38th ANNUAL CATALOG

Contents

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A family of passionate, committed professionals that leverages our rich solar heritage
to ensure that our customers and partners succeed
in building the solar ecosystem that will create a planet run by the sun.

2019 AEE Solar
RENEWABLE ENERGY DESIGN GUIDE & CATALOG

As we introduce the 38 th edition of our Design Guide and Product Catalog, I catch myself thinking about the trajectory of our industry and the amazing opportunity that lies ahead for all of us. Public opinion of renewable energy is a growing force that can no longer be silenced. Multiple surveys show that becoming 100% renewable is a very popular goal and customers are demanding that solar be used as much as possible. With public opinion at an all-time high and the impacts of climate change upon us, we are dedicated to helping you better serve your customers so that we can all make a difference.

This catalog represents months of work in researching, comparing, and selecting the best of what's available in the residential and commercial solar+storage space. That includes rigorous third-party testing on many of the modules, inverters, batteries and meters we bring to market.

We're confident in offering them to you because in many instances we've seen them being built and we see audited quality checks. Our product teams scrutinize the market to ensure that the products we sell are the right product for the job, at the right price.

We are optimistic for 2019 in terms of the growth, and maybe more importantly, the maturation of the solar+storage market. We recognize the role that we've played in the industry in always bringing to market a terrific breadth and depth in solar, and we're steadfast in our commitment to scrutinize these products, and support them as well. If you've never reached out to our Technical Sales team for a project quote, a support question, or even just to ask a "What if" question, I encourage you to do so.

We also recognize that as we have grown, we have fallen short on some of our core values. We've listened to your honest feedback and taken a hard look at our processes and service. We have brought back, by popular demand, sales teams with dedicated territories and simplified our contact information so you can more easily contact us. Feedback on our freight carriers drove us to find new ones. And we've added useful functionality to AEEExpress, now allowing you to apply for credit online and pay your invoices by credit card without fees. We've continued to invest in our back-end systems, namely in forecasting and transportation management, to make sure that we can provide you the right product, at the right place, at the right time. Although we've made progress in improving your experience with us, we are committed to providing you industry leading customer service and won't stop until we achieve it.

Thank you for being a valued AEE Solar dealer and trusting us to be your partner in providing solar energy across North America. We will continue our efforts to improve our service to you every day and are excited to see where 2019 takes us!

Sincerely,

Antonio Cintra, President, AEE Solar

Help Us Keep This Resource Up-to-Date

Keeping this catalog accurate and up-to-date is very important to us. While we do our best, we cannot guarantee that every specification and detail is current since products and specifications can change without notice, as can availability. Please let us know if you suspect any information may be inaccurate. We always appreciate your feedback and can be reached anytime at salessupport@aeesolar.com.

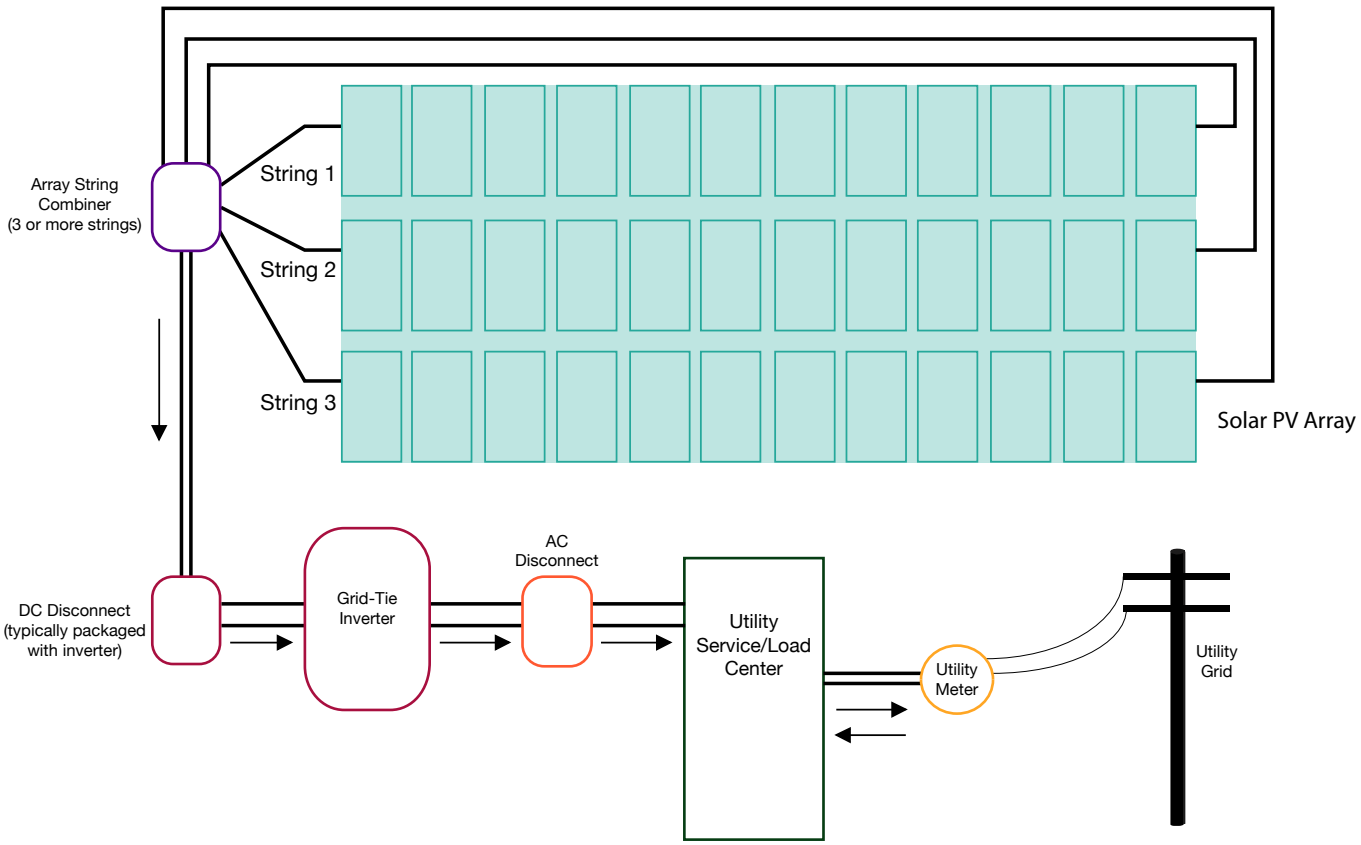
Contact Us for All Your Renewable Energy Needs

As questions arise, we look forward to answering them. Please call us at 800-777-6609, email us at salessupport@aeesolar.com, or visit our contact page at www.aeesolar.com/contact. We thank you and look forward to working closely with you to take advantage of all the great opportunities that 2019 has to offer.

Utility Grid-Tie PV System Design

A grid-connected PV system consists of PV modules, output cables, a module mounting structure, AC and DC disconnect switches, inverter(s), grounding equipment, and a metering system, as shown in the diagram below. The Grid-Tie System Worksheet is designed to help size a PV array to offset a site's electrical usage with the largest system that would be cost-effective to install. A smaller system can reduce part of the electric bill, and in locations with tiered or progressive rates, it may have a faster financial payback. Compare the worksheet result with the amount of space available to mount the PV array in order to get a rough idea of the maximum PV array size.

Below is a diagram of a typical grid-tie system (utility intertie) without energy storage. Many grid-tie inverters have built-in DC disconnect switches, while some have both a DC and an AC disconnect. Many models also contain a PV array string combiner so a separate one may not be necessary. Separate overcurrent protection for each series string of modules in a PV array (typically provided in the array combiner box) is required only if there are three or more series strings of modules connected to a single inverter input. Inverters with multiple MPPT input channels can have one or two series strings per channel without individual string fusing.



AEE Solar was born in 1979, long before grid-tie, when off-grid solar was the only form of domestic solar PV. So when it comes to off-grid know-how and equipment knowledge, **AEE Solar's experience, expertise, and product selection is unsurpassed.**

Worksheet: Grid-Tie PV System Design

Determine PV array size for a grid-tied system (no energy storage)

Step 1: Determine the daily average electricity usage from the electric bills.

This will be in kilowatt-hours (kWh). Due to air conditioning, heating, and other seasonal usage, it is a good idea to add up all the kWh for the year and then divide by 365 to find the average daily usage.

Step 2: Find the location's average peak sun-hours per day.

See the map below and/or the insolation map in the Reference section near the end of the catalog. For example, the average for Central California is 5 sun-hours. NREL's PVWatts online sizing program (http://pvwatts.nrel.gov/) can provide this data as well as monthly and yearly expected AC production totals. It can also account for array tilt-angle and azimuth to get more accurate results.

Step 3: Calculate the system size (AC watts) needed to offset the average usage.

Divide the daily average electricity use by average sun-hours per day. For example, if the daily average electricity use is 30 kWh and the site is in Central California, system size would be: 30 kWh / 5 h = 6 kW AC. Multiply kW by 1,000 to get AC watts.

Step 4: Calculate total required nameplate power of the PV array.

Divide the AC watts from step 3 by the system derate factor. Use a derate factor of 0.82 for most systems (this is the standard derate used by PVWatts). For example, if an array size of 6,000 WAC is calculated in Step 3, divide 6,000 WAC by 0.82 to get 7,318 WDC based on the module's STC rating.

NOTE: System derating factors

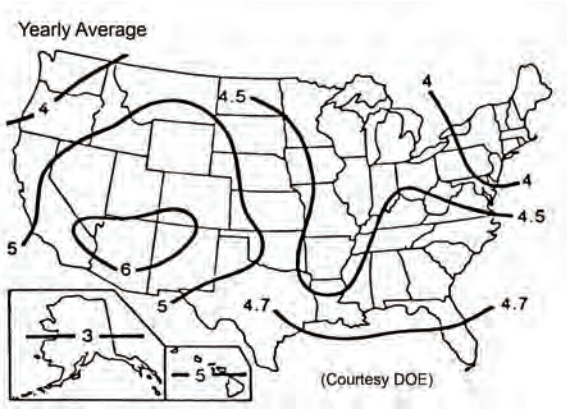
The overall system derating factor represents losses in the system due to the difference between the PV module's nameplate DC ratings, and actual expected output in real-world conditions, module mismatch, losses in diodes, connections and wiring, module soiling, array shading, tracking error, system aging, and the inverter efficiency at maximum power. The default derate typically used is 0.82, but specific site conditions and equipment used may cause variations. The 0.82 derate is based on 14% systemic losses and 96% inverter efficiency.

Step 5: Calculate the number of PV modules required for this system.

Divide the system DC wattage in Step 4 by the nameplate rating of the chosen modules to calculate the number of PV modules needed to provide the desired AC output.

Step 6: Select the inverter/module combination available from AEE that will work with the desired system size, and system AC voltage and phase.

Generally in most locations the nameplate solar array size can be up to 1.25 times larger than the maximum inverter capacity. Solar radiation is rarely the full 1000 WsqM that is the standard condition. Also it has to be very cold for the PV cells to be operating at 25°C where they are rated for full power. At some locations, particularly at high altitude these conditions may be possible and oversizing the array may not be advised.



Most inverters now have two or more MPPT channels, some of which are limited to one string of modules, so it is best to use series strings at the highest voltage possible so long as the maximum voltage is never exceeded even in the coldest conditions. Because PV modules have the potential to have a voltage output +-10% from the rating, and there is voltage drop in the wiring and connections, and there is about 0.1% drop in power per year, it is best to size strings so that they are at least 10% higher than the minimum input voltage for the inverter in the hottest conditions.

Most inverter manufacturers have online calculators for sizing arrays and strings with their inverters. For assistance in sizing an inverter, you are also welcome to contact AEE technical support.

Other factors, such as high or low temperatures, shading, array orientation, roof pitch, and dirt on the modules, will affect the system's actual output.

Grid-Tie with Battery Backup

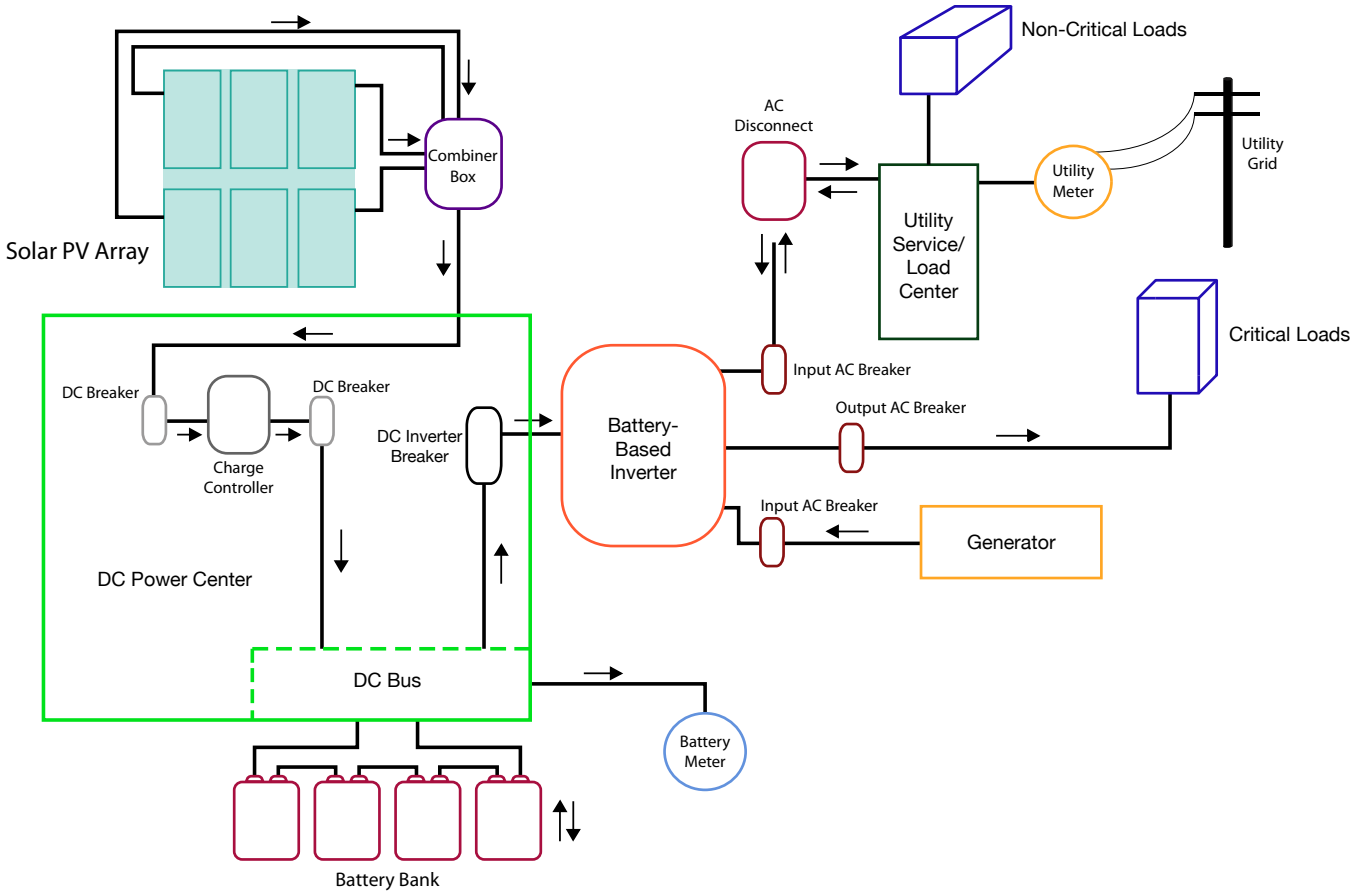
Many solar customers are surprised and disappointed to learn that their typical grid-tie solar PV system will not power their home during a utility outage. In areas where blackouts and extended weather-related outages are common, a battery backup system, like the one shown in the diagram below, can add substantial value.

Sizing and designing a grid-tie system with battery backup is more complex than designing a typical system without energy storage. They perform two separate functions: offsetting the power purchased from the electric utility, just like a standard grid-tie system, and providing emergency backup power during utility outages. Both of these functions require separate design considerations and calculations.

The "grid-tie" part of the system is designed to offset kilowatt-hour energy consumption using the average peak sun-hours available where the PV array is located.

The "battery backup" part of the system is designed to meet the power draw of the critical loads that need to operate during a grid outage for however long the outage is expected to occur. These systems are generally designed to run only specific circuits located in a separate sub-panel. They are not designed to power the whole house; although this can be done, it adds considerable cost and complexity.

Battery backup systems require specialized inverters and other components and must be carefully sized, so be sure to call AEE Solar's Technical Support Team for assistance if you're unfamiliar with this type of system.

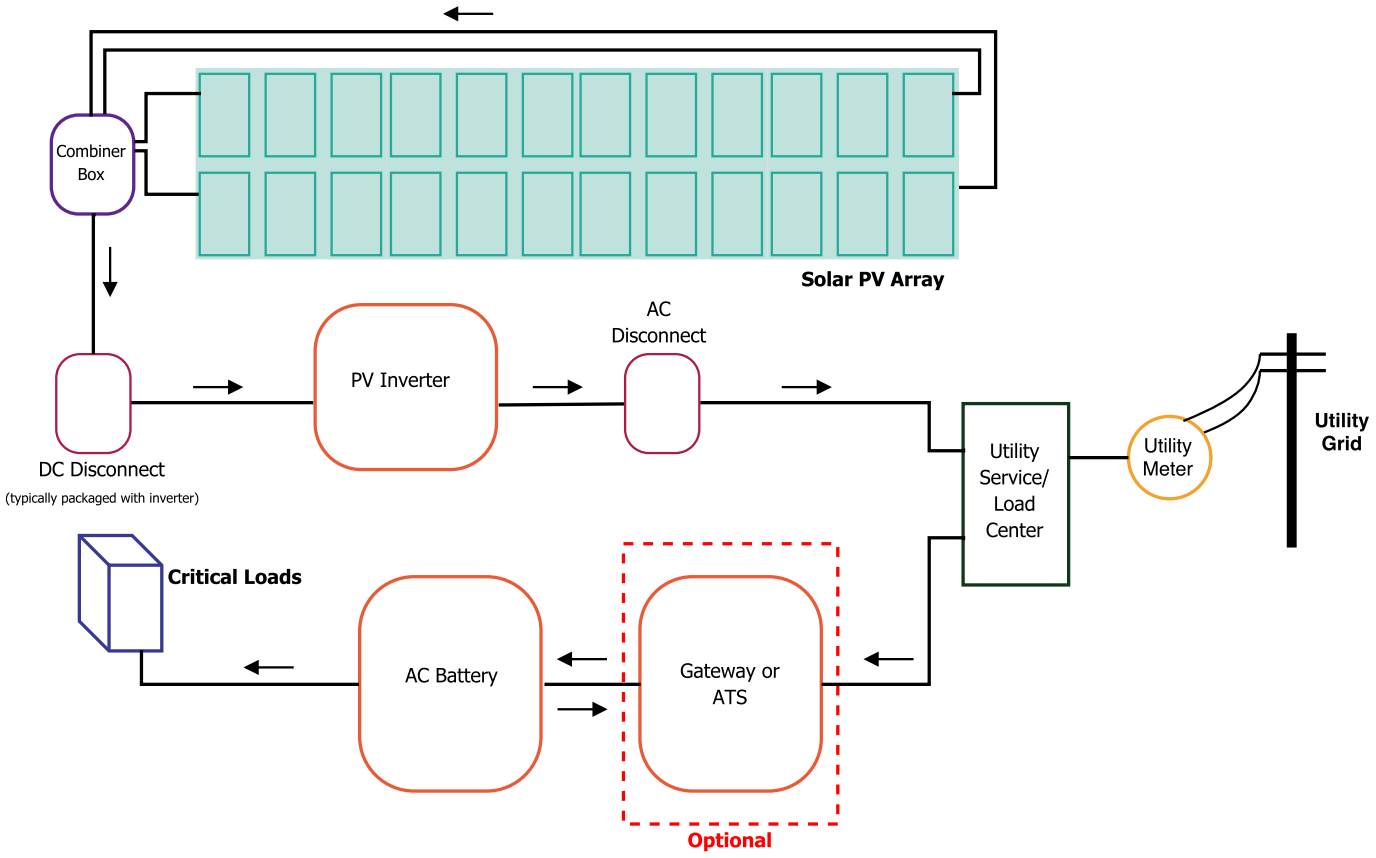


AC Battery

In the past several years several new storage solutions have reached the market which are best described as "AC Batteries". While this is obviously a contradiction in terms, it does help to describe the coupling of the battery to the loads in a home.

In an AC battery, the solution typically contains an onboard inverter which couples directly to the main or critical loads panel. As there is no electrical or communication path between the AC Battery and the PV inverter (if there is one), it cannot be described as AC- or DC-Coupled. It is truly a solution unto itself.

An AC battery can be installed as a pure self-consumption solution, or as a battery-backup solution. In the latter, the AC battery would need to be installed with a gateway or transfer switch to prevent backfeeding the grid during an outage. In a pure self-consumption solution, the battery is connected directly to the main AC panel. It is worth pointing out that Federal ITC incentives may not apply to AC Batteries; please consult your tax professional.



Fast, Accurate Shipping to Your Job Site. With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

Inverters for Grid-Tie with Battery Backup

OutBack Power FXR inverters and switch gear, as well as **OutBack Power Radian** inverters, can power loads individually from 2 to 8 kW and multiple inverters can be combined in a single system up to 80 kW in size.

The **Schneider Electric Conext XW+** series of inverters offers grid-tie inverters with battery backup capability in 4 kW, 5.5 kW, and 6.8 kW increments. Up to four units can be paralleled for battery backup systems up to 27.2 kW.

The **SMA Sunny Island** inverters, in conjunction with a **SMA Sunny Boy** inverter and PV array, can be used to provide backup power in a grid-tied home or business using **AC coupling**. Backup systems can be configured with up to 24 kW single-phase output using up to four Sunny Island inverters or up to 72 kW of three-phase output with up to 12 Sunny Island inverters and a Multi-Cluster Box.

See Battery-Based Inverters for more information on these inverters.

Follow steps 1-6 on the Grid-Tie PV System Design Worksheet (on page 2) to determine the size of the PV array required to provide the desired percentage of total power, then calculate the inverter size and battery capacity needed using the worksheet below.

Worksheet: Inverter and Battery Sizing for Grid-Tie with Backup System

Determine energy storage requirement for backup system.

Step 1: Find the power requirements (watts) for the appliances that need power during an outage.

Make a list of the loads and appliances that need power during an outage, such as refrigerators, safety lighting, etc. You can use the Load Analysis template on page 8 or create your own. Only list the essential items, since the system size (and cost) will vary widely with power needed. The wattage of individual appliances can usually be found on the back of the appliance or in the owner's manual. If an appliance is rated in amps, multiply amps by the operating voltage (usually 120 or 240 VAC) to find watts. Add up the wattage of all the items on the list that may need to run simultaneously to arrive at the total amount of watts. This is the "peak wattage" inverter requirement and will determine the minimum size of the dual-function inverter that you will need. If the PV array total wattage is larger than the peak wattage required to run the chosen loads, then ensure that the inverter capacity is equal to or greater than the PV array nameplate capacity.

Step 2: Define how long of an outage the system must accommodate.

Power outages last from a few minutes, to a day or more. This decision will greatly affect the system size and cost, so the desired length of time should be traded against the total loads supported. If the system needs to provide power for an indefinite period of time, use the array and battery bank sizing instructions for an off-grid system on the following pages.

Step 3: Determine the amount of energy (kWh or watt-hours) that would need to be consumed during the length of the expected outage.

Multiply the power requirements (in step 1) by duration in hours (in step 2). The result will be watt-hours. For example, powering a 350 W refrigerator, a 150 W computer, and a 500 W lighting system for 2 hours would require 2,000 watt-hours (or 2 kWh) of energy storage.

Step 4: Factor in the inverter losses.

Multiply the total watt-hours or kWh to be supplied to the loads by 0.87 to account for inverter losses.

Step 5: Calculate the minimum energy storage needed.

Divide the Step 3 result by 0.8 (batteries should not be discharged past 80%). For example, if the battery bank needs to supply 2 kWh of energy, at least 2 kWh ÷ 0.8 = 2.4 kWh of nominal battery energy storage is needed.

Step 6: Calculate battery capacity needed.

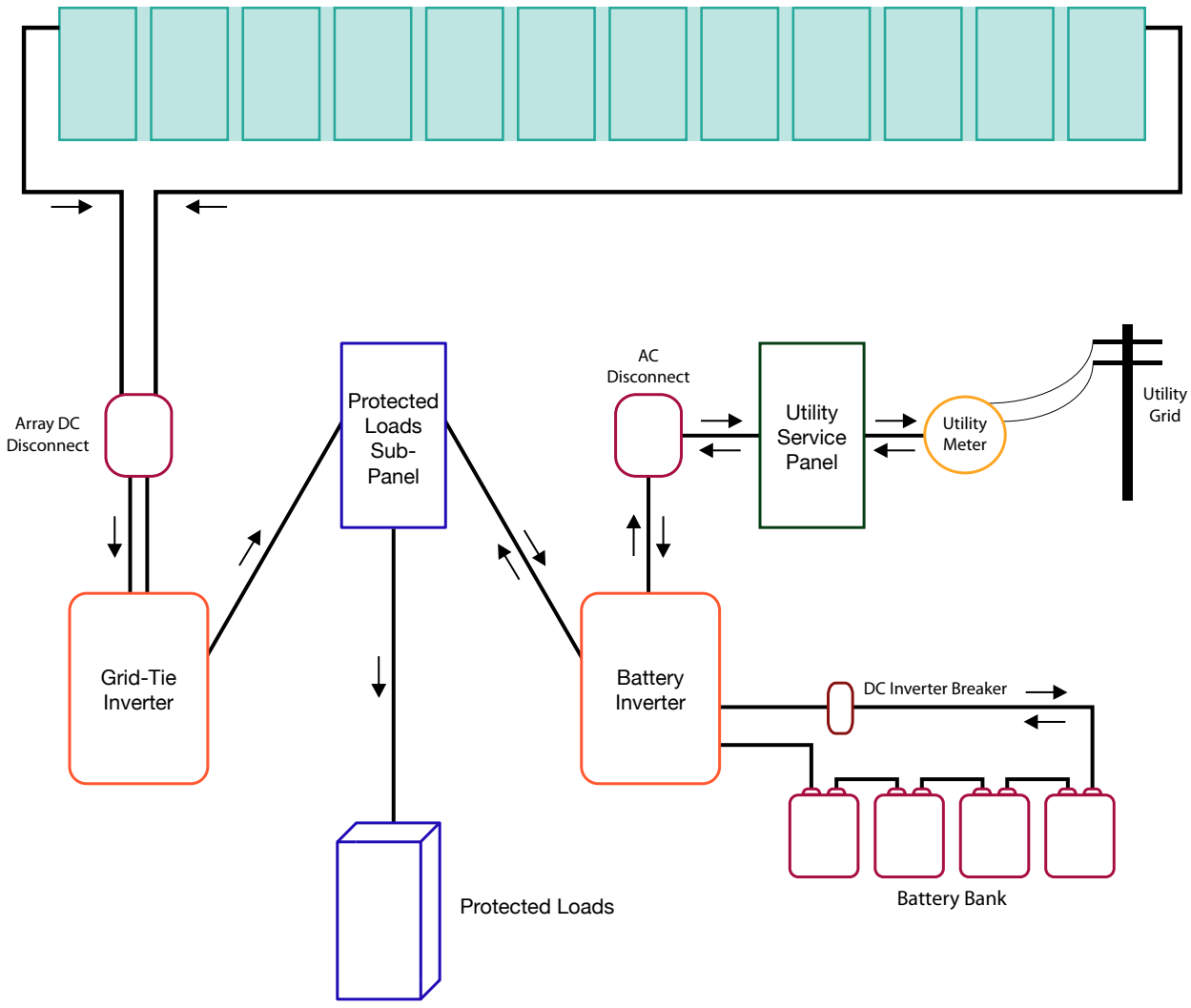
Divide the energy storage requirement from step 4 by the DC voltage of the system (usually 48 VDC, but sometimes 24 VDC) to get battery amp-hour (Ah) capacity. Most backup systems use sealed batteries due to their reduced maintenance requirements and because they can be more easily placed in enclosed battery compartments. Flooded batteries are not recommended for backup or standby applications.

AC-Coupled Systems

An AC-coupled power system is another form of a battery-based system. It can be used either in a grid-tie system with a battery backup application, or in a completely off-grid system. Instead of using a battery charge controller with the PV array, these systems utilize standard grid-tie inverters that produce AC power (usually 240 VAC), which can be "sold" to the utility grid when the grid is connected or can be used by a separate battery-based inverter to charge a battery bank during a grid outage.

Along with the standard grid-tie inverter, a second, bidirectional, battery-based inverter is used with a battery bank to provide AC power during a grid outage. Both the AC output of the grid-tie inverter and the AC output of the battery inverter are connected to the protected loads sub-panel. During normal operation when the grid is "up", the power from the PV array and grid-tie inverter simply passes through the sub-panel and the battery inverter's built-in AC transfer switch and on to the utility main panel. From there it is either consumed by house loads connected there or exported to the grid. If a grid outage occurs, the grid-tie inverter will automatically shut off. At the same time, the battery-based inverter will automatically switch off the grid connection and begin to power the loads in the protected loads panel using energy drawn from the battery bank. Since the grid-tie inverter is connected in this sub-panel, it detects the AC power from the battery inverter and, (after a 5-minute delay) will turn back on. The power output from the array and grid-tie inverter will then be used directly by the protected loads connected to the sub-panel or be used to charge the batteries via the battery-based inverter/charger.

The Magnum Energy MS-PAE and the GT500 micro-inverters are designed to work with each other to control the battery charging process. Other brands of battery-based inverters, such as Outback Power, Schneider Electric XW+ and SW, and SMA Sunny Island models may be used with most grid-tie inverters in an AC-coupled system; most however have no built-in way to control battery charging from the grid-tie inverter. A relay can be placed in the AC connection to the grid-tie inverter, controlled by a battery voltage activated switch (such as the AUX relay built into many inverters) to disconnect the grid-tie inverter when the battery voltage rises to the full-charge voltage, ending the charge cycle. Some battery inverters have a frequency shift algorithm that will cause the grid tie inverter to drop off line on high battery voltage, but may not be a reliable method. Alternatively, a diversion controller connected to the battery, can be used with an AC or DC diversion load to consume the excess power and keep the batteries from being overcharged.



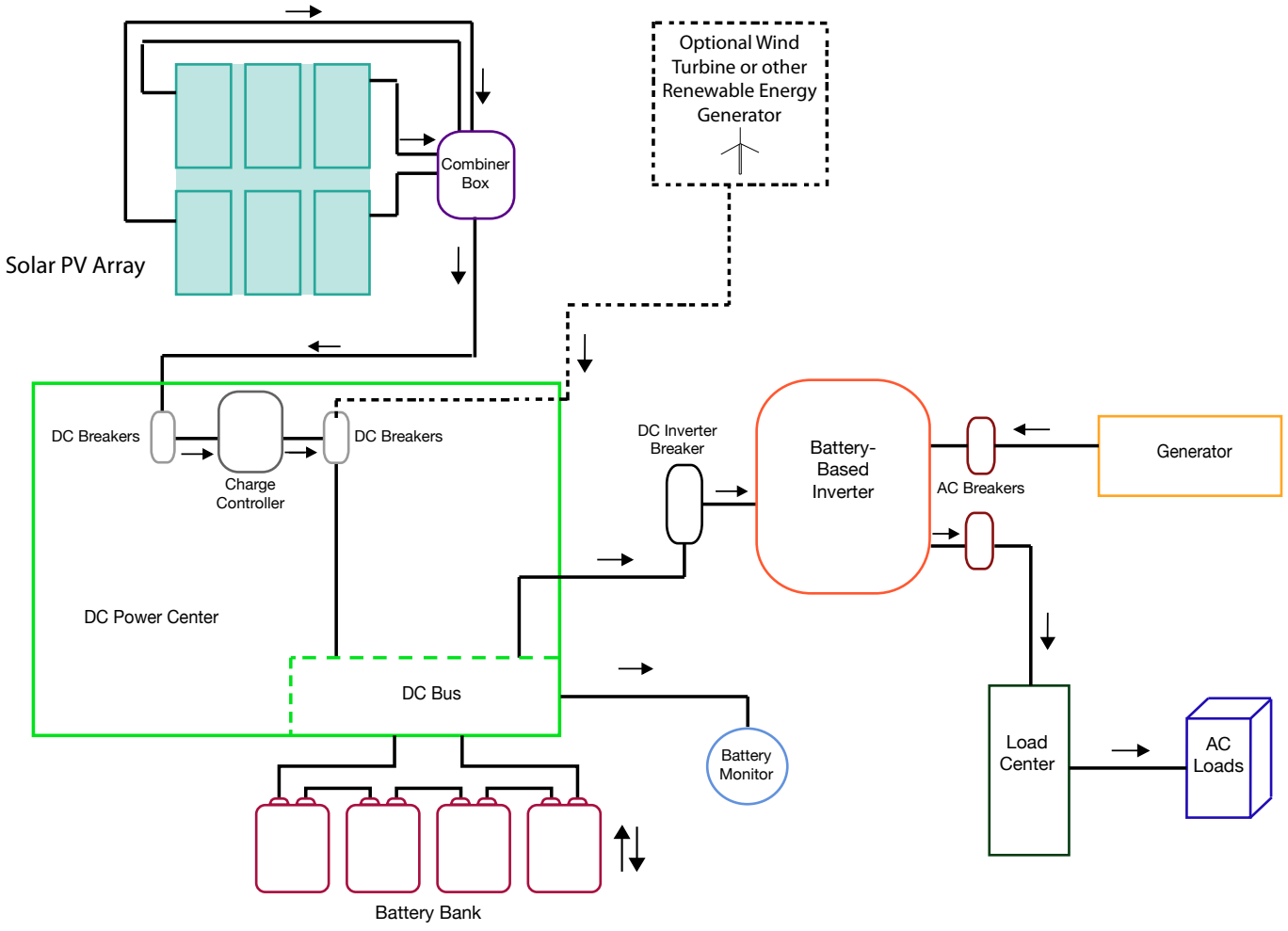
Off-Grid System Sizing Information

Off-grid solar PV systems, like the one shown in the diagram below, are one of the most economical ways to provide electricity in the absence of an electrical power grid. Off-grid systems are useful for remote homes and cabins, RVs and boats, and even for industrial applications like remote telemetry, cathodic protection, and telecommunications.

The size of an off-grid solar electric system depends on the amount of power that is required (watts), the amount of time it is used (hours), and the amount of energy available from the sun in a particular area (sun-hours per day).

Off-grid power systems are designed differently than grid-tie systems. With a typical grid-tie system, sizing calculations are based on the yearly average peak sun-hours available at the site, and are used to offset the annual power consumption drawn from the utility grid. With an off-grid system design, the calculations are usually based on the peak sun-hour figures for the darkest month of the year, rather than the yearly average, in order to provide sufficient on-site power year-round. In locations where it is not practical to install a PV power system that will provide 100% autonomy during the darkest time of the year, a generator may be used to help run loads and charge the battery bank, or if site conditions allow, other energy producing systems, such as wind or micro-hydroelectric turbines can be used to supplement the PV array.

Off-grid power system design is complex, and these systems require specialized inverters, charge controllers, and battery banks. Please contact the AEE Solar Technical Support Team for system design assistance.



Efficiency and Energy Conservation

Energy-efficient appliances and lighting, and non-electric alternatives, can help to reduce the cost of producing and storing energy in off-grid systems. Every watt that doesn't need to be used is a watt that doesn't have to be produced or stored. The information below pertains mostly to off-grid systems, but can also help to reduce the size and cost of grid-tied PV systems, with or without battery backup capability.

Cooking, Heating and Cooling

Each burner on an electric range uses about 1,500 W, which is why bottled propane or natural gas is a popular alternative for cooking. A microwave oven has about the same power draw, but since food cooks more quickly in a microwave oven, the amount of kilowatt hours used is typically lower. Propane, wood or solar-heated water are generally better alternatives for space heating than electric baseboards. Good passive solar design and proper insulation can reduce the need for winter heating. Evaporative cooling is a more reasonable load than air conditioning and in locations with low humidity, it's a great alternative.

Lighting

Lighting requires careful study since type, size, voltage, and placement can all significantly impact the power required. In a small cabin, RV, or boat, low voltage DC lighting with LEDs is sometimes the best choice. DC wiring runs can be kept short, allowing the use of fairly small gauge wire. Since an inverter is not required, the system cost is lower. In a large installation with many lights, using an inverter to supply AC power for conventional lighting is more cost-effective. AC LED lights are now common and very efficient, but it is a good idea to have a DC-powered light in the same room as the inverter and batteries in case of an inverter fault. Finally, AC light dimmers will only function properly with inverters that have true sine-wave output.

