

MiaSolé FLEX FAQ

GENERAL SOLAR QUESTIONS

What is efficiency?

Module efficiency characterizes a PV module's ability to convert available sunlight into useable power within a given area.

The formula to calculate efficiency is:

$$\text{Efficiency (\%)} = \frac{\text{Module Power Rating (W}_p\text{)}}{1000 \text{ W/m}^2 * \text{Total PV module area (m}^2\text{)}}$$

The module area is the total area of the product that includes both the active and inactive area.

Aperture efficiency is when only the active area of a PV module is considered. This does not include the inactive area.

What is the maximum rated power of PV module?

Maximum rated power of a PV module is the nominal power rating that is based on STC.

What does STC mean?

STC stands for Standard Test Conditions. STC has three conditions:

- 1) Cell Temperature 25 deg C
- 2) Irradiance 1000 W/m²
- 3) Air Mass 1.5

What is rating tolerance?

The tolerance is specified on the datasheet by a "+/-" label by a nominal rating. This is the nominal deviation from a specification.

What is temperature coefficient? How does temperature and sunlight impact PV system performance?

On the datasheet, you'll notice 3 different temperature coefficients:

- 1) Temperature Coefficient of P_{mpp}
- 2) Temperature Coefficient of V_{oc}
- 3) Temperature Coefficient of I_{sc}

The performance of a PV cell behaves differently depending upon applied sunlight and temperature. The sunlight (aka irradiance) significantly impacts the *current* of the PV cell. The temperature has a significant impact on the *voltage* of PV cell.

At higher irradiance levels, the current goes higher, which means the temperature coefficient is positive.

At higher temperatures, the voltage goes lower, which is why the temperature coefficient is negative.

The P_{mpp} temperature coefficient is the factor that impacts the maximum rated power per deg C.

For example, if the temperature coefficient is $-0.35\%/deg\ C$, this means that for every degree above 25 deg C cell temperature (based on STC), you'll see a -0.35% impact on the nominal voltage rating.

What factors contribute to the overall system performance of a PV system?

“System performance” is a term we use to describe how closely the energy output of the PV system matches up with expectations. When determining whether a PV system is outperforming, meeting expectations or underperforming, it is very important to establish expectations based on technically sound assumptions.

There are a number of factors that can contribute overall to the absolute system performance of a PV system which may include:

- Type of PV modules: product, technology, electrical specifications etc.
- Installation location (determines environmental factors)
- Ambient Temperature
- Irradiance at the PV module
- Shading
- The azimuth (Direction of PV plane in relation to due north) and tilt angle of the PV modules
- The cell temperature during operation: is there air flow on the back of the modules?
- The type of inverters being used
- System Application: Directly Adhered vs. Ballasted system
- Length of DC wiring: i.e. Homerun Wiring (cables between PV Array and Inverter)
- Module level power electronics, for example DC optimizers.
- Soiling : dirt on the PV modules, debris, leaves

MiaSolé PRODUCT QUESTIONS

What makes the MiaSolé FLEX modules different from conventional C-Si solar modules?

- Flexible – conforms to curved surfaces
- Lightweight – structures don't have to be reinforced to support the weight of racks and panels
- Powerful – the efficiencies are superior to other thin-film modules, rivaling rigid silicon modules
- Wind resistant – low profile modules offer little resistance to wind
- Theft resistant – once attached, FLEX modules are difficult for a thief to remove (but can be removed by the owner if necessary)
- Easy to install – peel-and-stick application requires very little training. In addition, the modules offer superior resistance to damage in seismic events and are difficult to steal once installed.
- Shatterproof – FLEX modules will not shatter when struck by debris
- Improved shade performance – FLEX modules use bypass diodes for every two cells that ensure that every cell receiving lights contributes to the module output
- Improved aesthetics – the thin modules are unobtrusive and blend into surfaces
- Doesn't require ballasting – many municipalities are restricting the use of ballast to secure solar modules. FLEX modules adhere directly to surfaces using peel-and-stick adhesive.
- No roof penetrations – no increased risk of leaks or damage to surfaces

What is CIGS?

CIGS is a type of solar cell that uses Copper Indium Gallium and Selenium.

Unlike conventional solar panels, MiaSolé FLEX modules use cells made of CIGS instead of crystalline silicon.

What is the weight per area of the MiaSolé FLEX modules?

The MiaSolé FLEX modules weigh 2.0 kg /m² (0.4 lb/ft²).

What certifications do MiaSolé FLEX modules have?

