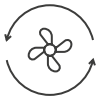
HEM HYBRID

SOLAR-PLUS-STORAGE TURN-KEY SOLUTION

DC/DC BUILT-IN

CLIPPING RECOVERY

FIELD REPLACEABLE UNITS



ICOOL 3

ECON MODE

3 LEVEL TOPOLOGY

OUTDOOR DURABILITY

THE ALL IN ONE INVERTER FOR SOLAR+STORAGE POWER PLANTS

The Power Electronics HEM HYBRID is designed for utility scale solar-plus-storage applications. It can reach up to 3.6 MVA of nominal power and include up to six Freemaq DC/DC converters of 525 kW each one all integrated in the same enclosure. Following the Freesun HEM and HEMK family philosophy, the HEM HYBRID includes the advantages of a central inverter solution but also the modularity of a string architecture. It is the lowest LCOE solution in the market for solar+storage applications. It also has the added advantage of having an integrated medium voltage transformer and switchgear. Its architecture, composed of six field replaceable units (FRU) for DC/AC conversion and up to six FRUs for DC/DC conversion, is designed to provide the highest availability and optimize yield production. Its use in utility scale PV plants provides considerable savings in CAPEX, since the integration of the DC/DC converters, MV transformer and switchgear reduces the need of additional connections.

Thanks to the Power Electronics iCOOL3 cooling system, the HEM HYBRID is able to provide NEMA 3R degree of protection with an air cooling system, and as a result reducing OPEX costs.

ROBUST DESIGN

Polymeric Painting

Closed-Cell Insulation

Galvanized Steel | Stainless Steel (Optional)

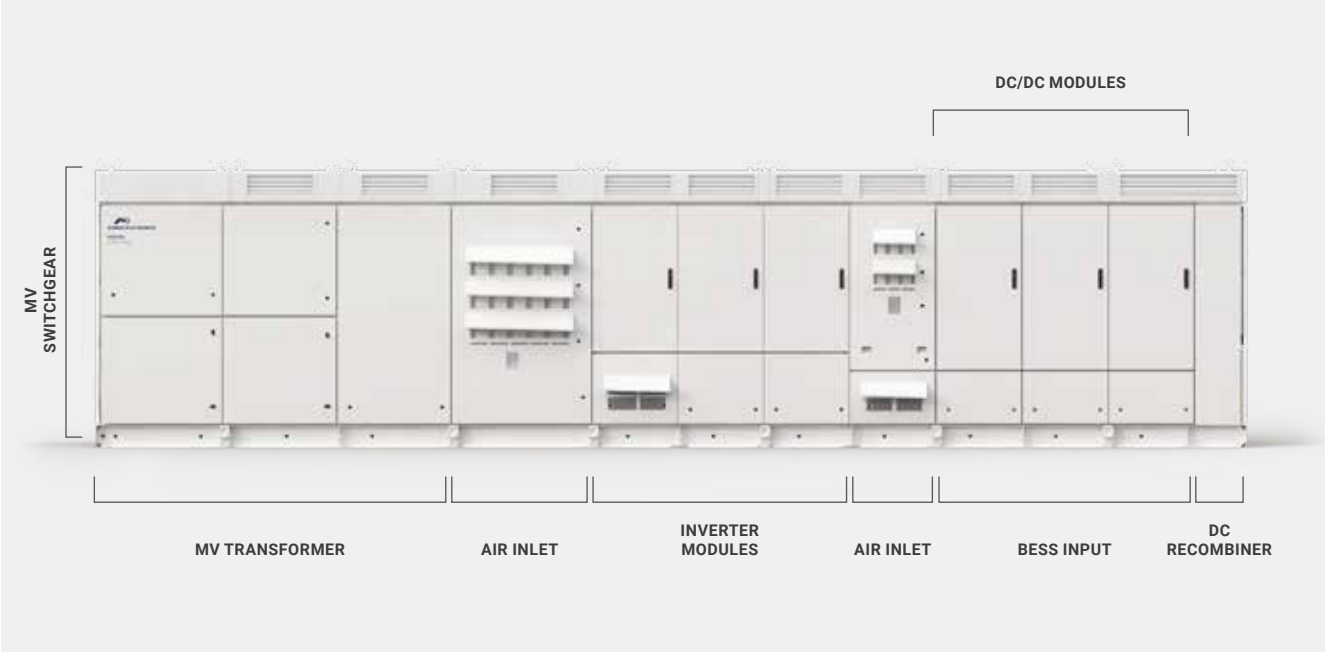
HEM HYBRID modules have a design life of greater than 30 years of operation in harsh environments and extreme weather conditions. HEM HYBRID units are tested and ready to withstand conditions from the frozen Siberian tundra to the Californian Death Valley, featuring:

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 HYBRID structure avoids the need of additional external structures.
Random units selected to pass a Factory Water Tightness Test ensuring product quality.
NEMA 3R.