Refrigeration

Gas powered absorption refrigerators can work well in small systems when bottled gas is available. Modern absorption refrigerators consume approximately 5-10 gallons of LP gas per month. If an electric refrigerator will be used in a standalone system, it should be a high-efficiency type. High-efficiency DC refrigerators are also available and can offer significant energy savings.

Major Appliances

Standard AC electric motors in washing machines, larger shop machinery and tools, swamp coolers, and pumps, are usually ¼ to ¾ horsepower and consume relatively large amounts of electricity, thus requiring a large inverter. These electric motors can also be hard to start on inverter power, due to the large surge of power they need for starting, which can be as much as three-times or more of the power as they draw while running. Variable-frequency drives can be used with large motors to provide a "soft-start", reducing the surge load on the inverter system. A standard top-loading washing machine uses between 300 and 500 watt-hours per load, but new front-loading models can use less than half the energy per load. If the appliance is used more than a few hours per week, it is often more economical to pay more for a high-efficiency appliance rather than make the electrical system larger to support a low efficiency load.

Small Appliances

Many small appliances with heating elements such as irons, toasters, and hair dryers consume a very large amount of power when they are used but, by their nature, require only short or infrequent use. With a sufficiently large inverter system and batteries, they will operate, but the user may need to schedule those activities with respect to the battery charging cycle. For example, by ironing in the morning, the PV system can then recharge the battery bank during the day. Or, if these loads can be run during a sunny day, the energy from the PV array can supply the power to run the appliance without needing to draw energy from the battery bank.

Electronic equipment, such as stereos, televisions, DVD players and computers, draw less power than appliances with heating elements, but these loads can add up, so opt for more efficient models when possible, such as an LED or LCD TV instead of a plasma or CRT design.

Phantom Loads

Many appliances, especially ones with wireless remote controls, draw power even when turned "off". While each load may be small, the energy consumption of multiple appliances over a 24 hr period can add up and be quite large. Placing these loads on a switchable outlet or plug strip can save a considerable amount of energy.

Worksheet: Off-Grid Load Analysis

Determine the total kilowatt-hours (kWh) per day used by the AC and DC loads.

Step 1: List all AC loads, wattage and hours of use per week in the table below.

(If there are no AC loads, skip to Step 5)

Multiply watts by hours/week to get AC watt-hours per week. Add up all the watt hours per week to determine total AC watt-hours per week.

NOTE: Wattage of appliances can usually be determined from tags on the back of the appliance or from the owner's manual. If an appliance is rated in amps, multiply amps by operating voltage (120 or 240 VAC) to find watts. Energystar.gov lists annual Wh consumption for Energy Star electrical appliances; divide this number by 52 to get watt-hours per week.

Calculate AC loads *(If there are no AC loads, skip to Step 3)*

Description of AC loads run by inverter	watts	x	hours/week	=	watt-hours/week
		x		=	
		x		=	
		x		=	
		x		=	
		x		=	
		x		=	
		x		=	
		x		=	
		x		=	
				Total watt-hours per week:	

Step 2: Convert to DC watt-hours per week.

Multiply the result of Step 1 by 1.13 to correct for inverter loss.

Step 3: List all DC loads, wattage and hours of use per week in the table below.

Multiply watts by hours/week to get DC watt-hours per week (Wh/Wk). Add up all the watt hours per week to determine total DC watt-hours per week.

Calculate DC loads *(if applicable)*

Description of DC loads run by inverter	watts	x	hours/week	=	watt-hours/week
		x		=	
		x		=	
		x		=	
		x		=	
		x		=	
				Total watt-hours per week:	

Step 4: Calculate total DC watt-hours per week.

Add the total DC watt-hours per week used by AC loads from Step 2 to the watt-hours per week used by DC loads from Step 3 to get the total DC watt-hours per week used by all loads.

Step 5: Calculate your total watt-hours per day consumption.

Divide the total DC watt-hours per week from Step 4 by 7 days to get the total average watt-hours per day that needs to be supplied by the battery.

You will need this number to begin sizing the PV array and battery bank. Note that the Solar Array Sizing Worksheet in this section, as well as the Battery Sizing Worksheet in the Batteries Section, both begin with this number in their Step 1.

Worksheet: Off-Grid Solar Array Sizing

Determine how much energy (kWh) the solar array must produce to size the PV array and determine the total number of solar modules required for the system.

Step 1: List the total average watt-hours per day needed to power the electrical loads.

Obtain this number from the Off-Grid Loads Worksheet on the previous page.

Step 2: Calculate the minimum watt-hours needed per day.

Multiply the watt-hours per day needed by 1.25 to compensate for PV array and battery charge/discharge losses. This is the minimum total watt-hours that the PV array needs to produce, on average, each day. However, increasing the array size further will allow the system to provide some additional charging during cloudy weather and catch up more quickly after a cloudy period. Increasing the array size can also allow for reduced battery storage requirements.

Step 3: List the average sun-hours per day at the system's location.

Check local weather data, look at the map below, or find a city on the Solar Insolation Table in the Reference Section that has similar latitude and weather to your location. If you want year-round autonomy, use the lower winter insolation. If you want 100% autonomy only in summer, use the higher summer insolation. If you have a utility grid-tie system with net metering, use the yearly average figure.

Step 4: Determine the minimum nameplate capacity.

Divide the result of Step 2 by the average sun-hours per day from Step 3 to determine the minimum nameplate capacity of the PV array.

NOTE: Sizing Solar Arrays with PWM or MPPT Charge Controllers

If you are planning a small low-cost system with a PWM charge controller, with 12 or 24 VDC "nominal" PV modules (36 or 72 cells), continue to Step 5 below. If you are planning a system with an MPPT charge controller, go to Step 5 in "Sizing Solar Arrays with MPPT Charge Controllers". Information on the different types of PV charge controllers can be found in the Charge Controller section.

Step 5: Calculate peak amps.

Divide the total solar array wattage required from Step 4 by the system's DC battery voltage (usually 12, 24, or 48 VDC) to get the total peak amps (A) that the PV array must produce.

Step 6: Find the peak-power current (Imp) of the module you will be using from its specifications or Data Sheet.

Step 7: Calculate the number of parallel strings.

Divide the result of Step 5 by the result of Step 6. Round up to the next whole number. This is the total number of parallel module strings required to produce the total array current needed.

Step 8: Use the table below to determine the number of modules in each series string needed to match the DC battery voltage of the power system.

Nominal System Voltage	Number of Series Connected Modules per String	
Volts	12 V module	24 V module
12	1	--
24	2	1
48	4	2

Step 9: Calculate the minimum number of solar modules.

Multiply the number of strings from Step 7 by the number of modules per string from Step 8 to get the total minimum number of solar modules required with a PWM charge controller.

Step 10: Calculate minimum PWM charge controller rating.

Multiply the number of strings from Step 7 by the module's short-circuit current (ISC) and then by a 1.25 Code-required safety factor. The current rating of the selected PWM charge controller must exceed this number.

Sizing Solar Arrays with MPPT Charge Controllers

Step 5: Note the minimum solar array nameplate capacity required from Step 4.

Step 6: Enter the nameplate power (in watts) of the PV module you plan to use.

Step 7: Determine the minimum number of modules needed.

Divide the PV array capacity from Step 5 by the module nameplate power from Step 6 to determine the minimum number of modules needed. Round up to the nearest whole number. *(NOTE: This number may need to be adjusted in Step 10).*

Step 8: Determine the number of modules in each series string.

Use the table below to determine the number of modules needed in each series string based on the system's battery voltage and PV charge controller used.

MPPT Charge Controller Sizing Table – Range of Modules in Series[1]

Charge controller model	Max DC input voltage	Nominal battery voltage	Cell count of PV module used			
			36	54	60	72
OutBack FM 60 & 80 Schneider XW-MPPT150-60 Morningstar TriStar 45 & 60	150 VDC	12 VDC	1 to 5	1 to 3	1 to 3	1 or 2
		24 VDC	2 to 5	2 or 3	2 or 3	1 or 2
		48 VDC	4 or 5	3	3	2
MidNite Solar Classic 150	150 VDC	12 VDC	1 to 5	1 to 3	1 to 3	1 or 2
		24 VDC	2 to 6	2 to 4	2 or 3	1 to 3
		48 VDC	4 to 6	3 or 4	3	2 or 3
MidNite Solar Classic 200	200 VDC	12 VDC	1 to 7	1 to 5	1 to 4	1 to 3
		24 VDC	2 to 7	2 to 5	2 to 4	1 to 4
		48 VDC	4 to 7	3 to 5	3 to 4	2 to 4
MidNite Solar Classic 250 OutBack Ultra FM100-300	250 VDC	12 VDC	1 to 9	1 to 6	1 to 5	1 to 4
		24 VDC	2 to 9	2 to 6	2 to 5	1 to 4
		48 VDC	4 to 9	3 to 6	3 to 5	2 to 4
Schneider XW-MPPT600-80	600 VDC	24-48 VDC	14 to 22	9 to 15	9 to 13	7 to 11
Morningstar TS-MPPT-60-600V-48 (DB)	600 VDC	48 VDC	5 to 23	3 to 15	3 to 12	3 to 10
Magnum PT-100	200 VDC	12 VDC	1 to 7	1 to 5	1 to 4	1 to 3
		24 VDC	2 to 7	2 to 5	2 to 4	1 to 3
		48 VDC	4 to 7	3 to 5	3 to 4	2 to 4

[1]Based on temp range of 14°F to 104°F. Adjustments may be needed in locations with temps outside this range.

Step 9: Calculate the number of series strings needed.

Divide the total number of modules from Step 7 by the number of modules per series string from Step 8. Round up to a whole number. This is the total number of array series strings needed.

Step 10: Determine the total number of modules needed.

Multiply the number of module strings from Step 9 by the number of modules per string from Step 8 to determine the total number of modules needed.

Step 11: Find the total number of chosen controllers needed.

Multiply the total number of modules needed (from Step 10) by the rated wattage of the module being used. This is the adjusted total PV array nameplate capacity. Using the chart below, find a controller rated for the total array wattage (or more). If the total array wattage is more than a single controller can handle, either use a larger controller or use multiple controllers in parallel. NOTE: Most charge controllers must have their own separate PV array, so larger arrays need to be divided into sub-arrays for each charge controller.

Max Array Wattage per Controller Size

Battery voltage	Controller rated output amps								
	15 A	20 A	30A	45 A	60 A	75 A	80 A	95 A	100 A
12 V	216 W	265 W	431 W	647 W	862 W	1100 W	1149 W	1379 W	1437 W
24 V	431 W	530 W	862 W	1293 W	1724 W	2100 W	2299 W	–	2874 W
48 V	--	–	1724 W	2586 W	3448 W	4000 W	4598 W	–	5747 W

Photovoltaic (PV) Modules

Solar photovoltaic modules, often referred to as solar panels, convert light energy into a direct electrical current (DC). As solid-state devices, solar modules have no moving parts and are extremely reliable and durable compared to any other generator technology. While solar modules have become somewhat commoditized in recent years, there are important differences in form, footprint, quality, and performance that can impact both installation time and long-term system performance. This section of our catalog presents a selection of high-quality crystalline modules with a variety of features and price-points to suit virtually any project.

Output characteristics

The output power, voltage, and current profile of the solar module will dictate the number of modules needed and what inverters, optimizers, or charge controllers can be used. Some small off-grid applications may require 12 VDC (nominal) modules to directly charge batteries or operate DC loads. Larger modules with output voltages ranging from 24 to 50 VDC are now standard in grid-tie or grid-interactive applications where a high DC voltage is required to operate the inverter.

Mechanical Characteristics

Basic mechanical characteristics, such as dimensions, frame profile, static load rating, as well as grounding and mounting locations, will need to be understood when designing your system. Frame and back sheet color may also come into play for residential customers, particularly when specified by a homeowners' association. Also be sure you know what type of connector the module comes with, since this can impact the selection of optimizers, microinverters, and cabling.

Solar Modules at a Glance[1]

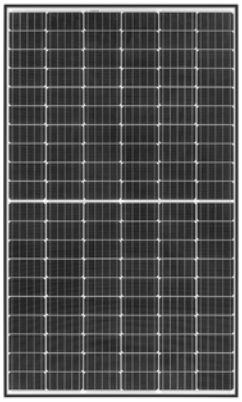
Power	Brand/model	Cell type	Frame	Power tolerance	V_{MP}	I_{MP}	Area efficiency	Dimensions (L" x W" x D")	Weight	Static load rating	Item code
330 W	REC330NP	Mono	Black	-0/+5 W	34.6 VDC	9.55 A	19.80%	65.94 x 39.25 x 1.18 in	40 lbs	98 psf [4666 Pa]	**011-02615**
320 W	REC320NP	Mono	Black	-0/+5 W	34.2 VDC	9.37 A	19.20%	65.94 x 39.25 x 1.18 in	40 lbs	98 psf [4666 Pa]	**011-02614**
315 W	REC315TP2M	Mono	Black	-0/+5 W	33.7 VDC	9.36 A	18.90%	65.94 x 37.64 x 1.5 in	41 lbs	75 psf [3600 Pa]	**011-02617**
310 W	REC310TP2M	Mono	Black	-0/+5 W	33.5 VDC	9.26 A	18.60%	65.94 x 37.64 x 1.5 in	41 lbs	75 psf [3600 Pa]	**011-02616**
290 W	REC290TP2-BLK	Poly	Black	-0/+5 W	32.1 VDC	9.05 A	17.40%	65.94 x 39.25 x 1.5 in	40 lbs	75 psf [3600 Pa]	**011-02605**
350 W	REC350TP2S 72	Poly	Clear	-0/+5 W	38.9 VDC	9.00 A	17.40%	78.9 x 39.4 x 1.2 in	49 lbs	75 psf [3600 Pa]	**011-02609**
345 W	REC345TP2S 72	Poly	Clear	-0/+5 W	38.7 VDC	8.92 A	17.20%	78.9 x 39.4 x 1.2 in	49 lbs	75 psf [3600 Pa]	**011-02608**
360 W	LG NeON R 360	Mono	Black	-0/+3 %	36.5 VDC	9.87 A	20.80%	66.9 x 40.0 x 1.57 in	40 lbs	125 psf [6,000 Pa]	**011-02631**
350 W	LG NeON R 350	Mono	Black	-0/+3 %	36.4 VDC	9.62 A	20.30%	66.9 x 40.0 x 1.57 in	40 lbs	125 psf [6,000 Pa]	**011-00225**
335 W	LG NeON2 335	Mono	Black	-0/+3 %	34.1 VDC	9.83 A	19.60%	66.40 x 40.0 x 1.57 in	40 lbs	125 psf [6,000 Pa]	**011-00221**
330 W	LG NeON2 330	Mono	Black	-0/+3 %	33.7 VDC	9.80 A	19.30%	66.40 x 40.0 x 1.57 in	40 lbs	125 psf [6,000 Pa]	**011-00233**
310 W	Longi LR6-60PE 310	Mono	Black	-0/+5 W	33.2 VDC	9.35 A	19.00%	65.0 × 39.0 x 1.60 in	40 lbs	113 psf [5,400 Pa]	**011-09606**
305 W	Longi LR6-60PE 305	Mono	Black	-0/+5 W	33.0 VDC	9.24 A	18.70%	65.0 × 39.0 x 1.60 in	40 lbs	113 psf [5,400 Pa]	**011-09605**
305 W	Longi LR6-60PB 305	Mono	Black	-0/+5 W	33.0 VDC	9.24 A	18.70%	65.0 × 39.0 x 1.60 in	40 lbs	113 psf [5,400 Pa]	**011-09607**
300 W	Longi LR6-60PB 300	Mono	Black	-0/+5 W	32.8 VDC	9.15 A	18.30%	65.0 × 39.0 x 1.60 in	40 lbs	113 psf [5,400 Pa]	**011-09603**
320 W	Hanwha G5 Duo	Mono	Black	-0/+5 W	33.6 VDC	9.66 A	19.30%	66.3 × 39.4 x 1.26 in	41 lbs	75 psf [3600 Pa]	**011-06545**
305 W	Hanwha G4.1 305	Mono	Black	-0/+5 W	32.6 VDC	9.35 A	18.30%	65.7 × 39.4 x 1.26 in	41 lbs	75 psf [3600 Pa]	**011-06544**

[1] Module availability may vary - Visit www.AEEexpress.com for latest pricing and availability.

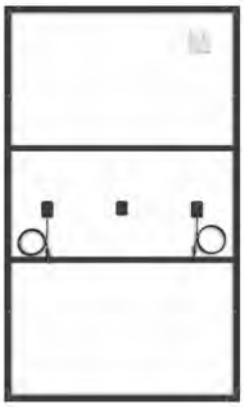
[2] See Dasol listing on page 20 for our selection of nominal 12 VDC modules.

REC Solar

Founded in Norway in 1996, REC has grown to become the largest European brand of solar panels. With around 26 million panels produced and a dependable warranty, REC has solid foundations and a bright future in the solar industry.



REC N-Peak (Front)



REC N-Peak (Back)

NEW! REC N-Peak Series PV Modules

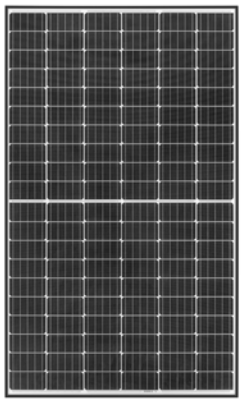
New for 2019 is the line of **N-Peak modules** from REC. Building upon years of proven success in split-cell technology, the N-Peak line adds in a cutting edge N-type monocrystalline cell to push performance and module efficiency. Featuring improved performance in shaded conditions and zero light-induced degradation (LID). The N-Peak line features a 12-year workmanship warranty and a 25-year linear power guarantee.

All modules are listed to UL 1703 for the U.S.A. and Canada.

REC Solar N-Peak Series Modules		
Technical Data		
Cells (qty/size)	120 / 156 x 78 mm	
Power output tolerance	-0/+5 W	
Nominal Operating Cell Temperature (NOCT)	112.3 +/-3.6 °F [44.6 °C (±2 °C)]	
Voltage temperature coefficient	-0.49%/°F [-0.27%/ °C]	
Fire rating/type	Class C / Type 2	
Connector type	MC4 Compatible	
Cable length	39 in (pos) / 47 in (neg))	
Static load rating	97.5 PSF [4666 Pa]	
Quantity per pallet	33	
Quantity per 53' trailer	924	
Max. system voltage	1,000 VDC	
Series fuse rating	25 A	
Dimensions (L x W x D)	65.94 x 39.25 x 1.1 in [1675 x 997 x 38 mm]	
Weight	39.7 lbs [18 kg]	
Module	**REC320NP**	**REC330NP**
Peak power	320 W	330 W
Voltage at peak power	34.2 VDC	34.6 VDC
Current at peak power	9.37 A	9.55 A
Open circuit voltage	40.8 VDC	41.3 VDC
Short circuit current	10.18 A	10.36 A
Module area efficiency	19.20%	19.0%
Item code	**011-02614**	**011-02615**

[1] Data subject to change without notice

NEW! REC TP2 Mono Series PV Modules



RECTP2 Mono

This line of modules combines the robust physical performance of the TP2 line, while leveraging new monocrystalline cells to increase module efficiency without sacrifificing quality or durability. These modules come with a 10-year workmanship warranty and a 25-year linear power guarantee that allows for no more than 0.7% degradation per year.

Certifications

All modules are listed to IEC 61215 and 61730, UL 1703 for the U.S.A. and Canada, and are manufactured in Singapore.

REC Solar N-Peak Series Modules		
Technical Data		
Cells (qty/size)	120 / 156 x 78 mm	
Power output tolerance	-0/+5 W	
Nominal Operating Cell Temperature (NOCT)	114.3 +/-3.6 °F [45.7 °C (±2 °C)]	
Voltage temperature coefficient	-0.522%/°F [-0.29%/ °C]	
Fire rating/type	Class C / Type 2	
Connector type	MC4	
Cable length	35 in (pos) / 47 in (neg)	
Static load rating	75 PSF [3600 Pa]	
Quantity per pallet	26	
Quantity per 53' trailer	832	
Max. system voltage	1,000 VDC	
Series fuse rating	20 A	
Dimensions (L x W x D)	65.94 x 37.64 x 1.5 in [1675 x 956 x 38 mm]	
Weight	40.8 lbs [18.5 kg]	
Module	**REC310TP2M**	**REC315TP2M**
Peak power	310 W	315
Voltage at peak power	33.5 VDC	33.7 VDC
Current at peak power	9.26A	9.36 A
Open circuit voltage	39.8 VDC	39.9 VDC
Short circuit current	9.90 A	10.05 A
Module area efficiency	18.60%	18.90%
Item code	**011-02616**	**011-02617**

REC Solar

TwinPeak 2 Series PV Modules

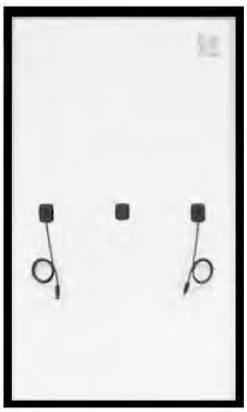
REC290TP2
(Front)

Based on a multicrystalline cell platform, the REC TwinPeak 2 Series encompasses a number of new and innovative technologies that provide performance comparable to monocrystalline p-type and N-type modules.

Most visibly, these modules use "half-cut" cells with 60 cells on each side of the module wired in parallel. This keeps the voltage similar to 60-cell modules, while improving shade tolerance and reducing energy loss due to cell resistance.

The cells themselves feature state-of-the-art Passivated Emitter Rear Cell (PERC), aka "backside passivation" technology that improves the light capture of the cell, resulting in improved energy harvest in real-world conditions.

The modules are equipped with a novel "split" junction box that places the PV wire cables with MC4 connectors near each side of the module, to better dissipate heat. The PV wire output cables are long enough to enable landscape array layouts..



REC290TP2
(Back)

REC TwinPeak 2S 72 Series PV Modules

REC is now producing a 72-cell equivalent module of their popular TwinPeak Series, using 144 half cut cells with "split" junction boxes, primarily for commercial applications and larger projects. These modules have clear anodized frames and white back sheets, and MC4-compatible connectors.

REC345TP2S

Certifications:

All modules are listed to IEC 61215 and 61730, UL 1703 for the U.S.A. and Canada, and are manufactured in Singapore.

REC Solar TwinPeak2 and TwinPeak-2S 72 Series PV Modules[1]			
Technical Data	**120-cell TP 2 Series**	**144-cell TP-72 series**	
Cells (qty/size)	120 / 156 x 78 mm	144 / 156 x 78 mm	
Power output tolerance	-0/+5 W	-0/+5 W	
Nominal Operating Cell Temperature (NOCT)	112.3 +/-3.6 °F [44.6 °C (±2 °C)]	112.3 +/-3.6 °F [44.6 °C (±2 °C)]	
Voltage temperature coefficient	-0.56%/°F [-0.31%/ °C]	-0.56%/°F [-0.31%/ °C]	
Fire rating/type	Class C / Type 2	Class C / Type 2	
Connector type	MC4	MC4 Compatible	
Cable length	35 in (pos) / 47 in (neg)	47 in [1.2 m]	
Static load rating	75 psf [3600 Pa]	75 psf [3600 Pa]	
Quantity per pallet	25	21	
Quantity per 53' trailer	700	462	
Max. system voltage	1,000 VDC	1,000 VDC	
Series fuse rating	20 A	20 A	
Dimensions (L x W x D)	65.94 x 39.25 x 1.5 in [1675 x 997 x 38 mm]	78.9 x 39.4 x 1.2 in [1969 x 1001 x 30 mm]	
Weight	39.7 lbs [18 kg]	61.7 lbs [28 kg]	
Module	**REC290TP2**	**REC345TP2S72**	**REC350TP2S72**
Peak power	290 W	345 W	350 W
Voltage at peak power	32.1 VDC	38.7 VDC	38.9 VDC
Current at peak power	9.05 A	8.92 A	9.00 A
Open circuit voltage	38.8 VDC	46.5 VDC	46.7 VDC
Short circuit current	9.71 A	9.64 A	9.72 A
Module area efficiency	17.40%	17.20%	17.40%
Item code	**011-02605**	**011-02608**	**011-02609**

[1] Data subject to change without notice

REC

SOLAR'S MOST TRUSTED

LOWEST CARBON FOOTPRINT
for solar grade silicon
(75% less energy used compared to traditional Siemens method)

#1 producer of panels with **HALF-CUT CELLS**

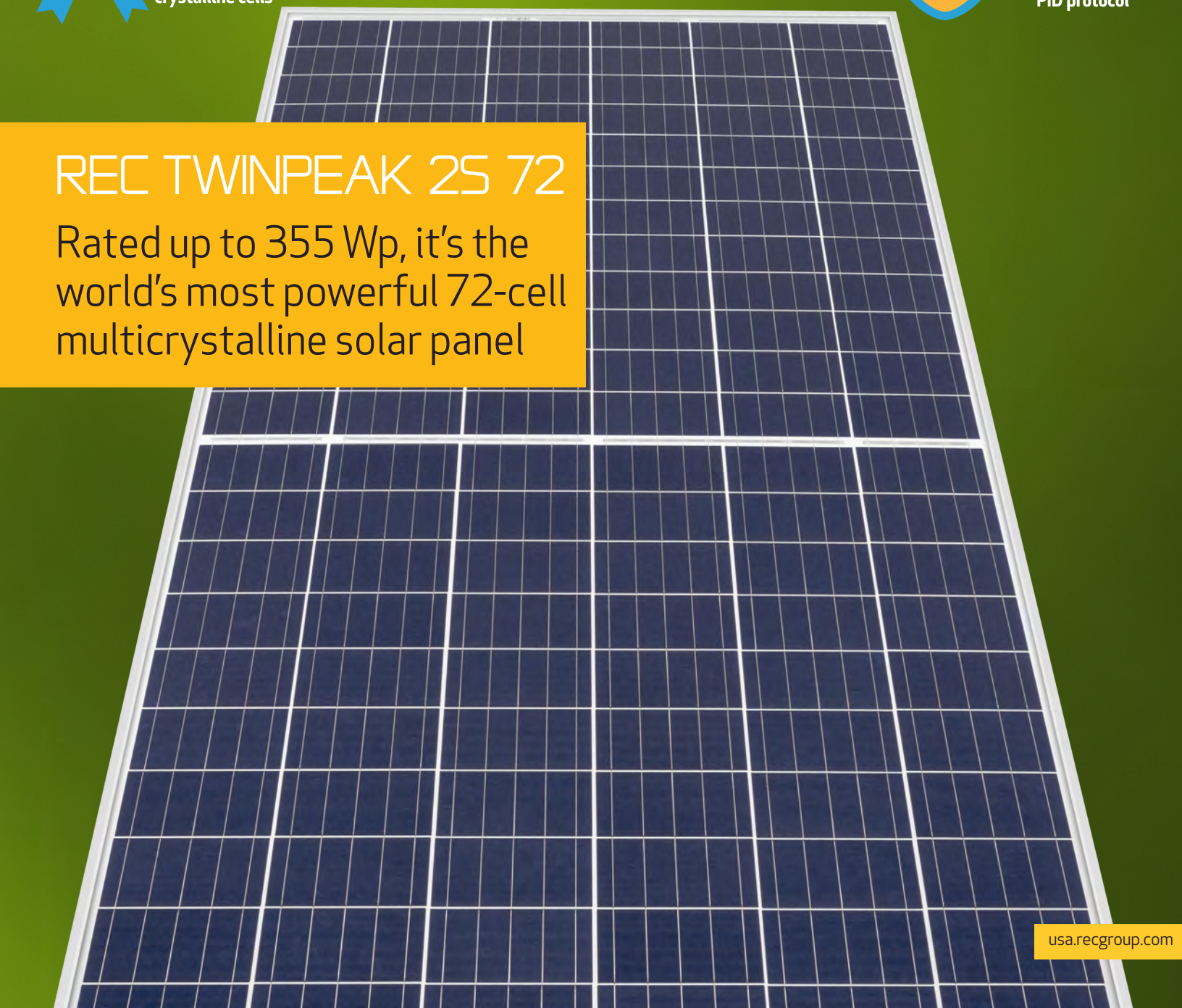
LOWEST known warranty **CLAIMS** rate
(REC 2017 PPM: <100)

1st to mass produce **PERC** on multi-crystalline cells

WORLD'S MOST POWERFUL
72-cell multicrystalline panel

PID FREE

100% of production clearing IEC PID protocol



REC TWINPEAK 2S 72

Rated up to 355 Wp, it's the world's most powerful 72-cell multicrystalline solar panel

usa.recgroup.com

LG Solar

NeON2 Series PV Modules

LG's **NeON2** monocrystalline PV modules are among the most efficient PV modules available thanks to a host of innovative technologies and enhancements at both the cell and module level. These modules feature high-gloss black frames, white back sheets, and thinner cell busses for a sleek appearance.

As a world-leading diversified manufacturer, LG backs these modules with 25-year linear performance guarantee and 12-year product warranty. These modules are listed to UL 1703, IEC 61215, IEC 61730- 1/-2, IEC 62716, and IEC 61701 and are produced in Korea in an ISO 9001 certified factory.

LG335N1C-A5

LG NeON2 PV Modules[1]		
Technical data		
Cells (qty/size)	60 / 6 x 6 in [156.75 mm]	
Power output tolerance	-0/+3%	
Nominal Operating Cell Temperature (NOCT)	113 +/-5.4 °F [45 °C +/-3 °C]	
Voltage temperature coefficient	-0.49%/°F [-0.27%/°C]	
Fire rating/type	Class C / Type 1	
Connector type	MC4	
Cable length	39.4 in [1 m]	
Static load rating	125 psf [6,000 Pa] front load / 113 psf [5,000 Pa] rear load	
Quantity per pallet	25	
Quantity per 53' trailer	850	
Max. system voltage	1,000 VDC	
Series fuse rating	20 A	
Dimensions (L x W x D)	66.40 x 40.0 x 1.57 in [1686 x 1016 x 40 mm]	
Weight	39.7 lbs [18 kg]	
Module	**LG330N1C-A5**	**LG335N1C-A5**
Peak power	330 W	335 W
Voltage at peak power	33.7 VDC	34.1 VDC
Current at peak power	9.80 A	9.83 A
Open circuit voltage	40.9 VDC	41.0 VDC
Short circuit current	10.45 A	10.49 A
Module area efficiency	19.30%	19.6%
Item code	**011-00233**	**011-00221**

[1] Data subject to change without notice.

Fast, Accurate Shipping to Your Job Site. With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

LG Solar

NeON R Series PV Modules

LG's **NeON R** represent the cutting edge of monocrystalline PV modules available on the market. These modules feature a new cell structure without electrodes or buss bars on the front, thanks to LG's proprietary CELLO back-contact technology. Additionally, the NeON R series feature decreased light-induced degradation, and improved warm-weather performance thanks to an improved temperature coefficient.

The NeON R also incorporates all of the standard features you've come to expect from LG: linear performance guarantee, excellent snow and wind ratings, superior aesthetics, and of course a name brand that homeowners can trust. The NeON R line of modules is manufactured in Korea in an ISO9001/12001 facility. LG warrantees this product with a full 25-year warranty on workmanship and output..

LG350Q1C-A5

LG NeON R PV Modules[1]		
Technical data		
Cells (qty/size)	60 / 6 x 6 in [156.75 mm]	
Power output tolerance	-0/+3%	
Nominal Operating Cell Temperature (NOCT)	111 +/-5.4 °F [44 °C +/-3 °C]	
Voltage temperature coefficient	-0.43%/°F [-0.24%/°C]	
Fire rating	Class C / Type 1	
Connector type	MC4	
Cable length	39.4 in [1 m]	
Static load rating	125 psf [6,000 Pa] front load / 113 psf [5,000 Pa] rear load	
Quantity per pallet	25	
Quantity per 53' trailer	850	
Max. system voltage	1,000 VDC	
Series fuse rating	20 A	
Dimensions (L x W x D)	66.9 x 40.0 x 1.57 in [1700 x 1016 x 40 mm]	
Weight	40.7 lbs [18 kg]	
Module	**LG350Q1C-A5**	**LG3560Q1C-A5**
Peak power	350 W	360 W
Voltage at peak power	36.1 VDC	36.5 VDC
Current at peak power	9.70 A	9.87 A
Open circuit voltage	42.7 VDC	43.5 VDC
Short circuit current	10.77 A	10.79 A
Module area efficiency	20.3%	20.80%
Item code	**011-00225**	**011-00231**

[1] Data subject to change without notice.

LONGi Solar

PE and PB Series

Longi LR6-60PE

Longi LR6-60PB

Longi LR6-60PE (Back)

AEE Solar is proud to introduce LONGi Solar to the US distribution market. Established in 2000, LONGi has produced photovoltaic cells since 2007 and is the world leader in photovoltaic cell production. The **LR6 lineup** is an efficient monocrystalline 60-cell module, with excellent electrical and solid structural performance (5400 Pa snow load and 2400 Pa wind load). These modules feature black 40mm frames with white or black backsheets, MC4 connectors, and industry-standard -0/+5W sorting.

LONGi backs these modules with a 10-year product warranty and 25-year linear warranty. They are certified to UL 1703, IEC 61215, IEC 61730 and are manufactured in an ISO 9001/14001 certified facility.

LONGi LR6-60PE and LR6-60PB Series 60-Cell Modules[1]		
Technical data		
Cells (qty/size)	60 / 6 x 6 in [156.75 mm]	
Power output tolerance	-0/+5 W	
Nominal Operating Cell Temperature (NOCT)	113 +/- 3.6°F [45 °C +/-2 °C]	
Voltage temperature coefficient	-0.59%/°F [-0.33%/°C]	
Fire rating/type	Class C / Type 1	
Connector type	MC4	
Cable length	39.4 in [1 m]	
Static load rating	113 psf [5,400 Pa] front load / 50 psf [2,400 Pa] rear load	
Quantity per pallet	26	
Quantity per 53' trailer	780	
Max. system voltage	1,000 VDC	
Series fuse rating	15 A	
Dimensions (L x W x D)	65.0 × 39.0 x 1.60 in [1650 × 991 × 40 mm]	
Weight	40.1 lbs [18.2 kg]	
Module	LR6-60PE-305M	LR6-60PE-310M
Peak power	305 W	310 W
Voltage at peak power	33.0 VDC	33.2 VDC
Current at peak power	9.24 A	9.35 A
Open circuit voltage	40.2 VDC	40.3 VDC
Short circuit current	9.94 A	9.98 A
Module area efficiency	18.70%	19.00%
Item code	**011-09605**	**011-09606**
Module	LR6-60PB-300M	LR6-60PB-305M
Peak power	300 W	305 W
Voltage at peak power	32.8 VDC	33.0 VDC
Current at peak power	9.15 A	9.24 A
Open circuit voltage	40.1 VDC	40.3 VDC
Short circuit current	9.81 A	9.94 A
Module area efficiency	18.30%	18.70%
Item code	**011-09603**	**011-09607**

[1] Data subject to change without notice

Hanwha Q-Cells

Q.PEAK Series PV Modules

Q.Peak G4.1 305

These Korean-made modules represent the latest advances in Q-Cells' workhorse monocrystalline module line. These modules feature black anodized frames with white back sheets and are suitable for most residential and commercial applications. Hanwha Q-Cells modules are manufactured in Korea.

As a global manufacturer of a wide variety of products, Hanwha Q-Cells backs these modules with a 12-year product warranty and a 25-year linear performance guarantee. These modules are listed to UL 1703, IEC 61215, and IEC 61730-2. They are certified for use in 600 VDC or 1,000 VDC applications.

Q-Cells Q-PEAK G4.1 Series PV Modules[1]	
Technical data	
Cells (qty/size)	60 / 6 in x 6 in [156.75 mm]
Power output tolerance	-0/+5 W
Nominal Operating Cell Temperature (NOCT)	113 +/- 5.4°F [45 °C +/-3 °C]
Voltage temperature coefficient	-0.50%/°F [-0.28%/°C]
Fire rating/type	Class C / Type 1
Connector type	MC4
Cable length	39.4 in [1 m]
Static load rating	75 psf [3,600 Pa] (design load)
Quantity per pallet	32
Quantity per 53' trailer	960
Max. system voltage	1,000 VDC
Series fuse rating	20 A
Dimensions (L x W x D)	65.7 × 39.4 x 1.26 in [1670 × 1000 × 32 mm]
Weight	40.8 lbs [18.5 kg]
Module	Q.PEAK-G4.1 305
Peak power	305 W
Voltage at peak power	32.62 VDC
Current at peak power	9.35 A
Open circuit voltage	40.05 VDC
Short circuit current	9.84 A
Module area efficiency	18.30%
Item code	**011-06544**

[1] Data subject to change without notice

Hanwha Q-Cells

NEW! Q.PEAK Duo Series PV Modules

Q.Peak DUO Front

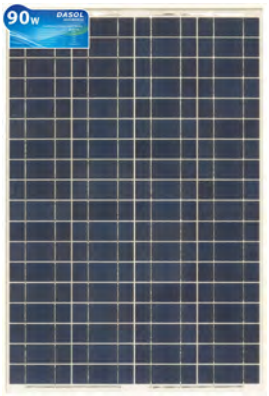
Q.Peak DUO Back

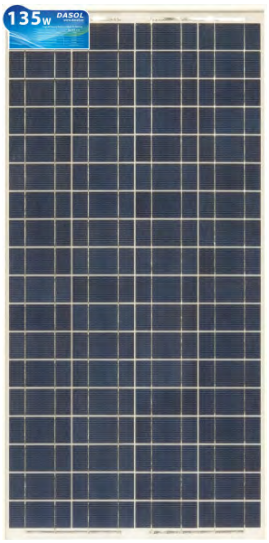
The new **Q.PEAK DUO-G5** solar module from Q CELLS impresses thanks to innovative Q.ANTUM DUO Technology, which enables particularly high performance on a small surface. These innovative split-cell modules leverage Hanwha Q-Cells legacy in high-performance mono- PERC cells, packaged in a new 120-cell format.

