Course: Sustainable Energy Technology 12110598

Title: PV Technology-PV system Components – L6

Dr. Mahmoud Ismail

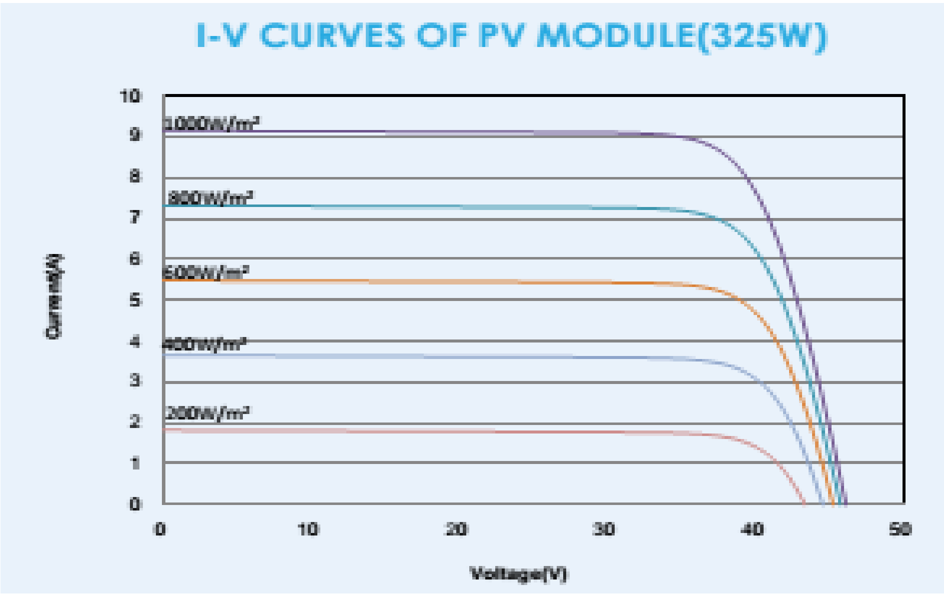
Photovoltaics Systems –Design Examples

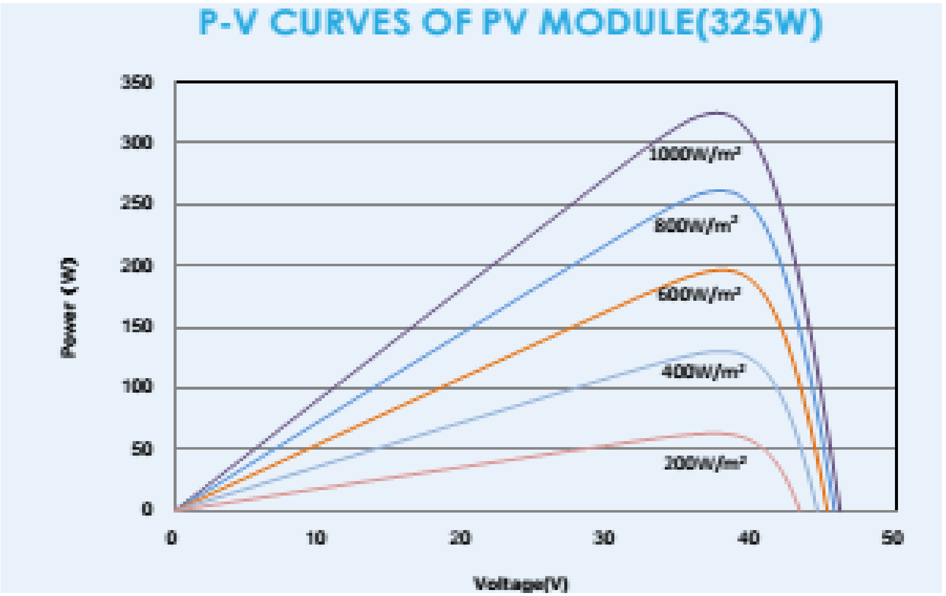
TRINA MODULE DATA SHEET (Specifications):

ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)*	310	315	320	325
Power Output Tolerance-P_{MAX} (W)	0 ~ +5			
Maximum Power Voltage-V_{MPP} (V)	37.0	37.1	37.1	37.2
Maximum Power Current-I_{MPP} (A)	8.38	8.51	8.63	8.76
Open Circuit Voltage-V_{OC} (V)	45.5	45.6	45.8	45.9
Short Circuit Current-I_{SC} (A)	8.85	9.00	9.10	9.25
Module Efficiency η_m (%)	16.0	16.2	16.5	16.8

STC: Irradiance 1000 W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Test tolerance: ±3%.





