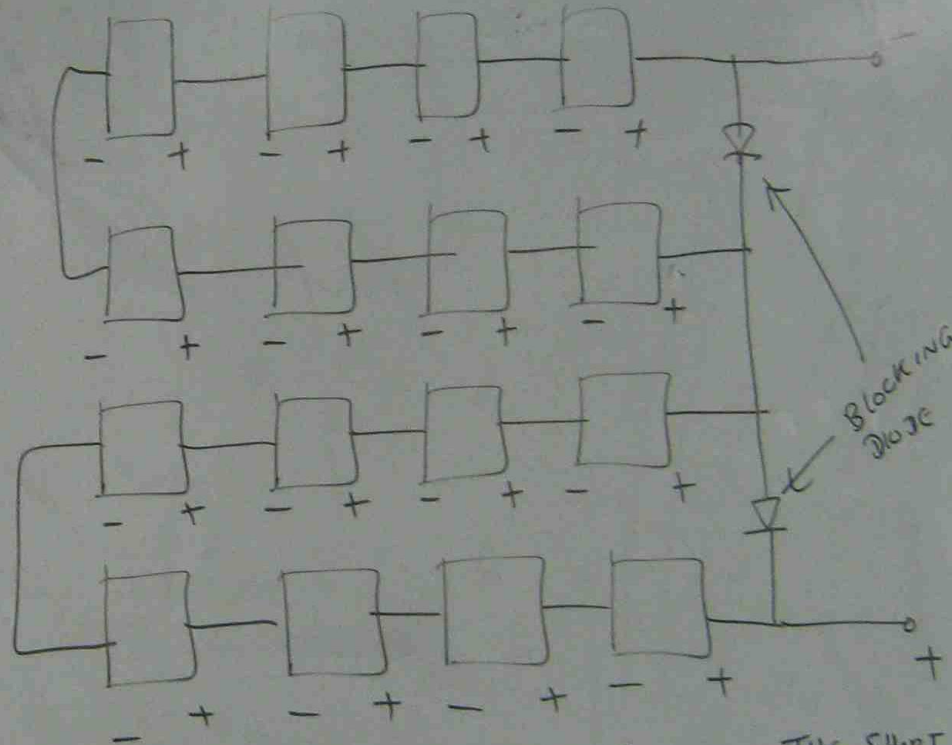

USE OF BLOCKING DIODE IS TO AVOID THE SHORT CIRCUIT FAULT WHICH OCCURS IN ONE STRING CAUSING THE OUTPUT VOLTAGE TO BE REDUCED.

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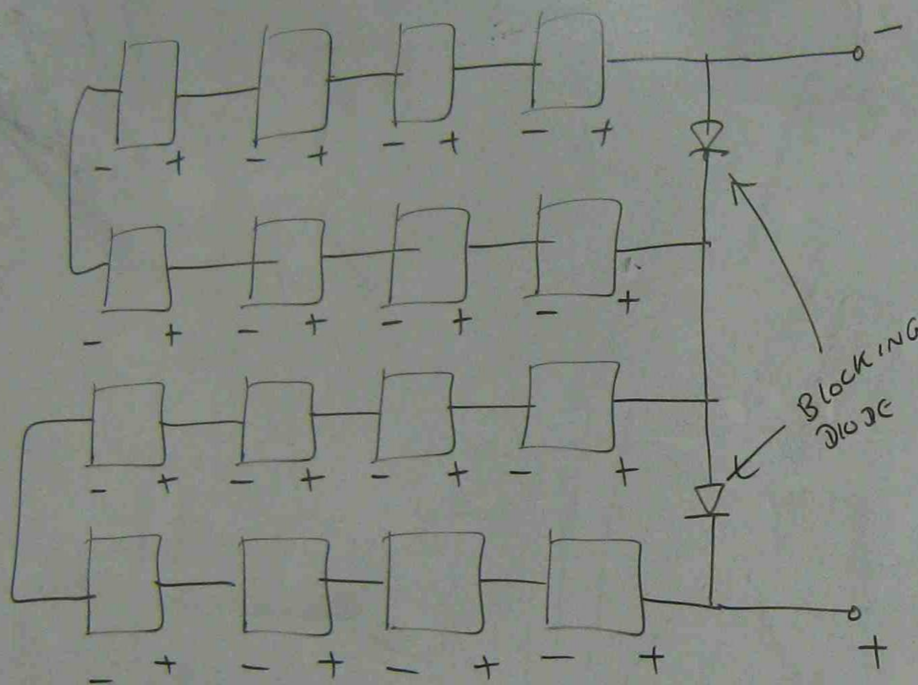