Made in Korea, these modules ship from the US and feature a 12-year product and 25-year linear performance warranty.These modules are listed to UL 1703, IEC 61215, and IEC 61730-2. They are certified for use in 600 VDC or 1,000 VDC applications.

Q-Cells Q-PEAK DUO Series PV Modules[1]	
Technical data	
Cells (qty/size)	120 / 6 in x 3 in [78.375 mm]
Power output tolerance	-0/+5 W
Nominal Operating Cell Temperature (NOCT)	113 +/- 5.4°F [45 °C +/-3 °C]
Voltage temperature coefficient	-0.50%/°F [-0.28%/°C]
Fire rating/type	Class C / Type 1
Connector type	MC4
Cable length	43.3 in [1.1 m]
Static load rating	75 psf [3,600 Pa] (design load)
Quantity per pallet	32
Quantity per 53' trailer	960
Max. system voltage	1,000 VDC
Series fuse rating	20 A
Dimensions (L x W x D)	66.3 × 39.4 x 1.26 in [1685 × 1000 × 32 mm]
Weight	41.2 lbs [18.7 kg]
Module	Q.PEAK-DUO 320
Peak power	320 W
Voltage at peak power	33.32 VDC
Current at peak power	9.60A
Open circuit voltage	40.13 VDC
Short circuit current	10.09 A
Module area efficiency	19.00%
Item code	**011-06545**

[1] Data subject to change without notice





Dasol Energy

DS-A18 Series PV Modules

These 12 VDC nominal modules have an output voltage that is well-suited for charging 12-Volt batteries and can be wired in series for charging 24- or 48-Volt battery banks. They can be used with inexpensive PWM controllers (see Charge Controllers for more information).

These modules, from Dasol Energy, are efficient and robust with tempered glass, tough polymer back sheets, and anodized aluminum frames. The modules offered here are listed to UL 1703, CSA 5311-10 & 90 as well as IEC 61215 and are produced in an ISO 9001 certified facility. The DS-A18-10 has wire leads. The **DS-A18-30** has a single-port J-box and can be ordered with a 2-conductor lead. The larger modules feature diode-accessible junction boxes with pre-assembled MC4 compatible style leads. Made in China.

Dasol Energy DS-A18 Series PV Modules				
Technical data				
Number of cells	36			
Power output tolerance	+/- 5%			
$Voltage_{oc}$ temperature coefficient	-0.68%/°F [-0.38%/°C]			
Fire rating	Class C			
Connector type	Wire leads (10-30 W) or J-box with MC4-type leads			
Maximum system voltage	600 VDC			
Module	**DS-A18-30**	**DS-A18-60**	**DS-A18-90**	**DS-A18-135**
Peak power	30 W	60 W	90 W	135 W
Voltage at max power	18.0 VDC	18.0 VDC	18.0 VDC	18.0 VDC
Current at max power	1.67 A	3.33 A	5.0 A	7.5 A
Open circuit voltage	22.3 VDC	22.3 VDC	22.3 VDC	22.3 VDC
Short circuit current	1.82 A	3.64 A	5.45 A	8.18 A
Series fuse rating	4.0 A	6.0 A	8.0 A	12.0 A
Length	20.1" [510 mm]	26.2" [665 mm]	36.6" [930 mm]	52.36" [1330 mm]
Width	17.7" [450 mm]	25.6" [650 mm]	26.2" [665 mm]	26.2" [665 mm]
Depth	1" [25 mm]	1.38" [35 mm]	1.38" [35 mm]	1.38" [35 mm]
Weight	6.6 lbs [3 kg]	10.8 lbs [4.9 kg]	15.9 lbs [7.2 kg]	22.5 lbs [10.2 kg]
Item code	**011-08967**	**011-08968**	**011-08969**	**011-08970**

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Mounting Structures

Mounting structures are used to fix PV modules to the roof or to the ground so they aren't moved by wind or snow. Be sure to consult the PV module manufacturer's installation manual when selecting and configuring a mounting system as not all modules are compatible with all mounting methods. If the manufacturer doesn't explicitly allow for the type of clamp and mounting locations or grounding method used by the mounting system, it may not pass inspection.

Some ground-mounting systems fasten to the bottom flange using specialized clips, enabling installers to perform virtually all of their work underneath the modules. Top clamps, which clamp the module frame to a mounting rail or roof attachment, are most popular today as the clamps can double as spacers and clamp two modules simultaneously, reducing the total number of fasteners required. Regardless of clamp type, it is also important to clamp the module in the right places.

Most PV modules are designed to be clamped at the quarter-points where the mounting holes typically are. This ensures optimal loading on the module frame and provides maximum static and dynamic load capacity. Some manufacturers also allow for mounting on the short ends of the module, which can allow two rows of modules to share a rail. However, mounting on the ends typically reduces the load ratings of the module, which is why some module manufacturers don't allow it. Recently, there has been new developments in 'rail-less' solar racking solutions, potentially reducing components and cost for roof mounted solar modules.

Early equipment grounding for module frames was accomplished with a bolt or screw with a star washer attached to the grounding wire. AEE Solar later introduced grounding lugs which provided a faster and more secure method for attaching the ground wire and these gave way to WEEB grounding clips or washers (See Electrical Distribution Parts) which enabled module grounding through the rail. With the advent of the UL 2703 mounting and grounding standard, many mounting systems, such as SnapNrack, accomplish grounding through the mounting components so that the installer only needs to run a grounding wire to the end of each row of modules.

SnapNrack

Solar Mounting Solutions

SnapNrack was developed by a team of veteran solar engineers working with installers in the field to ensure a quick, efficient installation using modules from virtually any manufacturer. The SnapNrack roof mounting system simplifies and reduces the cost of the solar installation process.

The rail is a lightweight aluminum extrusion that is easy to transport, handle, and install. Snap-in sliding channel nuts ensure quick and easy installation and precise alignment of module clamps. Every bolt in the system uses the same sized wrench, ensuring efficient installations and reducing labor hours on the roof. Standoffs and L-feet connect to the rails using the same snap-in channel nuts as the module clamps and no drilling is required.

SnapNrack is engineered for durability and structural integrity in all environments, providing excellent seismic, wind, and snow loading protection on all products. Its compact and efficient rail design reduces material requirements and ensures a low-profile installation on any roof. SnapNrack has been engineered from the ground up with maximum standoff adjustability for a clean, level installation even on irregular roof surfaces.

Online Configuration Tools for Series 100, Series 200, as well as the new RL and Ultra Rail systems, are available on AEE Express or the SnapNrack website (SnapNrack.com), as are installation manuals. The SnapNrack manuals are a complete how-to guide full of color photos, illustrations, and step-by-step instructions.

UL 2703 Grounding and Bonding Compliance

SnapNrack 100 and 200 systems are fully listed to the UL 2703 Standard for Grounding and Bonding. As of January 1, 2016, all SnapNrack system products offered through AEE Solar have been certified by UL for electrical continuity, eliminating the need for additional grounding hardware. Bonding pins are integrated into product assemblies including module clamps and rail splices, eliminating the need for bonding washers on each PV module or rail splice jumpers. Only one SnapNrack Grounding Lug is required per individual row of modules (not per rail).

UL 2703 Class A Fire Rating Compliance

In addition to grounding and bonding, SnapNrack's UL 2703 Certification and Compliance ensures that the Series 100 roof mount system is Class A Fire Rated when installed with Type 1 and Type 2 photovoltaic modules. SnapNrack achieved the Class A fire rating through stringent testing that included the Spread of Flames tests and the Burning Brand tests. The system also meets the requirements of the California building codes set by local jurisdictions and the 2012 International Building Codes which went into effect on January 1, 2015.

SnapNrack Product Selector

SnapNrack offers many racking solutions to fit just about any residential or small commercial application. Ultra Rail is a new offering to optimize total install cost. Series 100 has been the mainstay for many years, and offers the most current mounting options for roof type, wind, and snow conditions. RL is a new rail-less product that speeds installs and eliminates use of long rails.

RL	Series 100	Ultra Rail
The greatest labor efficiencies realized through elimination of rails. No longer are you dealing with 14 foot long sticks of rail both on the roof or in the warehouse. The intuitive design allows modules to lay down in place by a single installer. Focus on ergonomics and installation mechanics with features like top side bolting.	The most comprehensive residential roof mount racking system on the market with solutions for virtually any installation type. Superior strength and performance with allowable spans up to 10 ft. Dual integrated wire management channels along with a full suite of wire management accessories that ensures a top quality install that lasts the life of the system.	Our newest rail system optimized for low load regions. Unique snap-in mounts and splices while still maintaining the SnapNrack wire management channel and compatibility with our full suite of wire management accessories and module attachments.

	RL	S100	Ultra Rail
Composition Shingle	✓	✓	✓
Tile		✓	✓
Standing Seam and Corrugated Metal		✓	✓
Universal End Clamps Keep Racking Hidden Underneath Array		✓	✓
Sleek Black Mounts for Front of Array	✓		
Integrated Wire Management Channel		✓	✓
Dual wire channels for separation of circuits/voltages		✓	
Snap-in Wire Clamps, Junction Boxes and More		✓	✓
Module Frame Wire Management w/ Smart Clip & Wire Saver	✓		
1½ inches Vertical Leveling	✓	✓	✓
Flash Track w/ 6" North-South Adjustability	✓		
Elimination of Rails for Improved Labor Efficiency	✓		
Features for Single Person Install	✓		
Capable of 6 ft. Spans	✓	✓	✓
Capable of 8 ft. Spans		✓	
Capable of 10 ft. Spans		✓	

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SnapNrack™

Solar Mounting Solutions

The Ultimate Value in Rooftop Solar

New Snap-in L Foot Mounts

Single fastener Splice requires no drilling

Compatible with full suite of SnapNrack Accessories

877-732-2860 www.snapnrack.com contact@snapnrack.com

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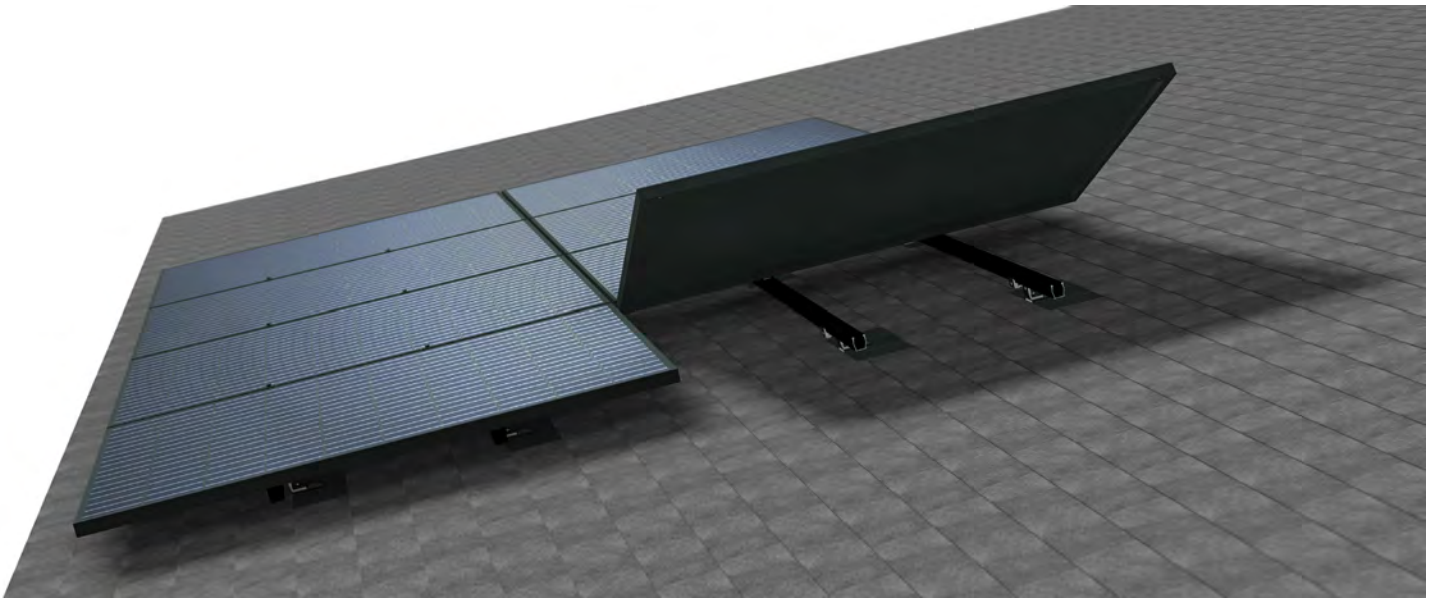
SnapNrack Ultra Rail

The Ultimate Value in Rooftop Solar

Ultra Rail is a sleek, lightweight rail solution for mounting solar modules on the roof. The entire system is a snap to install utilizing new Ultra Rail Mounts that include Snap-in brackets for attaching rail. Compatibility with all existing module clamps maintains the same intuitive install experience installers know and love.

- Industry-leading aesthetics with Universal End Clamps and Snap-in End Caps that make the mounting system invisible underneath the array
- Unparalleled wire management solutions with accessories such as Junction Boxes, Universal Wire Clamps, MLPE Attachment Kits, and Conduit Clamps
- Low profile rail maintains the open channel with room for running wires resulting in a top quality finished install
- The largest span capabilities of any light rail solution.



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SnapNrack Ultra Rail

Ultra Rail is a sleek, lightweight rail solution for mounting solar modules on the roof. The entire system is a snap to install utilizing new Ultra Rail Mounts that include snap-in brackets for attaching rail. Compatibility with all existing module clamps maintains the same intuitive install experience installers know and love.

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- The largest span capabilities of any light rail solution

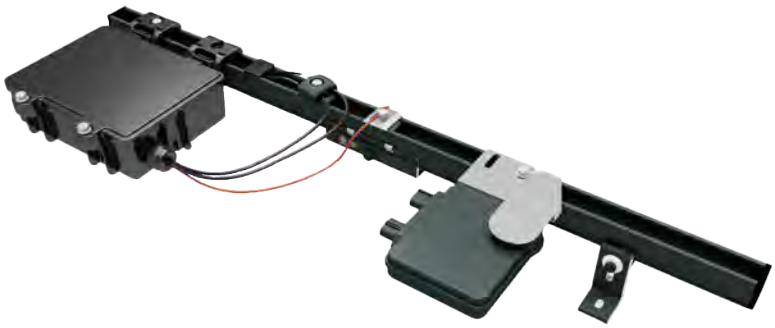
UR-40 Rail, Black

UR-40 Rail, Silver

Ultra Rail Splice

UR-40 End Cap

UR-40 Rail	
Description	**Item Code**
Black Rail	
UR-40 Rail Set, 168", Black (Box of 8)	**015-10202**
UR-40 Rail, 168", Black (Bundle of 144, priced as each)	**232-02451**
Silver Rail	
UR-40 Rail Set, 168", Silver (Box of 8)	**015-10201**
UR-40 Rail, 168", Silver (Bundle of 144, priced as each)	**232-02450**
Mill Rail	
UR-40 Rail Set, 168", Mill (Box of 8)	**015-10203**
UR-40 Rail, 168", Mill (Bundle of 144, priced as each)	**232-02449**
Rail Accessories	
Ultra Rail Splice, Black	**242-01214**
Ultra Rail Splice, Silver	**242-01214**
UR-40 End Cap	**232-02452**



Ultra Rail with Wire Management Solution

SnapNrack Ultra Rail Roof Attachments

Composition Roof Solutions

The new SnapNrack Ultra Rail features all new attachments, suitable for composition, seamed and corrugated metal, and tile roof surfaces. A new, patented Umbrella Bolt provides waterproofing for all roof surfaces when used with the newly designed composition flashing. Purchase either the Black Comp Flashing or the Silver Comp Flashing, the Ultra Rail Umbrella L Foot, and the Umbrella Lag for a complete set for attaching the Ultra Rail to a composition roof surface. The L Foot Extension Kit is also available if needed.

Comp Flashing

Ultra Rail Umbrella L Foot

Umbrella Lag

Ultra Rail Comp Shingle Roof Attachments	
Description	**Item code**
Ultra Rail Umbrella L Foot, Silver	**242-92047**
Ultra Rail Umbrella L Foot, Black	**242-01220**
Ultra Rail Mounting Hardware, Silver	**242-01229**
Ultra Rail Mounting Hardware, Black	**242-01230**
Comp Flashing, 9" x 12", Black Alum (Requires Umbrella Lag)	**232-01275**
Comp Flashing, 9" x 12", Silver Alum (Requires Umbrella Lag)	**232-01276**
L Foot Extension Kit	**242-01120**
Umbrella Lag, 4"	**242-92266**

Metal Roof Solutions

SnapNrack's new Ultra Rail can also be used for many types of metal roof surfaces. The **Metal Roof Base with L Foot** provides a robust, self-sealing mounting base for common corrugated metal roof profiles with a flat mounting surface. It can't be beat for ease of installation and reliability over the service life of the system.

Seam Clamps are designed to allow the attachment of solar rails and modules directly to a standing seam metal roof without penetrating the metal or collapsing the ridge in the metal roof material. We offer both the **Ultra Rail Standard Base Seam Clamp with L Foot** and the **Ultra Rail Wide Base Seam Clamp with L Foot**. If using a 3rd party metal roof attachment, we also offer the **Ultra Rail All Purpose L Foot (90º)**.

Ultra Rail Metal Roof Base w/ L Foot

Metal Roof Attachments	
Description	**Item code**
Ultra Rail Metal Roof Base w/ L Foot	**242-02158**
Ultra Rail Standard Base Seam Clamp w/ L Foot and Lock	**242-05158**
Ultra Rail Wide Base Seam Clamp w/ L Foot and Lock	**242-05159**
Ultra Rail All Purpose L Foot 90º (Silver)	**242-01223**
Ultra Rail All Purpose L Foot 90º (Black)	**242-01239**

Ultra Rail Standard Base Seam Clamp w/ L Foot

Ultra Rail Wide Base Seam Clamp w/ L Foot

Ultra Rail All Purpose L Foot 90º

Tile Roof Solutions

The new Tile Replacement products, including the **Ultra Flat Tile Replacement, Ultra S Tile Replacement,** and **Ultra W Tile Replacement,** create a source of tiles to replace those broken during installation. Tile Replacements and feature a base assembly for simply lagging the base into place and then sliding the riser shaft into position for the tile replacement flashing. The Ultra Rail L Foot then allows quick and easy installation of Ultra Rail for these projects. **For each solution, customers will need a Flashing Kit and a Hardware Kit.**

The new **Ultra Rail Tile Hook** features a strong and rigid design, reducing the quantity of roof attachments required and a slotted attachment provides 1.25" of vertical adjustment for array leveling.

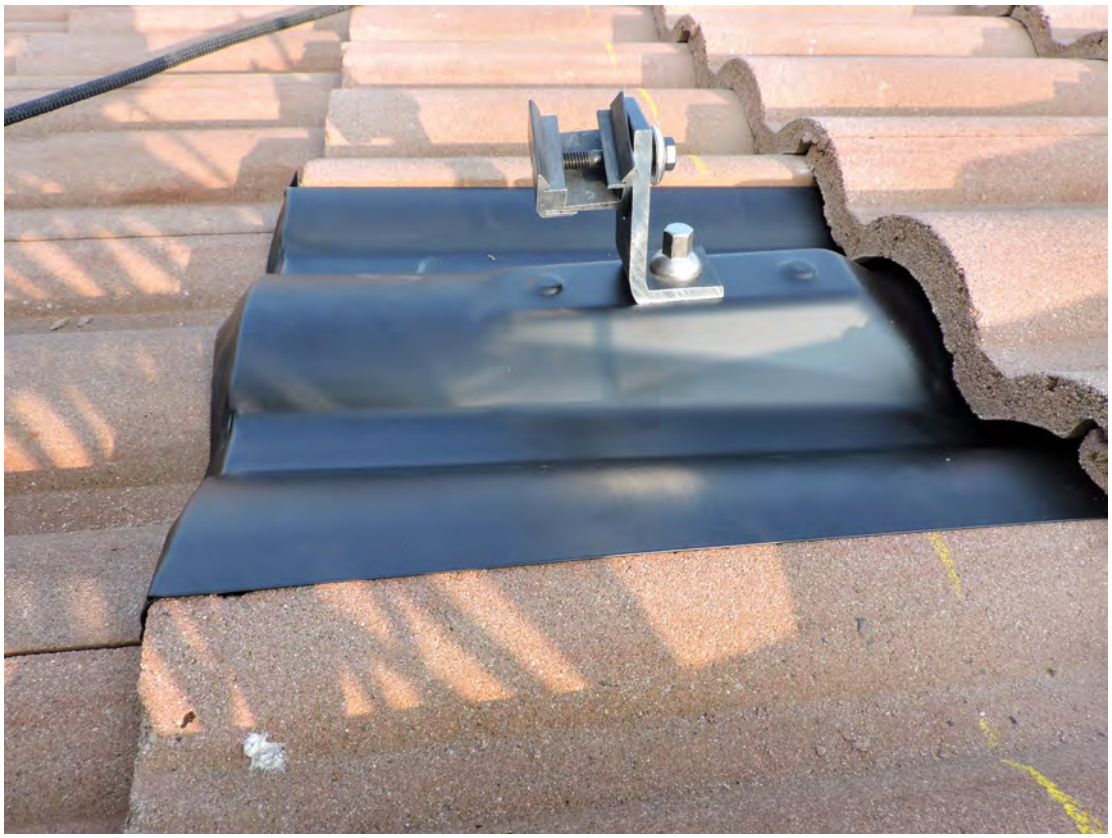
Ultra Flat Tile Replacement Solution

Ultra S Tile Replacement Solution

Ultra W Tile Replacement Solution

Ultra Flat Tile Hook Kit

Ultra Rail Tile Roof Attachments	
Description	**Item Code**
Flat Tile	
Flat Tile Replacement, 0.56 in Hole, No Insert, Black	**232-01190_BK**
Ultra Rail Flat Tile Hardware Kit W/Cone	**242-01250**
S Tile	
S Tile Replacement, 0.56 in Hole, No Insert, Black	**232-01192_BK**
Ultra Rail S Tile Hardware Kit W/Cone	**242-01252**
W Tile	
W Tile Replacement, 0.56 in Hole, No Insert, Black	**232-01191_BK**
Ultra Rail W Tile Hardware Kit W/Cone	**242-01251**
W Tile	
Ultra Rail Flat Tile Hook	**242-01224**
L Foot Extension Kit	**242-01220**



Ultra Rail W Tile Replacement Solution, Installed

SnapNrack Module Attachments

SnapNrack Mid and End Clamps work with Ultra Rail, S100 and S200 systems. **Module Mid Clamps** and **Adjustable End Clamps** are available in different sizes to match PV module frame thickness/ depth. **Universal End Clamps** are a unique one-size-fits-all time saver that slips inside the module frame – completely out of sight. The rails are cut flush with the modules and finished with SnapNrack end caps to create a system with a flush, clean line homeowners love.

Bonding Mid Clamp Assembly, Black

Bonding Adjustable End Clamp 1.19"-1.49", Black

Universal End Clamp

Module Clamps	
Mid Clamps	
Description	**Item code**
Bonding Mid Clamp, 30-38mm (1.19-1.49"), Black	**242-92332**
Bonding Mid Clamp, 30-38mm (1.19-1.49"), Clear	**242-92335**
Bonding Mid Clamp, 33-45mm (1.30-1.77"), Black	**242-02054**
Bonding Mid Clamp, 33-45mm (1.30-1.77"), Clear	**242-02051**
Bonding Mid Clamp, 38-51mm (1.49-2.00"), Black	**242-02055**
Bonding Mid Clamp, 38-51mm (1.49-2.00"), Clear	**242-02052**
Bonding Mid Clamp, 49-57mm (1.93-2.24"), Black	**242-02057**
Bonding Mid Clamp, 49-57mm (1.93-2.24"), Clear	**242-02056**
End Clamps	
Description	**Item code**
Universal End Clamp	**242-02215**
Bonding Adjustable End Clamp, 30-38mm (1.19-1.49"), Black	**242-02067**
Bonding Adjustable End Clamp, 30-38mm (1.19-1.49"), Clear	**242-02065**
Bonding Adjustable End Clamp, 38-51mm (1.49-2.00"), Black	**242-02068**
Bonding Adjustable End Clamp, 38-51mm (1.49-2.00"), Clear	**242-02066**

SnapNrack Array Skirt

The **SnapNrack front Array Skirt** easily attaches to the front row of modules on almost any system. Only a ½" socket is required for attaching the **Skirt Frame Mount** to the modules. Attaching the Skirt to the mounts as well as installing the Splices requires no tools. The **Skirt End Cap Pair** provides the finishing touch.

Array Skirt

Skirt Frame Mount

Skirt Splice

Skirt Cap Pair

Front Array Skirt	
Description	**Item code**
Skirt Kit, 162" (2) + Mounts (8) + Spice (1) End Cap Pairs (2)	**015-11788**
Skirt, 162" (Bundles of 60, priced as each)	**232-01259**
Skirt Frame Mount	**242-92211**
Skirt Splice	**232-01251**
Skirt End Cap Pair	**232-01250**

SnapNrack Series 100

The Installer's Choice for Residential Solar Mounting

Series 100 is the most complete system solution for mounting solar modules on the roof in any region or loading condition. The top-of-the-line features of this SnapNrack mounting solution reduce install times and labor cost while eliminating the need for service calls creating the lowest installed lifecycle cost of any mounting system. Industry-leading aesthetics with Universal End Clamps and snap-in End Caps make this mounting system invisible underneath the array

- Undeniable aesthetics using Universal End Clamps that render the mounting system invisible by fastening on the inside of the modules underneath the array
- Optional Array Skirt provides a sleek look and attractive design to the front of the array
- Two rail channels keep wires neatly organized providing a clean finished look to every install
- Industry's largest offering of wire management accessories include snap-in Junction Boxes and Universal Wire Clamps, as well as conduit clamps for both composition shingle and tile roofs
- The largest span capabilities of any SnapNrack mounting system

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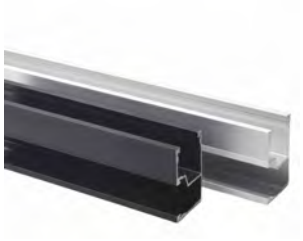
SnapNrack Series 100 Rails



S100 Rail, Black

Bonding Standard Rail Splice, Black

Standard Rail End Cap

UEC Rail Cutting Tool

Series 100 Rail is offered in two lengths, three finishes, and shipped in 2-piece or 6-piece sets and 112-piece bundles. 122" rail can accommodate a single portrait row of three 60-cell or 72-cell modules. 162" rail accommodates four modules. Use the **UEC Rail Cutting Tool** to protect module frames when cutting rails flush with the module edges when using Universal End Clamps.

Standard Rail Splices & Accessories	
Rail Splice	
Description	**Item code**
Bonding Standard Rail Splice, Black	**242-04015**
Bonding Standard Rail Splice, Clear	**242-04014**
Standard Rail Accessories	
Description	**Item code**
Standard Rail End Cap	**232-01023**
UEC Rail Cutting Tool	**232-02284**
Black Standard Rails	
Description	**Item code**
Standard Rail Set, 122", Black (Box of 2)	**015-09816**
Standard Rail Set, 122", Black (Box of 6)	**015-09822**
Standard Rail, 122", Black (Bundle of 112, priced as each)	**232-01067**
Standard Rail Set, 162", Black (Box of 2)	**015-09818**
Standard Rail Set, 162", Black (Box of 6)	**015-09826**
Standard Rail, 162", Black (Bundle of 112, priced as each)	**232-01069**
Clear Standard Rail	
Description	**Item code**
Standard Rail Set, 122", Clear (Box of 2)	**015-09814**
Standard Rail Set, 122", Clear (Box of 6)	**015-09813**
Standard Rail, 122", Clear (Bundle of 112, priced as each)	**232-01068**
Standard Rail Set, 162", Clear (Box of 2)	**015-09817**
Standard Rail Set, 162", Clear (Box of 6)	**015-09824**
Standard Rail, 162", Clear (Bundle of 112, priced as each)	**232-01070**

Mill Standard Rail	
Description	**Item Code**
Standard Rail, 122", Mill (Bundle of 112, priced as each)	**232-02112**
Standard Rail, 162", Mill (Bundle of 112, priced as each)	**232-02113**

SnapNrack Series 100 Roof Attachments

SnapNrack offers a variety of roof attachment methods by combining familiar parts with more specialized hardware. The L Foot, Flashing & Base Kit, is recommended for simple flush mounts to a roof with composition shingles only.

Black L Foot, Black Galv Flashing, and Base Kit

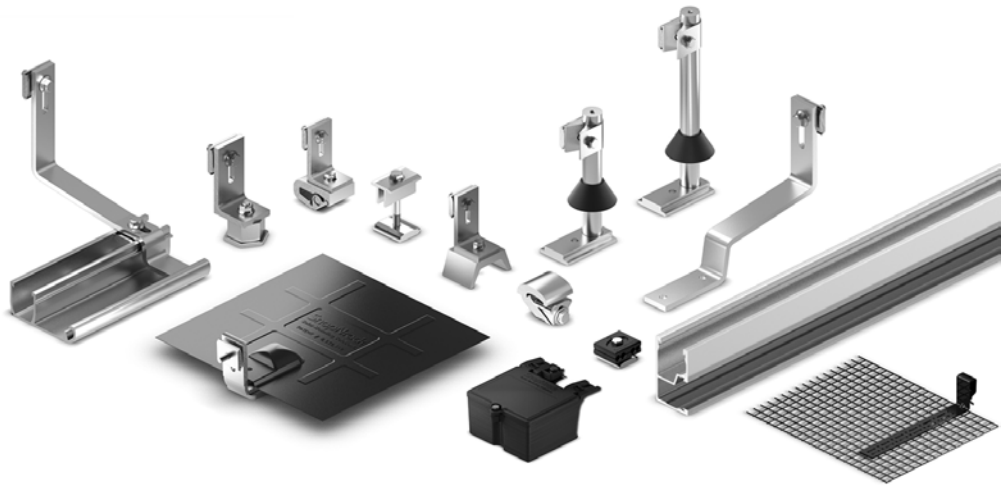
Black 90 Deg L Foot

Silver 92 Deg L Foot

Standoff Spacer 1"

Stainless Steel Lag Screws

Standoff Mounts for All Roof Types	
Standoff Kits	
Description	**Item code**
S100 Comp Kit With Black Composition L Foot, Black Alum Flashing, And Base	**242-92048**
S100 Comp Kit With Silver Composition L Foot, Black Galv Flashing, And Base	**242-92050**
S100 Comp Kit With Black Composition L Foot, Black Galv Flashing, And Base	**242-92051**
Flashed L Foot Flashing, 12" X 12", Black Galv (L Foot not included)	**232-01060**
Flashed L Foot Flashing, 12" X 12", Black Alum (L Foot not included)	**232-01151**
Flashed L Foot Flashing, 12" X 12", Silver Alum (L Foot not included)	**232-01150**
Flashed L Foot Base (Inc. Base Plate and Flange Nut)	**242-00016**
S100 Composition L Foot (92 Deg), Black (flashing not included)	**242-09015**
S100 Composition L Foot (92 Deg), Silver (flashing not included)	**242-09005**
S100 All Purpose L Foot (90 Deg), Black (flashing not included)	**242-09020**
S100 All Purpose L Foot (90 Deg), Silver (flashing not included)	**242-09019**
Standoff Spacer, 1"	**242-92081**
Lags and Washers	
5/16" X 3 1/2" Hex Lag Screw And 5/16" X 3/4" Washer, SS, 12 Pk	**014-06500**
5/16In X 5" Hex Lag Screw And 5/16" X 3/4" Washer, SS, 12 Pk	**014-06502**
Lag Screw 5/16" X 3-1/2" , SS, 100 Pk	**164-03252**
Lag Screw 5/16" X 5" , SS, 100 Pk	**164-03253**
SS Split Lock Washer, 5/16", 100 Pk	**165-02204**



SnapNrack Series 100 System

SnapNrack S100 Tile Solutions

Flat Tile Replacement Kit

W Tile Replacement Kit

Flat Tile Hook & Universal Tile Hook

S100 Metal Roof Base w/ L Foot

S100 Standard Base Seam Clamp w/ L Foot

The SnapNrack **Tile Replacement** solution provides the highest quality method for mounting Series 100 Rail on tile roofs, eliminating the need for grinding or cutting of tiles. Quick and intuitive install saves time on the roof compared to standoffs. Since the tile replacement completely takes the place of the existing tile, installers will have plenty extra in case replacements need to be made. The tile replacement is composed of four main components: the base, riser, flashing, and L Foot assembly. Simply lag the base into the rafter and adjust the riser to line up with the hole in the flashing, insert the flashing and tighten on the L foot then you're ready to attach rails. **Customers will need to order both the Tile Replacement Flashing and the Tile Hardware Kit for their respective tile type.**

The **Universal Tile Hook** is designed to work with Flat, S, and W shaped tile roofs which can typically install with minimal cutting/grinding of tiles. Provides enhanced install flexibility regardless of the rafter location due to the 1.25" vertical adjustability and 6" horizontal adjustability of the tile hook in relation to the large 4" x 8" base. Its 1/4" steel arm is thicker and more rigid compared to competing products on the market, requiring less roof attachments per installation. The **Flat Tile Hook** is an efficient solution for mounting on flat concrete tile rooftops;the design focuses on maximizing speed and efficiency for installing specifically with concrete flat tiles.

S100 Tile Roof Attachments	
Description	**Item code**
Flat Tile Replacements	
Flat Tile Replacement, 0.56 in Hole, No Insert, Black	**232-01190_BK**
S100 Flat Tile Hardware Kit W/Cone	**242-01253**
S Tile Replacements	
S Tile Replacement, 0.56 in Hole, No Insert, Black	**232-01192_BK**
S100 S Tile Hardware Kit W/Cone	**242-01255**
W Tile Replacements	
W Tile Replacement, 0.56 in Hole, No Insert, Black	**232-01191_BK**
S100 W Tile Hardware Kit W/Cone	**242-01254**
Tile Hooks and Accessories	
S100 Flat Tile Hook	**242-02045**
S100 Universal Tile Hook	**242-02044**
L Foot Extension Kit, Black	**242-01120**

The **Metal Roof Base** provides a robust self-sealing EPDM rubber washer and a sealing top cap mounting base for common corrugated metal roof profiles. The **Standard and Wide Base Seam Clamps** are made from a high tensile strength aluminum that will work with a range of metal roof designs. The **Corrugated Straddle Block** allows attachment of the L Foot directly to a structural member covered with a corrugated metal roof without collapsing or crushing the ridge in the metal roof material.

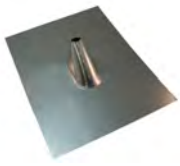
S100 Metal Roof Attachments	
Description	**Item code**
S100 Metal Roof Base With All Purpose L Foot	**242-02037**
Metal Roof Base	**242-02036**
S100 Standard Base Seam Clamp With All Purpose L Foot and Lock	**242-05156**
Standard Base Seam Clamp	**242-05000**
S100 Wide Base Seam Clamp With All Purpose L Foot and Lock	**242-05157**
Wide Base Seam Clamp	**242-05001**
S100 Corrugated Straddle Block With All Purpose L Foot	**242-02046**
Corrugated Straddle Block, Mill	**232-02421**
S100 Hanger Bolt Clamp	**242-01102**

S100 Standoff Kit, 5½"

S100 HD Standoff Kit, 12 IN

S100 Standoff Clamp Assembly

10° Tilt Kit w/ 5 ½" & 10" Standoffs



Standoff Flashing, 4" Offset Cone, 18 ¾" X 15", Galv

SnapNrack Series 100 Roof Attachments

S100 Standoffs can be used on flat roofs or pitched roofs, comp shingle or tile and include a onehole base, anodized standoff shaft, rubber rain collar and a standoff clamp assembly. **S100 HD Standoffs** are typically used on flat roofs with built up foam insulation where a taller standoff is required. They include a six-hole HD base, anodized HD standoff shaft, rubber rain collar and standoff clap assembly. Use appropriate metal flashing or E-Curb flashing for your roof application, or have a certified roofer install and seal roof attachments for your project.