ALL IN ONE

With the HEM HYBRID, Power Electronics offers a real turnkey solution, including the MV transformer, switchgear and up to six DC/DC converters to allow the BESS connection. Everything fully assembled and tested at the factory.

The HEM HYBRID is an all in one inverter that will reduce site design, installation and connection costs, and therefore will minimize the LCOE. By providing full front access the HEM HYBRID 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 HYBRID 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.

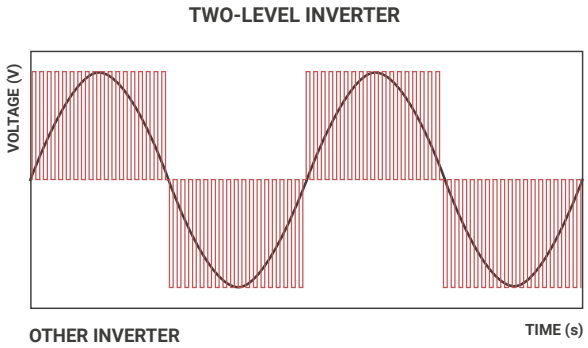
Following the modular philosophy of the Freesun series, the HEM HYBRID is composed of 6 FRUs (field replaceable units) for DC/AC conversion and up to 6 FRUs for DC/DC conversion. DC/AC power stages are physically joined in the DC side and therefore, in the event of a fault, the faulty module is taken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

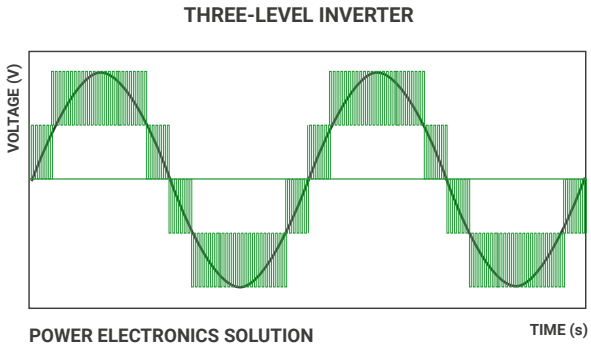
INNOVATIVE COOLING SYSTEM

Based on more than 3 years of experience with our MV Variable Speed Drive and the HEM inverter, the iCOOL3 is the first air-cooling system allowing 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 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.

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 HYBRID 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.





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 payback time of less than a few years, therefore resulting in the increase of the plant lifetime overall revenue.

EASY TO MONITOR

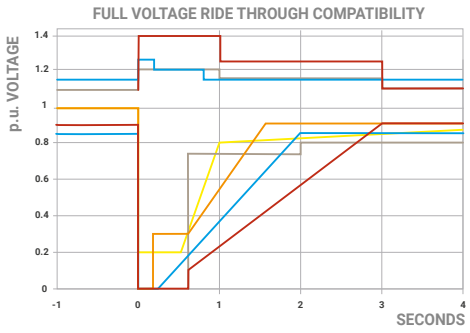
The Freesun app is the easiest way to monitor the status of our inverters. All our inverters come with built-in wifi, allowing remote connectivity to any smart device for detailed updates and information without the need to open cabinet doors.

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

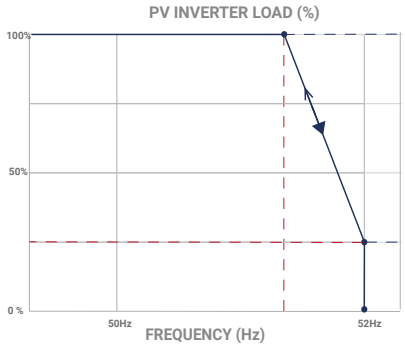
AVAILABLE INFORMATION	Grid and PV field data. Inverter and Power module data (Voltages, currents, power, temperatures, I/O status...). Weather conditions. Alarms and warnings events. Energy registers. Others.
FEATURES	Easy Wireless connection. Comprehensive interface. Real time data. Save and copy settings.
LANGUAGE	English, Spanish.
SYSTEM REQUIREMENTS	iOS or Android devices.
SETTINGS CONTROL	Yes.