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Trina Module Specifications:

MECHANICAL DATA	
Solar Cells	Multicrystalline 156 × 156 mm (6 inches)
Cell Orientation	72 cells (6 × 12)
Module Dimensions	1956 × 992 × 40 mm (77.0 × 39.1 × 1.57 inches)
Weight	22.5 kg (49.6 lb)
Glass	3.2 mm (0.13 inches), High Transmission, AR Coated Tempered Glass
Backsheet	White
Frame	Silver Anodized Aluminium Alloy
J-Box	IP 67 or IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm² (0.006 inches²), 1200 mm (47.2 inches)
Connector	MC4 Compatible or Amphenol H4/UTX
Fire Type	Type 1 or Type 2

TEMPERATURE RATINGS	
Nominal Operating Cell Temperature (NOCT)	44°C (±2°C)
Temperature Coefficient of $_{MAX}$	- 0.41%/°C
Temperature Coefficient of V_{oc}	- 0.32%/°C
Temperature Coefficient of I_{sc}	0.05%/°C

MAXIMUM RATINGS	
Operational Temperature	-40~+85°C
Maximum System Voltage	1000V DC (IEC) 1000V DC (UL)
Max Series Fuse Rating	15A

Photovoltaics Systems –Design Examples

Kaco Inverter specifications

Technical data

blueplanet 15.0 TL3 | 20.0 TL3

Electrical data	15.0 TL3	20.0 TL3
Input variables		
Maximum PV generator power	18000 W	24000 W
MPP range@Pnom	420V ... 800V	515V ... 800V
Operating range	200V - 950V	200V - 950V
Min. DC voltage / starting voltage	200V / 250V	200V / 250V
No-load voltage	1000 V	1000 V
Max. input current	2x20.0 A	2x20.0 A
Max. short circuit current [$I_{SC\ max}$]	2x22.4 A	2x22.4 A
Number of MPP trackers	2	2
Max. power/tracker	14.9 kW	15.0 kW
Number of strings	2x2	2x2

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Kaco Inverter specifications

Output variables		
Rated output (@ 230 V)	15 000 VA@230 V	20 000 VA@230 V
Line voltage	400 V / 230 V (3 / N / PE)	400 V / 230 V (3 / N / PE)
Rated current	3 x 21.8 A	3 x 29.0 A
Rated frequency	50 Hz / 60 Hz	50 Hz / 60 Hz
cos phi	0.30 inductive ... 0.30 capacitive	0.30 inductive ... 0.30 capacitive
Number of grid phases	3	3
General electrical data		
Max. efficiency	98,0 %	98.4 %
Europ. efficiency	97.7 %	98.1 %
Night consumption	1.5 W	1.5 W
Switching plan	transformerless	transformerless
Grid monitoring	acc. to local requirements	acc. to local requirements

Photovoltaics Systems –Design Examples

Example: Design of an on-grid PV system:

Services Building-Kadoorie: The PV modules (panels) rated power – 48.1 kWp.

Use Kaco Blue planet 20TL3 inverter.

Use 325 Wp Trina Modules.

The azimuth angle of the modules is 0 degrees

The tilt angle of the modules is 22 degrees.

1- Find the number of PV modules = Total power/power of each module = 48100/325

= **148 panel**

2- Find the number of inverters = Total power / power of each inverter = 48100/24000

= **2 inverters**

3- Check number of MPPTs of each inverter: in our case **2 MPPTs**.

4- Check number of parallel strings for each MPPT: in our case **2 strings**.

Photovoltaics Systems –Design Examples

Example: Design of an on-grid PV system:

5- if we divide the total number of modules on the 4 MPPTs, then each MPPT deals with 37 Panels .

This can't be happen because if we divide this number by the number of strings for each MPPT. The result will be fraction or there will be unequal panels in the two strings and this also can't be happen.

[Each MPPT should have EVEN number of modules].

So we will go to the following arrangement: Each inverter has 74 (=148/2) panels and will be divided between the two MPPTs in this inverter such that **the first MPPT has 36 panels**, whereas **the second MPPT has 38 Panels**.