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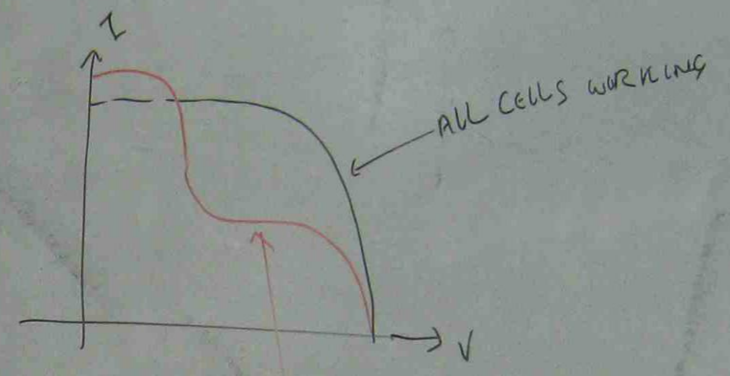
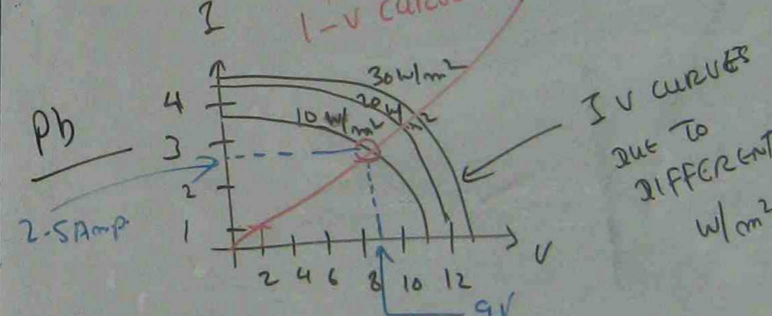




FIND OPERATING VOLTAGE & CURRENT FOR 2Ω LOAD ON 10 W/m².

$V = 9V$

$I = 2.5Amp$

POWER = $V \times I$

$= 9 \times 2.$

$= 22.$

$R = \frac{V}{I}$

IF $V = 2V$ THEN $R = \frac{V}{I} = \frac{2}{1} = 2\Omega$

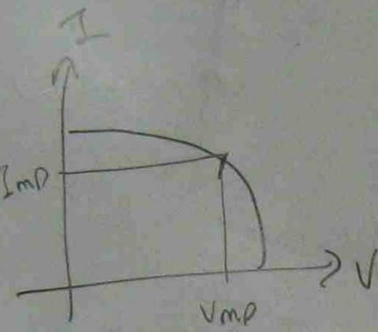
$\therefore I = 1Amp$

$$P_{PV} = G \times A$$

SUN POWER

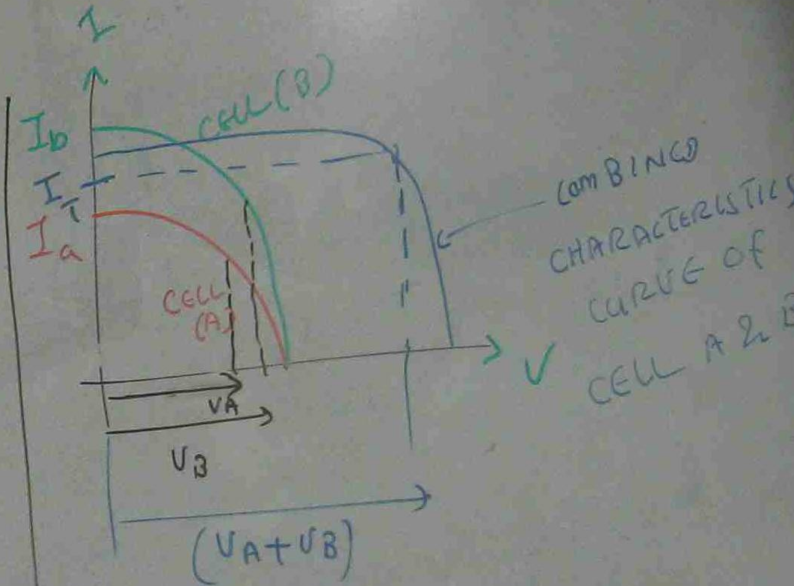
$$P_{mp} = V_{mp} \times I_{mp}$$

ELECTRICAL POWER



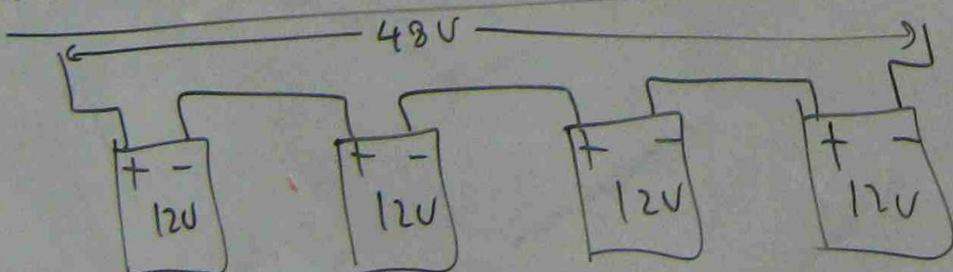
$$\text{POWER CONVERSION EFFICIENCY } (\eta) = \frac{P_{mp}}{P_{PV}} = \frac{V_{mp} \times I_{mp}}{G \times A}$$

$$\eta = \frac{V_{oc} \times I_{sc} \times FF}{G \times A}$$



$$I_T = \frac{I_a + I_b}{2}$$

INTERCONNECTION OF SOLAR MODULES



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