DYNAMIC GRID SUPPORT

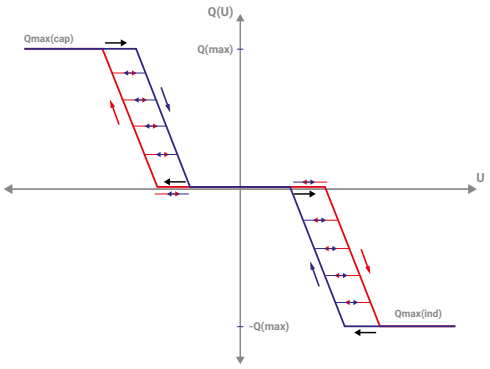
HEM HYBRID firmware includes the latest utility interactive features (LVRT, OVRT, FRS, FRT, Anti-islanding, active and reactive power curtailment…), and can be configured to meet specific utility requirements.

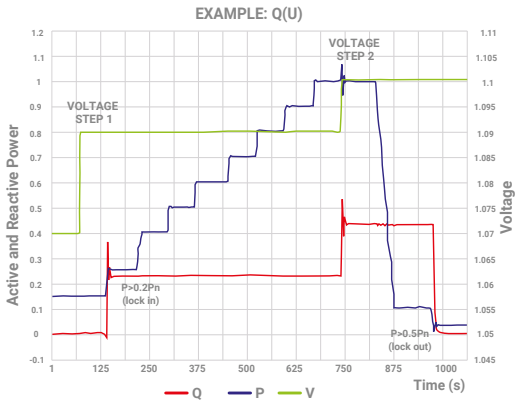


Low Voltage Ride Through (LVRT or ZVRT). Inverters can withstand any voltage dip or profile required by the local utility. In this situation, the inverter can inject current up to the nominal value.

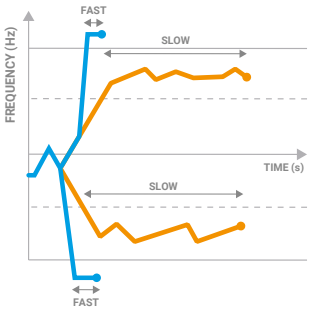


Frequency Response (FR). Active power can be adjusted automatically along a preset characteristic curve in response to high or low frequency events for grid stabilization.

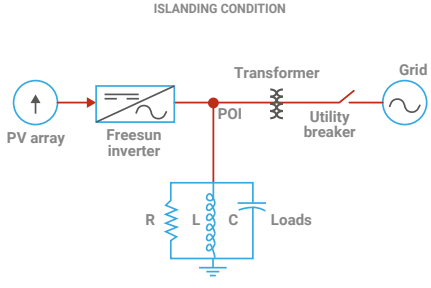




Q(V) curve. It is a dynamic voltage control function which provides reactive power in order to maintain the voltage as close as possible to its nominal value.



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

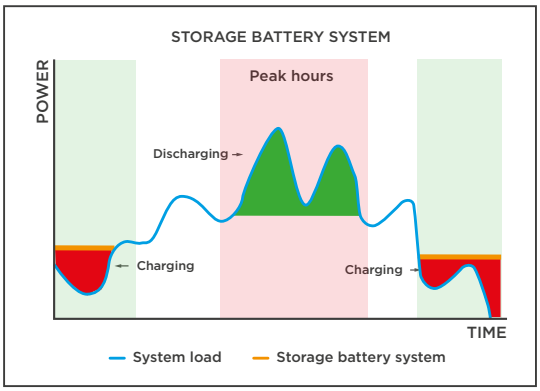


Anti-islanding. This protection combines passive and active detection methods that eliminate nuisance tripping and allow to comply with IEC 62116 and IEEE 1547 standards.