Photovoltaics Systems –Design Examples

Example: Design of an on-grid PV system:

6- Also, we have to check the minimum number and the maximum number of modules in each string such that we conform with the MPP range @Pnom as stated by the manufacturer. In our case (515V – 800V).

Minimum number = minimum level / VMP of the panel = 515/37.2 = 13.8 (**Take 14**)

Maximum number = maximum level/VMP of each panel =800/37.2= 21.5 (**Take 21**).

7- We have to check the maximum number of modules in each string such that we conform with <u>the maximum no load voltage</u> (in our case 1000V)

The maximum number considering the operating range = maximum operating level/VOC

= 10000/45.9 = 21.7 (**Take 21**)

8- **The lower value** will be considered (taking into account the MPP range and the operating range). (**Take 21**).

9- <u>Check the suitable number of Strings at each MPPT</u>

= Maximum short circuit current of each MPPT / ISC of the each panel (string).

= 22.4/9.25 = 2.4 (2 STRINGS per MPPT as maximum).

10- <u>The first MPPT which has 38 panel</u> (**each string in it will be 19 Panel** (within the range)

<u>The second MPPT which has 36 panel</u> (**each string in it will be 18 Panel** (within the range)

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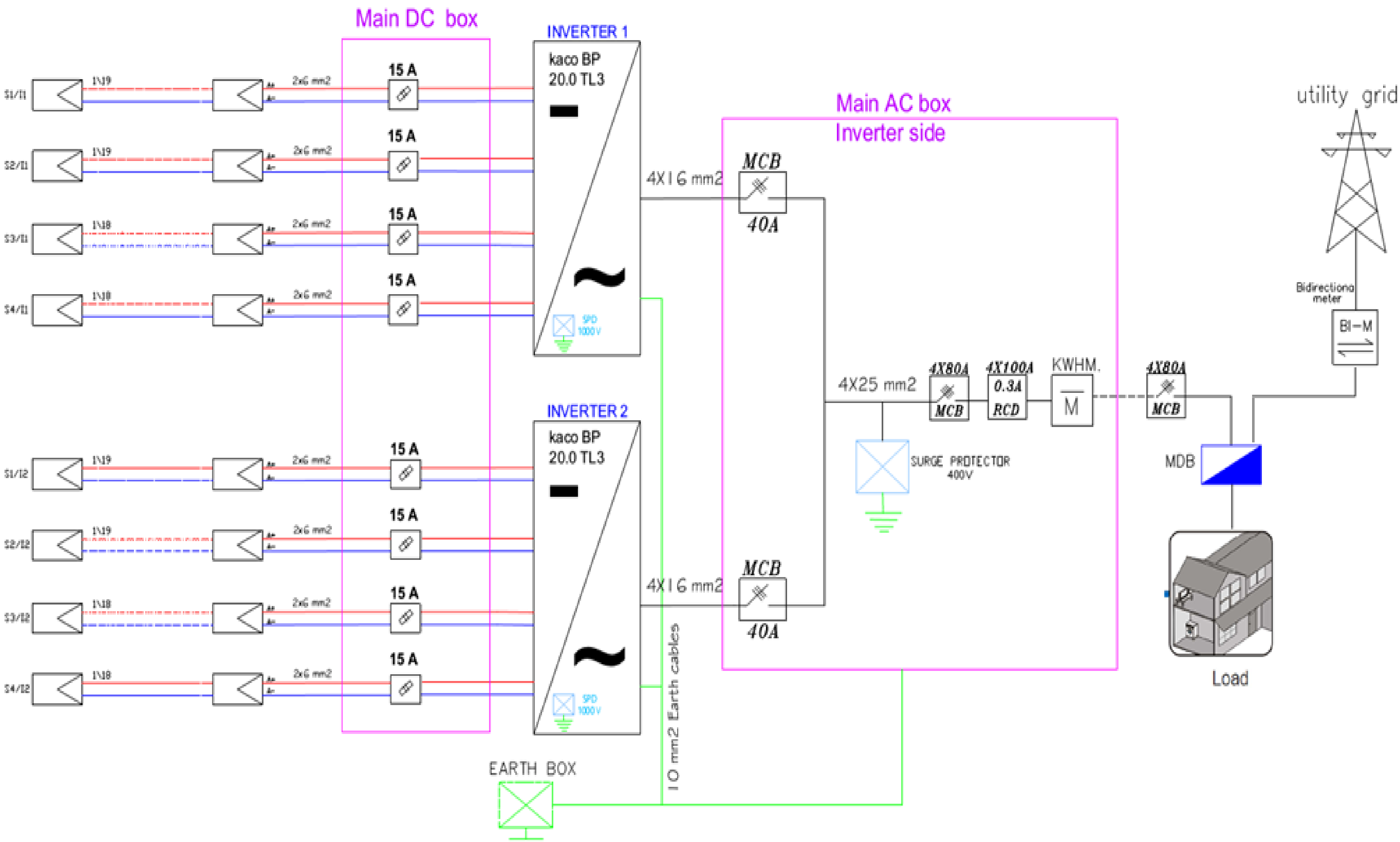
Example: Design of an on-grid PV system:



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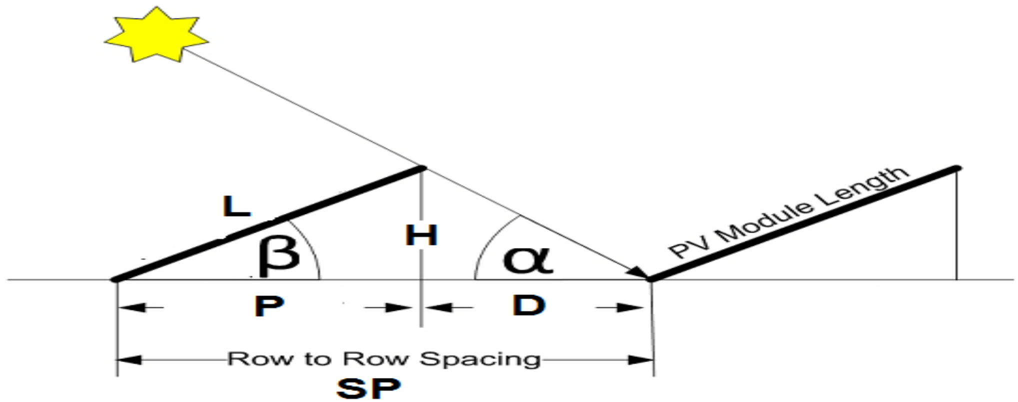
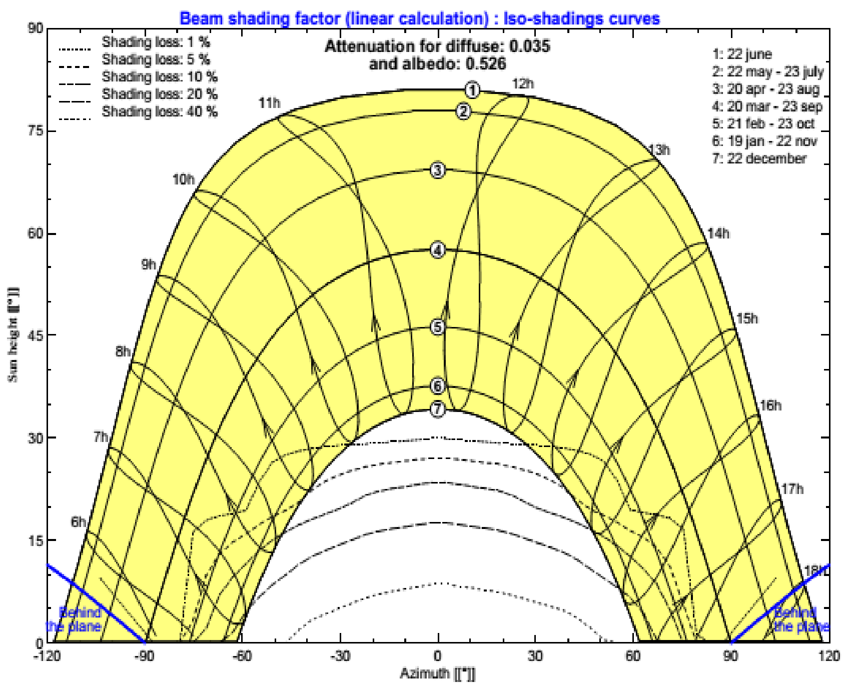
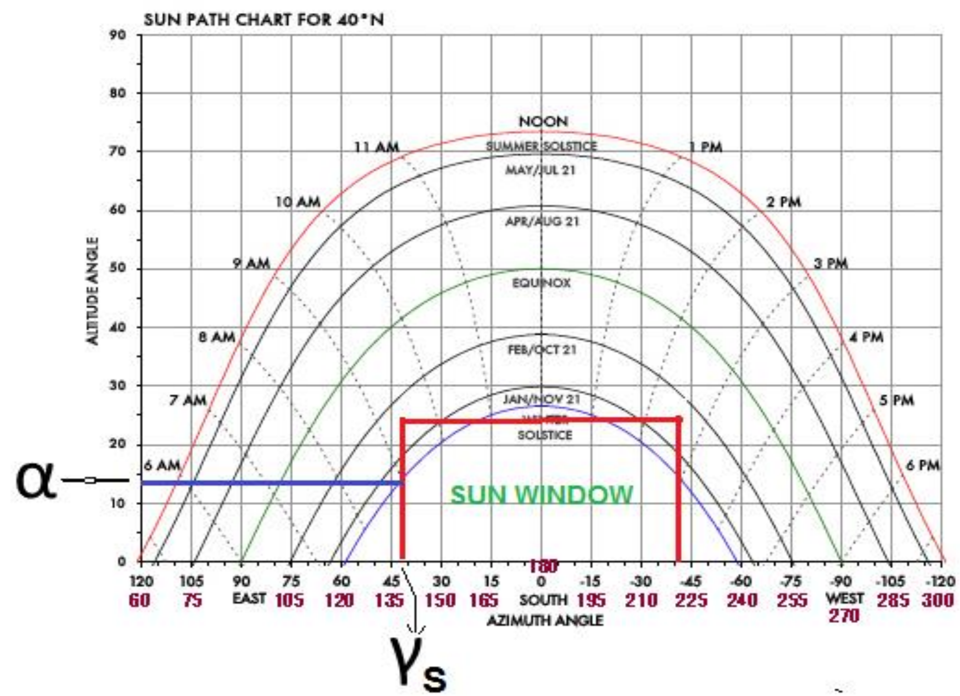
Spacing of adjacent PV rows:



$$SP = D + P$$

$$SP = \frac{L * \sin \beta}{\tan \alpha} * \cos \gamma_s + L * \cos \beta$$





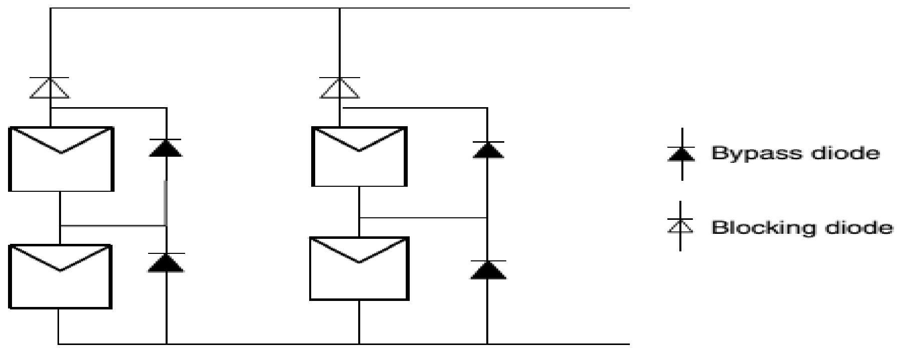
Photovoltaics Systems

Blocking and Bypass diodes:

Bypass Diodes are used in parallel with either a single or a number of photovoltaic solar cells to prevent the current(s) flowing from good, well-exposed to sunlight solar cells overheating and burning out weaker or partially shaded solar cells by providing a current path around the bad cell (or number of cells).

Blocking diodes, also called a series diode or isolation diode, ensure that the electrical current only flows in one direction "OUT" of the series array to the external load, controller or batteries.

The reason for this is to prevent the current generated by the other parallel connected PV panels in the same array flowing back through a weaker (shaded) network and also to prevent the fully charged batteries from discharging or draining back through the array at night. So when multiple solar panels are connected in parallel, blocking diodes should be used in each parallel connected branch.



Photovoltaics Systems

Bypass diodes (72 cell module):