All MiaSolé FLEX modules have IEC 61646, IEC 61730 and UL 1730.

MiaSolé FLEX modules are also certified as a system for various applications. Please consult with MiaSolé technical engineer for more details.

What fire class rating are the MiaSolé FLEX modules?

MiaSolé FLEX-02 modules have a UL Class A rating over TPO and EPDM roof surfaces. This rating is good up to 2.5"/12" slope for TPO and ¾" slope for EPDM.

For other applications, please consult a MiaSolé technical engineer.

Can MiaSolé FLEX modules withstand hailstorms?

MiaSolé FLEX modules pass both IEC 61646 and UL1703 hail tests with no visual damage reported or dielectric breakdown. These tests typically use a minimum of 25 mm diameter ice balls and 51 mm diameter steel ball respectively.

What BOS components are required to install a MiaSolé FLEX module?

Since MiaSolé FLEX modules are flexible, lightweight and frameless, the modules can be directly adhered to the surface. This avoids the necessity of a mechanical racking system and ballasting. This also provides the benefit of having no roof penetrations.

For the electrical installation, all other BOS components like combiner boxes, wire management, and inverters would still be required.

Which inverters are MiaSolé FLEX modules compatible with?

On non-metal surfaces, any type of inverter is compatible with MiaSolé modules.

For metal surfaces, Please consult with a MiaSolé technical engineer for guidance and contact the inverter manufacturer prior to designing the PV system to determine compatibility.

Micro-inverters vs. string inverters vs. central inverters: What is the difference?

Central inverters start at around 100kW to as large as 10MW inverters. These inverters can be very large and heavy. The central inverter design is optimized for utilizing the least number of inverters at the site and is usually ideal for large ground mount projects. This is typically the most cost-effective solution from an installed cost standpoint. However, if a 1MW project utilizes a 1MW central inverter, the production at the site has a single failure point at the inverter. This adds O&M cost for any loss of energy production and the need for more skilled labor for any maintenance and repair in the case of an event. This is the reason why more EPCs are starting to use the string inverter configuration for large projects. There is a higher potential for cost savings from an O&M perspective.

String inverters are usually 10kW-80kW sized inverters that are ideal for commercial rooftop applications. Although you may need more string inverters for a project when comparing to a central inverter configuration, you can take advantage of multiple failure points, more max power tracking throughout the system, string level monitoring and lower skilled labor that is required for maintenance and repair.

Micro-inverters are designed to attach to a single or a couple of PV modules at a time. Although this configuration is more expensive than the other inverter configurations, it offers more maximum power tracking throughout the system, module-level monitoring and better energy output in shaded conditions. Micro-inverters are ideal for the residential market where the projects are smaller and more likely subject to shading conditions that are difficult to avoid. Also,

since they are attached at the module-level, they can provide more control over the system with the ability to shut off the power and energize the DC homerun cables between the PV system and the inverter.

What is a DC-DC optimizer and do I need to be using them?

DC-DC optimizers offer module-level benefits such as max power tracking, more power during shading, monitoring capabilities, and module-level control. Depending on the type of DC-DC optimizer type you go with, it may require a special lower-cost inverter that leverages the benefits of DC-DC optimizers from an overall system standpoint. An inverter is still required to convert the DC power to AC power.

DC-DC optimizers are not required for your PV system to operate. From an energy production standpoint, it could make the system less efficient since they draw energy from the solar modules. However, they will usually produce more power in certain shaded scenarios when compared to regular modules without DC-DC optimizers. When making a decision as to whether to use this configuration for your project, consider all the benefits that DC-DC optimizers provide versus the cost.

What is rapid-shutdown? What are the changes anticipated for NEC 2017?

In the U.S. solar industry, rapid-shutdown refers to the ability to de-energize DC controlled conductors in the case of an emergency within a PV system on any type of building. This requirement is driven by the National Electric Code (NEC) which is operated by the Nation Fire Protection Agency (NFPA) in the USA. You can find this in the NEC 2014 code book under NEC 690.12.

NEC 2014 requires that any DC controlled conductors outside a 10-foot boundary around the PV array have to lower the DC conductor voltage to 30VDC within 10 seconds of initiation. The initiation is technically defined by an activation of some type of switch by an emergency first responder.