ENERGY STORAGE APPLICATIONS

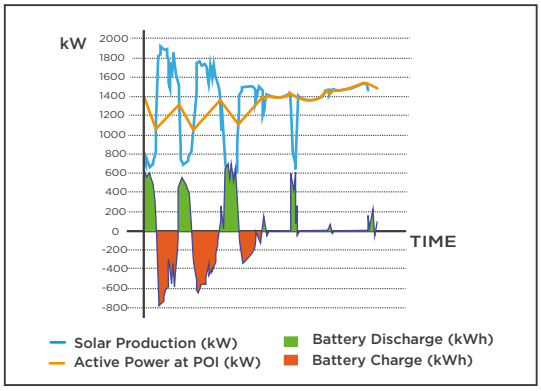
LOAD LEVELING

The HEM HYBRID series allow to store energy during periods of low demand from the grid, in order to later supply this energy when there is a higher demand. This has the benefit of selling the energy at a higher market price during peak periods. It also allows grid operators to supply electricity with a higher renewable origin. Since PV generation may not be at the same time as peak demand, this facilitates the flexibility and integration of renewable generation into the grid.



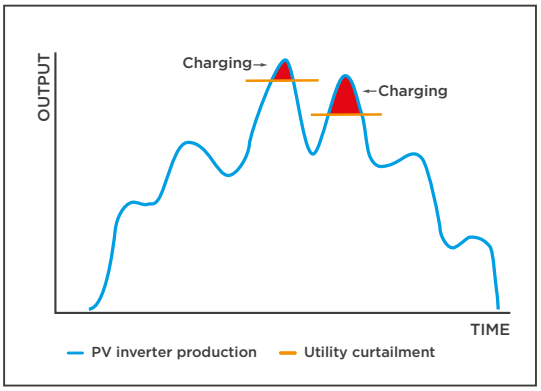
RENEWABLE INTEGRATION

The HEM HYBRID series allow to attenuate the intermittent nature of renewable energy sources, to provide a smoother power output. The HEM HYBRID controls the ramp rate at which power is injected into the grid, and thus reduces the impact of rapid power fluctuations due to sudden or transient conditions experienced by the PV array. The system monitors the PV inverter output to inject or consume power accordingly to ensure the output remains within the ramp requirements.



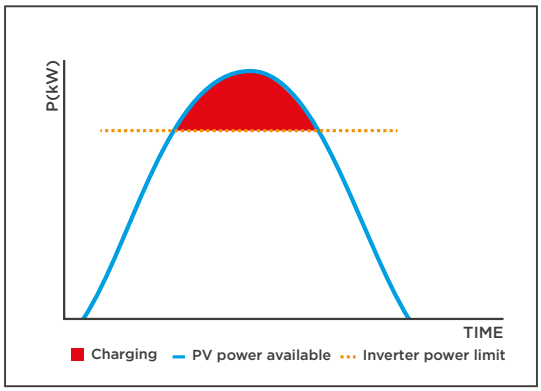
UTILITY CURTAILMENT RECOVERY

Utility scale inverter production can be curtailed by the grid operator, due to the high energy sources penetration in the grid during certain periods. With this DC-coupled energy storage system, the excess energy from the PV field can be stored in the Battery Energy Storage System (BESS) and then delivered when needed.



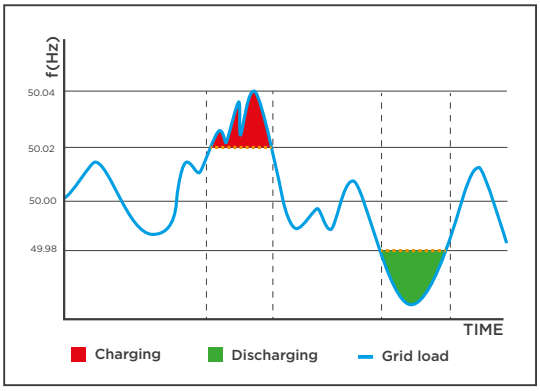
CLIPPING RECOVERY

The Power Electronics HEM HYBRID gets the maximum revenues from the PV generator, by charging the battery storage system when the PV inverter is clipping the output power, due to the high DC/AC power ratios. This stored energy can be exported to the utility grid when the price per KWh is high.



