

## **Exhibit B**

### **Manufacturer's Equipment Cut Sheets Specifications**

# PRODUCT CATALOGUE 2019/20

Premium high performance solar modules and components





# YOU ARE THE FOCUS

## WE WANT YOU TO BE SUCCESSFUL

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Dear Customer,

As a practical user of our products, you are always the focus of our work. We want you to be successful and to offer your customers only the best products and services.

A lot has happened at Q CELLS, and our product catalogue testifies to it: More comprehensive than before, but all the clearer and expanded by essential product groups that you need every day. In the Q CELLS product catalogue you will find everything you need to work with your customers in addition to our powerful and excellent solar modules.

So what's new? From now on, we will also provide you with Q.MOUNT and Q.FLAT-G5, the right elements for the sub-structure of your photovoltaic systems and with Q.HOME' ESS a wide range of storage options.

Q CELLS is your central partner for all photovoltaic products and services. Our Q.PARTNER installers take over the important part of the high quality installation of our products.

As a Q.PARTNER you benefit from a variety of services to score points with your customers. Whether by supporting your marketing activities, delivering all components directly to your construction site or supporting your customer acquisition - Q.PARTNER will cut a fine figure with their customers at any time. Feel free to inform yourself at [www.q-cells.eu](http://www.q-cells.eu) about the possibilities that are open to you.

And now we hope you enjoy browsing and look forward to working with you.

Your Q CELLS team

# Q CELLS SOLAR MODULES

## THE FOUR LEVELS OF QUALITY

For our solar modules high quality means a long service life and excellent technical characteristics. That is why quality assurance plays a critical role for us.

### LEVEL 1 – YIELD SECURITY

Since 2011, Q CELLS Yield Security has been the guarantee for PID resistance, Anti LID and LeTID Technology which is ensured by weekly production monitoring. For protection against Hot-Spots, 100% of the cell production is tested.

### LEVEL 2 – ONE-TIME CERTIFICATION TESTS

The second level is comprised of international initial certification tests, for example, in accordance with IEC, CSA/UL, MCS, JET and Kemco. These guarantee that the electrical safety of the modules and the safety of its construction comply with international standards.

### LEVEL 3 – VDE QUALITY TESTED

The “VDE Quality Tested” program exceeds the initial certification testing of IEC by e.g. double cycles of thermal tests. In addition, monthly re-testing guarantees consistent quality.

### LEVEL 4 – Q CELLS QUALITY PROGRAM

Q CELLS internal quality program ensures that all products meet our company's high standards and additional tests than required by VDE as e.g. 3 x more cycles of humidity-frost Test. 100% high-resolution EL inspection is Q CELLS standard.

### Q CELLS:

- is German Engineering from Bitterfeld-Wolfen, Germany.
- is guaranteed quality with an outstandingly low rate of module degradation backed by a 12-year product warranty and a 25-year linear performance warranty.
- is the first manufacturer of solar modules to participate successfully in the Quality Tested program of the VDE, an independent certification institute from Germany. For the first time, periodic testing is now required.
- operates the largest technology and module test centre in the industry, as well as its own VDE-certified testing laboratory.
- tests its products under extreme climate conditions, such as tropical humidity, desert heat, and Arctic cold.



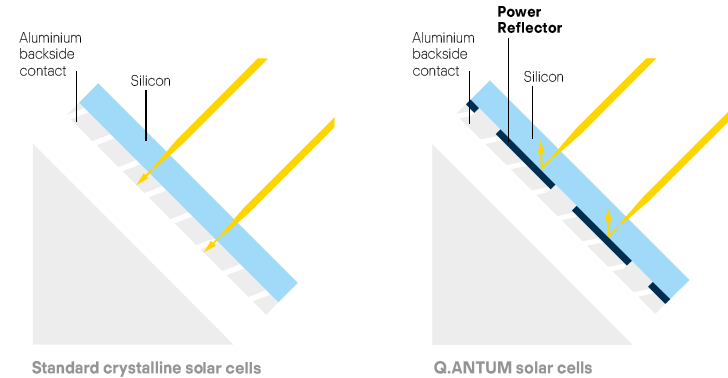
# Q.ANTUM CELL TECHNOLOGY

## MORE LIGHT. MORE PERFORMANCE. MORE ELECTRICITY.

Q.ANTUM combines the best characteristics of all available cell technologies to obtain high performance under real conditions, all with low levelised cost of electricity (LCOE).

### DO NOT MAXIMISE, OPTIMISE:

The rear surfaces of Q.ANTUM solar cells are treated with a special nano coating that functions much like a typical household mirror. Rays of sunlight that would otherwise go to waste are reflected back through the cell to generate more electricity. This enhances the electrical properties, considerably increasing the efficiency.



### HIGHER PERFORMANCE CLASSES

Thanks to Q.ANTUM Technology, Q CELLS solar modules offer more power per surface, resulting in higher yields at lower BOS costs.



### TEMPERATURE COEFFICIENT

Even on hot days, Q CELLS solar modules produce reliable yields and lose less efficiency than standard solar modules.



### LOW-LIGHT BEHAVIOUR

High yields with low radiation intensity, for example, during sunrise and sunset and on cloudy days, but also in autumn and winter when the sun is flat over the horizon.



# Q.ANTUM DUO TECHNOLOGY

## PERFORMANCE HAS NEVER LOOKED THIS GOOD

The Q.PEAK DUO and Q.PEAK DUO BLK solar modules benefit from the Q.ANTUM DUO Technology for outstanding performance and aesthetics.



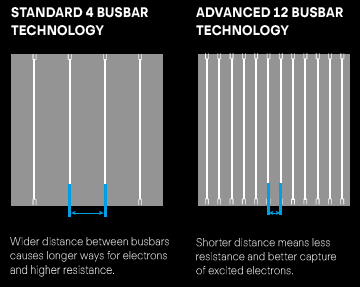
### WHAT IS DUO TECHNOLOGY ALL ABOUT?

The Q.ANTUM DUO Technology combines cutting edge advancements in cell separation technology with round wires – reducing both electrical and optical losses, respectively. This is achieved by halving the current passing through each cell and making use of incident light more effectively. Q.ANTUM DUO not only increases nameplate power, but also improves reliability. Anti LID /LeTID ensure low initial degradation and the half-cell design minimises cell stress reducing the potential for micro cracks in the field. This is

backed by improved guaranteed initial and yearly degradation ensuring the highest energy yields. Combined with Q CELLS award winning Q.ANTUM cell technology, Q.PEAK DUO and Q.PEAK DUO BLK are the modules with the highest power available at a reasonable price, maximising energy yields and ensuring low LCOE. With more than 15GW of Q.ANTUM solar cells deployed, only Q CELLS has the experience and the knowledge to push forward cell and module technology simultaneously, to create Q.ANTUM DUO.

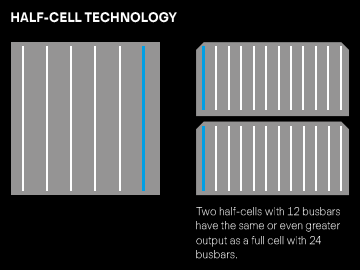
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**12 BUSBAR TECHNOLOGY**  
Reduced distance in between the busbars and additional paths for electric current results in 2% power increase. More paths means lower congestion which in return reduces resistive losses.



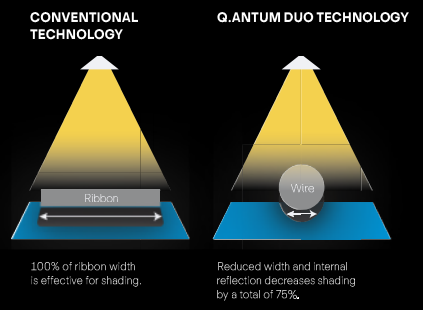
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**HALF-CELL TECHNOLOGY**  
Halving the cell halves the current. Combined with a module layout which reduces the distance travelled by the electric current results in an increase of power by 3%.

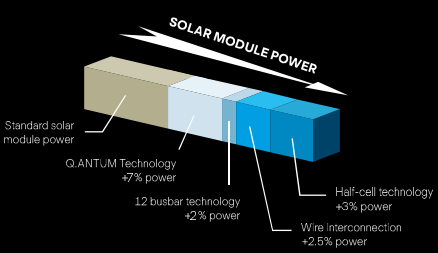


3

**WIRE INTERCONNECTION**  
Utilising wires instead of flat ribbons reduces both the width and the effective shading width decreasing shading by 75% and increasing the power by 2.5%. The light reflected from the round shape of the wires improves the light capturing effect of the module.




### THE Q.ANTUM DUO EFFECT

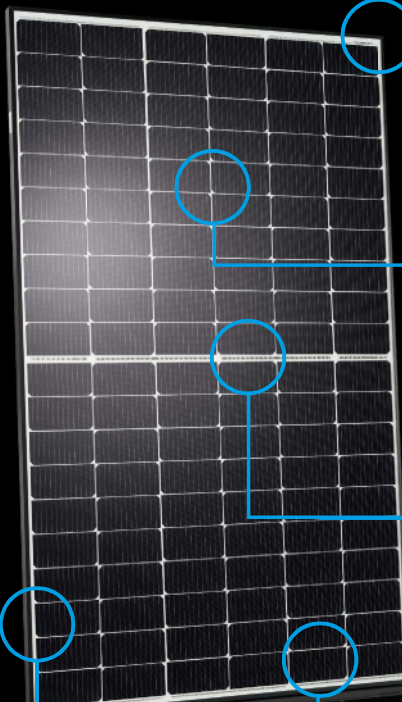


**EXCEPTIONAL POWER, SUPERIOR EFFICIENCY AND BEST-IN-CLASS WARRANTIES**  
Q CELLS solar modules equipped with Q.ANTUM DUO Technology not only offer impressive performance under real life conditions, but also best-in-class warranty terms of 98% power in the first year and 85% after 25 years.

# NEW Q.PEAK DUO SOLAR MODULES

## WE PAY ATTENTION TO DETAILS

 Visit the Q CELLS YouTube Channel for product videos and more.