Standoff Mount Roof Attachments	
Description	**Item code**
S100 Standoff Kit, 5-1/2"	**242-92057**
S100 Standoff Kit, 7"	**242-92059**
S100 Standoff Kit, 8-1/2"	**242-92061**
S100 Standoff Kit, 10"	**242-92055**
S100 HD Standoff Kit, 7"	**242-92073**
S100 HD Standoff Kit, 12"	**242-92074**
S100 HD Standoff Kit, 18"	**242-92075**
Standoff Base, 1"	**242-02412**
Standoff Spacer, 1"	**242-92081**
S100 Standoff Clamp Assembly	**242-04100**

Series 100 Tilt Kits

Tilt Kits can be used to tilt up arrays on low-slope roofs. These kits include two standoff mounts with bases (one-hole for standard and six-hole for HD), anodized standoff shafts, rubber rain collars and the Standoff Clamp and L Foot Assembly.

Tilt System Roof Attachments	
Description	**Item code**
S100 10 Deg Tilt Kit With 5-1/2" And 10" Standoffs	**242-92077**
S100 20 Deg HD Tilt Kit With 7" And 18" HD Standoffs	**242-92079**
10-30 Deg Variable Tilt Hardware Kit	**242-92083**

Standoff Flashings and Accessories	
Description	**Item code**
Flashing Kits, E-Curb, 4.5" X 3.5", Gray, 3Pk, Pourable	**131-01357**
Rubber Rain Collar	**232-01000**
Standoff Flashing, Straight Cone For 1" Standoff, 18" X 18" X 4", Galv	**131-01213**
Standoff Flashing, Verde 1.0Stf, Skinny Cone For Tile, 20" X 20" X 3", Dead Soft Alum	**175-05001**
Standoff Flashing, Offset Cone For 1-Hole Base On Flat Tile, 19" X 15" X 4", Galv	**131-01216**
Standoff Flashing, Oatey 11830, No Caulk Rubber Cone, 9" X 12", Galv	**015-00162**
Standoff Flashing, Verde 1.0Sso, Deck Level For 1-Hole Base, 10" X 12" X 1", Galv	**175-05005**

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ChemLink Sealants and Adhesive

ChemLink Rectangular ECurb

E-Curbs seal penetrations by using a plastic mold and a pour-in-place polymer seal. E-Curbs are designed for use on granulated modified bitumen, asphalt and coal tar B.U.R. (built up roofing), and are specified for PVC, PIB, and TPO single-ply roofing membranes. The service temperature range for the E-Curbs is -40 °F to 200 °F, but should not be applied at temperatures below 32 °F. This rectangular E-Curb was specifically designed to work with SnapNrack one-hole standoff kits and the SnapNrack HD standoff kits. E-Curbs also make good conduit penetration seals. Round E-Curbs are also available, if needed, but must be special ordered and purchased in lot sized quantities.

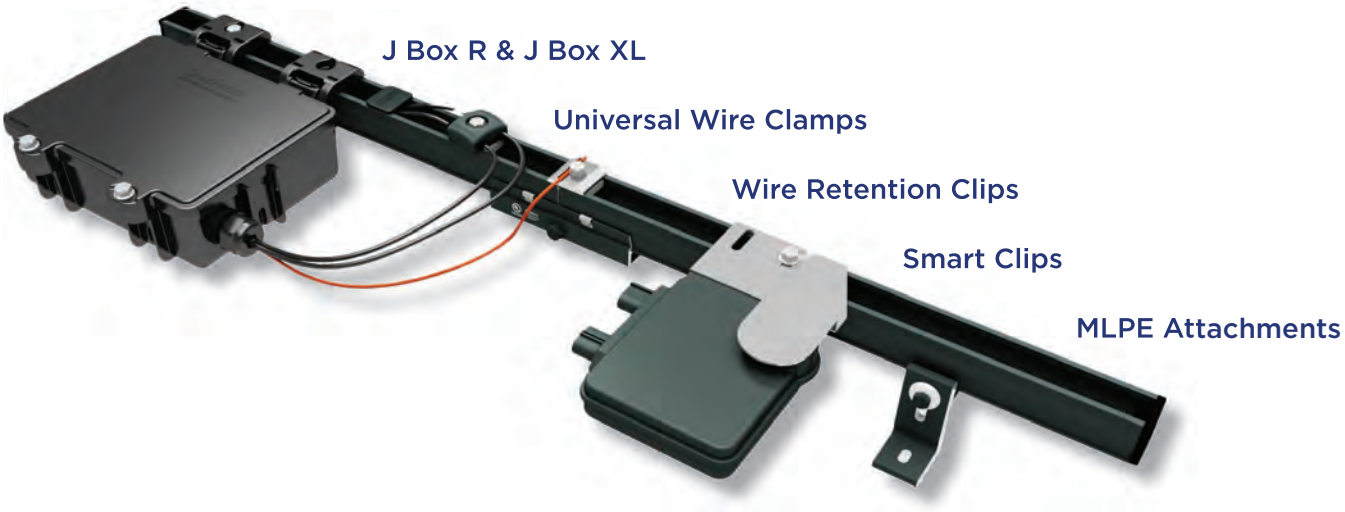
The M-1 Black Structural Adhesive can be used under standoffs for water protection on roof penetrations, and is compatible with most roof materials.

Chem Link E-Curbs	
Description	**Item Code**
E-Curb, 4.5" x 3.5" rectangle, Grey - three - E-Curbs, 1.5 gal pouches of one-part pourable sealer, two 10.1 oz cartridge of M-1	**131-01357**
M-1 Black Structrual Adhesive and Sealant, 10.1 oz. Plastic Cartridge	**178-06009**

SnapNrack™
Solar Mounting Solutions

Industry Leading
Wire Management Solutions

Large Rail Channel
J Box R & J Box XL
Universal Wire Clamps
Wire Retention Clips
Smart Clips
MLPE Attachments



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Junction Box R

Junction Box XL for Rail

Universal Wire Clamp R

Snap-In Wire Retention Clip

Smart Clip I

MLPE Rail Attachment Kit

MLPE Frame Attachment Kit

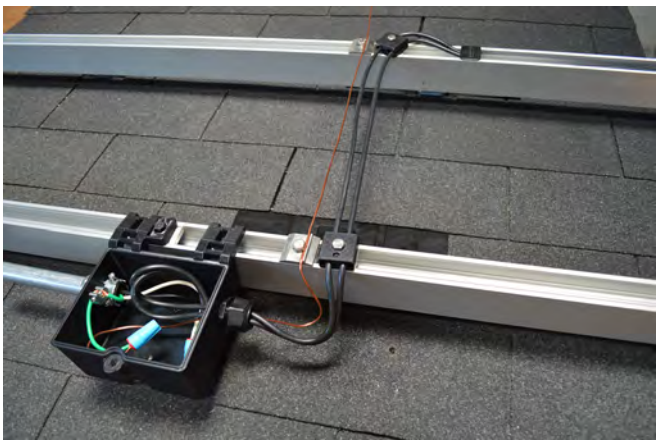
Series 100 / Series 200 / Ultra Rail Grounding and Wire Management

SnapNrack's **Ground Lug R** is a fully custom solution for grounding arrays. Only one lug is required per individual row of modules, not one per rail. For the Series 200 Ground Mount System, only one ground lug is required for an entire array. The lug is secured with a single 5/16" bolt and requires no drilling of rails. SnapNrack **Wire Management Solutions** comprise a set of dedicated components to reliably and cost effectively secure PV module and microinverter leads. All components are made of materials which have been selected for their ability to handle high UV exposure and extreme rooftop temperatures common under solar arrays. With an integrated rail connector the UL-listed **Junction Box R** and **Junction Box XL** provide a quick and easy method for concealing and protecting electrical connections. The Junction Box R is a 6" x 5" x 3" enclosure and the Junction Box XL is a 10.6" x 9.4" x 3.5" enclosure, each have a NEMA 4X rating with integrated DIN rail mounts inside. The **Universal Wire Clamp** offers a strong and reliable solution for securing up to four PV conductor cables or up to two microinverter cables along SnapNrack rail channels, transitioning in and out of channels, and even routing across rails. **Snap-In Wire Retention Clips** allow you to quickly secure PV conductor and AC trunk lines in the rail channels. With materials selected to handle high UV exposure and extreme rooftop temperatures these solutions provide wire management that will last the life of the system after a quick and cost-effective installation.

Wire & Electronics Management	
Description	**Item code**
Junction Boxes	
Junction Box R For Rail	**242-01104**
Junction Box XL For Rail	**242-92120**
Junction Box S With Comp Kit	**242-01113**
Junction Box XL With Comp Kit	**242-92121**
Wire Management	
Universal Wire Clamp R	**242-02150**
Universal J Box Wire Clamp	**242-09025**
Snap-In Wire Retention Clip	**232-01106**
Smart Clip I, Pack of 100	**052-09128**
Smart Clip II, Pack of 100	**052-09129**

SnapNrack Attachment Accessories

Attachment Accessories	
Module Level Power Electronics	
Description	**Item code**
MLPE Rail Attachment Kit	**242-92093**
MLPE Frame Attachment Kit	**242-02151**



S100 with Junction Box and Wire Management

SnapNrack Conduit Supports

The **Conduit Support for Tile** works with flat and curved tiles, requiring no drilling or cutting to install. These mounts are fully assembled with a captive bolt in the conduit clamp makes installation a snap. The **Conduit Support Kit for Comp** includes all of the parts necessary to quickly install a fully flashed solution, including the lag screw. Both conduit supports are designed for 3/4" EMT.

Conduit Support for Composition Shingle Roofs

Conduit Support for Tile Roofs

Conduit Supports	
Description	**Item code**
Conduit Support For Tile, 3/4" EMT	**242-02104**
Conduit Support Kit For Comp, 3/4" EMT	**242-02106**
Conduit Support For Tile, 1" EMT	**242-02108**
Conduit Support Kit For Comp, 1" EMT	**242-02109**

Grounding

SnapNrack's **Ground Lug R** is a fully custom solution for grounding arrays. Only one lug is required per individual row of modules, not one per rail. For the Series 200 Ground Mount System, only one ground lug is required for an entire array. The lug is secured with a single 5/16" bolt and requires no drilling of rails. Lay-In Lugs can also be employed for grounding purposes, if needed or desired.

Ground Lug R, 6-12 AWG

Conduit Supports	
Description	**Item code**
Ground Lug R, 6-12 Awg	**242-02101**
Ilsco Lay-In Lug W/ Bolt And Keps Lock Nut, 4-14 AWG (Pack Of 10)	**051-03418**

SnapNrack Array Skirt

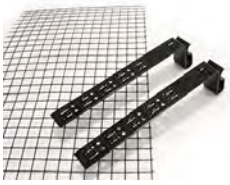
The SnapNrack front **Array Skirt** easily attaches to the front row of modules on almost any system. Only a ½" socket is required for attaching the **Skirt Frame Mount** to the modules. Attaching the Skirt to the mounts as well as installing the Splices requires no tools. The **Skirt End Cap Pair** provides the finishing touch.

Skirt, 162"

Conduit Supports	
Description	**Item code**
Skirt Kit, 162" (2) + Mounts (8) + Spice (1) End Cap Pairs (2)	**015-11788**
Skirt, 162" (Bundles of 60, priced as each)	**232-01259**
Skirt Frame Mount	**242-92211**
Skirt Splice	**232-01251**
Skirt End Cap Pair	**232-01250**

Skirt Frame Mount

Skirt End Cap Pair



Array Edge Screen Kit, 4"x100'

SnapNrack Array Edge Screen

The **Array Edge Screen** (a.k.a. Critter Guard) is designed to keep birds and rodents from making their home under new and existing solar arrays. The clips attach to the flanges on the bottom of module frames The painted steel clips can be "snapped" to the appropriate length to accommodate height variations. Hooks on the clips secure the PVC-coated ½" steel mesh in place. The open mesh screen allows for excellent air flow, ensuring modules remain cool, but is still rigid enough to keep out even the most industrious squirrel.

Array Edge Screen	
Description	**Item code**
Array Edge Screen Kit, 4" x 100'	**015-11176**
Array Edge Screen Kit, 8" x 100'	**015-11177**
Array Edge Screen Clip, 4"	**232-03993**
Array Edge Screen Clip, 8"	**232-03994**
Add-A-Lip Box Frame Adapter	**242-01101**

Installed Deck Level Flashiing

Deck Level Flashing is available for customers desiring an extra level of insurance against water intrusion and for jurisdictions that require it. One flashing set consists of two pre-cut pieces of self-adhering, exposable Protecto Wrap PS45 flexible flashing, good for one mount. 9x9/4x13 for Flat Tile Hook. 5x12/4x16 for Tile Replacements and Universal Tile Hook. Protecto-Tak Spray Adhesive is recommended for use with the Protecto Wrap flashings, especially for colder applications and aging roof felt.

Deck Level Flashings	
Description	**Item code**
PS45 Deck Level Flashing Set, 9x9 And 4x13 Pcs	**242-02723**
PS45 Deck Level Flashing Set, 5x13 And 4x17 Pcs	**242-02728**
Protecto Wrap, Protecto-Tak Spray Adhesive	**131-01347**

SnapNrack Channel Nut

SnapNrack Attachment Accessories

SnapNrack Original Channel Nuts can be used with SnapNrack Rail to mount additional accessories, like roof attachments, or junction boxes. This is the nonbonding variety. Purchase a **SnapNrack MLPE Rail Attachment Kit** if bonding is required. Use the **UEC Rail Cutting Tool** to protect module frames when cutting rails flush with the module edges when using Universal End Clamps..

UEC Rail Cutting Tool

SnapNrack Attachment Accessories	
Description	**Item code**
Original Channel Nut	**232-02284**
UEC Rail Cutting Tool	**232-02284**

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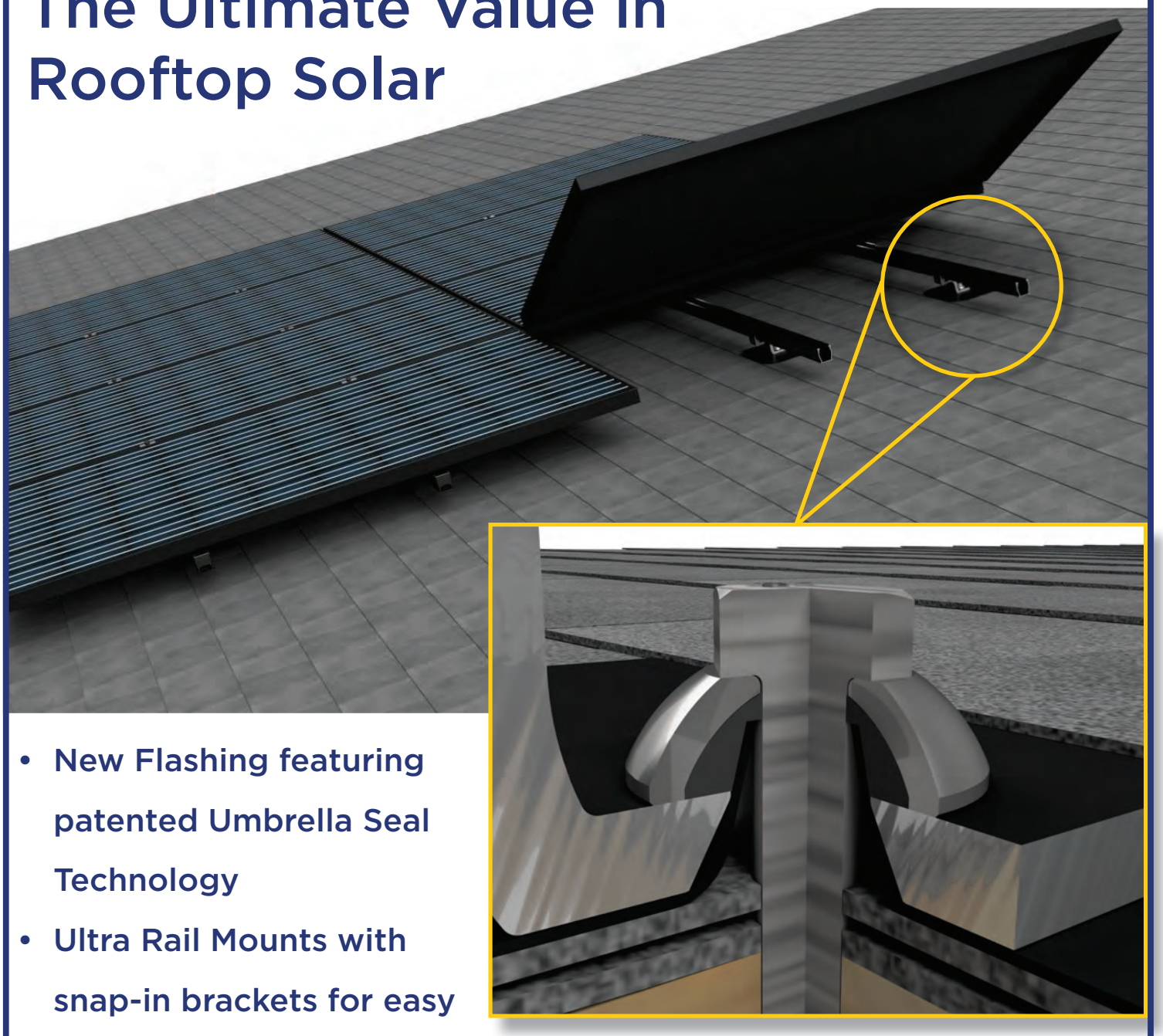
SnapNrack™
Solar Mounting Solutions

Ultra Rail

The Ultimate Value in Rooftop Solar



- New Flashing featuring patented Umbrella Seal Technology
- Ultra Rail Mounts with snap-in brackets for easy rail attachment
- Compatible with full suite of SnapNrack module clamps and Wire Management Solutions

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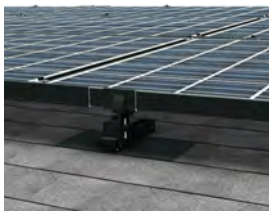
SnapNrack RL



SnapNrack RL Racking System

SnapNrack RL is the newest innovation in residential solar mounting that provides the fastest install experience available on the roof. RL is designed to achieve the lowest possible installed cost without compromising performance, quality, or aesthetics.

Simple as A, B, C, the system requires only 4 components for complete assembly with **A Mounts**, **B Mounts**, **C Links**, and **Flash Tracks**. Flash Tracks secure A Mounts and B Mounts to the roof using patented Umbrella Seal technology. A Mounts align the front of the array with a sleek black finish and drop-in design for module insertion. B Mounts secure the top side of modules and provide drop-in mounting for next row of modules. C Links attach each module within a row and provide a structural and electrical connection. RL Ridge Mounts are used for installing modules at or near the ridge line of the roof or for avoiding obstructions.

- Smaller individual components means easier logistics to get parts on the roof
- Pre-assembled mounts and single tool installation make jobs fast and easy
- System design requires only securing module on top side meaning less steps during install

Flash Track

SnapNrack RL provides the industry's best wire management solutions for systems that don't contain rails. New **Smart Clips** provide intuitive wire management at any point along the module and easily tucks wires away within the module envelope to avoid any unintended removal over time. **Wire Savers** provides the ability to secure loose wires post module install. Perfect for last minute wire management.

Comp Flashing

RL A Mount

RL B Mount

RL Roof Attachments	
Description	**Item code**
RL Flash Track, 7 1/2"	**232-04060**
Comp Flashing, 9" X 12", Black Alum	**232-01375**
Comp Flashing, 9" X 12", Silver Alum	**232-01376**
Umbrella Lag, Type 3, 4", SS [2-Pc W/ Ots Lag]	**242-92266**
Flash Track Spacer	**242-92254**
RL A Mounts	
Description	**Item code**
RL A Mount, 32mm	**242-92332**
RL A Mount, 35mm	**242-92335**
RL A Mount, 38mm	**242-92338**
RL A Mount, 40mm	**242-92340**
RL B Mounts	
Description	**Item code**
RL B Mount, 32mm	**242-92432**
RL B Mount, 32mm	**242-92435**
RL B Mount, 38mm	**242-92438**
RL B Mount, 40mm	**242-92440**

RL C Link

RL Ridge Mount

RL Mount Sleeve

RL Flash Track Spacer

Ground Lug RL

Smart Clip I

Smart Clip II

RL C Links	
Description	**Item code**
RL C Link, 32mm	**242-92532**
RL C Link, 35mm	**242-92535**
RL C Link, 38mm	**242-92538**
RL C Link, 40mm	**242-92540**
RL Ridge Mounts	
Description	**Item code**
RL Ridge Mount, 32mm	**242-92632**
RL Ridge Mount, 36mm	**242-92635**
RL Ridge Mount, 38mm	**242-92638**
RL Ridge Mount, 40mm	**242-92640**

SnapNrack RL Racking System	
Roof Mounts	
Description	**Item code**
RL Mount Sleeve, 32mm	**232-01532**
RL Mount Sleeve, 35mm	**232-01535**
RL Mount Sleeve, 38mm	**232-01538**
RL Mount Sleeve, 40mm	**232-01540**
RL Flash Track Spacer	**242-92254**
RL Wire and Electronics Management	
Description	**Item code**
Ground Lug RL	**242-92202**
Smart Clip I	**232-01170**
Smart Clip II	**232-01173**
Wire Saver	**242-92262**
MLPE Frame Attachment Kit	**242-02151**
Junction Box S with Comp Kit	**242-01113**
Junction Box XL with Comp Kit	**242-92121**
Universal J Box Wire Clamp	**242-09025**

Wire Saver

MLPE Frame Attachment Kit

Junction Box XL with Comp Kit

SnapNrack Series 200

The Adaptable High Quality Solution for Ground Mount Installations

The **Series 200 Ground Mount System** is designed to attach easily to a standard galvanized pipe structure using structural pipe fittings. Using a standard three or four-module high assembly, the system is efficient and flexible while optimizing materials and minimizing system footprint. Industry leading installation times are achieved with unique snap-in fasteners.

- Assembles easily using snap-in bonding pipe clamps that connect the rails
- Fully compatible with all SnapNrack module clamps and accessories
- Ground rail channel keeps wires neatly organized providing a clean finished look to every install
- Industry's largest offering of Wire Management accessories include snap-in Junction Boxes, Universal Wire Clamps, as well as ground rail channel to keep wires neatly organized
- Maximum versatility with the ability to configure easily to desired tilt between 0 and 45 degrees
- Using pipe structural fittings, labor hours to install the system are typically less than required for a more complicated racking system not using standardized components

Fast, Accurate Shipping to Your Job Site. With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

SnapNrack Series 200 Ground Mount

Ground Rail Set, 122", Clear

The **SnapNrack 200 Ground Mount System** is a solar module installation system that is low profile and visually appealing. This innovative suite of racking products simplifies installation to save time and money. The SnapNrack ground rail and rail-to-pipe clamp creates a multi-pole, fixed-tilt ground mount. The ground rail accepts all Series 100 module mounting clamps and the pipe clamp is designed for 1.5" (1.9" outside diameter) schedule 40 or 80 steel pipe substructures. It can be installed with tilt angles up to 45° and in locations that may see wind speeds up to 170 mph and snow loads up to 120 psf. For module attachment hardware refer to the SnapNrack Module Attachments section.

Ground Rail End Cap

Array Edge Screen	
Description	**Item code**
Ground Rail Set, 122", Silver (Box of 4)	**015-09839**
Ground Rail, 122", Silver (Bundle of 112, priced as each)	**232-02183**
Ground Rail Set, 162", Silver (Box of 2)	**015-09819**
Ground Rail Set, 162", Silver (Box of 4)	**015-09855**
Ground Rail, 162", Silver (Bundle of 112, priced as each)	**232-01072**
Ground Rail Accessories	
Description	**Item code**
Ground Rail End Cap	**232-01043**
Structural Fittings	
Description	**Item code**
Bonding Pipe Clamp for 1 ½"	**242-09004**
Single Socket Tee, Hollaender (5E-8), 1 ½", AL-MG	**172-05800**
Single Adjustable Socket Tee, Hollaender (17-8), 1 ½", AL-MG	**172-05803**
Double Adjustable Socket Tee, Hollaender (19E-8), 1 ½", AL-MG	**172-05804**
Rectangular Base Flange, Hollaender (46-8), 1 ½", AL-MG	**172-05807**
Plug End, Hollaender (62-8), 1 ½" Sched 40, AL	**172-05808**

Bonding Pipe Clamp for 1 ½"

Single Socket Tee, Hollaender (5E-8)

Single Adjustable Socket Tee, Hollaender (17-8)

Double Adjustable Socket Tee, Hollaender (19E-8)

Rectangular Base Flange, Hollaender (46-8)

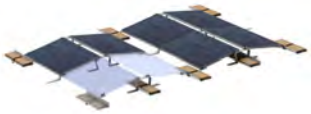
Plug End, Hollaender (62-8)

Commercial Roof and Ground Mounting Structures

Commercial PV systems tend to be significantly larger than residential ones, but also more price sensitive, requiring installers to achieve economies of scale to keep the price per watt or kilowatt-hour as low as possible. In addition, commercial rooftops are seldom the sloped composition or tile roofs so common in residential settings, so specialized mounting systems can be make-or-break for a commercial PV project. Most of the systems presented here are highly customizable and must be specifically engineered for each building or site so you'll need to contact your AEE Solar representative with the particulars of your project for a custom quote.

Aerocompact 2.1 South System

Aerocompact 2.1 with Ballast Trays



Aerocompact+ with ballast and trays

Aerocompact

CompactFlat S and CompactFlat + Roof Ballasted Racking System

Aerocompact offers an affordable, highly aerodynamic, fast to assemble, and fully engineered ballasted racking system for flat commercial roof mounts. Improvements have been made, including new wire management, clamps, and roof protection to the 2.1 Version. Each racking system is designed with site specific information, and a detailed layout, ballast plan, and engineering report are provided for every project. The reports generated are very detailed, and can be used in sales presentations, and in obtaining permits for your projects.

CompactFlat S is a South-oriented aerodynamic racking solution for framed modules on flat roofs. It is ETL listed to UL 2703, TUV Certified; wind tunnel tested up to 150 mph, and is provided with a 25-year limited warranty. It is fast and easy to install, and can be designed with 5°, 10°, and 15° tilt angles. Module clamps come with integrated grounding, and an Alpine Version is available in areas with high snow loads. Adding ballast trays can accommodate more ballast to allow the system to be installed in high wind areas.

CompactFlat + is a 10°, East/West mounting system. This racking solution allows more modules to be placed on a roof surface by eliminating the inter-row shading that occurs with a south facing system. The East/West solution allows the placement of up to 30% more modules on a given roof surface with a minimal loss in production per module, resulting in more generated kWh to the end customer. It also benefits from having fewer components, thus less racking cost per module. Since the modules are placed edge to edge, there is less wind loading, thus lower the ballast requirements for this system. Therefore, it can be deployed on more roofs with less roof loading. An Alpine Version is available for the Aerocompact+ where high snow loads are expected.

Both versions of **CompactFlat** racking can be fully ballasted with no penetrations, or with limited penetrations for reduced ballast requirements, or where required due to seismic concerns.

Contact your AEE Solar representative with your array layout and site information to receive a custom quote and engineering report with ballast recommendations. Be prepared to supply site information such as building height, roof material, module quantity and type, wind and snow load requirements, and exposure category.

CompactGround G
Ground Mount Racking

CompactGround +
Ground Mount Racking

CompactGround G and CompactGround + East/West Ballasted Ground Mount Racking System

The **CompactGround G** and **CompactGround +** offers commercial and utility ground mount installations quicker install times, without the need for piles, concrete or large machinery. The system can be designed to be completely ballasted, or with optional anchors. Up to 1 MW of racking can ship to a job site in a single truck load. Ideal for areas that have soil issues like landfills or brown-fields, areas that cannot support deep piles or excavation due to rocks, or for areas of sensitive ecological nature where excavation is discouraged. Fleece mesh can be supplied to prevent vegetation growth around the module field. The South Facing ground mount system can be designed with either a 15° or 20° tilt, or with a 10° tilt East/West layout to maximize module fill in a given area.

Contact your AEE Solar representative with your array layout and site information to receive a custom quote and engineering report with ballast recommendations. Be prepared to supply site information specific to the project, including system size, module quantity and type, terrain conditions, wind and snow load requirements, and exposure category.

CompactPitch Metal Roof Solutions

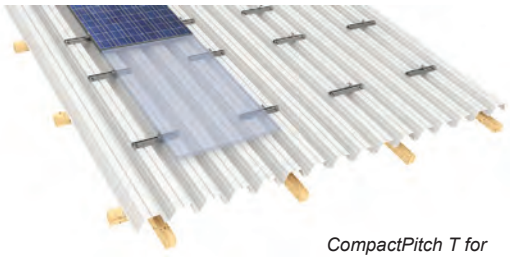
TRAPEZODIAL

AEROCOMPACT offers the **CompactPitch T** rail-less racking system for regular trapezoidal roofs and is designed for landscape and portrait module configurations. It comes with sealing tape underneath, to protect the underlying metal roof. It includes 4 metal sheet screws with EPDM sealing washers and the pre-assembled grounding clamp. The rails are available in 9.85 inch and 15.75 inch length. The CompactPitch T is a trapezoidal short rail solution with the best price-value combination.

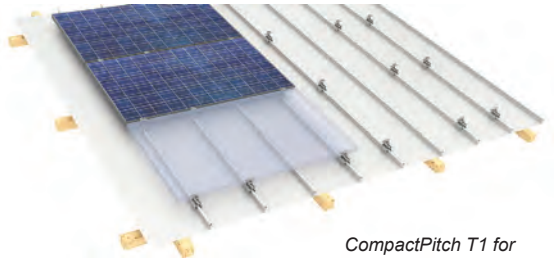
STANDING SEAM

The **CompactPitch T1** standing seam clamp is the perfect solution for all common standing seam roof types. With just two components the clamp is very easy to install and comes with the pre-assembled module clamp with grounding pins.

Contact your AEE Solar representative with your array layout and site information to receive a custom quote and engineering report with ballast recommendations. Be prepared to supply site information specific to the project, including system size, module quantity and type, terrain conditions, wind and snow load requirements, and exposure category



CompactPitch T for
Trapezoidal Metal Roof



CompactPitch T1 for
Standing Seam Metal Roof

PLP Ballasted Flat Roof Mount

PLP Ground Mount

PLP Top-of-Pole Mount

PLP Side-of-Pole Mount

PLP Multi-Pole Mount

PLP Power Peak Ground Mount

PLP Mid and End Clamps

Preformed Line Products Solar Racking

All Preformed Line Products solar racking is made in the U.S.A. and can be ordered to fit virtually any module. A variety of made-to-order Top-of-Pole Mounts, Side-of-Pole Mounts, and Multi-Pole Mounts, Ballasted Roof Mounts, and commercial ground mounts are available to suit a variety of installation needs. Compare the dimensions of the module you plan to use with the sizing chart below to determine the module series.

When ordering, be sure to include a copy of the data sheet for the module you plan to use. For modules having dimensions that fall outside of the chart, use the next larger size. Some of these mounting systems fasten to the modules using the mounting holes on the module frame rather than top clamps. If you are working with modules that lack a bottom flange, be sure to check for compatibility when ordering.

The High Wind Version upgrade (not available for MPM's) is made for winds up to 130 mph, Exposure C Wind Zones.

Stainless steel module mounting hardware is provided with all mounts. Additional stainless steel hardware for the racking assembly is available as an option. Black clamps are available upon request, if needed.

Use the Module Sizing Chart below to determine the frame size of the PLP racking needed. While only options for frame size G and H modules are listed, other sizes are available upon request. Call your AEE Solar representative for more details.

Note: All Preformed Line Products are built to order and cannot be returned nor exchanged

PLP Module Series Sizing Chart	
Module size range (W x L)	**PLP module series**
19"-23" x 35"-44"	A
20"-26" x 39"-53"	B
22"-27" x 56"-63"	C
31"-33" x 60"-67"	D
38"-40" x 51"-56"	E
38"-40" x 58"-61"	F
37"-42" x 61"-67"	G or GL*
38"-40" x 77"-82"	H or HL*
50"-52" x 65"-79"	I

* GL or HL – Includes longer module rails for module widths greater than 39.45" (i.e. SunPower 327, 335, 345)

PLP RAD Mid and End Clamp are shown in the table below. These are specific to module frame heights, so be sure to check current module data sheets for frame dimensions prior to ordering. These units are made from Type 304 stainless steel, and the mid clamps are 3/8" wide. These clamps provide grounding per UL1703, and come from the factory pre-assembled for easy installation. Please be sure to provide a module data sheet with any orders.

PLP Roof/Ground Mount Mid and End Clamps			
PLP Part #	**PLP Grounding Module Mid and End Clamps**	**Item code**	
		Clear	**Black**
PA-EC-XX-RAD	Module End Clamps w/ RAD Hardware (specify module thickness)	**013-10975**	CALL
PA-MC-28-33-RAD	Module Mid Clamps w/ RAD Hardware for 28-33 mm (1.1" - 1.3")	**013-10976**	CALL
PA-MC-34-39-RAD	Module Mid Clamps w/ RAD Hardware for 34-39 mm (1.31" - 1.54")	**013-10977**	CALL
PA-MC-40-46-RAD	Module Mid Clamps w/ RAD Hardware for 40-46 mm (1.55" - 1.81")	**013-10978**	CALL
PA-MC-47-52-RAD	Module Mid Clamps w/ RAD Hardware for 47-52 mm (1.85" - 2.0")	**013-10979**	CALL
PA-MC-53-59-RAD	Module Mid Clamps w/ RAD Hardware for 53-59 mm (2.1" - 2.32")	**013-10980**	CALL

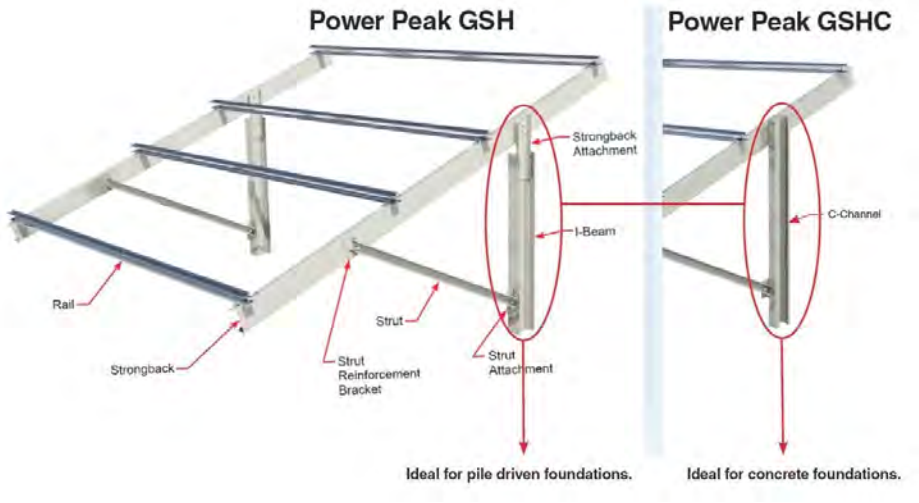
PLP Power Peak Commercial Ground Racking

The **PLP POWER PEAK** mounting system is designed for larger scale ground mount installations that require faster build rates. Optimized to site-specific conditions, POWER PEAK mounting structures assemble over pile driven galvanized H-Beams or C-Channel. The single row, vertical post design greatly reduces the number of ground penetrations while providing increased ground clearance options. An intake form defining the project variables will need to be completed for us to work on a layout and supply a quote.

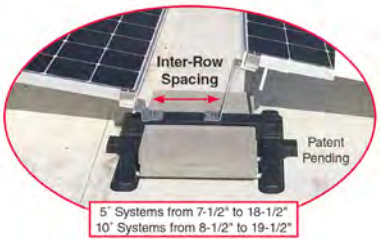
Call us or download the intake form at *http://www.preformed.com/solar/commercial/groundmounts/power-peak*.

Also available in distributor kits with pre-assembled components, the POWER PEAK system provides a fast and secure mounting structure for most PV modules. POWER PEAK structures are assembled without lifting equipment and do not require field modifications, including drilling or welding. Pre-assembled components, including the patent pending module clamps, significantly reduce installation time and labor. Structures are designed and manufactured to match module string counts to reduce wiring time and materials. The unique module rails feature built in wire channels for a professional appearance.

Contact AEE Solar with the details of the array layout for your project to get a custom quote for the PLP Power Peak Ground Mount System



PLP Power Max Ballasted Roof Mount System



POWER MAX Commercial Ballasted Racking

The **POWER MAX PV** Solar Mounting System is a fully ballasted high strength mounting structure developed with the professional installer in mind, featuring minimum components and no loose hardware. The POWER MAX is designed to provide a faster assembly and shorter learning curve. The modular design simplifies roof layouts, ordering and final installation while stackable components reduce shipping volume and provide easy transport of materials to the roof. An intake form defining the project variables will need to be completed for us to work on a layout and supply a quote.

Call us or download the intake form at *http://preformed.com/solar/commercial/roof-mounts/power-max*.