FREQUENCY RESPONSE

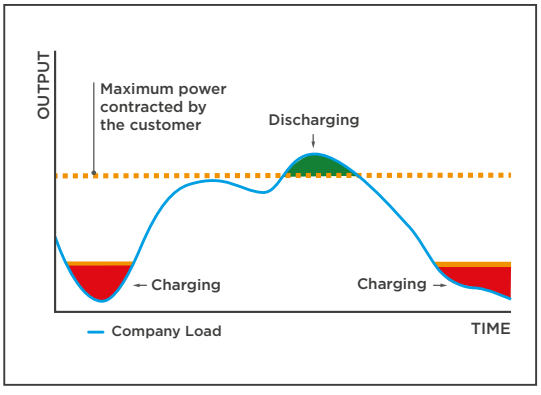
The HEM HYBRID provides ability to regulate grid frequency in both directions. When there is a grid overfrequency (generation>demand) inverter power output is curtailed and this energy is stored. When there is a grid under-frequency (generation<demand) inverter power output is increased by discharging the batteries and injecting more power to the grid.



PEAK POWER SHAVING

By delivering stored energy to the grid during periods of high demand, it reduces the burden on the distribution network and increases significantly its efficiency.

Energy is stored during periods of low demand increasing the load on the grid. During peak periods this stored energy is then injected into the grid reducing the demand at this time. The result is a more flattened demand curve which means the grid can avoid switching on more expensive and polluting generators.



FRONT VIEW

BACK VIEW

TECHNICAL CHARACTERISTICS HEM HYBRID

REFERENCE		FS3510M2	FS3510M4	FS3510M6
OUTPUT	AC Output Power (kVA/kW) @50°C [1]	3510		
	AC Output Power (kVA/kW) @40°C [1]	3630		
	Operating Grid Voltage	34.5 kV ±10 %		
	Operating Grid Frequency	60Hz		
	Current Harmonic Distortion (THDi)	< 3% per IEEE 519		
	Power Factor (cosine phi) [2]	0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night		
INPUT	MPPt @full power	934V - 1310V		
	Maximum DC voltage	1500V		
	Number of PV inputs [3]	Up to 36		
	Number of Freemaq DC/DC	2	4	6
	Freemaq DC/DC Power (kW) @50ºC	1050	2100	3150
	DC ESS Voltage range [4]	700V - 1500V		
	Max. DC continuous current (A) [5]	6200		
	Max. DC short circuit current (A) [5]	12000		
EFFICIENCY & AUXILIARY SUPPLY	Max. PV Inverter Efficiency PAC, nom (η)	97.80% including MV transformer (preliminary)		
	CEC PV Inverter Efficiency (η)	97.51% including MV transformer (preliminary)		
	Max. Power Consumption (kVA)	30		
CABINET	Dimensions [WxDxH] (ft)	30.38 x 7 x 7 (preliminary)		
	Dimensions [WxDxH] (m)	9.26 x 2.2 x 2.2 (preliminary)		
	Weight (lb)	< 41888		
	Weight (kg)	< 19000		
	Type of ventilation	Forced air cooling		
ENVIRONMENT	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) [6]	2000 m		
	Noise level [7]	< 79 dBA		
CONTROL INTERFACE	Communication protocol	Modbus TCP		
	Plant Controller Communication	Optional		
	Keyed ON/OFF switch	Standard		
PROTECTIONS	Ground Fault Protection	GFDI and isolation monitoring device		
	General AC Protection	MV switchgear (configurable)		
	General DC Protection	Fuses		
	Overvoltage Protection	Type 2		
CERTIFICATIONS	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 other configurations.
[4] Consult Power Electronics for derating curves.
[5] Consult Power Electronics for higher currents.
[6] Consult Power Electronics for other altitudes.
[7] Readings taken 1 meter from the back of the unit.