**Reduced frame edge avoids moss and dirt build-up**

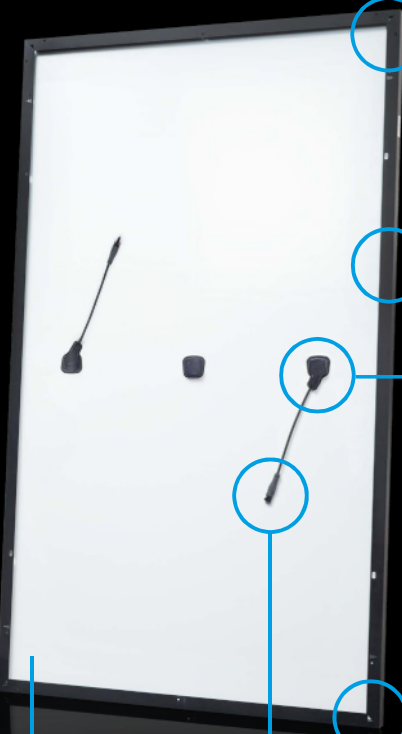
**Q.ANTUM DUO half-cells with 12 busbar technology for higher yield per surface area and low BOS costs**

**Independent upper and lower module-halves connected in parallel ensure improved yield when modules are partly shaded**

**Q CELLS YIELD SECURITY**

- Anti PID Technology against power loss through Potential-Induced Degradation
- Hot-Spot Protect to protect against module fire
- Tra.Q™ Laser identification for additional protection against counterfeiting
- Anti LID Technology against power loss through Light-Induced Degradation

**New wire technology instead of ribbons with round shape and smaller width increasing internal reflections and reducing shading by up to 75%**



**32mm high-tech frame for high wind and snow loads up to 4,000 / 5,400 Pa (IEC, UL)**

**Reliable silicone connection for excellent stability and durability**

**Optimised junction box design for increased energy yields and corrosion protection**

**High quality backside for permanent sealing**

**High quality Stäubli MC4 connectors with >1,100mm cable length**

**Optimally positioned, large drainage holes protect against frost damage**

# Q.PEAK DUO-G5

## REVOLUTIONARY AND AWARD-WINNING



The Q.PEAK DUO-G5 solar module from Q CELLS is distinguished by its innovative Q.ANTUM DUO Technology, enabling outstandingly high performance on a small surface area. Winning the prestigious Intersolar Award as well as the Solar + Power Award is clear recognition of this excellence.

Also freely available as a particularly aesthetic, fully black Q.PEAK DUO BLK-G5 and 144 half-cell L version Q.PEAK DUO L-G5 for ground-mounted solar power plants.

### MONOCRYSTALLINE Q.ANTUM DUO TECHNOLOGY




The monocrystalline Q.PEAK DUO-G5 solar module provides excellent yields on smaller surface areas thanks to high power classes of up to 335Wp and an outstanding efficiency of up to 20.2%. This is enabled by the unrivalled Q.ANTUM DUO solar cell concept, which combines half-cells with state-of-the-art circuitry and 6-busbar design. The integrated Q CELLS yield security guarantees reliable electricity production over the entire life cycle of your solar installation.

This also includes the integrated Q CELLS Anti LID Technology, which prevents light-induced degradation (LID), thus reducing system performance drastically – or almost totally. In contrast, conventional monocrystalline solar modules without Anti LID Technology lose much of their initial power simply through insolation. The Q.PEAK DUO-G5 prevents this via the system of Q CELLS yield security.

### TECHNICAL DATA

**Type** 120-half-cell module  
**Power** Up to 335Wp  
**Efficiency** Up to 20.2%  
**Sorting** +5/-0W  
**Weight** 18.7kg

### THE IDEAL SOLUTION FOR

-  Private rooftop installations
-  Commercial and industrial rooftop installations
-  Ground-mounted solar power plants

### HOW YOU BENEFIT



Optimal yields, whatever the weather with excellent low-light and temperature behaviour (-0.36%/K)



Excellent stability: tested for wind loads up to 4,000Pa and snow loads up to 5,400Pa



Separated operation of upper and lower module-half enables better shading resistance



Q CELLS solar modules have a 12-year product warranty and 25-year linear performance warranty





# Q.PEAK DUO-G6

## ENDURING HIGH PERFORMANCE

The Q.PEAK DUO-G6 solar module from Q CELLS will impress thanks to its innovative Q.ANTUM DUO Technology with amazingly high module performance.



Also freely available as a particularly aesthetic, fully black Q.PEAK DUO BLK-G6 and 144 half-cell L version Q.PEAK DUO L-G6 for ground-mounted solar power plants.

### MONOCRYSTALLINE Q.ANTUM DUO TECHNOLOGY



Our Q.PEAK DUO-G6 is a monocrystalline solar module with outstanding power classes of up to 355Wp and an efficiency of up to 20.1%. The Q.PEAK DUO-G6 solar modules provide higher yields per surface area thanks to the unsurpassed Q.ANTUM DUO solar cell concept, in which half-cells are combined with state-of-the-art circuitry and 6-busbar design. The integrated Q CELLS yield security guarantees reliable electricity production over the entire life cycle of your

solar installation. This also includes the integrated Q CELLS Anti LID Technology, which prevents light-induced degradation (LID), thus reducing system performance drastically – or almost totally. In contrast, conventional solar modules without Anti LID Technology lose much of their initial power through insolation. Q.PEAK DUO-G6 prevents this via the system of Q CELLS yield security.

### TECHNICAL DATA

**Type** 120-half-cell module  
**Power** Up to 355Wp  
**Efficiency** Up to 20.1%  
**Sorting** +5/-0W  
**Weight** 19.9kg

### THE IDEAL SOLUTION FOR

-  Private rooftop installations
-  Commercial and industrial rooftop installations
-  Ground-mounted solar power plants

### HOW YOU BENEFIT



Optimal yields, whatever the weather with excellent low-light and temperature behaviour (-0.36%/K)



Excellent stability: tested for wind loads up to 4,000Pa and snow loads up to 5,400Pa



Separated operation of upper and lower module-half enables better shading resistance



Q CELLS solar modules have a 12-year product warranty and 25-year linear performance warranty





# Q.PEAK DUO-G7

## OUTSTANDING EFFICIENCY AND INNOVATION

Besides its outstandingly high efficiency – thanks to innovative Q.ANTUM DUO Technology – the Q.PEAK DUO-G7 solar module from Q CELLS also stands out with its sleek look.



Also freely available as a particularly aesthetic, fully black Q.PEAK DUO BLK-G7 and 144 half-cell L version Q.PEAK DUO L-G7 for ground-mounted solar power plants.

### MONOCRYSTALLINE Q.ANTUM DUO TECHNOLOGY

The Q.PEAK DUO-G7 is our monocrystalline solar module with power classes of up to 335Wp and an excellent efficiency of up to 20.2%. Q.PEAK DUO-G7 solar modules provide excellent and reliable yields thanks to the new generation of the unrivalled Q.ANTUM DUO solar cell concept, which is now combined with state-of-the-art circuitry and 12-busbar cell design. The black Q.ANTUM DUO half-cells in the Q.PEAK DUO-G7 lend even the most exclusive building a refined look. Our

Q CELLS yield security guarantees reliable electricity production over the entire life cycle of your solar installation. Thanks to integrated Q CELLS Anti LID Technology preventing light-induced degradation (LID), which can reduce system performance drastically – or almost totally – the Q.PEAK DUO-G7 eliminates slumps in yield. In contrast, conventional monocrystalline solar modules without Anti LID Technology lose much of their initial power through normal insolation.

### TECHNICAL DATA

Type	120-half-cell module
Power	Up to 335Wp
Efficiency	Up to 20.2%
Sorting	+5/-0W
Weight	18.7kg

### THE IDEAL SOLUTION FOR



Private rooftop installations



Commercial and industrial rooftop installations

### HOW YOU BENEFIT



Optimal yields, whatever the weather with excellent low-light and temperature behaviour (-0.35%/K)



Excellent stability: tested for wind loads up to 4,000Pa and snow loads up to 5,400Pa



Separated operation of upper and lower module-half enables better shading resistance



Q CELLS solar modules have a 12-year product warranty and 25-year linear performance warranty



# Q.PEAK DUO-G8

## MAXIMUM PERFORMANCE AND OUTSTANDING EFFICIENCY

The Q.PEAK DUO-G8 solar module from Q CELLS stands out with its impressive look and the latest generation of innovative Q.ANTUM DUO Technology with outstandingly high area output, plus module efficiency.

### MONOCRYSTALLINE Q.ANTUM DUO TECHNOLOGY

The Q.PEAK DUO-G8 is our monocrystalline solar module with power classes of up to 360Wp and an efficiency of up to 20.4%. Thanks to the latest generation of unrivalled cell concept Q.ANTUM DUO, the Q.PEAK DUO-G8 solar module provide uniquely high yields on a small surface area. To this end, half-cells are combined with state-of-the-art circuitry and 12-busbar design. The black half-cells of the

Q.PEAK DUO-G8 lend even the most exclusive building an aesthetic elegance. The Q CELLS Anti LID Technology prevents light-induced degradation (LID), which can reduce system performance drastically – or almost totally. Other conventional monocrystalline solar cells lose much of their initial power through insolation. The Q.PEAK DUO-G8 prevents this with Anti LID Technology.