The modular design simplifies roof layouts, ordering and final installation while stackable components reduce shipping volume and provide easy transport of materials to the roof. The new POWER MAX is backed by our 20+ years of industry experience, engineering support and dedicated customer service.

Contact AEE Solar with the details of the array layout for your project to get a custom quote for the Power Max Roof System.

PLP Power Max South Tilt System

PLP Power Max E/W Dual Tilt System

PLP Power Max Flush Mount

PLP Top-Pole Mounts (TPM)					
TPM Mounts for 60-Cell Modules					
Module size	PLP part #	# of modules	Pole size	Configuration	Item code
G	TPM1-G	1	2"SCHD80	1H x 1W-P	**013-10701**
	TPM2-G	2	3"SCHD40	1H x 2W-P	**013-10702**
	TPM3-G	3	4"SCHD40	1H x 3W-P	**013-10703**
	TPM4-G	4	4"SCHD80	2H x 2W-P1	**013-10704**
	TPM6-G	6	6"SCHD40	3H x 2W-L	**013-10706**
	TPM8-G	8	6"SCHD80	4H x 2W-L	**013-10708**
	TPM9-G	9	8"SCHD40	3H x 3W-P	**013-10709**
	TPM10-G	10		5H x 2W-L	**013-10710**
	TPM12-G	12	8"SCHD80	3H x 4W-P	**013-10712**
	TPM14-G	14		7H x 2W-L3	**013-10714**
	TPM15-G	15		5H x 3W-L	**013-10715**

PLP Top-Pole Mounts (TPM)					
TPM Mounts for 72-Cell Modules					
Module size	PLP part #	# of modules	Pole size	Configuration	Item code
H	TPM1-H	1	2.5"SCHD40	1H x 1W-P	**013-10801**
	TPM2-H	2	3"SCHD80	1H x 2W-P	**013-10802**
	TPM3-H	3	4"SCHD40	1H x 3W-P	**013-10803**
	TPM4-H	4	6"SCHD40	2H x 2W-P1	**013-10804**
	TPM6-H	6	6"SCHD40	3H x 2W-L	**013-10806**
	TPM8-H	8	8"SCHD40	4H x 2W-L	**013-10808**
	TPM9-H	9	8"SCHD80	3H x 3W-P	**013-10809**
	TPM10-H	10		5H x 2W-L	**013-10810**
	TPM12-H	12		3H x 4W-P1	**013-10811**

PLP Top Pole Mounts (TPM) – Upgrade Options		
PLP part #	Description	Item Code
HWV	High-Wind Version (add 25%)	**013-04000**
HGS	Hot-dip Galvanized Steel Components (adds 60%)	**CALL**
PCA	Powder-Coated Aluminum Rails and Components (adds 20%)	**CALL**
AA	Anodized Aluminum Rails and Components (adds 20%)	**013-10915**

Mounting sleeve upgrade (not all options shown,						
	Upgrade to:	2.5"	3"	4"	6"	8"
Standard Mounting Pole	2"	**013-03069**	**013-03070**	**013-03071**	**CALL**	**CALL**
	2.5"	—	**CALL**	**CALL**	**CALL**	**CALL**
	3"	—	—	**CALL**	**013-03079**	**CALL**
	4"	—	—	—	**013-03081**	**CALL**
	6"	—	—	—	—	**013-03083**

Preformed Line Products Multi-Pole Mounts (MPM)

The Preformed Line Products **Multi-Pole Mounts (MPM)** are designed to mount on 3, 4, or 6" Schedule 40 galvanized steel pipe (installer supplied), Multi-Pole Mounts (MPM) support two to four modules high in landscape orientation. These mounts can be horizontally expanded as far as necessary by installing additional vertical pipe supports. This type of mount requires fewer ground penetrations than traditional ground mounts and offers a full range of adjusting for seasonal elevation.

MPMs use a 4" x 4" square or 4" x 5" rectangular steel horizontal tube (also installer supplied) as well as PLP's Power Rail for module mounting. Multi-Pole mounts are also ideal for shade and carport structures because the design is capable of being installed with significant g round clearance. Please complete a Performed line Products MPM Request for Quote Form in order to properly obtain the foundation design and to generate a bill-of-materials. The form can be found at *http://www.preformed.com/solar*. Use the Module Series Sizing Chart and order the appropriate number of End and Mid Clamps from the RAD Mid and End Clamp table. Tamper resistant hardware is available upon request. Call your AEE Sales representative if this is a requirement for your project.

PLP Multi-Pole Mounts						
Module size	For 4" x 4" square steel horizontal tube			For 5" x 4" square steel horizontal tube		
	# of modules	PLP part #	Item code	# of modules	PLP part #	Item code
G or GL	two	MPM2-G-4x4	**013-13742**	two	MPM2-G-5x4	**CALL**
	three	MPM3-G-4x4	**013-13743**	three	MPM3-G-5x4	**CALL**
	four	MPM4-G-4x4	**013-13744**	four	MPM4-G-5x4	**CALL**
H or HL	two	MPM2-H-4x4	**013-13842**	two	MPM2-H-5x4	**CALL**
	three	MPM3-H-4x4	**013-13843**	three	MPM3-H-5x4	**CALL**

Multi-Pole Mount Pipe Caps (includes U-Bolts)		
Description	PLP part #	Item code
For connecting 3" SCH 40/80 vertical steel pipe to 4"x4" horizontal steel tube	PC -3V4x4H	**CALL**
For connecting 4" SCH 40/80 vertical steel pipe to 4"x4" horizontal steel tube	PC-4V4x4H	**013-02094**
For connecting 4" SCH 40/80 vertical steel pipe to 5"x4" horizontal steel tube	PC-4V5x4H	**CALL**
For connecting 6" SCH 40/80 vertical steel pipe to 4"x4" horizontal steel tube	PC-6V4x4H	**013-02096**
For connecting 6" SCH 40/80 vertical steel pipe to 5"x4" horizontal steel tube	PC-6V5x4H	**CALL**

Multi-Pole Mount – Optional Upgrades		
PLP part #	Description	Item code
DP-MPM-PCA	Powder-Coated Aluminum Components (add 25%)	**CALL**
DP-MPM-AA	Anodized Aluminum Components (add 35%)	**CALL**
DP-MPM-HGS	Hot-dip Galvanized Steel Components (add 60%)	**CALL**

Pole Mounts

Pole mounts represent a simple, cost-effective approach to mounting small PV arrays without the need for complex foundations or leveling. A Schedule 40 or 80 rigid steel pole with a deep concrete anchor is typically sufficient. However, specific requirements may vary due to soil type and expected wind loads. Most pole-mount systems are made-to-order so be sure to include a module data sheet and double-check your requirements as they typically cannot be returned.

Preformed Line Products

Preformed Line Products Side-Pole Mounts (SPM)

Preformed Line Products SPM mounts are made from mill-finish aluminum. Stainless-steel module mounting hardware is provided with all mounts, and tamper-resistant hardware kits are also available for installations that may be left unattended for long periods. Stainless-steel fastener kits and high-wind upgrades are also available for the mounting structure itself. Call if these features are needed on your project.

All single-module mounts, and the two-module mounts for size A-C modules come with stainless steel band clamps for 2-3.5” diameter pole sizes. All other SPM mounts come with stainless steel clamps for 3-4.5” diameter poles. Upgrade clamps sized for larger diameter poles are listed below. Most SPM mounts can also be attached to flat vertical surfaces using installer-supplied lag bolts or through-bolts. Band Clamp Upgrade Kits are available if the size of the pole is too large for these mounts. Please call and ask if you need a larger band clamp for your project.

Use the Preformed Line Projects Module Series Sizing Chart to determine module series.

PLP Side-Pole Mounts (SPM)			
Module size		Number of modules	
		One	Two
A	PLP part #	DP-SPM1-A	DP-SPM2-A
	Item code	**013-11101**	**CALL**
B	PLP part #	DP-SPM1-B	DP-SPM2-B
	Item code	**013-11201**	**CALL**
C	PLP part #	DP-SPM1-C	DP-SPM2-C
	Item code	**013-11301**	**013-11302**
D	PLP part #	DP-SPM1-D	DP-SPM2-D
	Item code	**013-11401**	**013-11402**
E	PLP part #	DP-SPM1-E	DP-SPM2-E
	Item code	**013-11501**	**013-11502**
F	PLP part #	DP-SPM1-F	DP-SPM2-F
	Item code	**013-11601**	**013-11602**
G	PLP part #	DP-SPM1-G	DP-SPM2-G
	Item code	**013-11701**	**013-11702**
H	PLP part #	DP-SPM1-H	DP-SPM2-H
	Item code	**013-11801**	**013-11802**

PLP Side-Pole Mounts (SPM) – High Wind Upgrade		
PLP part #	Description	Item code
HWV	High-Wind Version (add 25%)	**013-04000**

Preformed Line Products Top-of-Pole Mounts (TPM)

Preformed Line Products Top-of-Pole (TPM) mounts have heavy steel mounting sleeves, elevation pivots, and strong-backs that are factory powder coated for durability. The module rails are 6061-T6 mill-finish structural aluminum angles. Stainless steel module mounting hardware is provided. Standard top-of-pole mounts are adjustable from 15° to 65°, in 10° increments, and fit on Schedule 40 or 80 steel pipe. Tables are shown for common configurations for G and H sized modules, which correspond to most standard 60-cell and 72-cell modules. TPM Mounts for A-F and I sized modules can be custom ordered by contacting an AEE Sales Representative for a quote. Be ready to provide the module data sheet.

For harsh environments, upgrades to hot-dip-galvanized steel or anodized aluminum rails are available upon request. Use the tables below to determine the layout and minimum pipe size. Additionally, the mounting sleeves can be upgraded to accommodate a larger support pipe.

The Online Configuration Tool at *www.preformed.com* can be used to generate the specific configuration and bill of materials needed based on module number and type, array location, and environmental conditions (wind, snow, desired tilt, etc.). Use the Request for Quote Form from the web site to request site specific recommendations including foundation specifications, correct pipe length, pipe schedule, and foundation size requirements. An Engineering Stamp can be issued for all 50 states for additional cost.

Configuration: Array Layout and Module Orientation (P= Portrait L=Landscape)

All pipe recommendations conform to ASCE 7-10, IBC2006, and are based on 90mph, Exposure C, 65-degree max tilt, 12" max front edge ground clearance except for those noted:

[1] 6" max front edge clearance | [2] 55-degree max tilt | [3] 6" max front edge clearance nad 55-degree max tilt | [4] 45-degree max tilt

Tamarack Solar

Tamarack Side-Pole Mounts (SPM)

Tamarack Solar Side of Pole Mounts are simple mounting solutions for poles, walls and other flat surfaces. This an incredibly versatile mount that has been used on the sides of shipping containers, buildings, as an awning, and mounted to just about any flat surface. This system mounts also to poles of 2" to 4" diameter, and module widths between 5.26" and 25.5". Single Arm Mounts are manufactured using heavy-duty corrosion-resistant 5000 series aluminum. Schedule 40 pipe not included.

Tamarack Single Arm Mounts		
Model	**Description**	**Item code**
UNI-SA/14.0	Single Arm, Side Pole 14”	**013-01001**
UNI-SA/21.5	Single Arm, Side Pole 21.5”	**CALL**
UNI-SA/26.0	Single Arm, Side Pole 26”	**013-01003**

8 Panel Pole Mount

12 Panel Pole Mount

16 Panel Pole Mount

24 Panel Pole Mount

MT Solar

Top-of-Pole Mount (TPM) Solar Rack

The MT Solar Top-of-Pole Mount Racking system is designed to be assembled and wired at ground level then lifted to final position via a chain hoist. This eliminates the need for cranes, scaffolding, or dangerous ladder work. Once installed, the mounts are fully adjustable from 0° to 90° from ground level with a hand crank. Single-pole mounts are available supporting from one to twenty 60-cell modules and from one to fifteen 72-cell modules. Installers realize cost savings without needing to schedule a crane or scaffolding to install these mounts. The mounts attach to a Schedule 40 galvanized steel pipe, which is locally sourced and not supplied by MT Solar.

Standard engineering supports up to 130 mph wind speeds, with 30 psf. snow load. Foundation recommendations are provided, and stamped engineering documents are available for an additional fee for all 50 States. Custom engineered solutions are also available for conditions outside those listed. Top down clamping provides a truly universal mount for most solar modules. Options are available for using a 10" dia. pipe for the larger TPM mounts.

Two-pole mounts may be linked together to support larger multi-pole mounts for up to forty 60-cell modules. This racking solution is manufactured, assembled, and ships direct from the manufacturer in the state of Montana. Larger arrays requiring three or more pole mounts, and linked arrays for 72-cell modules available upon request. Contact AEE Solar for details.

MT Solar Top of Pole Mount			
MT Part #	**Single Pole Mounts for 60-Cell Modules**	**HD Frame Upgrade Option?**	**Item code**
2-TOP-1-60	TPM Mount for one 60-cell modules, on 2” dia. Schd. 40 pipe	N	013-00033
4-TOP-2-60	TPM Mount for two 60-cell modules, on 4” dia. Schd. 40 pipe	N	013-00006
4-TOP-3-60	TPM Mount for three 60-cell modules, on 4” dia. Schd. 40 pipe	N	013-00007
4-TOP-4-60	TPM Mount for four 60-cell modules, on 4” dia. Schd. 40 pipe	N	013-00008
6-TOP-6-60	TPM Mount for six 60-cell modules, on 6” dia. Schd. 40 pipe	N	013-00009
6-TOP-8-60-LIGHT	TPM Mount for eight 60-cell modules, on 6” dia. Schd. 40 pipe	N	013-00034
6-TOP-8-60-STND	TPM Mount for eight 60-cell modules, on 6” dia. Schd. 40 pipe	Y	CALL
8-TOP-9-60	TPM Mount for nine 60-cell modules, on 8” dia. Schd. 40 pipe	Y	013-00011
8-TOP-10-TALL-60	TPM Mount for ten 60-cell modules, on 8” dia. Schd. 40 pipe	Y	013-00035
8-TOP-12-60	TPM Mount for twelve 60-cell modules, on 8” dia. Schd. 40 pipe	Y	013-00013
8-TOP-14-60	TPM Mount for fourteen 60-cell modules, on 8" dia. Schd. 40 pipe	N	013-00036
8-TOP-15-TALL-60	TPM Mount for fifteen 60-cell modules, on 8" dia. Schd. 40 pipe	N	013-00014
8-TOP-16-60	TPM Mount for sixteen 60-cell modules, on 8” dia. Schd. 40 pipe	N	013-00015
8-TOP-20-TALL-60	TPM Mount for twenty 60-cell modules, on 8” dia. Schd. 40 pipe	N	013-00037
MT Part #	**Two Pole Mounts for 60-Cell Modules**		**Item code**
8-TOP-20-60	TPM Mount for twenty 60-cell modules, on two 8” dia. Schd. 40 pipes	Y	013-00016
8-TOP-24-60	TPM Mount for twenty-four 60-cell modules, on two 8” dia. Schd. 40 pipes	Y	013-00017
8-TOP-28-60	TPM Mount for twenty-eight 60-cell modules, on two 8” dia. Schd. 40 pipes	Y	013-00018
8-TOP-32-60	TPM Mount for thirty-two 60-cell modules, on two 8” dia. Schd. 40 pipes	N	013-00019
8-TOP-30-TALL-60C	TPM Mount for thirty 60-cell modules, on two 8” dia. Schd. 40 pipes	N	013-00048
8-TOP-35-TALL-60C	TPM Mount for thirty-five 60-cell modules, on two 8” dia. Schd. 40 pipes	N	013-00049
8-TOP-40-TALL-60C	TPM Mount for forty 60-cell modules, on two 8” dia. Schd. 40 pipes	N	013-00050
MT Part #	**MT Solar Accessories**		**Item code**
CHAIN-HOIST-BASIC	1 Ton Chain Hoist – can be used on multiple installs		013-00020
SM-MICRO	MT Solar Microinver ter/Optimizer attachment kit		013-00021
PEWETSTAMP	Wet Stamp Engineering for MT Solar TPM Mounts		013-00028
4IN-SCREW-ADJUSTER	Screw Adjustor for 4” Dia. Pole Mounts		013-00031
4IN-LIFT-BRACKET	Lifting Bracket for 4” Dia. Pole Mounts		013-00047
HD UPGRADE	Heavy Duty Frame Upgrade for Select Mounts, (25% price increase)		CALL

MT Solar Top of Pole Mounts for 72-cell modules			
MT Part #	**Single Pole Mounts for 72-Cell Modules**	**HD Frame Upgrade Option?**	**Item code**
2-TOP-1-72	TPM Mount for one 72-cell modules, on 2" dia. Schd. 40 pipe	N	CALL
4-TOP-2-72	TPM Mount for two 72-cell modules, on 4" dia. Schd. 40 pipe	N	CALL
4-TOP-3-72	TPM Mount for three 72-cell modules, on 4" dia. Schd. 40 pipe	N	CALL
6-TOP-4-72	TPM Mount for four 72-cell modules, on 6" dia. Schd. 40 pipe	N	013-00041
8-TOP-6-72	TPM Mount for six 72-cell modules, on 8" dia. Schd. 40 pipe	Y	013-00026
8-TOP-8-72	TPM Mount for eight 72-cell modules, on 8" dia. Schd. 40 pipe	Y	013-00024
8-TOP-9-72	TPM Mount for nine 72-cell modules, on 8" dia. Schd. 40 pipe	N	013-00025
8-TOP-10-TALL-72	TPM Mount for ten 72-cell modules, on 8" dia. Schd. 40 pipe	Y	CALL
8-TOP-12-72	TPM Mount for twelve 72-cell modules, on 8" dia. Schd. 40 pipe	N	013-00025
8-TOP-15-TALL-72	TPM Mount for fifteen 72-cell modules, on 8" dia. Schd. 40 pipe	N	CALL
MT Part #	**Two Pole Mounts for 72-Cell Modules**		**Item code**
8-TOP-16-72	TPM Mount for twenty 72-cell modules, on two 8" dia. Schd. 40 pipes	Y	CALL
8-TOP-20-72	TPM Mount for twenty-four 72-cell modules, on two 8" dia. Schd. 40 pipes	Y	CALL
8-TOP-24-72	TPM Mount for twenty-eight 72-cell modules, on two 8" dia. Schd. 40 pipes	N	CALL
8-TOP-30-TALL-72C	TPM Mount for thirty 60-cell modules, on two 8" dia. Schd. 40 pipes	N	CALL

Trackers

A solar racking system that tracks the path of the sun can increase a PV array's power production up to 40% depending on the season and location. Trackers are particularly useful when energy demand peaks during the summer months, such as for solar-powered irrigation systems. Trackers can also maximize net-metered electricity production in the summer, building up a credit toward high winter power bills. One should carefully weigh the cost of a PV tracker vs. installing a larger fixed PV ground array, as tracking PV systems can add significant cost and complexity to a project.

Wattsun Solar AccuTrak Trackers

Single and Dual Axis Trackers

Wattsun AccuTrak trackers use electronic sensors to track the sun from East to West. Dual Axis adds elevation tracking as well. The tracker fixes on the brightest area of the sky, capturing the maximum amount of sunlight available. Each night it returns to the morning sunrise position, ready to start tracking when the sun rises again.

These trackers are durable, and come with standard corrosion-resistant coatings on major components for harsh environments. All frames are made of galvanized steel tubing and anodized aluminum rails.

Manual controls are now standard on all trackers. These exterior switches on the controller cover plate allow the owner to turn off automatic tracking. They can then rotate the tracker East or West and/or up and down. This is useful for shedding snow, or to lay the tracker flat in extremely high wind conditions.

TheAccuTrak-AZ single-axis tracker automatically tracks the sun's path by rotating the PV array around a central post, which is set at a 45° set tilt angle. This provides greater stability for larger arrays. Wattsun azimuth trackers provide nearly 240° of rotational movement to maximize solar harvest.

The AccuTrak-DA gear drive, dual-axis tracker can hold up to twelve 60-cell solar modules. It is powered by a 24 VDC motor running a heavy-duty ball bearing/ worm-gear drive. Dual-axis operation ensures the maximum energy harvest. The AccuTrak-DA mounts on a 8" Schedule 40 or 80 steel pole.

Each Wattsun Tracker requires a 24 VDC power source. The IDEC Power Supply listed below can supply this power from a 120 VAC or 240 VAC source, and one power supply is needed per tracker.

All Wattsun AZ and DA trackers are now standard with galvanized corrosion-resistant components for harsh climates. Trackers include a 10-year standard warranty on all structural materials, with two years on the electronic controller and on all moving parts.

Wattsun AccuTrak Single and Dual-Axis Trackers

Cell and module size	Module quantity	Layout (Rows x columns) landscape	Single axis - AZ - corrosion resistant		Dual axis - DA - corrosion resistant	
			Wattsun Solar part #	Item code	Wattsun Solar part #	Item code
5" (96-cell) 41" x 62"	9	3x3	--	**--**	15022-004	**014-08265**
	12	4x3	15009-002	**014-08268**	15022-002	**CALL**
	16	4x4	15009-101	**014-08272**	--	**--**
6" (60-cell) 39" x 66"	9	3x3	15009-004	**014-08270**	15022-004	**014-08265**
	12	4x3	15009-001	**014-08267**	15022-001	**014-08262**
	16	4x4	15009-102	**014-08273**	--	**--**
6" (72-cell) 39" x 77"	9	3x3	15009-005	**CALL**	15022-005	**CALL**
	10	3-4-3	15009-003	**CALL**	15022-003	**CALL**

Wattsun AccuTrak Power Supply Option

Model	Description	Item code
IDEC PS5R-SF24	Accepts 120 or 240 VAC input and outputs 24 VDC at 5 A maximum. One power supply unit required for each motorized tracker. Power supply unit needs to be mounted in a rain-tight box if located outside.	**014-07115**

Zomeworks

Universal Track Rack - Passive Solar Tracker for PV Modules

UTRK-040

UTRF-072

UTRF-090

UTRF-168-2

The Zomeworks Passive Track Rack uses no motors, no gears, and no controls, eliminating common failure modes. The sun's heat moves liquid from side to side so that gravity naturally turns the Track Rack to follow the sun. The Zomeworks Universal Track Rack system allows for adjustment in both the East-West and North-South directions. Universal Track Racks are available in six standard sizes, and are designed to fit most typical solar modules.

(NOTE: Sizing for these trackers is based on total module surface area. The number in the Track Rack model number stands for the maximum square footage of modules that can be installed.)

These trackers ship partially assembled for easy installation. All of these mounts have a 10-year standard warranty, and are supplied with zinc-plated hardware and stainless steel module mounting screws.

High Wind Stabilization Kits are optional and can be added if needed for the UTRK-40 and the UTRF-168. Please specify if these are need prior to ordering. The High Wind Stabilization Kit can also be added to the tracker after installation, should they be found to be needed at a particular site.

Please specify number of modules to be mounted on the tracker and include the module data sheet with your order. The tracker will be customized with the correct hardware, and in some cases the rail length will be adjusted for a better fit. Some module quantities require an additional rail set at an extra charge. These racks are made-to-order and cannot be returned or exchanged.

Passive Solar Trackers for PV Modules						
Model	**UTR-020**	**UTRK-040**	**UTRF-072**	**UTRF-090**	**UTRF-120**	**UTRF-168**
Item code	**014-09020**	**014-09043**	**014-09072**	**014-09090**	**014-09120**	**014-09130**
Pole size SCH40 steel	2.5"	3"	6"	6"	6"	8"
Min. pole height	76"	84"	96"	108"	120"	144"
Min. pole depth	38"	42"	48"	54"	60"	72"
Shipping weight	95 lbs	145 lbs	363 lbs	480 lbs	540 lbs	607 lbs
Module type	**Number of modules that fit each Zomeworks model**					
Typical 60-cell Module (40" x 66")	one	two	three	four, five[1]	six	seven[1], eight, nine[1]
Typical 72-cell Module (40" x 78")	one	two	three	four	five[1]	six, seven[1]

[1] Additional rail required for this number of modules (add Item code: 014-09155 - ZOMEWORKS, ADDITIONAL RAIL SET)

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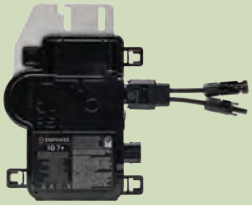

Grid-Tie Inverters

Often referred to as the "brains" of a renewable energy system, an inverter is an electronic device that converts direct current (DC) from batteries or solar modules into alternating current (AC) at the voltage and frequency required to run electrical loads or feed into the grid.

Grid-tie, or utility intertie, inverters convert DC power from photovoltaic (PV) modules directly into AC power to be fed into the utility grid. Batteries are not needed, as any power that is not consumed by the owner's electrical loads is fed into the utility grid to be used elsewhere. Due to the high voltages involved, grid-tie inverters should be installed and serviced only by qualified personnel.

Grid-tie PV systems typically use the utility grid for energy storage. Whenever the PV array is generating more power than the loads are using, excess energy is fed into the grid, turning the meter backward. When the loads require more power than the PV array can supply, the utility makes up the difference. Known as "net metering," this arrangement is the most efficient and cost-effective for grid-tied applications since there are no batteries to maintain. Increasingly, utilities are asking for more control over if, when, and how power can be fed back to the grid. Some states have restricted export altogether, while others have required inverters to be able to help stabilize the grid, rather than just disconnect. Grid-tie inverters are required by law to shut down during a utility outage per IEEE 1547, which is incorporated into UL 1741. More traditional, low-voltage battery-based grid interactive inverters (See Battery-Based Inverters) are typically used for back-up power applications.

Most batteryless grid-tie inverters are called "string" inverters because the PV modules must be wired together in series to obtain a higher input voltage. String Inverters are designed to run at voltages up to 600 VDC in residential systems and up to 1,000 VDC for commercial and industrial systems. String wiring is quick and easy to install, and the higher voltage helps to minimize line losses and required wire size. However, in string wiring, maximum power point tracking (MPPT), along with any monitoring output, is performed at the string or array level.

Module Optimizers, and other Module Level Power Electronics (or MLPEs), can be deployed behind each module to provide individual module-level MPPT tracking and monitoring, optimizing the DC output that is connected to a string inverter for very high efficiency, and can also provide module level rapid shutdown functions. Systems that combine optimizers with low-cost high-efficiency string inverters can simplify system design and maximize safety and energy harvest with minimal impact on cost.

Microinverters are typically mounted behind each solar module. They convert the DC output of each module to AC, replacing the high DC voltages (up to 1,000 VDC) with comparatively lower AC potentials (240 VAC or less) and simplifying system design. The microinverter output connects directly to the breakers in the AC load center using conventional wiring. Since microinverters provide MPPT tracking and monitoring for individual modules, the impact of differences in orientation or shading between modules is eliminated. Microinverters are a popular solution for electrical contractors that are new to solar as DC wiring is essentially eliminated, and can also provide module level rapid shutdown functions.

Three-Phase String Inverters are used in larger commercial grid-tie systems, and output at 208 VAC or 480 VAC, which is more common in larger buildings. Most of these 10 to 50 kW inverters are available with input voltage ratings of 1,000 VDC. This higher input voltage enables longer module strings, which can improve design flexibility and eliminate external combiners. These inverters can be mounted on building walls, or they can be placed on ballast racked skids alongside the array to comply with NEC 2014 690.12 rapid shutdown requirements. Traditional, pad mounted Central Inverters are rarely used anymore for systems under several megawatts in scale.

Enphase

NEW! IQ Grid Tied Microinverter System

Enphase IQ7+ Microinverter

Enphase IQ7 Microinverter

Enphase has improved upon the IQ series, and introduced the improved **IQ7/IQ7+** microinverters, and this year will further transition to the latest IQ8/IQ8+ series. IQ7 made improvements to the IQ6, by reducing component count, and allowing the inverter to auto-detectng between US Type 240VAC-60 hz grids and European 230VAC-50 hz grids, thus enabling these microinverters to be installed almost anywhere in the world.

IQ8/IQ8+ microinverters will have improved functionality and advanced features. These inverters will be part of an integrated solar, storage, and energy management platform that Enphase calls Ensemble. A new and improved AC Battery with integrated IQ8 microinverters will be introduced towards the middle of next year, and combined with additional switchgear will allow the system to be able to operate without the grid being present, and will be able to provide both load management and backup solutions.

With increased efficiency and a 25-year standard warranty, these lightweight microinverters utilize a simple two-wire cable system that lower cost and reduce installation time. Communications to the Enphase IQ Envoy is now over the current conductors, eliminating the need for a neutral wire in the PV system. Enphase IQ microinverters conform to NEC 2014 and NEC 2017 section 690.12 and C22.1-2015 Rule 64-218 Rapid Shutdown of PV Systems, when installed according manufacturer's instructions, and are compliant to new Rule 21 (UL 1741-SA) requirements.

IQ micros have a 97% CEC efficiency rating. The IQ7/IQ8 can be used with 60-cell modules up to 350W while the IQ7+/IQ8+ can work with 60-cell or 72-cell modules up to 440W. Enphase has no enforced DC/AC ratio. Visit the Enphase compatibility calculator located at www.enphase.com for compatible models.

Enphase IQ microinverters have an exchangeable cabling system, where you can change the input connectors from MC4 to H4 if needed. AEE Solar will be stocking IQ/IQ+ microinverters with MC4 connector as standard. The IQ Envoy gateway communicates over Powerline with the microinverters, providing module level reporting of PV Production. A new commercial three phase IQ Envoy is available to configure with 3P-208/230/240 utility grids.

Features:

- Simplified design and installation, using two conductor Q-Cable system, Aggregator roof-top combiners, and with AC Combiner Boxes included IQ Envoy Gateway
- UL1741-SA Compliant (CA Rule 21), with fixed power factor, voltage and frequency ridethrough requirements, and microinverters connected to Enlighten Portal, and will remotely update to respond to changing grid requirements
- Can be configured for export limiting or zero export grid profiles
- Built-in rapid shutdown compliant to meet both NEC 2014 and NEC 2017 requirements
- Communication over power line to IQ Envoy Gateway, providing link to Enlighten Manager and MyEnlighten monitoring, providing module level monitoring, with optional consumption monitoring
- Option to add IQ Battery, allowing storage and night time usage of solar power in zero export situations
- 25-year standard warranty
- Compliant with: UL 62109-1, UL1741/IEEE1547, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01

Enphase IQ/IQ+ Microinverters									
Model	Max AC Output	DC module voltage	Operating Range MPPT range	CEC efficiency	Max AC current		Weight	Connector	Item code
					208V	240V			
IQ7-60-2	240 W	<48 VDC	16 to 48 VDC 27 to 37 VDC	97.0%	1.15 A @ 208 V	1.00A @ 240 V	2.03 lbs	**MC4**	**030-07761**
IQ7PLUS-72-2	290 W	<62 VDC	16 to 60 VDC 27 to 45 VDC	97.0%	1.39 A @ 208 V	1.21 A @ 240 V	2.03 lbs	**MC4**	**030-07763**
IQ8-60-2	240 W	<48 VDC	16 to 48 VDC 27 to 37 VDC	97.0%	1.15 A @ 208 V	1.00A @ 240 V	2.03 lbs	**MC4**	**030-07766**
IQ8PLUS-72-2	290 W	<62 VDC	16 to 60 VDC 27 to 45 VDC	97.0%	1.39 A @ 208 V	1.21 A @ 240 V	2.03 lbs	**MC4**	**030-07767**

Engage Q-Cable Drop Connector

Q-Cable Terminator

Q-Sealing Caps

Q-Cable Disconnect Tool

Q-Aggregator

Male Field Wireable Connector with Pins

Male and Female Field Wireable Connectoer

Enphase Q-Cable System

The Enphase **Q Cable** offers a new two-wire cable that is 50% lighter than the previous generations of Enphase Cables, and has only two wires, with no neutral or ground required. These drop cables come with plug and play connectors that speed installation times and simplify wire management. New link connectors eliminate cable waste. The Q cable is specific to portrait 60-cell or 72-cell (**Q-12-10-240**), landscape 60-cell (**Q-12-17-240**) or landscape 72-cell (**Q-12-20-200**) modules. These cables are sold in cut-to order lengths, as well as in full box quantities.

The Enphase **Q Cable Terminator** (**Q-TERM-10**) provides a water tight seal that isolates the individual conductors contained in the Q cable. One is required for each branch circuit of microinveters.

Watertight **Q Sealing Caps** (**Q-SEAL-10**) are female caps used to seal unused Q Cable connectors. Unused connectors generally occur where the Q Cable transitions to another module row or needs to span a gap in the array.

The **Q Cable Disconnect** (**Q-DISC-10**) is a tool for Q cable connectors, MC and Amphenol DC connectors. The tool is reusable, so only one per job is usually sufficient.

The Enphase **Q Clip** (**Q-CLIP-100**) is a Q cable rail mount cable management clip, holding the cable securely to most rail based racking systems.

The Enphase **IQ Replacement Adapters** (**Q-DCC-5** for H4 and **Q-DCC**-2 for MC4) are replacement DC connectors for the IQ6+ microinverters, and can change the connector type accepted by the microinverter.

Field Wireable male and female connectors can be used to connect two sections of Q-Cable, or terminate an end for attaching to the Q Aggregator roof combiner box, allowing up to three branch circuits to be combined into one home run circuit. Extension cables or 'Home Run' cables can be assembled using the Field Wirable Connectors along with the Bulk Q-Cable (**Q-12-RAW-300**), which is sold in 300M length rolls. (Note: No connectors are provided on this cable.)

Enphase IQ Series Cable Kits and Accessories		
Model	**Description**	**Item code**
Q-12-10-240-CTO Q	Q Cable, Single Connector, Portrait, 240 VAC	**052-10109**
Q-12-17-240-CTO Q	Q Cable, Single Connector, 60-Cell Landscape 240 VAC	**052-10110**
Q-12-20-240-CTO Q	Q Cable, Single Connector, 72-Cell Landscape 240 VAC	**052-10111**
Q-12-10-240	Q Cable Bulk 240 connections, Portrait 240 VAC	**052-10112**
Q-12-17-240 Q	Q Cable Bulk 240 connections, 60-Cell Landscape 240 VAC	**052-10113**
Q-12-17-200 Q	Q Cable Bulk 200 connections, 72-Cell Landscape 240 VAC	**052-10114**
Q-12-RAW-300	Q Cable, Bullk Q-Cable, No Connectors, 300M Length	**052-10115**
Q-CLIP-100	Cable Clips, pack of 100	**300-07702**
Q-DCC-2 IQ	IQ Replacement adapters-MC4 inputs, each	**300-07703**
Q-DCC-5 IQ	IQ Replacement adapters-H4 inputs, each	**300-07704**
Q-CONN-M IQ	IQ Field Wirable male connector	**300-07712**
Q-CONN-F IQ	IQ Field Wirable female connector	**300-07711**
Q-DISC	Disconnect tool for AC and DC connections, each	**300-07705**
Q-SEAL	Female sealing cap for unused Q Cable connectors, each	**300-07706**
Q-TERM	Termination cap for Q Cable ends, each	**300-07707**
Q-BA-3-1P-60	Enphase Q Aggregator - combines up to 3 branches	**300-07709**
Q-BA-CAP-10	Enphase male sealing caps for Q Branch Aggregator, 10 pack	**300-07710**
242-02151	Enphase microinverter frame mount bracket, 35MM	**300-00190**

Enphase IQ Module Level Monitoring

Enlighten Portal view showing PV Production and Home Consumption

IQ-Envoy Communications Gateway

The **Enphase IQ Envoy-M (ENV-IQ-AM1-240 M)** communications gateway delivers revenue-grade accuracy of solar production and energy consumption data via calibrated solid core current transformers. Enphase Enlighten monitoring and analysis software for comprehensive, remote maintenance and management of the Enphase IQ System. With integrated revenue-grade production metering and optional consumption monitoring, the Envoy IQ is the platform for total energy management and integrates with the Enphase IQ Battery. One IQ Envoy can monitor up to 600 IQ inverters with integrated revenue-grade metering (ANSI 12.20 +/-0.5%).

(Note: The Enphase IQ Envoy and IQ 6 and IQ 6+ Micros do not communicate with, and should not be used with,previous generation Enphase Microinverters and Envoys.)

Enphase Envoy IQ Gateway Device

AC Combiner Box with IQ-Envoy

The **IQ AC Combiner (X-IQ-AM1-240-3 M)** consolidates interconnection equipment into a single enclosure and streamlines PV installations by providing a consistent, pre-wired solution for residentialapplications, and is Enphase IQ Battery ready. The combiner comes with three pre-installed 20A/240 VAC circuit breakers with an IQ Envoy Metered Gateway-M and provides PV production monitoring all with in a durable Listed NEMA 3R enclosure.

The IQ Envoy enables web-based monitoring and control with bidirectional communications for remote upgrades. This NEMA 3R enclosure is designed for installations either indoors or outdoors, and comes with a 5-year warranty.