TECHNICAL CHARACTERISTICS HEM HYBRID

REFERENCE		FS3430M2	FS3430M4	FS3430M6
OUTPUT	AC Output Power (kVA/kW) @50°C [1]		3430	
	AC Output Power (kVA/kW) @40°C [1]		3550	
	Operating Grid Voltage		34.5 kV ±10 %	
	Operating Grid Frequency		60Hz	
	Current Harmonic Distortion (THDi)		< 3% per IEEE 519	
	Power Factor (cosine phi) [2]		0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPt @full power		913V - 1310V	
	Maximum DC voltage		1500V	
	Number of PV inputs [3]		Up to 36	
	Number of Freemaq DC/DC	2	4	6
	Freemaq DC/DC Power (kW) @50ºC	1050	2100	3150
	DC ESS Voltage range [4]		700V - 1500V	
	Max. DC continuous current (A) [5]		6200	
	Max. DC short circuit current (A) [5]		12000	
EFFICIENCY & AUXILIARY SUPPLY	Max. PV Inverter Efficiency PAC, nom (η)		97.76% including MV transformer (preliminary)	
	CEC PV Inverter Efficiency (η)		97.50% including MV transformer (preliminary)	
	Max. Power Consumption (kVA)		30	
CABINET	Dimensions [WxDxH] (ft)		30.38 x 7 x 7 (preliminary)	
	Dimensions [WxDxH] (m)		9.26 x 2.2 x 2.2 (preliminary)	
	Weight (lb)		< 41888	
	Weight (kg)		< 19000	
	Type of ventilation		Forced air cooling	
ENVIRONMENT	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) [6]		2000 m	
	Noise level [7]		< 79 dBA	
CONTROL INTERFACE	Communication protocol		Modbus TCP	
	Plant Controller Communication		Optional	
	Keyed ON/OFF switch		Standard	
PROTECTIONS	Ground Fault Protection		GFDI and isolation monitoring device	
	General AC Protection		MV switchgear (configurable)	
	General DC Protection		Fuses	
	Overvoltage Protection		Type 2	
CERTIFICATIONS	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 other configurations.
[4] Consult Power Electronics for derating curves.
[5] Consult Power Electronics for higher currents.
[6] Consult Power Electronics for other altitudes.
[7] Readings taken 1 meter from the back of the unit.

TECHNICAL CHARACTERISTICS HEM HYBRID

REFERENCE		FS3350M2	FS3350M4	FS3350M6
OUTPUT	AC Output Power (kVA/kW) @50°C [1]	3350		
	AC Output Power (kVA/kW) @40°C [1]	3465		
	Operating Grid Voltage	34.5 kV ±10 %		
	Operating Grid Frequency	60Hz		
	Current Harmonic Distortion (THDi)	< 3% per IEEE 519		
	Power Factor (cosine phi) [2]	0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night		
INPUT	MPPt @full power	891V - 1310V		
	Maximum DC voltage	1500V		
	Number of PV inputs [3]	Up to 36		
	Number of Freemaq DC/DC	2	4	6
	Freemaq DC/DC Power (kW) @50ºC	1050	2100	3150
	DC ESS Voltage range [4]	700V - 1500V		
	Max. DC continuous current (A) [5]	6200		
	Max. DC short circuit current (A) [5]	12000		
EFFICIENCY & AUXILIARY SUPPLY	Max. PV Inverter Efficiency PAC, nom (η)	97.75% including MV transformer (preliminary)		
	CEC PV Inverter Efficiency (η)	97.48% including MV transformer (preliminary)		
	Max. Power Consumption (kVA)	30		
CABINET	Dimensions [WxDxH] (ft)	30.38 x 7 x 7 (preliminary)		
	Dimensions [WxDxH] (m)	9.26 x 2.2 x 2.2 (preliminary)		
	Weight (lb)	< 41888		
	Weight (kg)	< 19000		
	Type of ventilation	Forced air cooling		
ENVIRONMENT	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) [6]	2000 m		
	Noise level [7]	< 79 dBA		
CONTROL INTERFACE	Communication protocol	Modbus TCP		
	Plant Controller Communication	Optional		
	Keyed ON/OFF switch	Standard		
PROTECTIONS	Ground Fault Protection	GFDI and isolation monitoring device		
	General AC Protection	MV switchgear (configurable)		
	General DC Protection	Fuses		
	Overvoltage Protection	Type 2		
CERTIFICATIONS	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 other configurations.
[4] Consult Power Electronics for derating curves.
[5] Consult Power Electronics for higher currents.
[6] Consult Power Electronics for other altitudes.
[7] Readings taken 1 meter from the back of the unit.