### TECHNICAL DATA

Type	120-half-cell module
Power	Up to 360Wp
Efficiency	Up to 20.4%
Sorting	+5/-0W
Weight	19.9kg

### THE IDEAL SOLUTION FOR



Private rooftop installations



Commercial and industrial rooftop installations

### HOW YOU BENEFIT



Optimal yields, whatever the weather with excellent low-light and temperature behaviour (-0.35%/K)



Excellent stability: tested for wind loads up to 4,000Pa and snow loads up to 5,400Pa



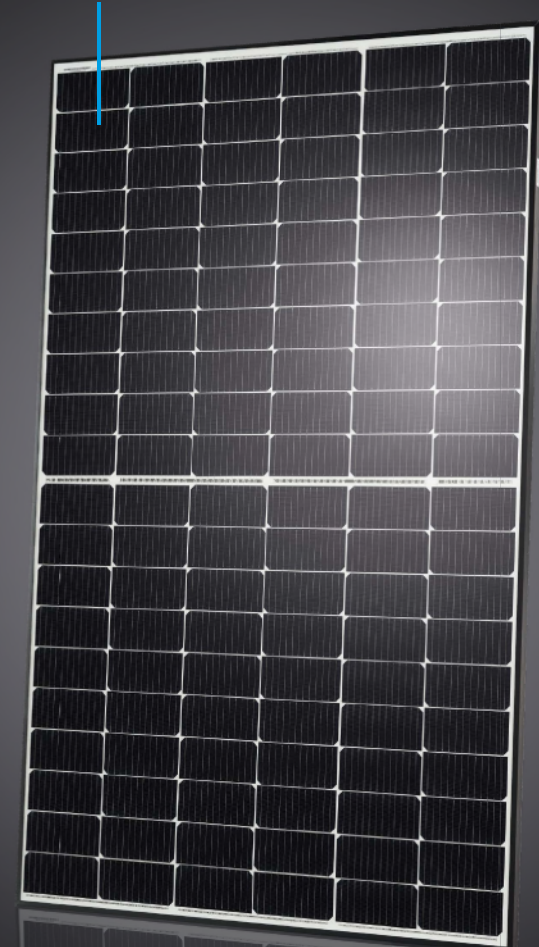
Separated operation of upper and lower module-half enables better shading resistance



Q CELLS solar modules have a 12-year product warranty and 25-year linear performance warranty



Also freely available as a particularly aesthetic, fully black Q.PEAK DUO BLK-G8 and 144 half-cell L version Q.PEAK DUO L-G8 for ground-mounted solar power plants.



# Q.PEAK DUO BLK SOLAR MODULES

## AESTHETIC YET POWERFUL

With their Q.ANTUM DUO Technology the solar modules of the Q.PEAK DUO BLK series cannot fail to impress thanks to especially high performance and efficiency, combined with an outstanding look and feel. Their homogeneous black surface allows these to be integrated unobtrusively on even the most exclusive building roofs.

### MONOCRYSTALLINE Q.ANTUM DUO TECHNOLOGY

Our Q.PEAK DUO BLK solar modules have been developed for use on truly exclusive buildings. To this end, we utilise black half-cells and black anodised aluminium frames in conjunction with black rear foil. Ultra-thin connecting wires on the solar cells allow the solar modules to look like a uniformly black area. Our monocrystalline solar modules of the Q.PEAK DUO BLK family are also distinguished by outstanding yields thanks to power classes of up to 350Wp and efficiencies of up to 19.8%.

A new generation of the unrivalled Q.ANTUM DUO cell concept, which is now combined with state-of-the-art circuitry and 6-busbar cell design, makes these tremendous values possible. The Q CELLS Anti LID Technology prevents light-induced degradation (LID), which can reduce system performance drastically – or almost totally. Conventional solar cells lose much of their initial power through normal insolation.

### TECHNICAL DATA

Type	120-half-cell module
Power	Up to 350Wp
Efficiency	Up to 19.8%
Sorting	+5/-0W
Weight	Up to 19.9kg

### THE IDEAL SOLUTION FOR



Private rooftop installations

### HOW YOU BENEFIT



Optimal yields, whatever the weather with excellent low-light and temperature behaviour



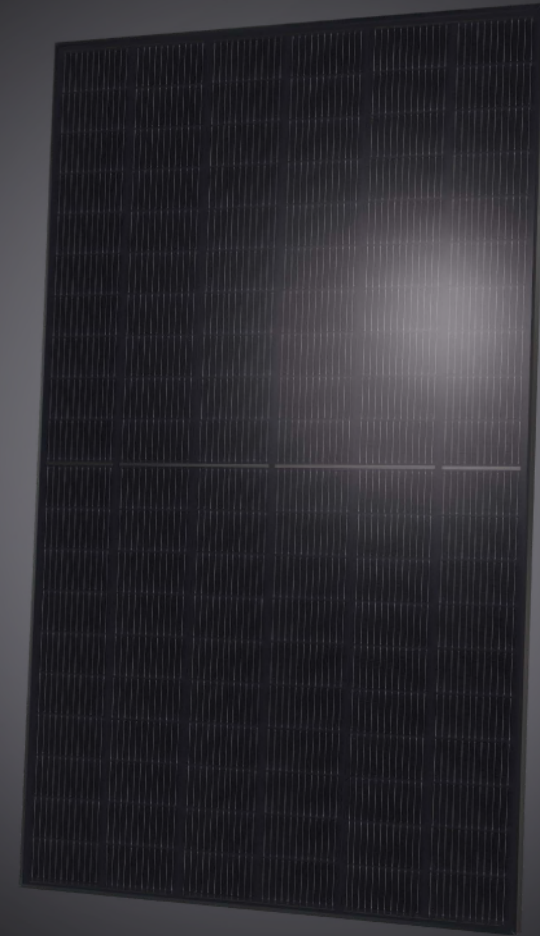
Excellent stability: tested for wind loads up to 4,000Pa and snow loads up to 5,400Pa



Separated operation of upper and lower module-half enables better shading resistance



Q CELLS solar modules have a 12-year product warranty and 25-year linear performance warranty







## SCALABLE SOLUTION ADVANTAGES AT A GLANCE



### SCALABLE SOLUTION FOR OPTIMISED CONSUMPTION

Scalable storage capacity from 4kWh up to 12kWh to suit the specific energy consumption.



### DURABILITY

High durability with 10 years product warranty and a performance to be maintained at least 80% of the initial battery capacity after 10 years. Very short recharge time and a high discharge depth.



### SMART DESIGN

Modular design for easy and fast installation, remote control operated systems with lithium-ion battery and battery charger.



### REMOTE MAINTENANCE

Easy maintenance of the device due to early error detection function, web and mobile monitoring and a reliable service network.



### SAFETY

Premium quality Samsung lithium-ion battery.



### CYCLE STRENGTH

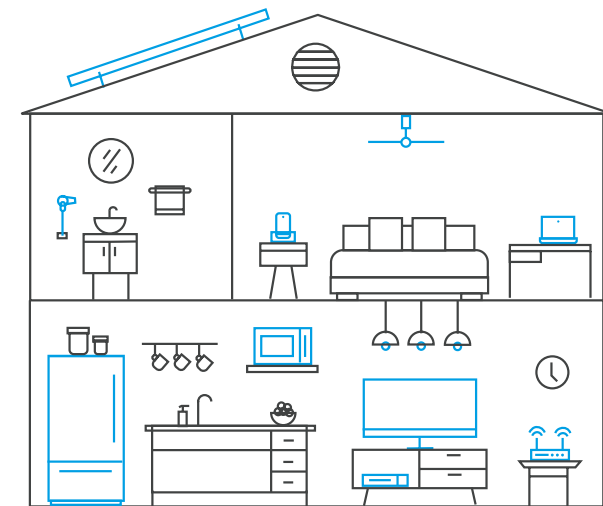
Exceptionally good cycle strength

## Q.HOME+ ESS HYB-G2 OPTIMISED CONSUMPTION

Q.HOME+ ESS HYB-G2\* is our scalable storage solution with integrated PV inverter for private photovoltaic systems.

General product information	Remote monitoring	Web, mobile
	Touch display	Integrated 5" TFT Touch Display
	Backup operation	"Stand alone mode" after switching time (max. one minute), 3kW continuous operation at the second output (4.6kW for 10 minutes)
DC Input (PV)	Energy Management System	Integrated
	Max. power	6.6kWp (3.3kWp per $M_{PV1}$ )
	No. of strings ( $M_{PV1}$ )	2 (2)
AC output	Power	4.6kW
	Feed-in phase / Connection	1/1
Efficiency	PV to grid (European)	95.5%
Lithium-Ion battery	Battery capacity	4 / 8 / 12kWh (each battery module 4kWh)
	Max. charging power / Max. discharge	2kW (one battery module), 3kW ( $\geq$ two battery modules) / 3kW

\* Availabilities vary amongst the markets, please check with your local supplier



It is often more economical to store generated solar power and use it when needed, instead of sell it back to the grid. Due to increasing energy bills, self-consumption of the own pro-

duced solar energy is the smart way to save money and reduce your carbon footprint. Our storage solutions ensure a reliable long-term operation and high output.



# AC-CONNECTED SOLUTION AT A GLANCE



### CAPACITY OPTIMISED FOR HOUSEHOLD APPLICATIONS

The AC-coupled home storage solution, for integration in new and existing solar installations. The system can communicate directly with the most common PV inverters in the market.



### INTELLIGENT DESIGN

Lean design for quick and easy installation, system with AC inverter and powerful lithium ion battery.



### ENERGY MANAGEMENT

The integrated energy management system enables a complete overview of energy production and self-consumption.



### TREMENDOUS DURABILITY

Thanks to a product guarantee of 10 years and retention of at least 80% of the original battery capacity after 10 years.



### BACKUP POWER FUNCTION

Thanks to the integrated backup power function, the electricity stored in the battery can also be used at the backup socket in the event of a power failure (230 V / 9 A).



### SAFETY

High-quality lithium ion battery with integrated battery management from LG Chem.

## Q.HOME+ ESS AC-G2 EASY RETROFITTING

Q.HOME+ ESS AC-G2\* is our AC-connected energy storage solution for existing photovoltaic systems

General product information	Dimensions	539 mm × 1,236 mm × 231 mm
	Display	LED: Battery SOC, grid connection state, service state
	Remote monitoring	Web, mobile
	Energy Management System	Inclusive and integration friendly
Grid data (Inverter)	Rated power	3 kW
	Rated voltage / Rated voltage range	230 / 183 - 265 V
	Battery	Lithium ion, nickel-manganese-cobalt
Battery data (Direct current)	Rated battery voltage / rated voltage range	48 / 42.0 ~ 58.5 V <sub>DC</sub>
	Backup power output	Rated apparent power / rated power
Lithium-Ion battery	Battery capacity	6.5 kWh
	Max. charge current / Max. discharge current	63 / 63 A <sub>DC</sub>

\* Availabilities vary amongst the markets, please check with your local supplier

### RELIABLE, HIGH-OUTPUT PV SYSTEMS MATCHING TO YOUR ELECTRICITY DEMAND AND ROOFTOP

There are all kinds of energy needs, just as there are all kinds of roofs. That is why we offer individually tailored solar packages – you can choose your own combination of products out of our wide range of high performance solar modules,

inverters, and energy storage systems. Just choose the ideal Q CELLS solar packages optimized to your customers needs and self-consumption rate.