X-IQ-AM1-240-3M Combiner Box with Envoy IQ

IQ-Envoy Accessories

A pair of **CT-200-SPLIT** consumption CTs can be added to the Enphase IQ Envoy-M enabling monitor household energy usage. These CTs are placed around the utility feed conductors, and can monitor home consumption and are necessary when zero export to the grid is required. Where Internet access is not available, the **Enphase Mobile Connect Cell Modem** can be added to the IQ Combiner Box to connect to the Enlighten monitoring portal over a secure cellular connection. Five and twelve year data plans are available.

CT-200-SPLIT Consumption Monitoring CT

Enphase Module Level Monitoring		
Model	**Description**	**Item code**
ENV-IQ-AM1-240 M	IQ Envoy Gateway, includes production CT's. 240 VAC	**300-07700**
X-IQ-AM1-240-3 M	AC Combiner with IQ Envoy, included 80A subpanel, and production CTs. 240 VAC	**300-07717**
CELLMODEM-01 M	Enphase Mobile Connect cellular modem with five-year data plan option for IQ Envoy	**300-00177**
CELLMODEM-03 M	Enphase Mobile Connect cellular modem with twelve-year data plan option for IQ Envoy	**300-00242**
CT-200-SPLIT	Consumption Monitoring CT, allows whole home consumption metering for AC Combiner with IQ Envoy (Note: Two CT's are required for consumption monitoring)	**300-00179**
ENV-IQ-AM3-3P	IQ Commercial Envoy for 3-phase utility grids (220/208/240 VAC)	**300-07716**

CELLMODEM-01 Enphase Mobile Connect

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SolarEdge

Distributed MPPT Grid-Tie Inverter System

SolarEdge HD Wave Inverter

The SolarEdge distributed grid-tied inverter system combines module-level maximum power point tracking (MPPT), DC-DC power optimizers, and monitoring with high-efficiency transformerless string inverters to maximize the energy yield of a PV installation. The SolarEdge system provides design flexibility by mitigating shading, module mismatch, uneven soiling, and aging variance losses. It automatically maintains a fixed string voltage so the inverter operates at peak efficiency regardless of string size, shading, or temperature. This allows flexible string lengths ranging from 8 to 25 modules for single-phase and 16 to 50 for three-phase inverters as well as various module sizes, tilts, and orientations. The system is scalable and simplifies expansions and replacements since future modules need not electrically match existing ones. Fewer, but longer, strings can also reduce DC-side balance-of-system (BOS) requirements.

The SolarEdge power optimizers have a 25-year warranty, while the SolarEdge inverters have a 12-year warranty (extendable to 20 or 25 years). Warranty extensions can be obtained directly from SolarEdge, and can be done on the SolarEdge website. (https://www3.solaredge.com/warranty). Power optimizers and inverters are listed to UL 1741 for the U.S.A. and Canada.

P-Series Power Optimizers

P320-P370-P400 Optimizer

All SolarEdge power optimizers can be used with crystalline silicon PV modules to provide module-level MPPT and performance monitoring, and are designed to work exclusively with SolarEdge inverters. All power optimizers have 99.5% peak efficiency and are backward compatible with older SolarEdge products. The P320, P370, and P400 optimizers can be used with any SolarEdge inverter. The P730 and P850 dual-module optimizers (two modules are connected in series, then connected to the optimizer) are compatible only with the SolarEdge three-phase inverters.

SolarEdge optimizers can be attached to most PV mounting systems using a single fastener; grounding can be accomplished via the included star washer, a WEEB between the washer and the racking, or through a ground lug, depending on racking. AEE Solar maintains stock of optimizers with MC4 input and MC4 output connectors. Optimizers with H4 connectors are available upon request. Frame mount versions of these optimizers may also be available, and attach directly to the module frame to speed installation or for use with rail-less racking systems.

P730-P850 Optimizer

Features:

- Increased energy harvest through module level optimizers, with 99.5% efficiency
- Mitigates losses due to module mismatch and partial shading
- Single optimizers and P800P dual input optimizer compliant with module-level rapi shutdown NEC 2017 code requirements, P730 and P850 compliant with NEC2014 code
- NEMA 6P, IP68 environmental protection rating
- Operating temperatures of -40 °F to +185 °F (-40 °C to +85 °C)
- 99.5% DC optimizer efficiency
- 25-year warranty on optimizers

P800P Commercial Optimizer

SolarEdge Power Optimizers						
Model	**Max DC input**	**Max input voltage**	**MPPT range**	**Module type**	**Input/Output connector**	**Item code**
P320-5 SERIES-N	320 W	48 VDC	8 - 48 VDC	60-cell	MC4	**300-00153**
P370-5 SERIES-N	370 W	60 VDC	8 – 60 VDC	60/72-cell	MC4	**300-09400**
P400-5 SERIES-N	400 W	80 VDC	8 – 80 VDC	72/96-cell	MC4	**300-00119**
P730-5 SERIES-N	730 W	125 VDC	12.5 – 105 VDC	two modules	MC4	**300-00223**
P850-5 SERIES-N	850 W	125 VDC	12.5 – 105 VDC	two modules	MC4	**300-09405**
P800P-5 SERIES-N	800 W	125 VDC	12.5 – 83 VDC	two modules	MC4	**300-09404**

SolarEdge HD-Wave Single-Phase Inverters

SolarEdge HD Wave Inverter

SolarEdge HD Wave Inverter with optional EV Charger

SolarEdge inverters with HD-Wave technology are half the size and weight of the previous generation, and raise the CEC weighted inverter efficiency to a record breaking 99%. Lightweight in comparison to other inverter manufacturers, these inverters have taken advantage of recent gains in electronics, magnetics, and cooling components to minimize the size, footprint, and to reduce the cost of these inverters. Increased reliability is achieved through the use of thin film capacitors instead of using more traditional electrolytic capacitors. These inverters are designed to work exclusively with SolarEdge power optimizers. These inverters are rated for use from -13 °F to 140 °F (-25 °C to +60 °C) temperatures, and are NEMA 3R rated for installation either in or outdoors. The **SE3000H** to **SE7600H** inverter includes terminals for up to two DC strings of modules, while the **SE10000H** and **SE11400H** has terminals accommodating up to three DC strings. These inverters are all available with optional Revenue Grade Metering, improving accuracy of reported data when needed to meet utility or SREC requirements.

The DC optimizers in a SolarEdge inverter system operate at a fixed voltage, regardless of string length. The voltage is fixed at 380 VDC (400 VDC for the SE7600H to SE11400H), and automatically limits the DC voltage to 1 VDC per module when detecting excessive heat, or when the inverter is not connected to the grid, which improves installer and firefighter safety.

SolarEdge has recently released versions of their SE3800H and SE7600H inverters with integrated electric vehicle car chargers. These units are identical in performance to the standard HD Wave inverter modules, but saves breaker space in the main panel and has a built in meter to track EV power usage. A separate stand-alone charger unit that communicates to the SolarEdge monitoring portal is also available.

Features:

- Grid Tie Inverters from 3,000 W to 11,400 W AC output
- 99.0% CEC weighted inverter efficiency
- Fixed DC input voltage due to use of SolarEdge power optimizers
- Internal Arc Fault Circuit Interrupter (AFCI) for added safety per NEC 2011: 690.11
- Rapid Shutdown upon AC Grid Disconnect (NEC 2014 / NEC 2017)
- Built-in module-level monitoring
  - RS485 and Ethernet Communications interface included
  - Optional WiFi Gateway and GSM Cellular Card accessories
- Optional models with Revenue Grade Metering (ANSI C12.20)
- Operating temperatures of -13 °F to +140 °F (-25 °C to +60 °C)
- NEMA 3R Enclosure
- 12-year inverter warranty, with optional upgrade to 20 or 25 year through SolarEdge
- Listed to UL 1741, UL1699B, CSA C22.2, Canadian AFCI per T.I.L. M-07
- IEEE 1547, Rule 21, Rule 14 (HI)
- UL1741-SA compliant, meeting CPUC Rule 21 requirements

SolarEdge HD Wave Single-Phase Inverters							
Model	Max AC output	CEC efficiency	Max continuous AC outputcurrent per phase		Weight	Item Code (without RGM)	Item Code (with RGM)
			208 V	240 V			
SE3000H-US	3,000 W	99.0%	—	12.5 A	25.0 lbs	**030-09528**	**030-09551**
SE3800H-US	3,800 W	99.0%	—	16.0 A	25.0 lbs	**030-09529**	**030-09552**
SE5000H-US	5,000 W	99.0%	24.0 A	21.0 A	25.1 lbs	**030-09530**	**030-09553**
SE6000H-US	6,000 W	99.0%	—	25.0 A	26.2 lbs	**030-09531**	**030-09554**
SE7600H-US	7,600 W	99.0%	—	32.0 A	26.2 lbs	**030-09532**	**030-09555**
SE10000H-US	10,000 W	99.0%	48.0 A	42.0 A	38.8 lbs	**030-09437**	**030-09462**
SE11400H-US	11,400 W	99.0%	—	47.5 A	38.8 lbs	**030-09438**	**030-09466**
SolarEdge HD Wave Single-Phase Inverters with EV Chargers							
SE3800H-US000NNV2	3,000 W	99.0%	—	16.0 A	22.0 lbs	**030-09439**	—
SE5000H-US000NNV2	5,000 W	99.0%	24.0 A	21.0 A	25.1 lbs	**030-09570**	—
SE6000H-US000NNV2	6,000 W	99.0%	—	25.0 A	26.2 lbs	**030-09571**	—
SE7600H-US000NNV2	7,600 W	99.0%	—	32.0 A	26.2 lbs	**030-09440**	—
SE-EV-KIT-25J40-1	40 A, Level 2 electric vechicle charge connector kit with 25 ft. cable and holder						**300-09403**
NEW CAR CHARGER	Stand Alone Level 2 EV Charging Station (reports to SolarEdge monityoring portal)						**300-09406**

SolarEdge Commercial Three Phase Inverter

SolarEdge Three-Phase Inverters

SolarEdge offers three models of three-phase commercial inverters. The **SE9kUS** and **SE14.4kUS** model can be used in 208 VAC 3-P WYE or Delta configurations, and the **SE33.3kUS** inverter can connect to 480 VAC 3-P WYE configuration grids. The SolarEdge inverters are designed to work exclusively with SolarEdge power optimizers, and can use either single-module optimizers, or P600/P700 dual-module optimizers. MPPT and voltage management is handled by the power optimizers, allowing for a very high-efficiency, low-cost inverter.

The SE9kUS and SE14.4kUS inverters have a fixed input voltage of 400 VDC, while SE33.3kUS inverters operate with fixed input voltage of 850 VDC. The fixed input voltage provided by the SolarEdge optimizers allows for longer module string lengths, resulting in less wire line losses and fewer system components. These wall-mountable inverters are lightweight, NEMA 3R rated, and have built in optimizer-level monitoring, and include an integrated code-compliant DC disconnect, Ethernet interface, and RS-485 serial port. All SolarEdge inverters are listed to UL 1741 and UL 1699B for the U.S.A. and Canada and are NEMA 3R rated. The inverters are rated for use from -40 °F to 140 °F (-40 °C to +60 °C) temperatures. The SE14.4kUS and the SE33.3kUS inverters also come with three fused DC+ and DC- inputs, eliminating the need for a third-party fused combiner box.

The optimizers automatically shut down the DC current and voltage when detecting excessive heat, or when the SolarEdge inverter is turned off or disconnected from the grid, to ensure installer and firefighter safety. NEC2017 Rapid Shutdown can be achieved using dual input commercial optimizers.If complying with earlier NEC2014 code, single input commercial optimizers where two modules are in series can be employed.

Monitoring through the SolarEdge monitoring portal can be enabled by wiring the inverter (using CAT5 cable) directly to an Internet router or switch, or connecting to the internet router wirelessly using the Zigbee Gateway Kit and Slave Modules. Additionally, commercial systems also can be equipped with optional Environmental Sensors, which provides irradiance, module and ambient temperature, and wind data to the monitoring platform.

Features:

- Three models: SE9kUS and SE14.4kUS for 3P-208, and SE33.3k for 3P-480
- Complies with NEC2014 and NEC2017 Rapid Shutdown Requirements (with dual input optimizers)
- Fixed DC input voltage due to use of SolarEdge commercial power optimizers
- Internal Arc Fault Circuit for added safety per NEC 2011 690.11
- Operating Temperatures of -40 °F to +140 °F (-40 °C to +60 °C)
- NEMA 3R Enclosure, allowing either wall or ballast rack mounting
- Built-in module-level monitoring
    - RS485 and Ethernet Communications interface included
    - Optional WiFi Gateway
    - Optional Commercial GSM Cellular Card, with data plans
- 12-year inverter warranty, with optional upgrade to 20 or 25 year through SolarEdge
- Listed to UL 1741, UL1699B, CSA C22.2, Canadian AFCI per T.I.L. M-07
- IEEE 1547, Rule 21, Rule 14 (HI)
- UL1741-SA compliant, meeting CPUC Rule 21 requirements

SolarEdge Three-Phase Inverters

Model	Max AC output		CEC efficiency	Max continuous AC outputcurrent per phase		Weight	Item Code
	208 WYE or 208 Delta	480 WYE		208 WYE or 208 Delta	480 WYE		
SE9kUS (Factory installed Rapid Shut Down Upgrade)	9,000 W	--	96.5%	25.0 A	--	80 lbs	**030-09481**
SE14.4k-USR (Factory installed Rapid Shut Down Upgrade)	14,400 W	--	97.0%	40.0 A	--	106 lbs	**030-09526**
SE33.3k-US R (Factory installed Rapid Shut Down Upgrade)	--	33,300 W	98.5%	--	40.0 A	106 lbs	**030-09527**
DCD-3PH-1TBK	Single Input Kit for SE14.4k-US and SE33.3k-US Inverters (Pack of 5)						**300-00214**

NEW! SolarEdge Synergy Three-Phase Inverters

SolarEdge Synergy Three Phase Inverter

SolarEdge expands its offering for commercial installations with its new line of Synergy inverters. Three models are available, with the **SE43.2kUS** for **3P-208-WYE** grids, and the **SE66.6kUS** and **SE100kUS** for 3P-480-WYE grid installations. Each consists of one primary central unit that contains the common disconnect, electrical connections, and other components, with one or two secondary units that are configured to work with the central primary unit. These units are easily installed by a two man team, and are wall mounted with a minimal footprint. Installation time is greatly reduced, and one common output breaker is or disconnect is needed on the AC output side. Commissioning is now done directly through a smart-phone or other WiFi device with the SolarEdge SetApp mobile application.

As with other SolarEdge products, power optimizers on the roof perform the MPPT functions for the inverter system, boosting energy harvest. The fixed input voltage provided by the SolarEdge optimizers allows for longer module string lengths, resulting in less wire line losses and fewer system components. The optimizers automatically shut down the DC current and voltage when detecting excessive heat, or when the SolarEdge inverter is turned off or disconnected from the grid, to ensure installer and firefighter safety. The high fixed voltage of a SolarEdge commercial system enables longer DC strings to be wired, lowering installation, connection, and wiring costs over typical commercial string inverter systems. Single input optimizers, where two panels are connected in series meet NEC2014 Rapid Shutdown requirements. Where NEC2017 is in effect, dual input commercial optimizers should be used.

Monitoring through the SolarEdge monitoring portal can be enabled by wiring the inverter (using CAT5 cable) directly to an Internet router or switch, or connecting to an Internet wireless router. The Control and Communications Gateway can also be installed and enables the use of Environmental Sensors, which provides irradiance, module and ambient temperature, and wind data to the monitoring platform.

Features:

- Easy installation of up to a 100kW inverter with just a two man team
- Lower BOS component costs, with installation and commissioning time reduced
- Fixed DC input voltage due to use of SolarEdge commercial power optimizers
- Complies with NEC2014 and NEC2017 Rapid Shutdown Requirements (with dual input optimizers)
- Internal Arc Fault Circuit for added safety per NEC 2011 690.11
- Wide Temperature Range of -40 °F to +140 °F (-40 °C to +60 °C)
- NEMA 3R Enclosure, allowing either wall or ballast rack mounting
    - Built-in module-level monitoring
    - RS485 and Ethernet Communications interface included
    - Optional WiFi Gateway
- Optional Commericial GSM Cellular Card, with data plans
- 12-year inverter warranty, with optional upgrade to 20 or 25 year through SolarEdge
- Listed to UL 1741, UL1699B, CSA C22.2, Canadian AFCI per T.I.L. M-07
- IEEE 1547, Rule 21, Rule 14 (HI)
- UL1741-SA compliant, meeting CPUC Rule 21 requirements

SolarEdge Three-Phase Inverters							
Model	Max AC output		CEC efficiency	Max continuous AC outputcurrent per phase		Weight	Item Code
	208 WYE or 208 Delta	480 WYE		208 WYE or 208 Delta	480 WYE		
SE43.2k-USRP0BNU4 (Primary Unit - Requires two Secondary Units	43,200 W	--	97.0%	120.0 A	--	105.8 lbs	**030-09569**
SE66.0k-USRP0BNU4 (Primary Unit - Requires one Secondary Unit	–	66,600 W	98.5%	80.0 A	--	105.8 lbs	**030-09572**
SE100k-USRP0BNU4 (Primary Unit - Requires two Secondary Units	--	100,000 W	98.5%	120.0 A	–	105.8 lbs	**030-09567**
SESU-USRS0NNN4 (Secondary Inverter Unit)	Secondary Inverter Unit - to be used with above primary inverters					99.2 lbs	**030-09567**

Web-based Monitoring

SolarEdge ZigBee Gateway Kit

SE1000-CCG-G
Control and Communications Gateway

SE1000-R12-XX-S1
GSM Cellular Card

SE1000-RS485
Expansion Card Kit

SolarEdge Module-Level Monitoring

SolarEdge provides free web-based PV performance monitoring, fault detection, and troubleshooting at module, string, and system levels. Web-based software provides real-time monitoring, facilitating increased system uptime, and system lowering maintenance costs. Remote fault detection pinpoints the location of under performing modules on a virtual PV site map. The monitoring sensors and transmitters are built-in and data is transmitted over the DC power lines. Connection between the inverter(s) and the Internet can either be by Ethernet or a wireless connection using a ZigBee gateway with connections between multiple inverters using their RS-485 connection ports.

The **ZigBee Gateway Kit** includes the ZigBee home gateway and a single ZigBee card with extended range antenna for wireless connection of a single inverter to an existing network router. Additional inverters can be added to the network using a **Zigbee wireless slave module**, and tied to the master unit. **The ZigBee Repeater** can be installed and used to extend the range of the Gateway Kit network by up to 800'.

For residential systems that lack Internet connection, SolarEdge **GSM Cellular Network Cards** will connect a single residential SolarEdge inverter to the monitoring portal over a cellular network. Residential systems with multiple inverters will need one card installed in each inverter. Five and twelve year data plans are avaialble.

The SolarEdge **Commercial GSM Card** can connect multiple inverters to the SolarEdge monitoring portal. This card can service up to 32 devices, and connect plants up to 500kW DC in size. A per inverter monitoring charge is billed directly through SolarEdge for commercial monitoring systems.

A free monitoring iPhone app is available as a download from the Apple iTunes Store. Registered users can monitor multiple sites from their iPhone. The application provides an at-a-glance view of past and present energy production. Current weather conditions and forecasts are also presented to aid in assessing the system's performance. For commercial systems, the monitoring portal is easily configured for display in a public display through a public web address. The display is refreshed every five minutes and shows the site production, and environmental benefits, along with the installer logo and the site image.

The Site Mapping Tool software is also available free on the SolarEdge website, which allows bar code scanning for creation of a virtual site map using an iPhone. The Site Designer software and an Inverter Configuration Tool for on-site configuration and module-level installation verification are available free online as well.

Commercial installations that require weather station data can install the optional **Control and Communications Gateway** and then connect up to three SolarEdge **Environmental Sensors** that will then display the data on the SolarEdge monitoring portal. Add and link additional Gateways if more sensors are needed.

Monitoring Accessories for SolarEdge		
Model	**Description**	**Item code**
SE1000-ZBGW-K5-NA	ZigBee-to-Ethernet gateway kit with extended range antenna and one slave module	**029-01641**
SE1000-ZB05-SLV-NA	ZigBee wireless slave module – one per each additional inverter	**029-01642**
SE1000-ZBRPT05-NA	ZigBee repeater – range extender	**029-01643**
SE1000-RS485-IF-NA	RS485 Expansion Card Kit – adds second RS485 port	**300-00219**
SE1000-CCG-G	Control and Communications Gateway (required for adding environmental sensors) (Inputs for up to three sensors)	**029-01644**
SE1000-SEN-IRR-S1	Irradiance Sensor	**300-00154**
SE1000-SEN-TAMB-S2	Ambient Temperature Sensor	**300-00155**
SE1000-SEN-TMOD-S2	Module Temperature Sensor	**300-00156**
SE1000-SEN-WIND-S1	Wind Velocity Sensor	**300-00157**
SE-RS485-SPD2-K1	RS485 Surge Supression Kit, 5 Pack (Surge suppression for RS485 comms)	**300-00243**
SE-GSM-R5-US-S1	Cellular GSM KIT, with included 5-year service data plan (for use with a single SolarEdge residential inverter, and two meters)	**300-00224**
SE-GSM-R12-XX-S1	Cellular GSM KIT, with included 12-year service data plan (for use with a single SolarEdge residential inverter, and two meters)	**300-00198**
SE-GSM-R05-US-S4	Commercial Cellular GSM KIT, with included 5-year service data plan (for use multiple SolarEdge Commercial inverters, up to 32 devices and 500kW)	**300-00241**

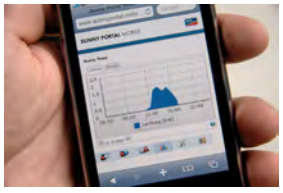
SMA SB-40 Inverter

SMA America

SMA Sunny Boy SB3.0-US-41 to SB7.7-US-41 Grid-Tie Inverters

The SMA **Sunny Boy SB-41** series of transformerless single-phase residential inverters can be used for both residential single phase 120/240 VAC applications, as well as for three-phase 208 and three-phase 240 volt applications, when used in groups of three inverters to balance the phases. These inverters utilize three separate MPPT channels, allowing more stringing options, and up to three array facings. The integrated DC disconnect simplifies and speeds installation. Solar array monitoring through SMA's Sunny Portal has also have been simplified, as these inverters ship with factory installed WiFi capable data loggers that enable fast and easy connection to the Sunny Portal platform, and can be field configured via a laptop, smart phone, or other WiFi enabled device.

SMA's unique Secure Power Supply feature has been improved, and now can supply up to 2,000 W (15 A / 120 VAC) of power to a protected outlet during a grid outage, which provides a single 'protected' outlet useful for recharging portable devices or a small UPS directly from the PV array.



SMA Sunny Portal Mobile

Power+ MLPE devices with the ROOFCOMKIT-P2 can be utilized for states that have adopted NEC2017 code to provide module level optimization, shade mitigation, and/or rapid shutdown functionality, based on customer needs and price point. These inverters are now Sunspec compliant, and can also use the new TS4-R-F MLPE devices to comply with NEC2017 module level RSD, without needed the ROOFCOMKIT. In states still enforcing NEC 2014 code, the SMA Rapid Shutdown Boxes and Controller can still be used.

These SMA inverters are listed to UL 1741, UL 1998, UL 1699B, and are compliant with IEEE-1547, and FCC Part 15 (Class A & B), as well as both ground and arc fault detection per NEC 2011. They are covered by a standard 10-year warranty, with 5-year and 10-year extensions available.

SMA Sunny Portal Monitoring Platform

Features:

- CEC Rated Efficiencies of up to 97.0%
- 2,000 W Secure Power Supply (requires installation of a dedicated outlet)
- Operating temperatures of -40 °F to +140 °F
- Up to three MPPT input circuits – 10 A max usable current (18 A max Isc) per MPPT input
- Integrated AFCI for arc-fault protection
- Available in sizes from 3.0 kW to 7.7 kW AC Output
- Field selectable 240 VAC Single-Phase or 208/240 VAC three-phase output
- NEC 2014 / NEC 2017 Rapid Shutdown Compliant
- SMA Rapid Shutdown Box and Controller (NEC 2014)
- SMA TS4-R-S/TS4-R-O Power+ Optimizers with ROOFCOMKIT-P2 (NEC 2017)
- SMA TS4-R-F Power+ MLPE, with SunSpec Communication (NEC 2017)
- 10-year standard warranty, with upgrade option to 20 years
- Listed to UL 1741 and UL1699B for U.S.A. and Canada
- Compliant with: IEEE 1547, IEEE 929, FCC Part 15 A& B , CSA C22.2 107.1-1
- Compliant to UL 1741-SA (CA Rule 21) requirements

SMA Sunny Boy TL-US-41 Inverters

Model	Max AC output	AC voltage	DC array	Rated MPPT	Est CEC	MPPT inputs / inputs per MPPT	Max usable input current per MPPT	Max AC current	Weight	Item code
SB3.0-US-41	3,000 W 3,000 W	240 VAC 208 VAC	125-600 VDC	155-480 VDC	97.0% 96.5%	2 / 1	10 A	12.5 A 14.5 A	57 lbs	**030-02984**
SB3.8-US-41	3,800 W 3,330 W	240 VAC 208 VAC		195-480 VDC	97.0% 96.5%	2 / 1	10 A	16.0 A 16.0 A		**030-02985**
SB5.0-US-41	5,000 W 5,000 W	240 VAC 208 VAC		220-480 VDC	97.0% 96.5%	3 / 1	10 A	24.0 A 24.0 A		**030-02986**
SB6.0-US-41	6,000 W 5,200 W	240 VAC 208 VAC		220-480 VDC	97.0% 96.5%	3 / 1	10 A	25.0 A 25.0 A		**030-02987**
SB7.0-US-41	7,000 W 6,660 W	240 VAC 208 VAC		245-480 VDC	96.5% 96.5%	3 / 1	10 A	29.2 A 32.0 A		**030-02988**
SB7.7-US-41	7,680 W 6,660 W	240 VAC 208 VAC		270-480 VDC	96.5% 96.5%	3 / 1	10 A	32.0 A 32.0 A		**030-02989**

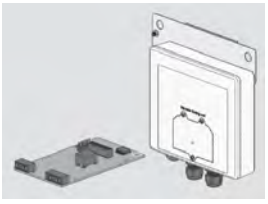
SMA Power+ MLPE Optimizer System

The SMA Power+ Solution offers a flexible MLPE (module level power electronics) system to meet all Rapid Shutdown and optimization needs. The Power+ TS4-R modular platform is a unique plug-and-play concept that enables customized functionality for any PV application.

If complying with NEC2017 module level rapid shutdown requirements residential or commercial applications, the **TS4-R-F** MLPE can be installed on each module, provided that the inverter is capable of SunSpec signaling. All of the SMA residential SB-41 and the commercial CORE1-41 inverters have this capability.

TS4-R-MLPE

Residential installations can comply with panel level Rapid Shutdown requirements, while also monitoring and optimizing each PV module's production utilizing **TS4-R-S** and **TS4-R-O MLPE** devices, and installing the new **ROOFCOMMKIT-P2**. This kit includes one Gateway device which mounts behind a panel on the roof and one Cloud Connect Advanced Module card, which is installed inside the SB-41 inverter. Panel level optimization, monitoring, and rapid shutdown is achieved with the **TS4-R-O**, while installing the **TS4-R-S** MLPE provides only monitoring and shutdown. Additional **TS4 GATEWAY** devices can be purchased for larger or more complicated arrays. The Gateway device(s) are connected through a RS485 wired connection to the Cloud Connect Advanced module, installed in the inverter, and provides a wireless connection to the Sunny Portal.



ROOFCOMMKIT-P2
(Inc. Cloud Connect Card and One Gateway)

TS4-R-O MLPE optimizers can also be used with the SMA Rapid Shutdown Box, to provide shade mitigation to a PV Array for selected panels for installations still installing under NEC2014 code. Installations in this manner would require the SMA Rapid Shutdown Box and SMA Rapid Shutdown Controller, but do not utilize the TS4 Gateway or Cloud Connect kit. While these installations do allow the Secure Power Supply of the SMA inverter to be utilized, they do not provide module level monitoring. This is known as 'selective deployment'.

TS4 GATEWAY

SMA Power+ MLPE Optimizer System	
Description	**Item code**
TS4-R-S MLPE (Safety and Monitoring Module)	**300-00236**
TS4-R-O MLPE (Optimization, Safety, and Monitoring Module)	**300-00235**
TS4-R-F MLPE (Rapid shutdown only - SunSpec enabled inverter or signaling device required)	**300-03007**
ROOFCOMMKIT-P1-US (one TS4 Gateway, one Cloud Connect with power supply, accessories)	**300-03001**
TS4 GATEWAY (additional Gateway device for large or complicated arrays)	**300-00238**
TS4 FIELD TOOL (allows removal of the back plate for service)	**300-00239**
TS4 Cloud Connect Advance Kit Outdoor (For use with non-SMA inverters)	**300-00240**

SMA Rapid Shutdown Box

SMA Rapid Shutdown Box

The SMA Rapid Shutdown System consists of the **Rapid Shutdown Controller** and one or more **Rapid Shutdown Boxes**, and allows SMA residential inverters to achieve compliance with string level NEC 2014 690.12 Rapid Shutdown requirements.

The system is DC powered, and will allow the use of the SMA Secure Power Supply in the event of a power outage. The Rapid Shutdown Box is installed on the roof and can accommodate up to 4 DC strings, with two combined DC outputs. (When using the SB-X.X-US inverters with three MPPTs, either two Shutdown Boxes can be used, or combined strings can be split in the inverter using the Illsco 3-Pole Connector Block to land on separate MPPT input circuits.)

One can add Power+ TS4-R-O optimizers in a 'selective deployment' mode for shade mitigation on a limitted number of panels in combination with the Rapid Shutdown Box.

SMA Rapid Shutdown Controller

The Rapid Shutdown Controller provides a visible indication of when safe conditions exist, and emergency shut off button with LED indicators. One Rapid Shutdown Controller can be used with multiple Rapid Shutdown Boxes for larger arrays. Both the Rapid Shutdown Controller and the Rapid Shutdown Box are rated NEMA 4X, for use with a maximum system voltage 600 VDC, and come with a 10-year warranty.

SMA Rapid Shutdown System for SMA Inverters	
Description	**Item code**
SMA Rapid Shutdown Box – Up to four DC input circuits (MC4 connectors), and up to two output circuits.	**053-01820**
SMA Rapid Shutdown Controller – For use with the SMA Rapid Shutdown Box	**053-01821**
ILSCO 3-Pole Connector Block, 4-14 AWG	**054-01143**

NEW! SMA Tripower CORE1-33/50/62 kW Commercial Inverters

The **SMA Tripower CORE1** 33 kW, 50 kW, and 62 kW commercial inverters from SMA are free standing, allowing easy installation supporting roof, carport, or ground mount PV arrays. These inverters are capable of 3P-480 VAC output, and can accommodate a very high DC to AC ratios, meaning that fewer inverter are needed to service a PV array. These inverters weigh just 180 lbs, and measure 24.4" x 28.8" x 22.4", and has a NEMA 6X rating. The standard warranty is on this inverter is 10 years, extendable to 20 years.

These inverters have many innovative features that simplify design, speed installation, and lower costs. These inverters have a total of six MPPT circuits, with twelve direct plug in connections. This eliminates the need for external DC combiners, string fusing, or pass through boxes. An integrated DC and AC disconnect further saves on material costs and installation.

A built in Wi-Fi Speedwire monitoring card allows for easy configuration and commissioning of these inverters from a WiFi enabled device, like a tablet or smartphone. Connection to the SMA Sunny Portal can be over wired or Wi-Fi connection, and the new SMA **Datamanager-M** can be installed for additional plant level monitoring and control for up to 50 connected inverters.

NEC2017 code can be met by installing TS4-O-F MLPEs on each solar PV module, as these inverters are SunSpec compliant, signaling the MLPEs to initiate a Rapid Shutdown. If needing to comply with NEC2014 code, then these inverters are easily be installed next to the solar array on rooftop installs.

Features:

- Six MPPT Circuits, each with two input strings with provided UTX/H4 connectors
- Freestanding design for roof or ground mount, without need for special racking
- Integrated AC and DC disconnect, and up to 1.5 DC to AC ratio on inverter sizing
- Optional SMA AC and DC Surge Suppression Modules
- OptiCool Active Cooling system
- Built in Datalogger, allowing WiFi or Wired communications, with local WiFi commissioning
- Optional Datamanager-M for plant level control of up to 50 devices
- Operating temperatures of -13 °F to +140 °F (-25 °C to +60 °C)\
- Meets SunSpec Standards, enabling use of module level MLPE Shutdown Devices
- 10-year warranty, extendable up to 20 years
- Listed to UL 1741, UL1998, UL 1699B
- Compliant with: IEEE 1547-2003, IEEE 1547.1, FCC Part 15 A&B, CAN/CSA C22. 2 No. 107.1-01
- Compliant to Rule 21 (UL 1741-SA) requirements

DC Surge Suppression Module for Core1 Inverters

AC Surge Suppression Module for Core1-US inverters

SMA Tripower CORE1 Commercial Inverter						
Model	**Max AC output**	**CEC efficiency**	**MPPT Range Operating / Rated**	**Max output current per phase**	**Weight**	**Item code**
STP-33-US-41	33,300 W	97.5%	150-1000 / 330-800	40.0 A	185.0 lbs	**030-02990**
STP-50-US-41	50,000 W	98.0%	150-1000 / 500-800	64.0 A	185.0 lbs	**030-02991**
STP-62-US-41	62,000 W	98.0%	150-1000 / 550-800	79.5 A	185.0 lbs	**030-02992**
SMA Accessory Items						
Data Manager M - Central monitoring and control device for 5 or more inverters						**300-03003**
Revenue Grade Meter RS485 Bundle						**030-03005**
AC Surge Suppression Module for Core1-US inverters						**053-04270**
DC Surge Suppression Module for Core1-US inverters						**053-04271**

Fronius

Primo Single Phase Inverters

The **Fronius Primo** is a lightweight, transformerless, single-phase inverter that allows for fast installation and easy setup. The Primo utilizes the Fonius SnapINverter™ hinge mounting system, which allows for tool-free attachment and removal of the inverter from the wall mounting plate and integrated disconnect, making it practical for one person to install. The NEMA 4X enclosure allows installation in harsh environments. Dual MPPT circuits and wide voltage windows allow for flexible design on two exposures with different module-string lengths.

Primo inverters span 3.8 kW to 15.0 kW configurations. The smaller Primo inverters (3.8 to 8.2 kWp) have two non-fused inputs for MPPT1 and MPPT2. The larger Primos (10.0, 11.4, 12.5 and 15.0 kWp) have four inputs to MPPT1 that ship with slugs and can be replaced with fuses if needed, and two non-fused inputs for MPPT2, eliminating the need for third-party combiner boxes. If more strings are needed, an external, 3rd party combiner can be utilized. (See Electrical Distribution Parts for fuses). The built-in WiFi Fronius Datamanager 2.0 card enables easy configuration using any WiFi enabled device, like a tablet or smart phone. Connection to the Internet can be through WiFi or Wired connection.

For compliance with NEC2014 code, the Fronius Duo or Quatro Rapid Shutdown boxes can be employed. 3rd party MLPE devices can be used to enable these inverters to be installed in states on NEC2017 code cycle, enabling module level Rapid Shutdown. (Example: Tigo TS4-R-S MLPE devices, with Cloud Connect and Gateway signaling).

These inverters are covered by a 10-year warranty, which can be extended to 15 or 20 years.

Features:

- Internal Arc Fault Circuit Interrupter (AFCI) for added safety per NEC 2011
- Easy-to-mount SnapINverter concept and NEMA 4X enclosure
- Dual MPPT inputs
- WiFi, wired Ethernet, or Serial monitoring through installed Datamanager 2.0 Card
- Monitoring included via Fronius Solar.Web Portal
- Operating temperatures of -40 °F to +140 °F
- Fronius RSD boxes for NEC2014 compliance, 3rd party RSD for NEC2017 compliance
- 10-year standard warranty, with upgrades available for 15 or 20 years
- Listed to UL 1741-2010 and UL1699B-2013 for U.S.A. and Canada
- Compliant to Rule 21 (UL 1741-SA) requirements.