The anticipated changes for NEC 2017 is still in process, however based on early reports, the rapid-shutdown requirements will become more stringent. NEC 2017 will likely require that any DC controlled conductors **INSIDE** a one foot boundary around the PV array will need to lower the DC controlled conductors to 80VDC within 30 seconds of initiation. **OUTSIDE** the one foot PV array boundary, the DC controlled conductors need to lower the voltage of the conductors to 30VDC within 30 seconds of initiation. NEC 2017 implies that every PV module will need some type of device that can control the voltage of the DC wires coming out of it. This is an unprecedented change in the industry. Early reports indicate that because of the enormous impact on the industry, that the new rapid shutdown changes will not be mandatory until January 1st, 2019.

This requirement only impacts USA markets.

Who are MiaSolé's partners?

Solar Lighting

MiaSolé's partner in the LED off-grid lighting space is ClearWorld. ClearWorld is our preferred partner for solar lighting applications in the US.

ClearWorld, LLC is an alternative energy systems provider, whose primary function is to design and to retrofit energy-efficient systems that reduce utility operating and maintenance costs in pursuit of grid independence.

Tomorrow's cities are in need of sustainable energy solutions. ClearWorld, LLC harnesses the cleanest, most abundant renewable energy source available—solar energy—to provide outdoor lighting that preserves resources, requires no moving parts, and is virtually maintenance-free. ClearWorld offers efficient, reliable systems and services that reduce the costs associated with the traditional utility light pole, from monthly energy bills to maintenance fees. ClearWorld's solar LED solutions are not only capable of producing more power per grid at a lower cost, but also of withstanding higher storm winds, thanks to our patented, aerodynamically engineered retroflex panels.

ClearWorld is focused on providing off-grid/on-grid solar LED lighting solutions for roadways, sidewalks, apartment and condominium complexes, retail and corporate parking lots, university campuses, government institutions, military installations and more. Through practical design and sustainable, cost-effective solutions, we provide a bundled set of technologies and services, along with the expertise to easily guide distributors, installers, and financiers through a turnkey program. ClearWorld is committed to providing the highest quality product to a rapidly growing marketplace.

ClearWorld

<http://clearworld.us/>

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Transportation Solar Kits

MiaSolé's partner in the trucking/transportation retrofit space is eNow. eNow has an exclusive agreement to use our modules in transportation applications in the US.

eNow's proprietary solar panel systems use the latest in technology to capture and convert the sun's energy into useable power. The transportation industry can use this "clean renewable energy", thereby reducing operating costs and reducing greenhouse gas emissions.

eNow's solution:

- Reduces fuel consumption
- Reduces maintenance costs, such as, oil changes, engine overhauls and battery change outs
- Reduces emissions to meet and comply with regulatory requirements
- Provides stand-by power when the truck engine is not running
- Provides power to truck de-icing system
- Provides electrical power to off-load alternator loads
- Utilizes solar for a cleaner environment

eNow

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What type of surfaces are MiaSolé FLEX modules compatible with?

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|--|---|---|
| <u>TPO Membranes</u> Carlisle Firestone GAF Stevens Johns-Manville | <u>Modified Bitumen*</u> Contact MiaSolé technical support for details | <u>Coated Steels</u> PVDF, SMP, Polyester, Acrylic Galvalume Plus Galvaneal |
| <u>EPDM Membranes</u> Carlisle Firestone Mulehide | <u>Coated Steels</u> PVDF SMP Polyester Acrylic Galvalume Plus Galvaneal | <u>Polycarbonate*</u> Contact MiaSolé technical support for details |
| <u>Other Materials</u> | | |
| Multiple PV Backsheets PVDF film (Kynar) Tefzel Glass Stainless Steel | Noryl Lexan Xyron Fiberglass reinforced plastics Aluminum | |

What type of applications are ideal for MiaSolé FLEX modules?

- Landfills
- Reservoirs
- Roofs and other structures not built to support racks & panels, such as already-constructed carports that can be retrofitted for solar
- Transportation
- Off-grid applications

What type of adhesive does the MiaSolé FLEX modules use?

We currently use ADCO BT600 made by Royal Adhesives & Sealants. We can also use other adhesives for certain applications. Please consult a MiaSolé technical engineer for special applications.

Will the adhesive bond to the surface for the lifetime of the PV System (25 years)?

The ADCO BT600 is a butyl rubber type of adhesive that is designed to adhere for a minimum of 25 years. Although the adhesive is strong to last the lifetime of the PV modules, it's important to consider the roof surface, coatings, environment and quality of the installation that can impact the module's ability to bond on the roof surface.

How flexible is a MiaSolé FLEX module? Can it be rolled?

We recommend a minimum bend radius of 508 mm (20 inches).