### EXEMPLARY PV SYSTEM SIZES WITH AND WITHOUT ENERGY STORAGE (USING Q.PEAK DUO-G5 330)

HOUSEHOLD SIZE / ENERGY CONSUMPTION	PV SYSTEM SIZE	MINIMUM ROOF SIZE	SELF-CONSUMPTION WITHOUT STORAGE SOLUTION	SELF-CONSUMPTION WITH STORAGE SOLUTION
2 people up to 3,200 kWh / p. a.	5.3 kWp	31 m <sup>2</sup>	45%	73%
3 people up to 3,800 kWh / p. a.	6.6 kWp	32 m <sup>2</sup>	44%	68%
4 people up to 4,400 kWh / p. a.	7.9 kWp	39 m <sup>2</sup>	41%	67%
5 people up to 5,000 kWh / p. a.	8.6 kWp	42 m <sup>2</sup>	40%	65%



## Q.MOUNT THE UNIVERSAL MOUNTING SYSTEM FOR SLOPING ROOFS

Enabling fast and easy installation of PV systems on sloping roofs.

### DIVERSE APPLICATIONS

Due to the variety of different roof shapes and roofing materials, sloping roofs provide a unique challenge when it comes to installing a PV system. Whether on traditional tiled roofs, corrugated eternit, corrugated sheet metal or tin joint roofs, Q.MOUNT includes easy-to-install elements for quick, efficient and safe installation of PV systems on sloping roofs.

### QUICK AND EASY INSTALLATION

Different roof types also create very different requirements for the installation of a PV system. Whichever roof-parallel configuration is necessary, the modular components of our Q.MOUNT substructure make installation quick, easy and cost-effective.

### YOUR BENEFITS:

- Q.MOUNT is suitable for all common types of sloping roof
- High quality, durable components
- Fast and safe installation
- Straightforward planning of the PV system and the required components via the Q CELLS ROOFTOP PLANNER

### EXTENSIVE COMPONENT SELECTION

The Q.MOUNT system from Q CELLS offers a comprehensive selection of mounting elements, which are individually adapted to the respective roof surface. All Q.MOUNT components are manufactured using high-quality, corrosion-resistant materials that are extremely durable and designed to ensure a long service life. Using the Q CELLS ROOFTOP PLANNER, the system can be designed quickly and easily, all necessary mounting components can be determined in a single step and the structural feasibility can also be checked.

### SUITABLE FOR ALL STANDARD SLOPING ROOF TYPES

Q.MOUNT is the ideal system for installing private and commercial rooftop arrays equipped with Q CELLS solar modules, because both the module layout and the substructure can be planned and implemented easily using the Q CELLS ROOFTOP PLANNER and Q.MOUNT.

## Q.FLAT-G5 THE FAST AND RELIABLE SYSTEM FOR FLAT ROOFS

Introducing the straightforward folding mechanism for time-saving installation

### QUICK INSTALLATION

The fully integrated base profiles with simple folding mechanism save any laborious pre-assembly and reduce the operational steps.

### ONE SCREW ONLY

The innovative design means that each module requires just one screw to secure it in place.

### FEWER INDIVIDUAL COMPONENTS

The Q.FLAT-G5 is mainly supplied pre-assembled and comprises just a base profile, ballast support and end clamp plate. This reduces the storage and logistics costs, as well as the amount of work required on the roof.

### LESS MEASURING WORK

The ballast carriers serve as a distance gauge between the base profiles. As soon as the first base profile is aligned, the distances to the following base profiles result by hanging in the ballast carriers. No more measuring is needed.

### KIND TO THE ROOF

The building material is spared thanks to installation without penetration of the roof membrane and the ballast floats over the roof surface, preventing damage to the roof skin.

### BALLAST

Various sizes of ballast stones can not only be stowed in the ballast tray, but also directly in the base profiles.

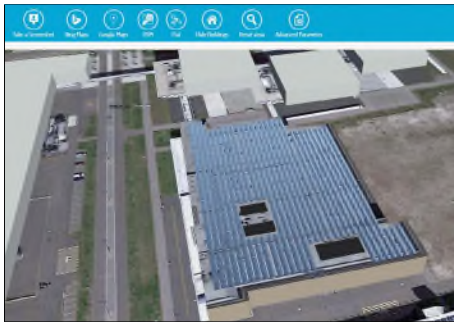
### HIGH YIELDS

The excellent yields are ensured almost independent of the system's orientation, allowing a high degree of flexibility in the rooftop array's design. With a significantly higher power density of over 180 Wp/m<sup>2</sup> compared to standard systems, Q.FLAT-G5 is the best solution for low-cost electricity production.



# Q CELLS ROOFTOP PLANNER ONE FOR ALL

We are offering Q.PARTNER installers a software solution - the Q CELLS ROOFTOP PLANNER - that combines all of the planning stages required in a single tool



## ALL-IN-ONE

The planning tool from Q CELLS combines various programs and makes planning easier for you. Save time and resources by implementing all steps of the design in a single program.

## ENTER AN ADDRESS – GET STARTED STRAIGHT AWAY

Simply enter the address of the object and the roof will be displayed instantly via Google Maps. After selecting the roof shapes and forms, the areas are displayed automatically – these can then be expanded or reduced with just a few clicks. Snow and wind load zones are automatically displayed and can also be detailed further.

## SELECTING COMPONENTS

After selecting the modules and substructure, an assignment including shadow simulation and cabling overview is performed automatically. The optional display in 3D is a further highlight that is sure to impress your customers.

## SIMULATION MADE EASY

Once you have selected the inverters and/or the storage solution, you are taken directly into the simulation, which previously had to be launched externally via PVsyst or PV\*SOL. The software includes preselected Meteonom weather data. Local topography such as mountains can easily be taken into account.

## EVERYTHING YOU NEED

Once you finish your project, a structured list of all the materials you need will be created, which you can easily export as an Excel document or a project report in PDF format.

# THE Q.PARTNER PROGRAM PROVIDING ADDED VALUE

As a partner of Q CELLS, you benefit from a string global brand, extensive marketing support, professional trainings, and attractive services.



## SO MUCH MORE FOR YOU

As a Q.PARTNER, you benefit from attractive prices to help you to stay even further ahead of the competition. Plus you can also ensure you qualify for a targeted bonus. More performance, more bonus, more for you.



## PERSONAL SUPPORT

Your direct contact partner at Q CELLS will be ready and waiting to help you whenever the need arises. Our qualified employees will be happy to answer any questions you may have about technical details, your orders and current deliveries.

## Q.PARTNER PORTAL

Everything under one roof. You can utilise all our services with a single login in our exclusive partner area. The Q.PARTNER portal gives you central access to all tools.



## Q CELLS ROOFTOP PLANNER

As a Q.PARTNER, you can save time and resources by implementing all configuration steps in a single program.



## EXTENSIVE MARKETING SUPPORT

Our partner portal has all Q CELLS communications ready for you – you can also order your promotional material directly via the marketing shop.



## TRAINING FOR PROFESSIONALS

Take part in our professional training sessions for installers. You will learn everything you need to know about application-specific installations, and the advantages of Q CELLS' high-quality products.



## ATTRACT NEW CUSTOMERS

For example, take advantage of our online solar calculator and projects from the Q CELLS network. You can handle all leads directly in our Lead Management tool at the Q.PARTNER portal.



## BENEFITS FOR OUR PARTNERS

Are you a believer in our products, and want to show it? Would you like to become our brand ambassador? Then choose a partnership with Q CELLS and become our Q.PARTNER.

- ✓ Exclusive online portal
- ✓ Professional sales documents
- ✓ Individual marketing and sales support
- ✓ Attractive pricing
- ✓ Bonus compensation
- ✓ Extensive planning software
- ✓ Individual contacts
- ✓ Local technical service support
- ✓ Product and online training
- ✓ Lead generation
- ✓ Speedy and direct product requests
- ✓ Special delivery conditions

### Become a Q.PARTNER

#### GET IN TOUCH WITH US

partner@q-cells.com  
+49(0) 34946699-23 222

#### WE WILL VISIT YOU

Our sales representative will come for a visit and complete the partnership agreement with you.

#### BENEFIT AS A Q.PARTNER

Receive access to our Q CELLS Q.PARTNER portal and marketing materials and benefit from attractive purchasing and delivery conditions.

## REFERENCES



JUNONY, POLAND

6.4 kWp

The photovoltaic installation was integrated into the appearance of the building. As a result, it is not only an additional element but an integral part of the building. This project deserves attention because aside from the obvious practical function, it also plays an aesthetic role, showing the beauty of home photovoltaic installations.



ROTTERDAM, NETHERLANDS

822 kWp

The largest PV system in Rotterdam was built on the frozen goods warehouse of FrigoCare in Waalhaven. 3,100 Q.PRO BFR-G4.1 solar modules were installed on a roof area of 7,500m<sup>2</sup> (the size of a soccer field), thereby ensuring 750,000kW of annual electricity generation.



STOWBRIDGE, UNITED KINGDOM

24.3 MWp

The Stowbridge solar park in the south-west of the UK was built in just 12 weeks in early 2014 and is based on our Q.MEGA system. Q.PRO-G3 solar modules in the 255 to 265Wp power classes were installed — the successor to our polycrystalline solar module that was crowned the winner of Photon magazine's 2014 yield test.



KLEVE, GERMANY

749 kWp

Since 2015, B&W Energy has installed two photovoltaic systems with a total output of around 1.25MWp: 'The generated solar power is used to operate our machinery and thus reduces the amount of externally sourced electricity. During our downtimes, the solar power is fed into our supplier's grid.' The second photovoltaic system (749kWp) included around 2,500 high-performance Q.PEAK-G4.1 solar modules from Q CELLS.



# HANWHA GROUP SOLAR BUSINESS VALUE CHAIN

Hanwha Group is vertically integrated across the entire photovoltaic value chain from silicon to large-scale solar power plants.