Fronius Primo Inverters								
Model	**Max AC output**	**AC voltage**	**DC array voltage**	**MPPT range**	**CEC efficiency**	**Max AC current**	**Weight**	**Item code**
Primo 3.8-1	3,800 W	240 VAC 208 VAC	80-600 VDC	200-480 VDC	95.0%	15.8 A 18.3 A	47.0 lbs	**030-08514**
Primo 5.0-1	5,000 W	240 VAC 208 VAC		240-480 VDC	95.5%	20.8 A 24.0A		**030-08515**
Primo 6.0-1	6,000 W	240 VAC 208 VAC		240-480 VDC	96.0%	25.0 A 28.8 A		**030-08516**
Primo 7.6-1	7,600 W	240 VAC 208 VAC		250-480 VDC	96.0%	31.7A 36.5 A		**030-08517**
Primo 8.2-1	8,200 W	240 VAC 208 VAC		270-480 VDC	96.5%	34.2 A 38.0 A		**030-08518**
Primo 10.0-1	10 kW	240 VAC 208 VAC	80-600 VDC	220-480 VDC	96.9%	41.7 A 48.1 A	76.7 lbs	**030-08528**
Primo 11.4-1	11.4 kW	240 VAC 208 VAC		240-480 VDC	96.9%	47.5 A 54.8 A		**030-08529**
Primo 12.5-1	12 kW	240 VAC 208 VAC		260-480 VDC	96.9%	52.1 A 60.1 A		**030-08530**
Primo 15.0-1	13.75 kW 15 kW	240 VAC 208 VAC		320-480 VDC	96.9%	62.5 A 66.1 A		**030-08531**

Fronius Symo Advanced Three-Phase Commercial Inverters

Fronius Symo three-phase commercial inverters utilizes the Fronius SnapINverter™ hinge mounting system, which enables tool-free attachment and removal of the inverter from the wall mounting plate and integrated disconnect, making it easier than ever to install large solar arrays. Power ranges from 10 kW to 24 kW. A wide MPPT voltage range, with two MPPT input circuits (note: There is only one MPPT circuit on Symo 15.0-208-3), and the NEMA 4X enclosure provides greater flexibility in system design even in extreme environments. The smaller Symo commercial inverters have two non-fused inputs for each MPPT circuit. The Symo 20.0-3-480, the 22.5-3-480, and 24.0-3-480 have four inputs for MPPT1, that can accommodate fuses, with two non-fused inputs for MPPT2. All these inverters can also be set up as a single combined MPPT inverter using an external, 3rd party fused combiner box, if additional input strings are necessary. Inverters with fuse holders ship with slugs, so appropriate fuses must be ordered separately. (See Electrical Distribution Parts)

Fronius Symo inverters can be equipped with the WiFi Fronius Datamanager 2.0 card that enables Internet monitoring via the Fronius Solar.web portal on computer or smartphone. Only one card is required for multiple Symo inverters installed in the same location. The inverters also support a Modbus interface for third-party monitoring and datalogging. The Fronius.Web monitoring portal can also utilize the free Fronius Solar.TV service, to transmit monitoring data to a public display, which includes system yield, energy production, and environmental benefits.

These inverters (with exception of the Symo 15.0-3-208) are now SunSpec compliant, enabling the use of third party MLPE devices to comply with NEC2017 code. If complying with NEC2014 code, all Symo inverters can be mounted next to the PV Array to meet Rapid Shutdown requirements.

Fronius Symo inverters are covered by a 10-year warranty, which can be extended to 15 or 20 years.

Features:

- Dual-MPPT DC input (except for Symo 15.0-3-208)
- Internal Arc Fault Circuit Interrupter (AFCI) for added safety per NEC 2011
- Inverter sizes available from 10.0 kW to 24.0 kW, 3P-208/240 VAC and 3P-480 VAC
- Easy-to-mount SnapINverter concept with NEMA 4X enclosure. Can be mounted vertical on a wall, or mounted flat on standard racking, without needing specialized ballasted tilt racking.
- WiFi, wired Ethernet, or Serial monitoring with Datamanager 2.0 Card through Fronius Solar. Web Portal
- Meets SunSpec Standards, enabling use of module level MLPE Shutdown Devices (with exception of Symo 15.0-3-208)
- Standard 10-year warranty, with extensions available for up to 20 years
- Listed to UL 1741-2010, UL 1699B Issue 2-2013 and CSA TIL M-07 Issue 1-2013 for U.S.A. and Canada.
- Complies with: IEEE 1547-2003, IEEE 1547.1, ANSI/IEEE C62.41, FCC Part 15 A & B, C22.2 No. 107.1-01 (Sept 2001)
- Compliant to Rule 21 (UL 1741-SA) requirements.

Fronius Symo Inverters

Model	Max AC output	AC voltage	DC array voltage	MPPT range	CEC efficiency	Max AC current	Weight	Item code
SYMO 10.0-3 208/240	9,995 W	240 VAC 208 VAC	200-600 VDC	300-500 VDC	96.5% 96.5%	24.0A 27.7 A	91.9 lbs	**030-08417**
SYMO 12.0-3 208/240	11,995 W	240 VAC 208 VAC	200-600 VDC	300-500 VDC	96.5% 96.5%	28.9 A 33.3 A	91.9 lbs	**030-08418**
SYMO 15.0-208	15,000 W	208 VAC	325-1000 VDC	325-850 VDC	96.5 %	41.6 A	95.7 lbs	**030-08423**
SYMO 17.5-3 480	14,995 W	480 VAC	200-1,000 VDC	350-800 VDC	97.0%	18.0A	95.7 lbs	**030-08419**
SYMO 20.0-3 480	19,995 W	480 VAC	200-1,000 VDC	450-800 VDC	97.5%	24.0 A	95.7 lbs	**030-08420**
SYMO 22.7-3 480	22,727 W	480 VAC	200-1,000 VDC	500-800 VDC	97.5%	27.3 A	95.7 lbs	**030-08421**
SYMO 24.0-3 480	23,995 W	480 VAC	200-1,000 VDC	500-800 VDC	97.5%	28.9 A	95.7 lbs	**030-08422**

(Note: Symo 15.0-3-208 is NOT SunSpec capable, and can not utilize SunSpec MLPE devices to comply with module level Rapid Shutdown.)

Datamanager Card

Modbus Card

Cellular Solution

Inverter Shade Cover

Fronius Monitoring and Accessories

The **Fronius Datamanager 2.0 Card** is a plug-in card that sends data directly to the free Fronius Solar web online portal. The connection from the Datamanager 2.0 card to the site router can be made with either WiFi or Ethernet cable. Open interfaces allow connection to third-party monitoring solutions. Only one Datamanager card is needed for up to 100 Fronius inverters.

Fronius Primo inverters have factory-installed Datamanager 2.0 Card, and therefore have built in WiFi and Ethernet connectivity. Symo inverters instead ship with a Com Card instead of the DM 2.0 card, as only one Datamanager 2.0 card is required for a bank of Symo commercial inverters.

For areas with poor or no Internet service, Fronius has introduced the **Fronius Cellular Solution**. This is a cellular modem installed inside the inverter, and communicates over the Verizon CDMA network, with an included prepaid 5-year data plan.

The **Fronius Modbus Card** is required for some third-party monitoring systems utilizing Modbus RTU protocol. One Modbus Card is required for each inverter to be monitored.

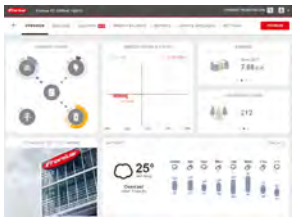
Fronius Monitoring and Accessories			
Model	**Mfg. #**	**Description**	**Item code**
Datamanager 2.0 Card	4,240,038,Z	Datamanager 2.0 Card for Galvo, Primo, and Symo inverters	**300-00132**
Modbus Card	4,240,021,Z	Modbus card for third-party monitoring	**300-00066**
Smart Converter USB	4,240,119	Converts the DATCOM system interface into USB interface	**030-03447**
Fronius Cellular Module	TBD	Wireless internet to access Solar.web, with pre-paid 5-yr Plan	**030-03447**
Fronius Shade Cover	2,0201,5443	Shade Cover for Fronius Inverters	**030-00250**

Fronius DUO and QUATTRO Rapid Shutdown Boxes

The **Fronius Rapid Shutdown Box** enables compliance with NEC 2014 which requires string level rapid shutdown function for PV systems on buildings. These boxes are reliable and easy to install for Fronius Primo single-phase inverters from 3.8 kW to 15 kW.

The boxes now feature a low profile design that cleanly fits underneath the modules, and includes mounting bracket to easily attach to a rail. MC4 input connectors rated up to 25A are provided on the DC input side, and spring loaded terminals are provided for quick and easy wiring on the output circuits. Using MC4 branch or "Y" connectors, one can wire two strings per input circuit, for up to two strings using the **DUO** rapid shutdown box, and up to for strings with the **QUATTRO** rapid shutdown box.

The box is triggered whenever AC is not present to the inverter, and the voltage and current within the DC wiring between the array and the inverter is quickly discharged. The box is NEMA 4X rated, and the **DUO** box can accommodate one or two DC Strings, while the **QUATTRO** box can accommodate two, three, or four DC strings, with a maximum rating of 600 VDC and 25 A per combined output circuit.



Fronius Solar Web Portal

Fronius Duo RSD Box

Fronius Quattro RSD Box

Fronius Rapid Shutdown Box for Fronius Inverters	
Description	**Item code**
Fronius DUO Rapid Shutdown Box, two input strings, one output string, 25 A max, 600 VDC max	**300-00244**
Fronius QUATTRO Rapid Shutdown Box, four input strings, two output strings, 25 A max ea, 600 VDC max	**300-00245**
MC4 Branch Connector, with 2 male inputs, and one female output	**052-09403**
MC4 Branch Connector, with 2 female inputs, and one male output	**052-09404**

SolarEdge StorEdge™ Hybrid Inverters

StorEdge Hybrid Inverter

StorEdge Electricity Meter

StorEdge Auto-transformer

SolarEdge's StorEdge storage solution can provide homeowners with backup power in case of grid interruption, and allows home owners to maximize self-consumption and to increase energy independence. This is useful when grid net-metering, or export to the grid is not available, or when exporting to the grid is not advantageous financially. This system uses DC coupling for both the solar and the connection to the battery system for greater overall roundtrip efficiency. The system supports export control, time-of-use shifting, maximized self-consumption, and peak shaving capabilities. These features can use any of the loads in the house, including those on the main service panel. Backup power is also available with the addition of the Auto-transformer. Backup power is only available to the loads connected to the backup loads panel. Backup power capacity is a maximum of 5000 watts. Switchover upon a power outage can take up to 2 seconds. The StorEdge inverter is compatible with certified high voltage battery systems. The preferred monitoring for this inverter system is through an included 5-year prepaid GSM cellular card, or optionally through a wired Ethernet connection. Using the cellular card ensures that the inverter can receive critical updates regardless of the customer's internet connection.

StorEdge inverters are designed to work exclusively with SolarEdge power optimizers for use with solar modules. Both the optimizer strings and battery system operate at a nominal 400 VDC. The inverter and optimizers have NEC required ground fault and arc fault protection. When the inverter is not connected to the grid and the battery is disabled, the optimizers limit their voltage to 1 VDC each, useful during installation and during an emergency shutdown.

When used for export control, time-of-use shifting, self-consumption, or peak shaving capabilities, the **SE Electricity Meter** is needed. Two CT's, sized to the service are required to be installed on a houses utility AC lines. To allow for backup power capability, the **SEAUTOTX- 5000** auto-transformer and a backup loads panel must be installed.

Features:

- 5,000 W backup, 3,800 W or 7,600 W grid-tie output
- Maximum surge rating for backup loads is 6600 W
- Internal Arc Fault Circuit Interrupter (AFCI) for added safety per NEC 2011: 690.11
- Inherently compliant with NEC 2017 690.12 rapid shutdown requirement
- Built-in module-level and battery system monitoring
- GSM Cellular Card with 5-year plan prewired and included
- RS485 and Ethernet communications interface included
- NEMA 3R outdoor rated
- Inverter operating temperatures of -13 °F to +140 °F (-25 °C to +60 °C).
- UL1741-SA, UL1699B, UL1998, CSA 22.2, IEEE1547, Rule 21, Rule 14

SolarEdge StorEdge Inverters						
Model	**Max AC output**	**CEC efficiency**	**Max continuous AC outputcurrent per phase**	**Weight**	**RGM**	**Item Code**
SE7600A-USS20NHB2	7,600W	97.5%	32 A	58 lbs	N	**030-09560**
SE7600A-USS20NHY2	7,600W	97.5%	32 A	58 lbs	Y	**030-09563**
SE3800A-USS20NHB2	3,800W	97.5%	16 A	58 lbs	N	**030-09564**
SE3800A-USS20NHY2	3,800W	97.5%	16 A	58 lbs	Y	**030-09565**
SEAUTO-TX-5000	SolarEdge Auto-transformer					**300-00180**
SE-MTR-0-000-S1	SolarEdge Electricity Meter. Does not include CTs.					**029-01658-1**
SE-ACT-0750-200	SolarEdge 200 A CTs for Electricty Meter, requires two					**029-01654**
SE-ACT-0750-400	SolarEdge 400 A CTs for Electricty Meter, requires two					**029-01655**

Sunny Boy Storage Hybrid Inverter

NEW! SMA Sunny Boy Storage

The Sunny Boy Storage is the newest addition to the SMA product line. The Sunny Boy Storage is specifically designed for energy management services such as; zero export and peak load shaving. The Sunny Storage AC coupled architecture allows for easy integration with existing PV systems as well as new installations of on-grid residential systems up to 30kWp. Installing the Secure Power Supply (SPS), allows up to 2000 W at 120 VAC of convenience power can be supplied through a dedicated protected outlet both day and night as long as battery power is available.

The inverter is available in a variety of sizes with up to three 10 A DC battery inputs allowing for extensive system flexibility. Each battery input has a voltage range of 100 V DC to 500 V DC and can support different battery brands and capacities on the same inverter.

The Sunny Boy Storage can be accessed via smart phone or laptop through WLAN connection for speedy configuration to decrease installation time. Communication is simplified with a direct Ethernet or Wi-Fi connection to SunnyPortal/SunnyPlaces via Webconnect.

The new SMA Automatic Backup Unit **(SBS-ABU-200-US-10)** allows the Sunny Boy Storage inverters to be used as a home backup system in event of grid outage or disruption, and is designed to specifically communicate with the SMA Sunny Boy line of inverters. This unit includes an automatic transfer switch that disconnects the PV System and loads from the utility grid, and creates a small battery-backup grid The included Backup Unit Controller coordinates grid disconnection and reconnection to ensure minimal downtime while also allowing for up to 5 kVA of unbalanced loads. When paired with SMA Sunny Boy inverters, the Sunny Boy Storage curtails PV power production to match load in the event the battery is full to maximize use of solar production.

Features:

- Rated efficiency of 97.5%
- 2000 W Secure Power Supply
- Operating temperatures of -13°F to 140°F
- Up to three 10 A DC battery inputs
- Available in 3.8, 5.0, and 6.0 kW
- 10-year warranty, extendable up to 20-years
- Listed to UL 1741-SA and UL1699B for U.S.A. and Canada
- Compliant with: IEEE 1547, IEEE 929, FCC Part 15 A& B, CSA C22.2 107.1-1

SMA Sunny Boy Storage Inverters					
Model	**Max AC output**	**CEC efficiency**	**Max continuous AC outputcurrent per phase**	**Weight**	**Item Code**
Sunny Boy Storage 3.8-US	3,800W	97.5%	15.8 A	57 lbs	**030-02993**
Sunny Boy Storage 5.0-US	5,000W	97.5%	20.8 A	57 lbs	**030-02995**
Sunny Boy Storage 6.0-US	6,000W	97.5%	25 A	57 lbs	**030-02994**
SBS-ABU-200-US-10	Sunny Boy Storage Automatic Backup Unit				**300-03004**

✔ **Fast, Accurate Shipping to Your Job Site.** With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

NEW! OutBack Power SkyBox

SkyBox Hybrid Inverter

The SkyBox hybrid grid tie inverter can be used as a grid-tie PV inverter with or without a battery. When used with a battery it can be used to enhance self-supply of solar energy. This is useful when netmetering,or grid feed is not available, or is not advantageous financially. This system uses DC coupling for both the solar and the connection to the battery system for greater overall efficiency. The SkyBox uses any commonly available 48 VDC battery bank, including flooded, AGM, or gel leadacid batteries, or newer Lithium batteries. PV input voltage range is 200-600 VDC, allowing longer PV strings. Compliant with California Rule 21 and Hawaii 14H grid support requirements.

The system features backup power; grid support; net metering; non-export; and prioritized charging from renewables. These features can use any of the loads in the house, including those on the main service panel, what we call "primary" self-supply. Backup power is available to support the loads connected to the backup loads panel, with a quick transfer time of 20ms. Backup power capacity is 5 kW. The inverter includes both ground fault and arc fault protection built in. CT's can be installed on the house AC lines for export control. 47" H x 21" W x 9.4" D, 110.6 lbs.

Features:

- 5,000 W backup power at 120/240 VAC
- 5-year warranty, extendable to 10-year
- Balance of Systems in one box
- Monitor and control over the Internet using OPTICS RE
- Internal Arc Fault Circuit Interrupter (AFCI) for added safety per NEC 2011: 690.11
- Maximum backfeed to array is <8ms
- Built-in battery system monitoring
- NEMA 3R outdoor rated
- Inverter operating temperatures of -6 °F to +140 °F (-20 °C to +60 °C).
- Compliant with: UL 1741-SA, CSA 22.2 No. 107.1, UL 1778, HECO Rule 14H SRD, CA Rule 21 SRD

Outback Power SkyBox Hybrid Inverter							
Model	**Max AC output**	**Battery Voltage**	**Efficiency**	**Max continuous AC outputcurrent per phase**	**MPPT Voltage Range**	**Weight**	**Item Code**
SBX5048-120/240	5,000 VA	48 VOC	94%	24 A	200 to 600 VDC	110.6 lbs	**030-04010**
OBCT-100	One pair of split core external current transducers, 100 Amp						**029-06502**
OBCT-200	One pair of split core external current transducers, 200 Amp						**029-06503**
OBCT-100	Remote temperature sensor for inverter or change control with 20' cable						**030-04190**

Battery-Based Inverters

A battery-based inverter converts direct current (DC) from batteries into alternating current (AC) at the appropriate voltage and frequency to operate lights, appliances or anything else that normally operates on electricity supplied by the utility grid. All battery-based inverters can be used in off-grid systems and some can also feed power back into the utility grid using net metering, similar to the more common grid- tie inverters. All of these battery-based inverters require a battery bank to function.

Grid-Interactive Inverters for Backup Power Applications

Grid-interactive inverters, also called dual-function or hybrid inverters, can export power to the utility grid, but can also supply backup power to protected loads during a grid outage. These inverters use a battery bank for energy storage, will not operate without batteries, and include an automatic transfer switch that enables them to safely operate off-grid during a blackout.

The grid-interactive inverter is connected to the battery bank (usually 24 or 48 VDC), an AC subpanel for protected loads, and the building's utility entrance. The battery bank is charged by the PV array connected through a charge controller (see Charge Controllers) or from a grid tie inverter via AC coupling. Under normal conditions, it will export surplus power produced by the PV array. During a grid outage, the inverter will automatically disconnect from the grid and supply AC power to the protected load subpanel by drawing energy from the battery bank and solar array. When the outage is over, the inverter will automatically switch back to grid-tie operation and recharge the batteries.

There is now a new version of the UL1741-SA standard to meet the new grid interactive requirements of the utilities in California and Hawaii with more states to be added during the year.

It is important to note that a significant amount of energy is used to maintain the battery bank. For this reason, systems with battery backup typically provide 5 to 10% less energy (kWh) per kW of PV array than equivalent grid-tie systems that don't include batteries.

Grid-Interactive Inverters for Self-Consumption Applications

Many of the grid interactive inverters can also work in applications where there is grid power, but net metering is not available or it is better to self-consume the solar power instead of feeding it back to the utility at a reduced rate. Another use for these is for peak load shaving applications, where supplying the peak load from the battery instead of the utility prevents the high peak load rates charged by the utility. There is a new type of hybrid inverter that is primarily a grid direct inverter that will operate without a battery, but can also use a battery bank for self-consumption with backup applications. See the new Hybrid Grid tie inverters section.

Off-Grid Inverters

Off-grid battery-based inverters convert DC electricity from a battery bank to AC. In this case, the PV array and/or wind generator is used to charge the batteries via a charge controller (see Charge Controllers for more information) and only the power demanded by the loads is inverted to AC. Because these systems do not have access to the electrical grid, it is important to properly size the inverter and battery bank (see System Design and Batteries for more information on sizing inverters and battery banks).

The nameplate capacity of an inverter is measured by its maximum continuous output in watts. The inverter capacity limits the sum of all AC loads you can operate simultaneously. Most AC appliances list their consumption on a tag located near the power cord and/or in the owner's manual. You will need to add up the consumption of all the appliances you may need to operate at once – that will represent your minimum inverter size. If your appliances include induction motors, like washers, dryers, dishwashers, furnace blowers, heat pumps, and large power tools, be sure to select an inverter with sufficient surge capability to accommodate the higher start-up loads.

Off-grid inverters will output either sine-wave or modified-sine-wave (modified-square-wave) AC wave- forms. Sine-wave inverters can closely mimic utility-grid power and will run virtually any AC appliance. Modified-sine-wave inverters are an economical choice when waveform is not critical. They often have a high surge capacity for motor starting and generally retain good efficiency when partially loaded. Unfortunately, this type of inverter may damage or fail to operate some sensitive appliances, such as rechargeable tools and flashlights, laser printers, copiers, variable speed drives, and any equipment with silicon controlled rectifiers (SCRs). Some audio equipment will have a background buzz when operated with a modified-sine-wave inverter.

Output Voltage

In the past, most battery-based inverters supplied only 120 VAC 60 Hz single-phase outputs. Now, many of the more popular residential-sized inverters, like the OutBack Radian, Schneider XW, and Magnum MS-PAE inverters, deliver 120/240 VAC power from one inverter. These inverters can also be wired in parallel for greater power output. Pairs of some 120 VAC output inverters like the OutBack FXR series inverters can also be wired in series for 120/240 VAC split-phase, or 120/208 VAC three-phase output.

Inverters that supply 50 Hz power are also available for most product lines for export to other countries. Please contact us with any special requirements you may have.

Interference

Battery-based inverters may interfere with radio and television reception, causing noise on telephones or buzz in audio equipment. Interference can be minimized by using sine wave inverters and by locating the inverter as close to the batteries as practical, twisting together the cables that connect the inverter to the battery, running AC lines separate from other wiring (such as telephone wires), and locating the inverter away from appliances that are susceptible to interference. All inverters are likely to cause interference with AM radio reception.

Wiring Considerations

Battery-based inverters require high current from a battery bank to operate large loads. A 2 kW inverter will draw nearly 200 A from a 12 VDC battery bank. Large cables and good connections are required for safe operation. Use caution when plugging a small inverter into a lighter outlet in a vehicle, as these outlets are usually not robust enough to handle high current for long periods of time. All battery-based inverters require proper overcurrent protection between the battery and the inverter.

Pre-wired power systems are available with most battery-based inverters to minimize design and wiring issues. Custom configurations are available for most OutBack FLEXware-based power systems. Prewired power systems with Schneider Electric, Magnum Energy and SMA Sunny Island inverters are also available. Please contact us for additional information. See the listings in this section, or contact us for additional information.

OutBack Power

Radian Grid-Hybrid™ Inverters

OutBack Power Radian inverters work equally well as a grid-tie or off-grid inverter. There are two separate AC inputs, one for the bi-directional grid connection and and one for an optional backup generator. There is a built-in 50 A transfer switch at 120/240 VAC. The output from this inverter is 120/240 VAC split phase in each unit for easy tie-in to US standard wiring and grid connections.

The Radian features 4 kW (GS4048A-01) or 8 kW (GS8048A-01) of continuous output power and can support large dynamic load variations and surge loads, making it well suited for demanding commercial applications as well as residential use. With two power stages (one on the GS4048A-01), the modular design is field serviceable. Radian inverters can be parallel stacked with up to ten inverters for 80 kW total output.

The Radian inverters also have auxiliary controls that include a contact closure, a 12 VDC output signal, and terminals for a remote on/off switch as well as a remote temperature sensor (RTS) for the battery bank. Each GS8048A-01 inverter requires dual 2/0 AWG battery cables (two positive and two negative) for connection to the battery bank. In fully off-grid applications, the minimum recommended battery size is 175 Ah for the GS4048A-01 and 350 Ah for the GS8048A-01 for each inverter installed in a power system (See Batteries).

The GS4048A-01 and GS8048A-01 inverters are made to work in off-grid, grid-tied, or grid-supported systems using OutBack Power's "GridZero" mode, optimizing solar production where net metering is not available. The "A-01" inverters also have an adjustable input-voltage range so they can be made to work with most lithium-ion, aqueous sodium-ion and other advanced battery technologies. The "A-01" inverters are now listed to the new version of UL1741-SA so that they meet the new grid interactive requirements of the utilities in some locations. Those locations currently include California and Hawaii, and more states may be added over the next several years.

EXPORT Radian Grid-Hybrid Inverters

The **GS3548E** and **GS7048E** include a built-in 50 A transfer switch at 230 VAC. The output is 230 VAC 50 Hz (or 60 Hz) single-phase in each unit for easy tie-in to most international standard wiring and grid connections. These inverters feature 3.5 kW or 7 kW of continuous output power and can support large dynamic load variations and surge loads up to 11.5 kW. The Radian can be parallel stacked with up to ten inverters for 70 kW total output. The Radian also has auxiliary controls which include a contact closure, a 12 VDC output signal and terminals for a remote on/off switch.

Each inverter comes with a standard 5-year warranty. The Radian is not rated for outdoor use. Dimensions are 28"H x 16"W x 8.7"D. Weight is 84 lbs for the GS4048A/GS3548E and 125 lbs for the GS8048/GS8048A/GS7048E. Listed to UL 1741-SA for U.S.A. and Canada.

A MATE3s, HUB10.3, and an appropriate GSLC are needed to complete a Radian system.

OutBack Radian Inverters										
Model	CEC rating	CEC grid-tie output	Continuous output	Battery voltage	AC out volts/hertz	No load draw	Charger output	AC surge	Weight	Item code
GS4048A-01	92.5%	3,600 W	4,000 W	48 VDC	124/240 V 60 Hz	34 W	57 A	6,000 W	82 lbs	**030-04077**
GS8048A-01	92.5%	7,200 W	8,000 W	48 VDC	124/240 V 60 Hz	34 W	115 A	12,000 W	125 lbs	**030-04076**

EXPORT OutBack Radian Inverters								
Model	Continuous output	Battery voltage	AC out volts/hertz	No load draw	Charger amps	AC surge output	Weight	Item code
GS3548E	3,500 W	48 VDC	230 V/50 Hz	34 W	50 A	5,800 W	84 lbs	**030-04059**
GS7048E	7,000 W	48 VDC	230 V/50 Hz	34 W	100 A	11,500 W	125 lbs	**030-04038**

Radian GSLC Load Centers

The **GS Load Center (GSLC)** is a wiring and circuit-protection enclosure that mounts under the Radian inverter. It is available in multiple versions:

The base GSLC includes positive and negative main inverter busbars, a 500 A 50 mV shunt with negative terminal bar, the main DC positive breaker plate, ground and neutral terminal bars, and two PV-positive terminal bars. It can also accommodate up to 18 AC or DC panel-mount breakers (ten top, eight bottom), two main 175 A DC breakers and a FLEXnetDC, which can be purchased separately. Up to two charge controllers can mount on the right side (mounting brackets sold separately), and the Mate3s (mounting brackets sold separately) and HUB10.3 can mount on the left side.

The **GSLC175-120/240** includes the base unit plus two 175 A DC main breakers, an AC output and bypass breakers with interlock plate, AC-grid and generator-input breakers (50 A two-pole), and six AC terminal bars (three black, three red). It can also accommodate ten additional panelmount breakers, (purchased separately).

The **GSLC175-PV-120/240** works with the GS8048A inverters, or the GS4048A inverter but will have an extra 175A breaker, and includes items in the 175-120/240 unit plus two 80 A PV array breakers, a two-pole GFDI 80 A breaker, three 500 A 50 mV shunts with shunt bus, and a FLEXnetDC. The GFDI acts as the breaker between the control and positive bus; there are no other breakers added for this purpose. It can also accommodate five additional panel-mount breakers, (purchased separately).

The **GSLC175-PV1-120/240** works with the GS4048A inverter and one charge control, and includes one 175 ADC main breaker plus one 80 A PV breaker, one two-pole GFDI 80 A breaker, two 500 A 50 mV shunts with shunt bus, and a FLEXnetDC.

The **AC bypass** assembly is only for use with a single Radian inverter. For multiple inverters, use the base GSLC with added DC and AC breakers as needed (no bypass) and use external transfer switches for bypass and external AC load centers for output combining and input distribution. One GSLC is required for each Radian inverter. Each 8 kW inverter requires two 175 A main DC breakers and each 4 kW inverter requires one.

The GSLC is rated for indoor use. Dimensions are 17"H x 16"W x 8.5"D. Weight is 26, 37, or 38 lbs. Listed to UL 1741 for U.S.A. and Canada. More accessories for OutBack Power can be found on the following pages.

GS Load Centers		
Model	**Description**	**Item code**
GSLC	GS Load Center with inverter bars, breaker bus, shunt, neg, ground, neutral, and PV-pos busbars	**053-02250**
GSLC175-120/240	GS Load Center with all items above plus two main 175 A breakers, AC IO/Bypass, and 6 AC busbars	**053-02251**
GSLC175-PV-120/240	GS Load Center with all items above with three shunts, FNDC, two-pole GFDI, and dual PV-input breakers	**053-02252**
GSLC175-PV1-120/240	GS Load Center with one 175 A main breaker with two shunts, FNDC, single-pole GFDI, and single PV-input breakers	**053-02256**
GS Load Center Accessories		
GS-IOB-120/240 VAC	GS AC input/output/bypass kit split phase 120/240 VAC for single inverter only	**053-07818**
GS-SBUS	DC shunt bus for GS Load Center	**053-00130**
STBB-BLACK	Short busbar kit with black insulators for GS Load Center	**053-00132**
STBB-RED	Short busbar kit with red insulators for GS Load Center	**053-00133**
STBB-WHITE	Short busbar kit with white insulators for GS Load Center	**053-00134**
PNL-50D-AC-120/240	Circuit breaker, 50 A, 120/240 VAC, two-pole, panel mount for GSLC (takes two ¾" spaces)	**053-17004**
PNL-175-DC	Circuit breaker, 175 A, 125 VDC, single-pole, main DC breaker for GS inverter (two required per inverter)	**053-01053**

GS Load Centers		
Model	**Description**	**Item code**
EXPORT GS Load Centers		
GSLC	GS Load Center with inverter bars, breaker bus, shunt, neg, ground, neutral, and PV pos busbars	**053-02250**
GSLC175-230	GS Load Center with all base items plus two main 175 A breakers, single-leg 230 VAC IO/Bypass, and three AC busbars	**053-02253**
GSLC175-PV-230	GS Load Center with all items above plus three shunts, FNDC, two-pole GFDI, and dual PV-input breakers	**053-02254**
GSLC175-PV1-230	GS Load Center with one 175 A main breaker plus two shunts, FNDC, single-pole GFDI, and single PV-input breakers	**053-02257**
EXPORT GS Load Center Accessories		
GS-IOB-230VAC	GS AC input/output/bypass kit, one-leg 230 VAC for single inverter only	**053-07817**
GS-SBUS	DC-shunt bus for GS Load Center	**053-00130**
STBB-BLUE	Short busbar kit with blue Insulators for GS Load Center for EXPORT GSLC	**053-00135**
STBB-BROWN	Short busbar kit with brown Insulators for GS Load Center for EXPORT GSLC	**053-00136**
PNL-30-AC	Circuit breaker, 30 A, 250 VAC, single-pole, panel mount for 230 VAC GSLC (takes one ¾" space)	**053-16998**
PNL-50-AC-240	Circuit breaker, 50 A, 250 VAC, single-pole, panel mount for 230 VAC GSLC (takes one ¾" space)	**053-16999**
PNL-175-DC	Circuit breaker, 175 A, 125 VDC, single-pole, main DC breaker for GS inverter (two required per inverter)	**053-01053**

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OutBack Power VFXR and FXR Hybrid Inverters

The OutBack Power FXR series inverters are a more advanced version of the venerable FX series. These new inverters are a good choice for off-grid or, with the 24 VDC and 48 VDC inverters, can be used in a grid-tied system. They have expanded voltage ranges for use with advanced-technology batteries, and have the advanced OutBack features including Grid Zero and Offset modes. The "A-01" inverters are now listed to the new version of UL1741-SA so that they meet the new grid interactive requirements of the utilities in some locations.

The ventilated OutBack Power VFXR inverters deliver more power in high ambient-temperature applications, and more throughput for generator-powered battery charging. The sealed, externally fancooled FXR is designed to be used in coastal or dusty environments.

Each inverter/charger is a multi-mode power conversion unit that includes an inverter, battery charger, and an AC transfer switch. Up to ten inverters can be stacked in parallel (120 VAC), up to eight inverters can be stacked in a series configuration (120/240 VAC), and up to nine inverters can be stacked for three-phase (120/208 VAC WYE) configurations. The 50 Hz export inverters can be stacked up to ten in parallel (230 VAC), and up to nine inverters in a three-phase configuration (230/400 VAC WYE). When stacking, all of the inverters must be the same model. The X-240 and similar transformers are not used with the FXR inverters. Due to the added control features, FXR series inverters should be deployed with the MATE3s controller (or AXS Port) and the Hub10.3. These inverters, with the MATE3s or AXS port, are compatible with OpticsRE.

VFXR inverters have a programmable, auxiliary relay output connection (AUX) that provides 12 VDC output to run cooling or ventilation fans or to operate an external relay for other functions, such as remote generator starting (two-wire). Sealed FXR inverters use this relay to power the external cooling fan, so it is not available for other uses.

The internal transfer switch is rated for 60 A. When an external source of AC power (either a generator or the utility grid) is detected at the "AC in" terminal on the inverter, the switch operates to transfer the loads to the external power source, and then activates the battery charger to recharge the battery bank depending on what mode is programmed. An RTS remote temperature sensor and other accessories are listed on the following pages.

Use the FlexWare 250, 500, or 1000 components with these inverters or refer to the pre-wired FLEXpower systems featuring FXR series inverters.

Dimensions: FXR: 16.25"L x 8.25"W x 13"H; VFXR: 16.25"L x 8.25"W x 12"H. Listed to UL 1741 or 1741-SA and CSA 22.2 by ETL for the U.S.A. and Canada and covered by a 5-year warranty.

OutBack VFXR and FXR Inverters								
Model	**Continuous output**	**Battery voltage**	**AC out volts/hertz**	**No load draw**	**Charger output**	**AC surge output**	**Weight**	**Item code**
US Models - can be connected in series 120/240, parallel or three-phase WYE 120/208 VAC								
Ventilated Cooled Inverters								
VFXR2812A	2,800 W	12 VDC	120 V/60 HZ	34 W	125 A	4,800 W	61 lbs	**030-04064**
VFXR3524A-01	3,500 W	24 VDC		34 W	82 A	6,000 W	61 lbs	**030-04080**
VFXR3648A-01	3,600 W	48 VDC		34 W	45 A	6,000 W	61 lbs	**030-04081**
Sealed/Turbo-Cooled Inverters								
FXR2012A	2,000 W	12 VDC	120 V/60 HZ	34 W	100 A	4,800 W	62 lbs	**030-04061**
FXR2524A-01	2,500 W	24 VDC		34 W	55 A	6,000 W	62 lbs	**030-04078**
FXR3048A-01	3,000 W	48 VDC		34 W	35 A	6,000 W	62 lbs	**030-04079**
EXPORT Models - can be connected in parallel or three-phase WYE 230/400 VAC								
Ventilated Inverters								
VFXR2612E	2,600 W	12 VDC	230 V/50 HZ	34 W	120 A	4,600 W	61 lbs	**030-04070**
VFXR3024E	3,000 W	24 VDC		34 W	80 A	5,750 W	61 lbs	**030-04071**
VFXR3048E	3,000 W	48 VDC		34 W	40 A	5,750 W	61 lbs	**030-04072**
Sealed/Turbo-Cooled Inverters								
FXR2012E	2,000 W	12 VDC	230 V/50 HZ	34 W	100 A	4,600 W	62 lbs	**030-04067**
FXR2024E	2,000 W	24 VDC		34 W	55 A	5,750 W	62 lbs	**030-04068**
FXR2348E	2,300 W	48 VDC		34 W	35 A	5,750 W	62 lbs	**030-04069**

OutBack Power Inverter Accessories

Use the **FX-DCA** to connect 2" conduit to the DC side of the inverter or to connect inverters to the FW- 500DC or FW-1000DC. Use the **FX-ACA** or **SP-ACA** to connect to the AC side of the inverter.

The **FW-SP-ACA** can be used in place of the **FX-ACA** and offers surge protection. Use either one to connect inverters to the **FW-500DC** or **FW-1000DC**. Use the **FW-SP-250** to replace the lid on the **FW250**. These surge protectors offer protection on both input and output AC and inverter DC surge protection. A separate SP should be used with each inverter.