TECHNICAL CHARACTERISTICS HEM HYBRID

REFERENCE		FS3270M2	FS3270M4	FS3270M6
OUTPUT	AC Output Power (kVA/kW) @50°C [1]		3270	
	AC Output Power (kVA/kW) @40°C [1]		3380	
	Operating Grid Voltage		34.5 kV ±10 %	
	Operating Grid Frequency		60Hz	
	Current Harmonic Distortion (THDi)		< 3% per IEEE 519	
	Power Factor (cosine phi) [2]		0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night	
INPUT	MPPt @full power		870V - 1310V	
	Maximum DC voltage		1500V	
	Number of PV inputs [3]		Up to 36	
	Number of Freemaq DC/DC	2	4	6
	Freemaq DC/DC Power (kW) @50ºC	1050	2100	3150
	DC ESS Voltage range [4]		700V - 1500V	
	Max. DC continuous current (A) [5]		6200	
	Max. DC short circuit current (A) [5]		12000	
EFFICIENCY & AUXILIARY SUPPLY	Max. PV Inverter Efficiency PAC, nom (η)		97.71% including MV transformer (preliminary)	
	CEC PV Inverter Efficiency (η)		97.47% including MV transformer (preliminary)	
	Max. Power Consumption (kVA)		30	
CABINET	Dimensions [WxDxH] (ft)		30.38 x 7 x 7 (preliminary)	
	Dimensions [WxDxH] (m)		9.26 x 2.2 x 2.2 (preliminary)	
	Weight (lb)		< 41888	
	Weight (kg)		< 19000	
	Type of ventilation		Forced air cooling	
ENVIRONMENT	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) [6]		2000 m	
	Noise level [7]		< 79 dBA	
CONTROL INTERFACE	Communication protocol		Modbus TCP	
	Plant Controller Communication		Optional	
	Keyed ON/OFF switch		Standard	
PROTECTIONS	Ground Fault Protection		GFDI and isolation monitoring device	
	General AC Protection		MV switchgear (configurable)	
	General DC Protection		Fuses	
	Overvoltage Protection		Type 2	
CERTIFICATIONS	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 other configurations.
[4] Consult Power Electronics for derating curves.
[5] Consult Power Electronics for higher currents.
[6] Consult Power Electronics for other altitudes.
[7] Readings taken 1 meter from the back of the unit.

TECHNICAL CHARACTERISTICS HEM HYBRID

REFERENCE		FS3190M2	FS3190M4	FS3190M6
OUTPUT	AC Output Power (kVA/kW) @50°C [1]	3190		
	AC Output Power (kVA/kW) @40°C [1]	3300		
	Operating Grid Voltage	34.5 kV ±10 %		
	Operating Grid Frequency	60Hz		
	Current Harmonic Distortion (THDi)	< 3% per IEEE 519		
	Power Factor (cosine phi) [2]	0.5 leading … 0.5 lagging adjustable / Reactive Power injection at night		
INPUT	MPPt @full power	849V - 1310V		
	Maximum DC voltage	1500V		
	Number of PV inputs [3]	Up to 36		
	Number of Freemaq DC/DC	2	4	6
	Freemaq DC/DC Power (kW) @50ºC	1050	2100	3150
	DC ESS Voltage range [4]	700V - 1500V		
	Max. DC continuous current (A) [5]	6200		
	Max. DC short circuit current (A) [5]	12000		
EFFICIENCY & AUXILIARY SUPPLY	Max. PV Inverter Efficiency PAC, nom (η)	97.68% including MV transformer (preliminary)		
	CEC PV Inverter Efficiency (η)	97.47% including MV transformer (preliminary)		
	Max. Power Consumption (kVA)	30		
CABINET	Dimensions [WxDxH] (ft)	30.38 x 7 x 7 (preliminary)		
	Dimensions [WxDxH] (m)	9.26 x 2.2 x 2.2 (preliminary)		
	Weight (lb)	< 41888		
	Weight (kg)	< 19000		
	Type of ventilation	Forced air cooling		
ENVIRONMENT	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) [6]	2000 m		
	Noise level [7]	< 79 dBA		
CONTROL INTERFACE	Communication protocol	Modbus TCP		
	Plant Controller Communication	Optional		
	Keyed ON/OFF switch	Standard		
PROTECTIONS	Ground Fault Protection	GFDI and isolation monitoring device		
	General AC Protection	MV switchgear (configurable)		
	General DC Protection	Fuses		
	Overvoltage Protection	Type 2		
CERTIFICATIONS	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 other configurations.
[4] Consult Power Electronics for derating curves.
[5] Consult Power Electronics for higher currents.
[6] Consult Power Electronics for other altitudes.
[7] Readings taken 1 meter from the back of the unit.