As a member of the Hanwha Group, one of South Korea's 8 largest corporations, Q CELLS is backed by a strong partner with a proud 65-year history. Globally, it is ranked 244th among Fortune Global 500 companies and operates 325 networks worldwide. At the centre of it all, it is our group's belief and desire to lead a sustainable future for both mankind and our planet. The sun powers everything that grows on earth – it

is clean, cost-effective, and infinite. Driven by our corporate philosophy of giving and earning trust and loyalty, we are able to meet the energy needs of people and institutions in diverse markets. Our full-scale entry into the photovoltaic business in 2010 was a natural extension of this mission, allowing us to offer a world-class array of sustainable solar products and services for generations to come.

## Q CELLS GERMAN QUALITY BACKED BY KOREAN FINANCIAL STRENGTH

For Q CELLS photovoltaic technology is not just a product. It is the key to reliable, powerful, and sustainable energy supply – today and for future generations.

Q CELLS is one of the world's largest and most recognised photovoltaic manufacturers for its high-quality, high-efficiency solar cells and modules. It is headquartered in Seoul, South Korea (Global Executive HQ) and Thalheim, Germany (Technology and Innovation HQ) with manufacturing facilities in South Korea, Malaysia and China. Q CELLS offer the full spectrum of photovoltaic products and solutions. Q CELLS,

as an affiliate of the Hanwha Group with assets over \$180 billion, is both a trusted and bankable solar partner for our customers worldwide. Our solar cell production capacity of 9GW (as of January 2019) makes us the largest cell manufacturer and one of the largest solar module manufacturers in the world. We have a Tier 1 Bloomberg rating and we are a BNEF Top Tier module supplier.



REVENUE 2018  
61,24<sub>B</sub>



FOUNDED IN  
1952



IN ASSETS  
180<sub>B</sub>



GLOBAL NETWORKS  
325



Cells



Modules



Residential  
Systems



EPC/Systems



Monitoring



O&M





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WEB [www.q-cells.eu](http://www.q-cells.eu)

# Technical Specifications

## 450MW Modules

powered by  
**Q.ANTUM DUO Z**



# Q.PEAK DUO XL-G9.2

## 445-465

ENDURING HIGH PERFORMANCE



#### BREAKING THE 20% EFFICIENCY BARRIER

Q.ANTUM DUO Z Technology with zero gap cell layout boosts module efficiency up to 21.1%.



#### LOW ELECTRICITY GENERATION COSTS

Higher yield per surface area, lower BOS costs and up to 30 watts more power per module.



#### ENDURING HIGH PERFORMANCE

Long-term yield security with Anti LID Technology, Anti PID Technology<sup>1</sup>, Hot-Spot Protect and Traceable Quality Tra.Q™.



#### EXTREME WEATHER RATING

High-tech aluminium alloy frame, certified for high snow (5400Pa) and wind loads (2400 Pa).



#### A RELIABLE INVESTMENT

Inclusive 12-year product warranty and 25-year linear performance warranty<sup>2</sup>.



#### STATE OF THE ART MODULE TECHNOLOGY

Q.ANTUM DUO combines cutting edge cell separation and innovative 12-busbar design with Q.ANTUM Technology.

<sup>1</sup> APT test conditions according to IEC/TS 62804-1:2015, method B (-1500 V, 168h)

<sup>2</sup> See data sheet on rear for further information.

#### THE IDEAL SOLUTION FOR:



Ground-mounted solar power plants

Engineered in Germany

**Q CELLS**



<b>Electrical Data</b>					
<b>Model</b>	<b>Q.PEAK DUO XL- G9.2 445</b>	<b>Q.PEAK DUO XL- G9.2 450</b>	<b>Q.PEAK DUO XL- G9.2 455</b>	<b>Q.PEAK DUO XL- G9.2 460</b>	<b>Q.PEAK DUO XL- G9.2 465</b>
<b>Peak Power Watt- Pmax (W)</b>	445	450	455	460	465
<b>Maximum Power Voltage- Vmpp (V)</b>	44.06	44.34	44.61	44.89	45.16
<b>Maximum Power Current- Impp (A)</b>	10.10	10.15	10.20	10.25	10.30
<b>Open Circuit Voltage- Voc (V)</b>	53.15	53.18	53.22	53.25	53.29
<b>Short Circuit Current- Isc (A)</b>	10.62	10.65	10.67	10.70	10.73
<b>Module Efficiency (%)</b>	20.0	20.2	20.4	20.6	20.9
<b>Power Output Tolerance (W)</b>	0 ~ +5				
<b>STC</b>	Irradiance 1000W/m <sup>2</sup> , Cell temperature 25°C, Air Mass AM1.5				
<b>Operational Temperature</b>	-40~+85°C				
<b>Maximum System Voltage</b>	1500V DC(IEC/UL)				
<b>Max Series Fuse Rating</b>	20A				
<b>Temperature Coefficient of Pmax</b>	-0.350%/°C				
<b>Temperature Coefficient of Voc</b>	-0.270%/°C				
<b>Temperature Coefficient of Isc</b>	+0.040%/°C				

<b>Mechanical Data</b>	
<b>Model:</b>	Q.PEAK DUO XL-G9.2 460
<b>Cell Type:</b>	6 * 24 monocrystalline Q.ANTUM solar half cells
<b>Cell number:</b>	144 (6*24)
<b>Dimensions:</b>	2163*1030*35mm
<b>Front glass:</b>	3.2mm thermally pre-stressed glass with anti-reflection technology
<b>Backsheet:</b>	Composite film
<b>Junction box:</b>	Protection class IP68, with bypass diodes
<b>Frame:</b>	Black anodised aluminium
<b>Connector:</b>	Staubli MC4, Hanwha Q CELLS HQC4; IP68
<b>Cable:</b>	4mm <sup>2</sup> Solar cable; (+) ≥1450mm, (-) ≥1450mm
<b>Standard Test Conditions:</b>	25°C, 1000W/m <sup>2</sup> )



# HEM

UTILITY SCALE MV CENTRAL STRING INVERTER



**FIELD REPLACEABLE UNITS**



**OUTDOOR DURABILITY**



**BUS PLUS** SOLAR + STORAGE



**NEMA 3R**



**iCOOL 3**



**ACTIVE HEATING**



**3 LEVEL TOPOLOGY**



**ECON MODE**

## THE INNOVATIVE MEDIUM VOLTAGE CENTRAL STRING INVERTER

The Power Electronics HEM medium voltage inverter is designed for utility scale solar applications, that require the advantages of a central inverter solution but also the modularity of a string architecture. The HEM can reach up to a nominal power of 3.6 MVA, and offers a wide MPPT window. It also has the added advantage of having an integrated medium voltage transformer and switchgear.

The Bus Plus ready feature allows the connection of up to six Freemaq DC/DC converters. It is the most cost competitive solution for solar-plus-storage retrofits.

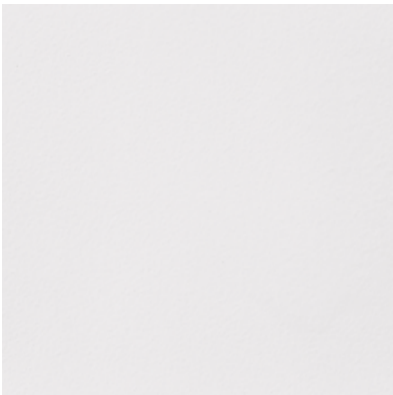
Its architecture, composed of six field replaceable units (FRU), is designed to provide the highest availability and optimize yield production. Its use in Utility Scale PV plants provides considerable savings in CAPEX, since having an integrated MV transformer and switchgear reduces the need of additional connections between the LV and MV sides.

Thanks to the Power Electronics iCOOL3 cooling system, the HEM is able to provide NEMA 3R degree of protection with an air cooling system, and as a result reducing OPEX costs. This product has been designed to be the lowest LCOE solution in the market for solar applications.

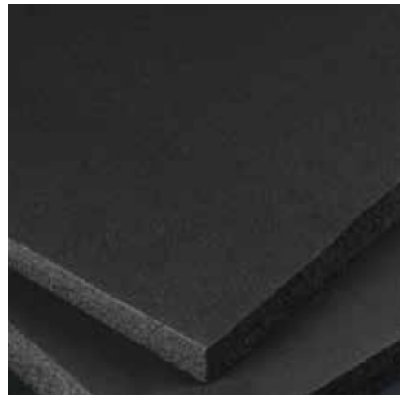


## ROBUST DESIGN

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Polymeric Painting



Closed-Cell Insulation



Galvanized Steel | Stainless Steel (Optional)

---

HEM inverter modules have a design life of greater than 30 years of operation in harsh environments and extreme weather conditions. HEM units are tested and ready to withstand conditions from the frozen Siberian tundra to the Californian Death Valley, featuring:

---

Totally sealed electronics cabinet protects electronics against dust and moisture.

---

Conformal coating on electronic boards shields PCBs from harsh atmospheres.

---

Temperature and humidity controlled active heating prevents internal water condensation.

---

C4 degree of protection according to ISO 12944.  
Up to C5-M optional.

---

Closed-Cell insulation panel isolates the cabinet from solar heat gains.

---

Roof cover designed to dissipate solar radiation, reduce heat build-up and avoid water leakages.

---

The solid HEM structure avoids the need of additional external structures.

---

Random units selected to pass a Factory Water Tightness Test ensuring product quality.

---

NEMA 3R.

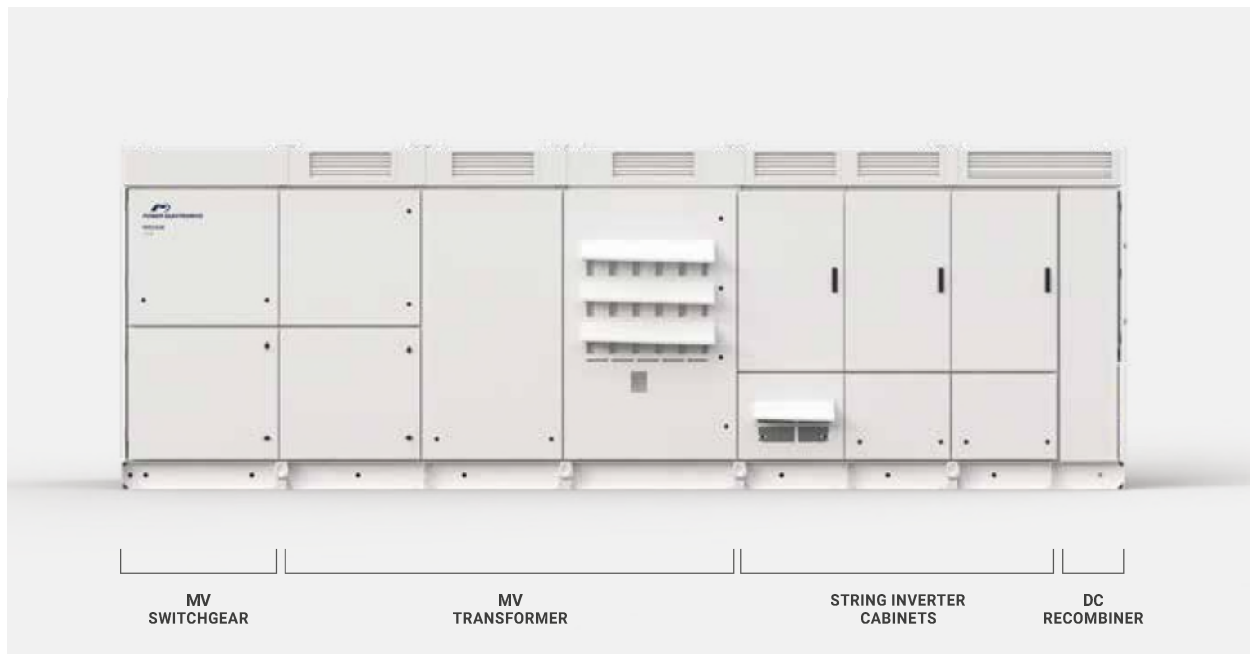
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## REAL TURN-KEY SOLUTION - EASY TO SERVICE

---

With the HEM, Power Electronics offers a real turn-key solution, including the MV transformer and switchgear fully assembled and tested at the factory. The HEM is a compact turn-key solution that will reduce site design, installation and connection costs, and therefore will minimize the LCOE.

By providing full front access the HEM series simplifies the maintenance tasks, reducing the MTTR (and achieving a lower OPEX). The total access allows a fast swap of the FRUs without the need of qualified technical personnel.



## STRING CONCEPT POWER STAGES

---

The HEM combines the advantages of a central inverter with the modularity of the string inverters. Its power stages are designed to be easily replaceable on the field without the need of advanced technical service personnel, providing a safe, reliable and fast Plug&Play assembly system.

Following the modular philosophy of the Freesun series, the HEM is composed of 6 FRUs (field replaceable units), where all the power stages are physically joined in the DC side and therefore, in the event of a fault, the faulty module is taken off-line and its power is distributed evenly among the remaining functioning FRUs.





## INNOVATIVE COOLING SYSTEM

Based on more than 3 years of experience with our MV Variable Speed Drive, the iCOOL3 system allows to get NEMA 3R degree of protection in an outdoor solar inverter. iCOOL3 delivers a constant stream of clean air to the FRUs and the MV transformer, being the most effective way of reaching up to NEMA 3R degree of protection, without

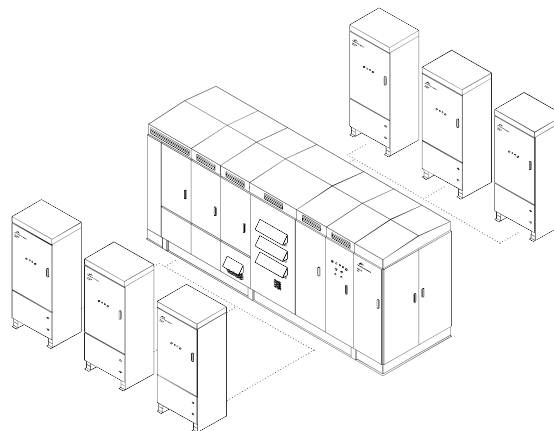
having to maintain cumbersome dust filters or having to use liquid-cooling systems, avoiding the commonly known inconveniences of it (complex maintenance, risk of leaks, higher number of components...), therefore resulting in an OPEX cost reduction and a LCOE improvement.



## BUS PLUS READY - SOLAR + STORAGE

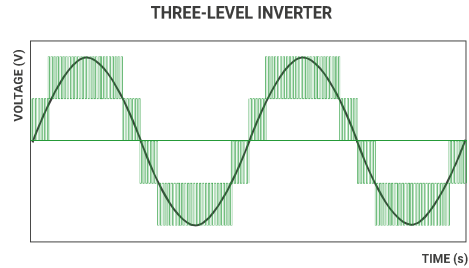
The Bus Plus feature allows the connection of up to six Freemaq DC/DC converters. It is the most cost competitive solution for solar-plus-storage retrofits. It prevents from additional connections out of the inverter between the DC/DC converters and the PV field. This solution provides considerable savings in CAPEX.

Power Electronics Freemaq DC/DC is a modular outdoor solution available from 500 kW to 3000 kW, fully compatible with different battery technologies and manufacturers. Freemaq DC/DC converter allows clipping energy recovery that will boost customer revenues and avoids the installation of additional station with a dedicated MV transformer.



## MULTILEVEL TOPOLOGY

The multilevel IGBT topology is the most efficient approach to manage high DC link voltages and makes the difference in the 1,500 Vdc design. Power Electronics has many years of power design in both inverters and MV drives and the HEM design is the result of our experience with 3 level topologies. The 3 level IGBT topology reduces stage losses, increases inverter efficiency and minimizes total harmonic distortion. High efficiency to deliver the lowest LCOE.



## VAR AT NIGHT

At night, in case of solar applications, the HEM inverter can shift to reactive power compensation mode. The inverter can respond to an external dynamic signal, a Power Plant Controller command or pre-set reactive power level (kVar).

## ACTIVE HEATING

At night, when the unit is not actively exporting power, the inverter can import a small amount of power to keep the inverter internal ambient temperature above -20°C, without using external resistors. This autonomous heating system is the most efficient and homogeneous way to prevent condensation, increasing the inverters availability and reducing maintenance. **PATENTED**

## ECON MODE

This innovative control mode allows increasing the efficiency of the MV transformer up to 25%, reducing the power consumption of the plant and therefore providing considerable

savings. Available as an optional kit, this feature has a pay-back time of less than a few years, therefore resulting in the increase of the plant lifetime overall revenue.

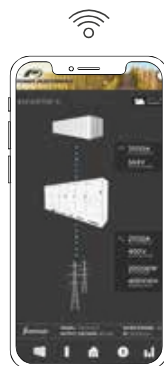
## EASY TO MONITOR

The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates

and information without the need to open cabinet doors.

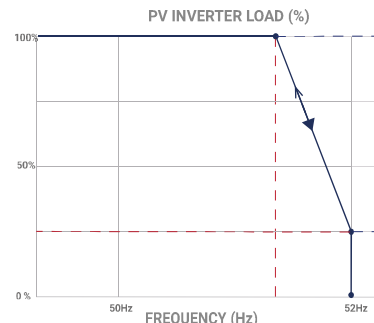
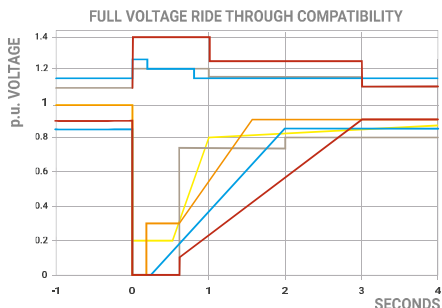
The app user-friendly interface allows quick and easy access to critical information (energy registers, production and events).

<b>AVAILABLE INFORMATION</b>	Grid and PV field data, inverter and power module data (voltages, currents, power, temperatures, I/O status...), weather conditions, alarms and warnings events, energy registers. Others.
<b>FEATURES</b>	Easy Wireless connection. Comprehensive interface. Real time data. Save and copy settings.
<b>LANGUAGE</b>	English, Spanish.
<b>SYSTEM REQUIREMENTS</b>	iOS or Android devices.
<b>SETTINGS CONTROL</b>	Yes.



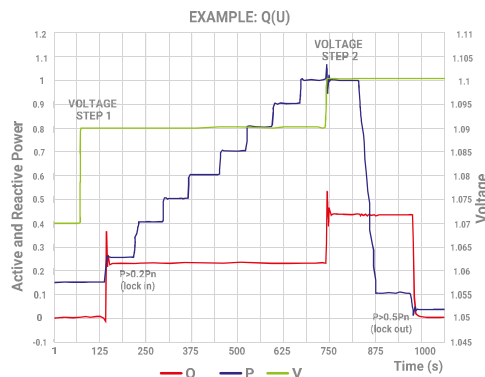
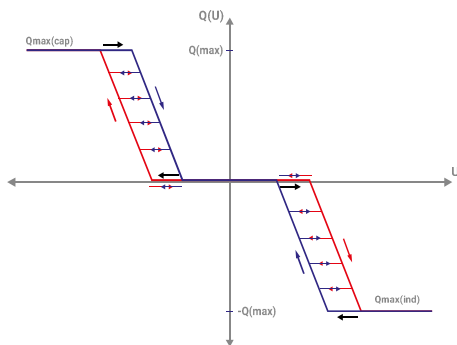
## DYNAMIC GRID SUPPORT

HEM firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment...), and can be configured to meet specific utility requirements.

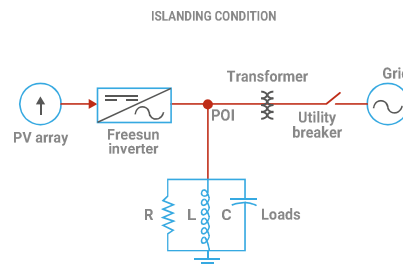
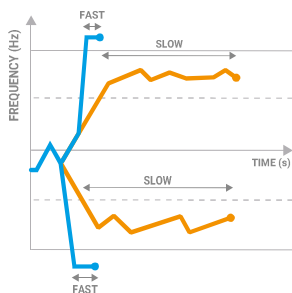


**Low Voltage Ride Through (LVRT or ZVRT).** Inverters can withstand any voltage dip or profile required by the local utility. In this situation, the inverter can inject current up to the nominal value.

**Frequency Regulation System (FRS).** Frequency droop algorithm curtails the active power along a preset characteristic curve supporting grid stabilization.



**Q(V) curve.** It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.



**Frequency Ride Through (FRT).** Freesun solar inverters have flexible frequency protection settings and can be easily adjusted to comply with future requirements.

**Anti-islanding.** This protection combines passive and active detection methods that eliminate nuisance tripping and allow to comply with the IEC 62116 and IEEE 1547 standards.



FRONT VIEW



BACK VIEW



## TECHNICAL CHARACTERISTICS

## HEM

REFERENCE	FS3510M	
<b>OUTPUT</b>	AC Output Power (kVA/kW) @50°C <sup>[1]</sup>	3510
	AC Output Power (kVA/kW) @40°C <sup>[1]</sup>	3630
	Operating Grid Voltage (VAC)	34.5kV ±10%
	Operating Grid Frequency (Hz)	60Hz
	Current Harmonic Distortion (THDi)	< 3% per IEEE519
	Power Factor (cosine phi) <sup>[2]</sup>	0.5 leading ... 0.5 lagging adjustable / Reactive Power injection at night
<b>INPUT</b>	MPPT @full power (VDC) @35°C <sup>[3]</sup>	934V-1500V
	MPPT @full power (VDC) @50°C <sup>[3]</sup>	934V-1310V
	Maximum DC voltage	1500V
	Number of PV inputs <sup>[4]</sup>	Up to 36
	Number of Freemaq DC/DC inputs <sup>[5]</sup>	Up to 6
	Max. DC continuous current (A) <sup>[5]</sup>	3970
	Max. DC short circuit current (A) <sup>[5]</sup>	6000
<b>EFFICIENCY &amp; AUXILIARY SUPPLY</b>	Efficiency (Max) (η)	97.80% including MV transformer
	CEC (η)	97.51% including MV transformer
	Max. Power Consumption (KVA)	20
<b>CABINET</b>	Dimensions [WxDxH] (ft)	21.7 x 7 x 7
	Dimensions [WxDxH] (m)	6.6 x 2.2 x 2.2
	Weight (lb)	30865
	Weight (kg)	14000
	Type of ventilation	Forced air cooling
<b>ENVIRONMENT</b>	Degree of protection	NEMA 3R
	Permissible Ambient Temperature	-35°C to +60°C / >50°C Active Power derating
	Relative Humidity	4% to 100% non condensing
	Max. Altitude (above sea level) <sup>[6]</sup>	2000m
	Noise level <sup>[7]</sup>	< 79 dBA
<b>CONTROL INTERFACE</b>	Communication protocol	Modbus TCP
	Plant Controller Communication	Optional
	Keyed ON/OFF switch	Standard
<b>PROTECTIONS</b>	Ground Fault Protection	GFDI and Isolation monitoring device
	General AC Protection	MV Switchgear (configurable)
	General DC Protection	Fuses
	Overvoltage Protection	AC, DC Inverter and auxiliary supply type 2
<b>CERTIFICATIONS</b>	Safety	UL 1741, CSA 22.2 No.107.1-16
	Compliance	NEC 2017
	Utility interconnect	IEEE 1547.1-2005 / UL 1741 SA-Feb. 2018

[1] Values at 1.00-Vac nom and cos Φ= 1. Consult Power Electronics for derating curves.

[2] Consult P-Q charts available:  $Q(kVAR)=\sqrt{(S(kVA))^2-P(kW)^2}$ .

[3] Consult Power Electronics for temperature derating curves.

[4] Consult Power Electronics for other configurations.

[5] Consult Power Electronics for Freemaq DC/DC connection configurations.

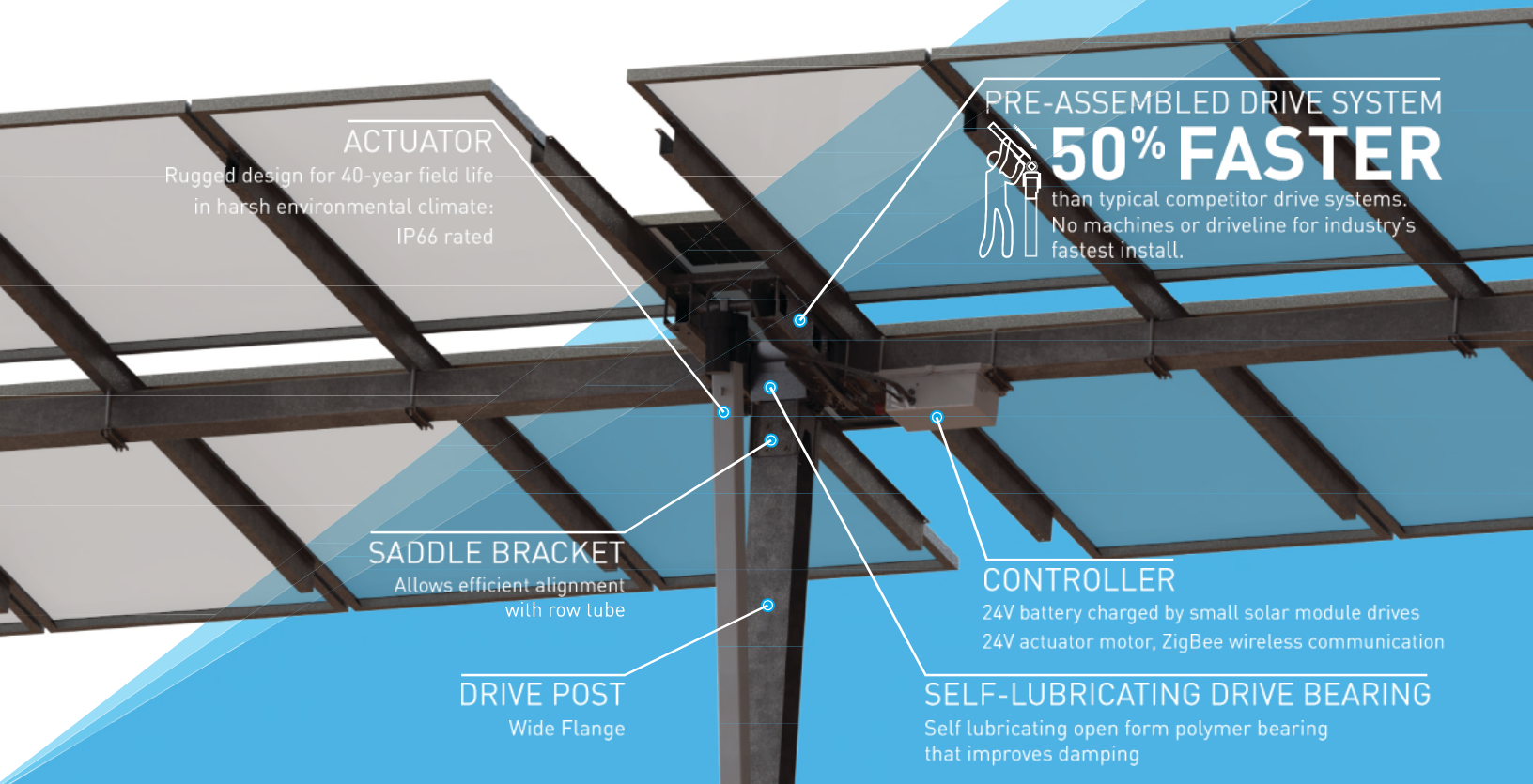
[6] Consult Power Electronics for altitudes above 1000m.

[7] Readings taken 1 meter from the back of the unit.

TECHNICAL DATASHEET

# GENIUS TRACKER™ 2P

WORLD'S HIGHEST POWER PRODUCING  
& FASTEST INSTALLING 2P SOLAR TRACKER



## OWNER BENEFITS

UP TO **1.25% MORE POWER PRODUCTION**  
RESULTS IN **HIGHER KWH OUTPUT AND HIGHER ROE**  
based on project specifics

## INSTALLER BENEFITS

- **FEWER POST COUNT PER MW** UP TO **55% LESS POSTS** THAN SOME 1P COMPETITORS
- **SHORTER 200 FT [61 M] TRACKERS** **INSTALL EASILY** ON UNDULATING SITES TO REDUCE GRADING
- **FASTEST INSTALLING DRIVE SYSTEM** UTILIZING PRE-ASSEMBLED COMPONENTS

## OWNER BENEFITS

**UP TO 1.25% MORE POWER PRODUCTION AND HIGHER ROE**  
 Combine to increase owner cash flow

**WEATHERSMART™**  
 Proprietary algorithm optimizes tilt angle based on weather data to maximize power production, adds up to 1.25% additional power production

**LOWEST O&M COST**  
 Lowest grass cutting & module washing cost

Zero maintenance drive system

## INSTALLER BENEFITS

**FASTEST INSTALLING SYSTEM**  
 Advanced design innovations & pre-assembled components

**PRE-ASSEMBLED DRIVE ARM**  
 Can be lifted by one worker, no machine required. 50% faster than typical competitors

**PE STAMPED DRAWINGS**  
 Design loads according to local building codes: ASCE 7, NBC, Eurocode, AS1170, GB 50009

**PROPRIETARY INTEGRATED HARDWARE™**  
 For faster structure assembly, module mounting and reduced O&M cost. Oversized Serrated Flange Nyloc Nut and Oversized Flange Star Bolt with integrated star washer eliminates the need for washers and star washers

### GameChange Solar

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Wuxi, China  
 Mumbai, India  
 Dubai, UAE

#### RESEARCH & DEVELOPMENT CENTER

Brimfield, MA, USA

#### SERVICE SUPERCENTERS

Lakeland, FL, USA  
 Mesa, AZ

**DISCLAIMER:** GameChange Solar provides this documentation without warranty in any form either expressed or implied. GameChange Solar may revise this document at any time without notice.

<b>Modules</b>	<b>Modules Supported</b>	Most commercially available modules, including frameless crystalline and thin film
<b>Civil</b>	<b>Slope Tolerance (N-S)</b>	7% standard, can go to 10% special order
	<b>Slope Tolerance (E-W)</b>	15%
	<b>Tracker follows slope (Y/N)</b>	Yes
<b>Structural</b>	<b>Drive Type</b>	Robust linear actuator stainless steel & aluminum
	<b>Posts per MW</b>	170/MW for normal wind conditions
	<b>Design Wind Load</b>	105 mph [46.9 m/s][Std] / 115 mph [51.4 m/s][Premium 1] / 130 mph [58.12 m/s][Premium 2]
	<b>Snow Load</b>	5 psf [24 kPa][Std] / 20 psf [96 kPa][Premium 1] / 40 psf [1.92 kPa][Premium 2] / 60 psf [2.87 kPa][Premium 3]
	<b>Tracking Range (Std)</b>	45° - 52°
	<b>Tracking Range (Premium)</b>	60°
	<b>Post Sections</b>	HDG wide flange steel
	<b>Post Size (Interior) &amp; (Exterior)</b>	W6 or W8 Wide Flange
	<b>Motor Foundation</b>	W6 or W8 Wide Flange
	<b>Standard Embedment</b>	5 - 9 ft. [1.52 - 2.75 m]
<b>Flood Plain Allowance</b>	Up to 6 ft. [1.83 m]	
<b>Design</b>	<b>Module Configuration</b>	2 up in portrait for crystalline & First Solar Series 6™, 2 up in portrait for Bifacial, 6 to 8 up landscape for First Solar Series 4®
	<b>Length per Table</b>	Up to 205 ft. [62.48 m] (for example 120 crystalline modules)
	<b>Module Attachment</b>	Bottom mount for framed modules or clamps for glass on glass modules
	<b>Ground Coverage Ratio</b>	0.3 to 0.65
	<b>Rows per Drive</b>	1 drive per tracker(table), distributed drive system
	<b>Powering System</b>	Onboard solar module with battery
	<b>Ground Clearance To Module</b>	18 - 48 in. [45.7 - 121.9 cm] typical
	<b>Min / Max Ground to Top of Post</b>	70 in. [1.78 m] typical + 9 in. [22.86 cm] min. adjustment range
	<b>Backtracking / Anti-shading</b>	Yes, although can be turned off as requested (i.e. for FSLR modules)
	<b>Temperature Range</b>	-20° C (-40° C also available) + 48° C
<b>Electromagnetic Interference</b>	Compliant with FCC guidelines/ Applicable sections EN 61000	
<b>Install</b>	<b>Specialty Tools Required</b>	No
	<b>Max Offload for Deliveries</b>	As per customer requirement
<b>Electrical</b>	<b>Tracking Method</b>	Time and location based algorithm
	<b>String Design</b>	Compatible with any string size
	<b>Cable Supports</b>	Hole punching as per customer requirement for nominal cost
	<b>Linear Actuator Motor</b>	24V DC UL Listed
	<b>Parasitic Loss</b>	0 amps
	<b>Controller Box</b>	ZigBee® wireless communications, 24V solar module and battery
	<b>Control System</b>	Master to Node: ZigBee® wireless communications Master to SCADA/DAS: Modbus TCP communications
	<b># of Motors</b>	25/MW for typical conditions, depending on module wattage and loading
	<b>1000V System or 1500V System</b>	Both
	<b>Grounding Method</b>	Tracker structure is part of grounding path per UL 2703
	<b>UL Compliance</b>	UL 2703 / UL 3703
	<b>Ingress Protection</b>	IP66 (NEMA 4/4x equivalent)
	<b># Weather Station</b>	1 per 6 MW - 10 MW typical
	<b>Monitoring System</b>	Web portal interface available Compatible with all standard third party monitoring vendors
	<b>Snow &amp; Flood Sensors</b>	Move modules to optimum location for weather events
<b>Backup Power</b>	Solar module and battery providing integrated backup - 3 days	
<b>O&amp;M</b>	<b>Warranty</b>	5 year drive & control, 10 year structural standard, 10 /20 also available
	<b>Shipping</b>	<b>Max load</b> International - 18.5 to 22.5 metric tons per container USA - 45,000 lbs. [20,411 kg] per truckload, 5,000 lbs. [2,267 kg] maximum bundle size, 2,900 lbs. [1315.4 kg] or other maximum as requested by customers
<b>Commissioning</b>	<b>Shipping Containers or Flatbeds</b>	Flat beds for structure, dry vans for hardware
	<b># Trucks or Containers per MWdc</b>	4 typical for trucks, 5 typical for containers
	<b>Backfeed required?</b>	No, Generator for power as alternative





TERRATRAK

REACH THE PEAK

# TERRA **TRAK**

WITH PEAKYIELD™ TECHNOLOGY

TerraTrak, a subsidiary of TerraSmart, is a single-axis tracker company specializing on advancing solar plant energy yield through tracker automation, intelligence, software and electronics.





## MISSION

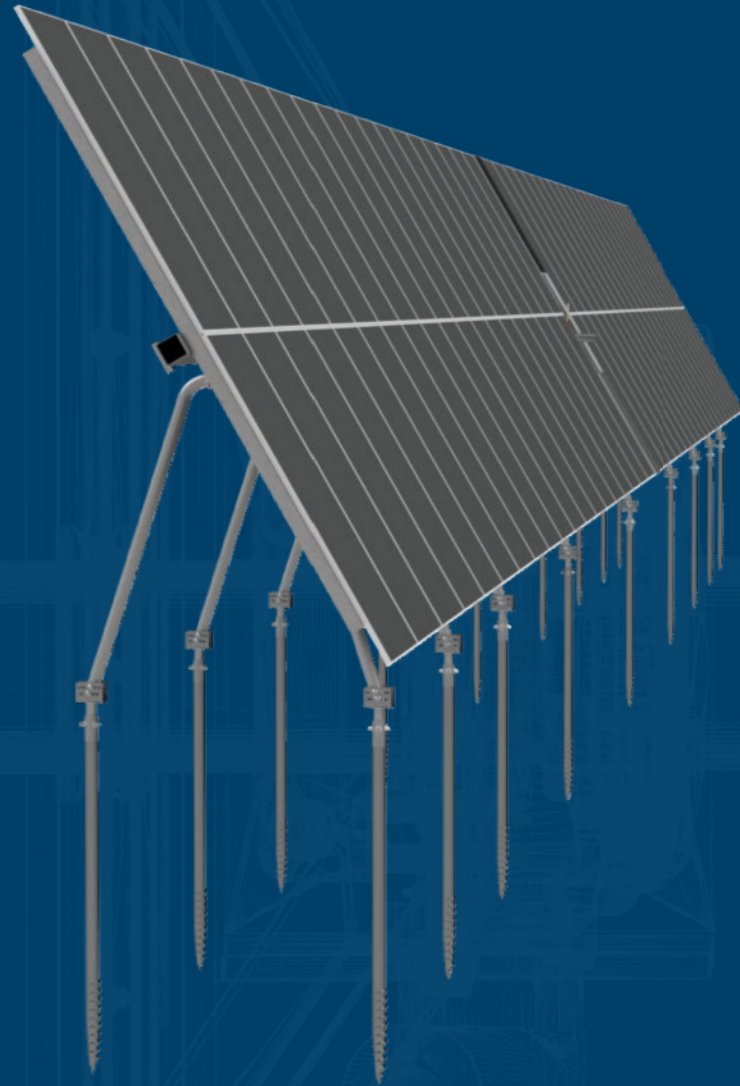
Expand solar renewables, economically, predictably and reliably through design innovation, organizational excellence and great execution.

## PEAKYIELD™ TECHNOLOGY

The underlying intelligence behind optimizing all facets of plant energy yield by maximizing revenues and lowering operating costs through land, hardware and software optimization.

# TERRA**TRAK**

## MECHANICAL DESIGN OVERVIEW





## TRACKER SUMMARY - MECHANICAL

Tracker Type	Horizontal, single-axis, self-powered. Wired version also available
Drive System	Independent row design 12VDC motorized slew drive, zero grid power consumption
Application	Ground mount solar applications
Module Orientation	Two Modules in Portrait
Tracker Row Orientation	TerraTrak rows installed in north-south direction
Stow Strategy	TerraTrak Rows Stow at max tilt of 60 Degrees. Stow wind speed is site variable, but typical is 45MPH. Tracker designed to withstand site specific max wind and snow. Hard stops located at each foundation to distribute load. Snow stow is triggered when ground snow depth reads 10 inches.
Tracker Range of Motion	±60 degrees
Module Fasteners	ARaymond PowAR Cinch. Standard module hardware with serrated flange nut also available.
Bushings	High impact polymer, lubricant-free, dry bushing
Tracker Component Hardware	Standard Hardware Stacks, Self-Locking hardware, no special tools required
Ground Coverage Ratio (GCR)	28% to 50%



## TRACKER SUMMARY - ENVIRONMENTAL CONDITIONS (continued)

<b>Temperature</b>	<b>Battery operated: -20 to 65 °C External DC supply: -20 to 65 °C *</b>
North – South Slope Grade	Up to 20% north-south slope tolerance
Tracker Plane Tolerance	Tracker north to south end to be installed within 1% plane
East – West Slope Grade	No east-west slope constraint due to tracker structure. East-west slope will impact row spacing optimization. Any row pair that has a height delta of $0.1L+6''+2x(\text{Module Length})$ above the other row plane will be considered exterior.
Altitude	5,000 m (16,000 ft)
Corrosion	Standard C2, Modifiable for C3 and C4* based on ISO 9223 Standards

\* In development, release date TBD



## TRACKER SUMMARY - TRACKING (continued)

Algorithm	NREL astronomical algorithm with Peak Yield
Accuracy	±2 Degree

### MODULE INFORMATION

Type	<ul style="list-style-type: none"><li>• 72 Cell Framed – 90 Panels</li><li>• 60 Cell Framed – 90 Panels</li><li>• First Solar Series 4 – 240 Panels *</li><li>• First Solar Series 6 – 72 Panels *</li><li>• Glass on Glass Framed – 90 Panels</li><li>• Glass on Glass Frameless – 90 Panels *</li></ul>
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\* In development, release date TBD



## 2 MIP

FEWER FOUNDATIONS

LESS LAND MANAGEMENT WITH SHORTER ROWS

WIDER SPACING FOR EASIER ACCESSIBILITY WITH HIGH GCR

BIFACIAL OPTIMIZED