OutBack Inverter Accessories		
Model	**Description**	**Item code**
DCA	2" conduit adapter – required to mount inverter to FLEXware 500 or 1000	**030-04163**
FW-ACA	AC wiring compartment extension – required to mount FX or VFX to FLEXware 500 or 1000	**030-04169**
FW-SP-ACA	AC wiring compartment extension with AC and DC surge arrestor	**030-04290**
FW-SP-250	Surge arrestor for FW250 - replaces the lid of the FW250	**030-04292**
FW-SP-R	Replacement surge protector board for FW-SP-ACA and FW250	**030-04294**

MATE Remote Monitors

The **MATE3s** system display and controller is the latest generation communication interface – providing control of every aspect of an OutBack Power System. Program and monitor your power system with an intuitive user interface and integrated configuration wizard. An easy-to-read backlit graphical LCD display, a user-set favorite key, and scroll-wheel operation allow easy adjustment of system set points. Expandable SD card memory allows you to increase data-logging capacity as well as upgrade units in the field. Built-in clock and calendar enable timer-based programming, permitting the user to set the system up to work with time-of-use utility rates, or set up a generator to only run at certain times of the day or week. The MATE3s has permanent memory and includes OutBack Power's best-in-class OPTICS Internet monitoring platform.

The SunSpec-compliant **AXS** Port Modbus/TCP Interface provides similar functionality to the MATE3, including access to OutBack Power's OPTICS RE platform, but must be accessed via Ethernet. Custom user interfaces can be developed if an independent monitoring system is used. System data logs can be downloaded using Modbus-read or FTP transfer.

OPTICS RE is a user-friendly online monitoring and control system that displays instantaneous and historical system performance via the Internet as well as provides remote troubleshooting and control functionality. Automated e-mail alerts can be set up to notify when faults or other events occur, enabling proactive maintenance. Most MATE3s system settings can be viewed and adjusted remotely via OPTICS RE, minimizing the need for on-site troubleshooting. OpticsRE is included with the MATE3s.

The original **MATE** is able to connect multiple inverter/chargers to OutBack Power FM charge controllers and to other OutBack power conversion and control products. The **MATE2** has a flush-mount black face for panel or in-wall mounting, but offers the same functionality as the MATE.

NOTE: The original Mates units do not work with all the functions and modes in the current OutBack Power inverters.

MATE Remote Monitors		
Model	**Description**	**Item code**
MATE3s	System Control with full graphical display and CAT 5 cable (required for -01 inverters)	**300-04178**
AXS Port	AXS MODBUS interface for Internet control of selected OutBack devices	**029-06500**
MATE	Original MATE, grey oval housing with a CAT 5 cable	**030-04180**
MATE-B	Black version of original MATE, oval black housing with cable	**030-04180-B**
MATE2	Flush-mount version of original MATE, black square housing with cable	**030-04181**

OutBack Power FLEXnet DC System Monitor

The **FLEXnet DC** System Monitor integrates the OutBack MATE3s communications device, providing data concerning system health, performance and efficiency. Easily see your system's current condition with this at-a-glance display. The FLEXnet DC shows battery state-of-charge and monitors the amount of power your system is currently producing and consuming as well as the amount of power going in or out of your battery bank. It allows the MATE3s to display real-time production monitoring of DC sources, such as a solar array or small wind turbine, as well as consumption by loads. It also displays the cumulative energy your system has produced and consumed as well as the total amount of energy that has gone to charging your batteries each day. You can also view each day's lowest state-of-charge, see how your overall system production compares to system consumption, review historical energy production and consumption data for the most recent 128 days, including the minimum battery state-of-charge reached for each day, and watch power system production and consumption trends. A HUB10.3 is required to use the FLEXnet DC.

A **HUB10.3** is required to connect inverters, MATEs, FLEXnet DCs and FLEXmax charge controllers to allow programming and monitoring of the entire system by the MATE3s as well as deploying multiple inverters in the same system.

The remote temperature sensor RTS is important for accurate battery charging, especially if the batteries get very warm or cold. If used with a HUB, one temperature sensor can be shared by all connected OutBack Power inverters and FM charge controllers.

HUB and The FLEXnet DC System Monitor		
Model	**Description**	**Item code**
FLEXnet DC	Advanced DC System Monitor, uses one DC breaker space, requires a MATE	**030-04187**
HUB10.3	Communications HUB for up to ten devices (inverters, charge controllers, FNDC) in addition to a MATE	**030-04188**
RTS	Remote temperature sensor for inverter or charge control with 20' cable	**030-04190**

OutBack Power FLEXware

FLEXware 250

The FW250 offers a low-cost solution for single-inverter installations where space and budget are of primary concern. Use one FLEXware250 on each end of the inverter, one for DC and one for AC. There is space for an array breaker and single-pole GFDI for one charge controller. Use panel-mount breakers (see Electrical Distribution Parts) for both DC and AC circuits, and one 175 A or 250 A breaker for the main inverter breaker.

FLEXware 500 and 1000

The **FW500** supports up to two inverter/chargers and two charge controllers in an attractive, versatile, and code-compliant package for installations where more power is needed. The **FW1000** accommodates up to four inverter/chargers and four charge controllers. Multiple power panels can be used for systems up to 36 kW. Both the FLEXware 500 and 1000 systems provide ample locations for AC and DC breakers, DC current shunts, an autotransformer, and other items required in higher kW systems. The **FW-MP** mounting plate is used with both FW500 and FW1000 enclosures. Use two mounting plates for the FW1000. Use ¾" panel-mount breakers for DC circuits up to 100 A and 1" or 1 ½" panel-mount breakers (see Electrical Distribution Parts) for 125, 175, or 250 A inverter breakers. For AC, use DIN mount breakers.

FLEXware Integration Hardware FW250, FW500, and FW1000			
Model	**FLEXware 250 Power System Box and IOB Kits**	**FXR Inverter Quantity**	**Item code**
FW250	FLEXware 250 enclosure with TBB-ground, for one inverter (one for DC and one for AC) and one charge control	one	**030-04205**
FW-IOBS-120VAC	IOB kit includes three 60 A 120 VAC breakers and AC breaker bypass slide plate		**030-04230**
FW-IOBS-230VAC	IOB kit includes three 30 A 230 VAC breakers and breaker bypass slide plate - EXPORT		**030-04233**
FLEXware Mounting Plate			
FW-MP	FLEXware Mounting plate for FLEXware 500 and 1000 enclosures (two required for FW1000 systems)	two	**030-04260**
FLEXware 500 Power System Boxes and IOB Kits			
FW500-AC	FLEXware 500 enclosure with TBB-ground, DIN rail for AC breakers	one or two	**030-04215**
FW500-DC	FLEXware 500 enclosure with DC breaker bracket, TBB, BBUS, 500 A shunt		**030-04212**
FW-IOBD-120/240VAC	IOB kit includes six 60 A 120 VAC breakers and AC breaker bypass slide plate, busbars, wire		**030-04237**
FW-IOBD-120VAC	IOB kit includes six 60 A 120 VAC breakers and AC breaker bypass slide plate, busbars, wire		**030-04240**
FW-IOBD-230VAC	IOB kit includes six 30 A 230 VAC breakers and breaker bypass slide plate, TBB, wire - EXPORT		**030-04243**
FLEXware 1000 Power System Boxes and IOB Kits			
FW1000-AC	FLEXware 1000 enclosure with TBB-ground, DIN Rail for AC breakers	up to four	**030-04223**
FW1000-DC	FLEXware 1000 enclosure with DC breaker bracket, TBB, two SBUS, BBUS, 500 A shunt		**030-04221**
FW-IOBQ-120/240VAC	IOB kit includes twelve 60 A 120 VAC breakers and AC breaker bypass slide plate, busbars, wire	four	**030-04247**
FW-IOBQ-230/AC	IOB kit includes twelve 30 A 230 VAC breakers and bypass slide plate, TBB, wire EXPORT		**030-04251**
FW-IOBT-120/208VAC	IOB kit includes nine 60 A 120 VAC breakers and AC breaker bypass slide plate, busbars, wire	three	**030-04253**
FW-IOBT-230/400VAC	IOB kit includes nine 30 A 230 VAC breakers and bypass slide plate, TBB, wire - EXPORT ONLY		**030-04255**

FLEXware Options

When adding charge controllers, additional inverters or circuit breakers, these components may be necessary.

FLEXware Options		
Model	**Description**	**Item code**
FW-X240	4 kVA 120/240 VAC autotransformer with 20 A two-pole breaker. Use w/ one inverter only, not used for balancing FXR or VFXR inverters.	**030-04270**
PSX-240	Stand-alone 6 kW 120/240 VAC autotransformer, in enclosure with 20A two pole breaker	**030-04429**
OBR-16-30 VDC250 VAC-DIN	Relay 16 A maximum 30 VDC/250 VAC rated DIN-rail mount	**030-04193**
PNL-GFDI-80	PV ground-fault detector interrupter, 150 VDC, 80 A, one-pole, panel mount	**053-03144**
PNL-GFDI-80D	PV ground-fault detector interrupter, 150 VDC, 80 A, two-pole, panel mount	**053-03145**
PNL-GFDI-80Q	PV ground-fault detector interrupter, 150 VDC, 80 A, four-pole, panel mount	**053-03146**
FW-SHUNT250	500 A 50 mv current shunt for top of vented inverter under top cover, with busbar to connect to negative post	**030-04275**
FW-SHUNT500	500 A 50 mv current shunt for FW500 and FW1000 includes terminal busbar with white insulator	**030-04277**
TBB-GROUND	Ground/neutral terminal busbar with mounting screws (no insulators)	**030-04356**
TBB-WHITE	Busbar with white insulators for grounded conductors (usually negative or neutral)	**030-04354**
TBB-BLACK	Busbar with black insulators	**030-04353**
TBB-RED	Busbar with red insulators	**030-04355**
TBB-BLUE	Busbar with blue insulators (for three-phase and EXPORT versions)	**030-04359**
TBB-BROWN	Busbar with brown insulators (for EXPORT versions)	**030-04352**
FW-BBUS	FLEXware Breaker Bus connector two 175-250 A, three 100-125 A, four 1-80 A DC breakers or three 500 A DC shunts	**030-04280**
FW-SBUS	FLEXware shunt bus connector allows up to four high-current cable connections on same side of DC shunt	**030-04284**
FW-CCB	FLEXmax charge-controller mounting bracket for one side-mounted on FW500 or FW1000 DC enclosures – with hardware	**030-04263**
FW-CCB2	FLEXmax charge-controller mounting bracket for two side-mounted on FW500 or FW1000 DC enclosures – with hardware	**030-04265**
FW-CCB2-T	FLEXmax charge controller mounting bracket for two top-mounted on FW500 or FW1000 DC enclosures – with hardware	**030-04267**
FW-MB1	MATE mounting bracket for the side of a FLEXware enclosure	**030-04182**
FW-MB2	MATE2 mounting bracket for the side of a FLEXware enclosure	**030-04183**
FW-MB3	MATE3 mounting bracket for the side of a FLEXware enclosure	**030-04175**
FW-MB3-F	MATE3 flat mounting plate for flush mounting	**030-04176**
FW-MB3-S	MATE3 surface-mounting bracket	**030-04177**

OutBack Power FLEXpower Radian Pre-Wired Power Systems

The FLEXpower **FPR** pre-wired power panels integrate Radian inverter/chargers, FM80 or FM100 charge controls, and all of the essential protective devices in an easy-to-install, fully pre-wired and factory-tested system. FLEXpower FPR systems are available with either 4.0 kW or 8.0 kW inverter sizes. The Radian inverters can be used for either grid-tied or off-grid systems and have the capacity to use and charge any technology batteries, as well as advanced OutBack features including Grid Zero and Offset modes. Dual AC inputs allow connection to both the utility and a backup generator set. Compatible with system monitoring and control via OpticsRE. Utilizing a compact all-on-one mounting plate design, they are fully pre-wired and factory-tested.

Each FPR is designed for 120/240 VAC single-phase output. Each power panel includes one inverter/chargers, one or two FM80 or FM100 charge controllers, FLEXnet DC, AC and DC wiring box, a MATE3s, HUB10.3, inverter and controller breakers with GFDI, and an AC Input-Output-Bypass Assembly. FLEXpower components are listed to applicable UL standards and the assemblies are marked for streamlined inspections. Dimensions are 47"H x 33.5"W x 9.84"D. Weight is 195 lbs for the FPR- 4048A-01 and 250 lbs for the FPR-8048A-01

FLEXpower Radian Pre-Wired			
Model	**Description**	**Inverter**	**Item code**
FPR-4048A-01	Pre-wired inverter system, 4.0 kW 120/240 VAC, 48 VDC, single FM80	GS-4048A-01	**033-04264**
FPR-8048A-01	Pre-wired inverter system, 8.0 kW 120/240 VAC, 48 VDC, dual FM80	GS-8048A-01	**033-04263**
FPR-4048A-300VDC	Pre-wired inverter system, 4.0 kW 120/240 VAC, 48 VDC, single FM100	GS-4048A-01	**033-04208**
FPR-8048A-300VDC	Pre-wired inverter system, 8.0 kW 120/240 VAC, 48 VDC, dual FM100	GS-8048A-01	**033-04207**

FLEXpower ONE Pre-Wired Power System

The FLEXpower One (**FP1**) pre-wired power panel integrates one inverter/charger, one charge controller, and all the essential protective devices in a small space at a low installed cost. They are ideal for applications with modest power requirements, such as cabins, chalets, homes, remote communication sites, and backup-power systems. Utilizing a compact design all integrated on a single back panel, they are fully pre-wired and factory tested as well as NRTL marked for streamlined inspections.

The FP1 power panels come with inverters that can be used for either grid-tied or off-grid systems and have the capacity to use and charge a variety of battery types, and have the advanced OutBack features including Grid Zero™ and Offset modes.

Each FP1 power panel includes a single inverter/charger, AC and DC wiring boxes, and a single FM80 charge controller, MATE3s, HUB10.3, FLEXnet DC, and AC-DC surge protector. The system is also equipped with an inverter breaker, PV array breaker, PV GFDI breaker, and AC input-output-bypass assembly. There are mounting locations for both AC GFCI Type B and EU Type F style outlets and additional AC breakers. FP1 components are listed to applicable UL standards for a code-compliant installation.

Dimensions are 33.44"H x 19.69"W x 12.88"D. Weight is 98 lbs.

FXR FLEXpower ONE Pre-Wired			
Model	**Description**	**Inverter**	**Item code**
FLEXpower ONE Pre-Wired			
FP1 VFXR3524A-01	Pre-wired inverter system, 3.5 kW 120 VAC, 24 VDC, 80 A PV control	VFXR3524A-01	**033-04267**
FP1 VFXR3648A-01	Pre-wired inverter system, 3.6 kW 120 VAC, 48 VDC, 80 A PV control	VFXR3524A-01	**033-04268**
FP1 FXR2524A-01	Pre-wired inverter system, 2.5 kW 120 VAC, 24 VDC, 80 A PV control	FXR2524A-01	**033-04265**
FP1 FXR3048A-01	Pre-wired inverter system, 3.0 kW 120 VAC, 48 VDC, 80 A PV control	FXR3048A-01	**033-04266**
EXPORT FLEXpower ONE Pre-Wired			
FP1 VFXR3024E	Pre-wired inverter system, 3.0 kW 230 VAC 50 Hz, 24 VDC, 80 A PV control	VFXR3024E	**033-04082**
FP1 VFXR3048E	Pre-wired inverter system, 3.0 kW 230 VAC 50 Hz, 48 VDC, 80 A PV control	VFXR3048E	**033-04083**

FLEXpower Multi-inverter Pre-Wired Power Systems

The FLEXpower pre-wired power panels integrate inverter/chargers, FM80 or FM100 charge controls, and all of the essential protective devices in an easy-to-install, fully pre-wired and factory-tested system. The FLEXpower is applicable for either grid-tied or off-grid applications with modest power requirements, such as homes, light commercial or larger backup-power systems. Utilizing a compact allon- one mounting plate design, they are fully pre-wired and factory tested. A FLEXpower can be mounted in either a horizontal or vertical orientation to allow installation in space-limited locations. There are also mounting locations for an AC GFCI Type B outlet and additional DC and AC breakers.

FP systems with VFXR…A-01 or FXR…A-01 inverters can be used for either grid-tied or off-grid applications and have the capacity to work with a variety of batteries, as well as advanced OutBack features including Grid Zero and Offset modes.

Each FP2 is designed for 120/240 VAC single-phase output. Each power panel includes two inverter/chargers, two FM80 or FM100 charge controllers, FLEXnet DC, AC and DC wiring boxes, a MATE3s, HUB10.3, and an AC/DC Surge Protector, inverter and controller breakers with GFDI, and an AC Input-Output- Bypass Assembly. Dimensions are 59"W x 21"H x 13"D. Weight is 260 lbs.

Each FP3 is designed for 120/208 VAC three-phase output. Each power panel includes three inverter/chargers, three FM80 or FM100 charge controllers, FLEXnet DC, AC and DC wiring boxes, a MATE3s, HUB10.3, and an AC/DC Surge Protector, inverter and controller breakers with GFDI, and an AC Input-Output- Bypass Assembly. Dimensions are 59"W x 46"H x 13"D. Weight is 430 lbs.

Each FP4 is designed for 120/240 VAC single-phase output. Each power panel includes four inverter/ chargers, four FM80 or FM100 charge controllers, FLEXnet DC, AC and DC wiring boxes, a MATE3s, HUB10.3, and an AC/DC Surge Protector, inverter and controller breakers with GFDI, and an AC Input-Output- Bypass Assembly. Dimensions are 59"W x 46"H x 13"D. Weight is 520 lbs.

FXR FLEXpower Pre-Wired			
Model	**Description**	**Inverter**	**Item code**
FLEXpower TWO Pre-Wired			
FP2 VFXR3524A-01	Pre-wired dual-inverter FM80 system, 7.0 kW 120/240 VAC, 24 VDC	VFXR3524A-01	**033-04271**
FP2 VFXR3648A-01	Pre-wired dual-inverter FM80 system, 7.2 kW 120/240 VAC, 48 VDC	VFXR3648A-01	**033-04272**
FP2 FXR2524A-01	Pre-wired dual-inverter FM80 system, 5.0 kW 120/240 VAC, 24 VDC	FXR2524A-01	**033-04269**
FP2 FXR3048A-01	Pre-wired dual-inverter FM80 system, 6.0 kW 120/240 VAC, 48 VDC	FXR3048A-01	**033-04270**
FP2 VFXR3524A-300	Pre-wired dual-inverter FM100 system, 7.0 kW 120/240 VAC, 24 VDC	VFXR3524A-01	**033-04212**
FP2 VFXR3648A-300	Pre-wired dual-inverter FM100 system, 7.2 kW 120/240 VAC, 48 VDC	VFXR3648A-01	**033-04211**
FP2 FXR2524A-300	Pre-wired dual-inverter FM100 system, 5.0 kW 120/240 VAC, 24 VDC	FXR2524A-01	**033-04210**
FP2 FXR3048A-300	Pre-wired dual-inverter FM100 system, 6.0 kW 120/240 VAC, 48 VDC	FXR3048A-01	**033-04209**
FLEXpower THREE Pre-Wired			
FP3 VFXR3648A-01	Pre-wired triple-inverter FM80 system, 10.8 kW 120/208 3Ø VAC, 48 VDC	VFXR3648A-01	**033-04246**
FP3 FXR3048A-01	Pre-wired triple-inverter FM80 system, 9.0 kW 120/208 3Ø VAC, 48 VDC	FXR3048A-01	**033-04245**
FP3 VFXR3648A-300	Pre-wired triple-inverter FM100 system, 10.8 kW 120/208 3Ø VAC, 48 VDC	VFXR3648A-01	**033-04214**
FP3 FXR3048A-300	Pre-wired triple-inverter FM100 system, 9.0 kW 120/208 3Ø VAC, 48 VDC	FXR3048A-01	**033-04213**
FLEXpower FOUR Pre-Wired			
FP4 VFXR3648A-01	Pre-wired quad-inverter FM80 system, 14.4 kW 120/240 VAC, 48 VDC	VFXR3648A-01	**033-04248**
FP4 FXR3048A-01	Pre-wired quad-inverter FM80 system, 12.0 kW 120/240 VAC, 48 VDC	FXR3048A-01	**033-04247**
FP4 VFXR3648A-300	Pre-wired quad-inverter FM100 system, 14.4 kW 120/240 VAC, 48 VDC	VFXR3648A-01	**033-04216**
FP4 FXR3048A-300	Pre-wired quad-inverter FM100 system, 12.0 kW 120/240 VAC, 48 VDC	FXR3048A-01	**033-04215**

OutBack System-Edge Pre-Bundled Systems

The OutBack Power SystemEdge kits combine all of the major components of a solar system except modules and racking into easily specified and purchased packages. Each SystemEdge package includes their FLEXpower integrated power panels or Skybox inverter, energy storage, PV combiners, and OpticsRE monitoring and control.

Each SystemEdge has a FLEXpower pre-wired power panel as a base with either a VFXR3648A-01, GS4048A-01 or GS8048A-01 inverter. The FLEXpower integrates one or more OutBack inverter/chargers, one or more FM80 or FM100 charge controls, a Mate3s with OpticRE system monitoring capability, and all of the essential protective devices in an easy-to-install, fully pre-wired and factory-tested system.

Added to the power panel in each system, is energy storage using either an IBR battery rack with 200PLR, RE or other batteries. One, two, or four array combiner boxes complete the system with the ICS+ systems that provide AFCI and Rapid Shutdown where required by code or JHA.

The Skybox SystemEdge packages include a Skybox inverter, energy storage, and an array rapid shutdown system. The Skybox includes everything needed for PV input, dual AC input, AC output, battery connection, and OpticsRE monitoring and control.

Systems with the PLR or RE AGM batteries are suitable for grid tie with backup where batteries are kept on a float charge for the majority of time, or off grid systems where the battery will get a full charge regularly. Carbon enhanced and lithium batteries are good for self-supply and off grid systems.

As there are a variety of systems possible, with more becoming available, please check in AEEExpress for the most recent selection.

Schneider Electric

Conext XW+ and NEW! XW Pro Grid-Tie or Off-Grid Inverters

The **Conext XW+** Series hybrid inverter/charger offers split-phase 120/240 VAC output from a single inverter. Up to four inverters can be paralleled for up to 27.2 kW of total output in a 120/240 VAC splitphase system. The XW+ inverters can be converted to 120 VAC only and three inverters can be configured into a 120/208 VAC three-phase system. Charge controllers, such as the Schneider Electric XWMPPT60- 150 or the XW-MPPT80-600, are required for use with any PV array (see Charge Controllers).

Dual AC inputs enable AC generator input as well as grid interaction. A configurable auxiliary relay with an output of 250 mA at 12 VDC is included in each inverter. A battery-temperature sensor is included with each inverter, but only one is needed per system. The inverter is field-serviceable on the wall. The XW+ comes with a 5-year warranty and is listed to UL1741 for the U.S.A. and Canada. These inverters are NOT currently listed to the new UL1741-SA standard and cannot be installed connected to utilities in areas where that is required. Dimensions of the inverter are 23"H x 16"W x 9"D.

The **Conext XW Pro** hybrid inverter/charger is an updated version of the XW+ line. The XW Pro has the ability to adapt to the new utility requirement for grid tied inverters. They are now listed to the new UL1741-SA standard and can be installed and connected to utilities in areas where that is required, such as California Rule 21.

Conext XW Accessories

The **XW+ Mini Power Distribution Panel** mounts under an XW+ inverter and has all AC/DC disconnects and AC bypass with wiring to support a single inverter. This distribution panel has enough space to install two DC breakers for charge controllers.

The **XW+ Power Distribution Panel** includes a conduit box and all AC/DC disconnects with wiring to support a single inverter. The distribution panel has enough space and knockouts to add up to two more inverters (three total) and up to four charge controllers. A field-reversible door with a magnetic catch simplifies access to wiring. Each charge controller requires the input breaker, or DC disconnect, and output breaker listed in the table below.

The **XW+ Connection Kit** and **XW+** split phase 120/240 VAC breaker kit contain everything needed to add a second inverter. For a third inverter, use one more Connection Kit and one of the AC breaker kits depending on split or three-phase configuration, plus a pair of 5 ft 4/0 AWG inverter cables. For four inverters, use two Power Distribution Panels and two Connection Kits. (see Wire and Cable). An external transfer switch will be required to enable the inverter bypass function. Use the XW+ conduit box to retrofit XW+ inverters into existing systems that already have AC/DC disconnects.

A Conext System Control Panel and/or Conext Combox, is needed to complete a Schneider Electric system. These accessories are listed on Page 96.

Schneider Electric Inverter/Charger System										
Model	**CEC rating**	**CEC grid-tie output**	**Continuous output**	**Battery voltage**	**AC out volts/hertz**	**No load draw**	**Charger output**	**AC surge output**	**Inverter weight**	**Item code**
XW+5548NA	93.5%	4,800 W	5,500 W	48 VDC	120/240 VAC 60 Hz	26 W	110 A	9,840 W	118 lbs	**030-01227**
XW+6848NA	92.5%	6,480 W	6,800 W	48 VDC	120/240 VAC 60 Hz	28 W	140 A	12,480 W	122 lbs	**030-01228**
XW Pro	92.5%	6,480 W	6,800 W	48 VDC	120/240 VAC 60 Hz	28 W	140 A	12,480 W	122 lbs	**030-01231**
XW Accessories										
RNW865101301	XW+ Mini Power Distribution Panel for only one XW+ inverter									**030-01185**
RNW865101501	XW+ Power Distribution Panel with conduit box for one XW+ inverter (add a connection kit for each additional inverter)									**030-01168**
RNW865102002	XW+ Connection Kit is needed for each additional inverter, includes DC breaker and conduit box, add AC breaker kit									**030-01170**
RNW865102501	XW+ empty conduit box raceway									**030-01174**
RNW865131501	XW+ three-phase 120/208 VAC breaker kit									**030-01173**
RNW865121501	XW+ split-phase 120/240 VAC breaker kit									**030-01180**

Conext SW with DC and AC breaker panels, and SCP

Conext SW Off-Grid Inverters and Systems

The **Conext SW** is an economical sine wave, off-grid or backup-power inverter/charger. The SW series offers generator support for loads larger than the generator can power on its own. The US version has split-phase 120/240 VAC output from each inverter. Use the stacking kits for two inverters to double the power output per system. The XW System Control Panel (SCP), Automatic Generator Start (AGS), and Conext CM Communication devices work with these inverters. Compatible with XW and other charge controls. Comes with a battery temperature sensor. 16.5"H x 13.4"W x 7.6"D. Listed to UL 1741, and covered by a 2-year standard warranty.

Conext SW Inverters and Accessories								
Model	**Continuous output**	**Battery voltage**	**AC out volts/hertz**	**No load draw**	**Charger output**	**AC surge output**	**Weight**	**Item code**
SW 2524	3,000 W	24 VDC	120/240 VAC 60 Hz	24 W	65 A	5,000 W	49 lbs	**030-02059**
SW 4024	3,400 W	24 VDC	120/240 VAC 60 Hz	29 W	90 A	7,000 W	62 lbs	**030-02060**
SW 4048	3,800 W	48 VDC	120/240 VAC 60 Hz	27 W	45 A	7,000 W	62 lbs	**030-02058**
Conext SW Accessories								
RNW8651016	Conext SW DC Breaker Panel, 250 A main breaker, Positive and Negative busbars							**053-00050**
RNW8651017	Conext SW AC Breaker Panel, 120/240 VAC output/bypass and input breakers, pre-wired							**053-00051**
RNW8651052	Conext SW Remote On/Off switch							**053-00055**

SCP System Control Panel

Conext Gateway

Conext XW and SW Accessories

The **Conext SCP System Control Panel** plugs into the Xanbus network and provides a central user interface The Conext SCP System Control Panel plugs into the Xanbus network and provides a central user interface to configure and monitor all components in the system. One is used per XW+ or SW system.

The **Conext Battery Monitor** can be used in the Xanbus network to keep track of the battery state of charge (not for Li-ion or batteries). The **Conext AGS** auto generator start can be used in the Xanbus network to supply the logic to remotely start a backup generator.

The **Conext ComBox** can be used to view, datalog, and control XW and SW inverters over the Internet. With a web browser or Android device, the user or installer can view current and historical system per- formance, see system alerts, and remotely change settings. A Micro-SD card provides additional data storage. 6.7"W x 4.5"H x 2.1"D. 5-year warranty.

NEW! The **Conext Gateway** is used as a communications interface between the Xanbus network with XW or SW inverters and a local network or the internet. The Gateway provides for local configuration, management and monitoring, with completely updated graphing and reporting interfaces. The system can also be monitored from anywhere using the Schneider Conext Insight 2 web-site. Data logging can be done via various channels, USB, SD card, Ehternet etc. Ethernet or wireless connection can be used to the local router. Remote control of the Conext system and firmware upgrades can be done through the Gateway web application (this and the wireless connection may not be available in early units).

For more information on the Schneider Electric charge controls listed here, see the Charge Controllers section.

Schneider SW and XW Accessories		
Model	**Description**	**Item code**
RNW865105001	Conext SCP System Control Panel central user interface for XW and SW systems	**300-00128**
RNW865108001	Conext Battery Monitor for XW and SW systems	**030-01182**
RNW865106001	Conext AGS automatic generator start module for XW and SW systems	**030-01183**
RNW8651058	Conext ComBox for XW and SW inverters	**300-00073**
RNW8650329	Conext Gateway for XW and SW inverters	**300-00249**
808-0232-02	Replacement BTS Battery Temperature Sensor for XW and SW	**300-00129**
XW-MPPT60-150	XW 60 A MPPT charge controller with built-in ground fault protection - 150 VDC max input voltage	**020-08040**
BREAKER 60A	Input circuit breaker for MPPT60-150 charge controller; 60 A 160 VDC	**053-01038**
BREAKER 80A	Output circuit breaker for MPPT60-150 charge controller; 80 A 125 VDC	**053-01039**
XW-MPPT80-600	XW 80 A MPPT charge controller with built-in ground fault protection - 600 VDC max input voltage	**020-08048**
SQD HU361RB	Input disconnect for MPPT80-600 charge controller; 30 A 600 VDC 3 pole	**053-02312**
BREAKER 100A	Output circuit breaker for MPPT80-600 charge controller; 100 A 125 VDC	**053-01034**
CONFIGURATION TOOL	Tool for updating the firmware on XW and SW systems	**030-01184**
250A 125VDC BREAKER	Replacement 250A main battery breaker	**030-01186**

Magnum Energy

Grid-Tie Micro-inverters

The **ME-GT500** micro-inverters connect to two common 60-cell or 72-cell modules each and converts the output to 120/240 VAC current for grid tie use. The inverters have the AC cabling built in so there is no separate trunk cable to buy or install. There are two sets of MC4 type connectors for the two solar modules. The output from each module is up to 250 Watts or 300 Watts, so up to 310 Watt or 375 Watt modules can be used with minimal limiting of the expected power. Each solar module input feeds a separate MPPT channel for optimum power production. Peak efficiency is 95.5%. Rated at NEMA 6 and for -40F to 149F (-40C to 65C) temperatures. The GT500 is listed to UL1741, CSA C22.2 No.107.1-01. These inverters are NOT currently listed to the new UL1741-SA standard and cannot be installed connected to utilities in areas where that is required, and are not CEC listed. They meet all rapid shutdown requirements with the loss of AC power to the circuits. Limited 25 year warranty.

Up to 7 of the GT500 inverters, with as many as 14 modules, can be connected together to form an AC circuit with a 20A circuit breaker. Multiple AC circuits can be paralleled for more power. The **MEMGT- AC-F AC** termination cable is used at one end of each string of inverters to connect to the output in a transition box. The **ME-MGT-ENDCAP-F** is used to cap the unused connector of the last inverter in a string. The **ME-MGT-AC-EXT** is a 6 foot long jumper cable with connectors on each end to allow greater spacing between two inverters.

The **ME-MGT-MW MagwebGT** is the gateway and communication unit for the Micro GT inverters. It plugs into a 120 VAC outlet near the system and reads the data from the inverters. One connection from the MagwebGT is made to the owners router via an Ethernet cable supplied. Indoor NEMA 1, listed to IEC 60950-1, EN60950-1, IEC 60529, ANSI/UL 60950-1, CAN/CSA C22.2 No.60950-1

These micro-inverters have been optimized to communicate with the Magnum MS-PAE off grid inverters to form a functional AC coupled grid tied system with battery backup. The **ME-MGT-ADAPTER** allows communication between the MagwebGT and a Magnum MS-PAE series battery inverter. Frequency shift in the MS-PAE inverter will cause the GT micro-inverters to reduce power output to prevent battery overcharge during a power outage. An AC-coupled system is limited to one MS-PAE inverter and eight GT500 inverters.

Conext SW Inverters and Accessories								
Model	**Max AC output**	**DC Module voltage**	**MPPT Range**	**Max input DC current**	**Max output AC current**	**DC Connectors**	**Weight**	**Item code**
ME-MGT500	500 W	< 55 VDC	22 to 45 VDC	12 A x 2	2.08 A @ 240 V	MC4	5.5 lbs	**030-02500**
ME-MGT-MW	Magweb GT Communication unit and display, 120 VAC, Ethernet							**300-02500**
ME-MGT-ADAPTER	Micro MGT500/MGT600 RS485 to RS232 Adapter and 25 ft cable from MagwebGT to PAE inverter							**300-02504**
ME-MGT-AC-F	Micro MGT500/MGT600 AC termination 6ft cable with one connector							**300-02501**
ME-MGT-AC-EXT	Micro MGT500/MGT600 AC jumper 6ft cable with two connectors for spacing inverters							**300-02502**
ME-MGT-ENDCAP-F	Micro GT AC connector end cap for last inverter in string							**300-02503**

Magnum Energy

True Sine-Wave Off-Grid Inverter/Chargers

MMS-Series Sine-Wave Inverter/Charger

The **MMS Series** sine-wave inverters provide a cost-effective solution for smaller power needs in mobile applications. The MMS is smaller, lighter, and less expensive, while retaining all the built-in protection and reliability of the larger ME and MS models. The MMS charger has an 85% efficient PFC (power factor corrected) charger. The **MMS1012G** model comes with a flexible cord on the AC input and a GFCI outlet for easy connection to AC appliances. Optional **MMS-RC-25** remote control available. The MMS Series is listed to UL 458 for the U.S.A. and Canada. MMS units have a 2-year warranty. Made in U.S.A.

MS-Series Sine-Wave Inverter/Chargers

The **MS Series** inverter/charger is a sine-wave inverter designed for the most demanding mobile and off-grid applications. The powerful easy-to-use MS Series inverters are available in 12, 24, and 48 VDC versions. The **MS4024** can be series stacked, using the ME-SSI, for 120/240 VAC operations, and 8 kW total output. The **MS2012-20B** has two 20 A AC breakers built-in.

The **M4024-PAE** and **MS4448-PAE** have 120/240 VAC split-phase output and can power 240 VAC loads without stacking. As many as four MS-PAE inverters can be paralleled for larger systems up to 17.6 kW with 120/240 VAC split-phase output (ME-RTR router required). The PAE inverters have the ability to transfer to AC input on low battery voltage, or state of charge if the BMS is installed.

The ME-RC50, ME-ARC50, or ME-RTR controller is required for inverter programming. The MS Series is listed to UL 458 for mobile use and UL 1741 for off-grid installations. The MS-PAE series is listed to UL1741. Dimensions: 13.75"H x 12.65"W x 8"D. MS units have a 3-year warranty, which is extended to five years when installed with the Magnum panels. Made in U.S.A.

MSH-Series Sine Wave Inverter/Chargers

The Magnum **MSH Series** inverters are similar to the MS Series, but add the generator-support feature. When the generator is supplying power through the inverter, and the load is too large for the generator alone, the inverter will add battery power to help power the loads. There are two AC inputs, one for generator and for grid. The inverter can offset grid power when PV power is available and the battery is fully charged. The RE version is listed to UL 1741 and the M versions are listed to UL 458 for mobile applications. The MSH inverters use the same options and accessories as the MS inverters.

Magnum Sine Wave Inverter/Chargers								
Model	**Continuous output**	**Battery voltage**	**AC out volts/hertz**	**No load draw**	**Charger output**	**AC surge output (5 sec)**	**Weight**	**Item code**
MMS1012	1,000 W	12 VDC	120 VAC / 60 Hz	19 W	50 A	1,750 W	23 lbs	**030-02320**
MMS1012G								**030-02321**
MS2012	2,000 W	12 VDC		25 W	100 A	3,300 W	42 lbs	**030-02332**
MS2012-20B								**030-02334**
MS2812	2,800 W	12 VDC		30 W	125 A	3,900 W	55 lbs	**030-02336**
MS2024	2,000 W	24 VDC		25 W	105 A	5,800 W	55 lbs	**030-02335**
MS4024	4,000 W	24 VDC		25 W	105 A	5,800 W	55 lbs	**030-02338**
MS4048	4,000 W	48 VDC		25 W	60 A	8,500 W	55 lbs	**030-02363**
MS4024-PAE	4,000 W	24 VDC	120/240 VAC / 60 Hz	27 W	105 A	5,800 W	55 lbs	**030-02342**
MS4448-PAE	4,400 W	48 VDC		25 W	60 A	8,500 W	55 lbs	**030-02341**
Magnum Sine Wave MSH Inverter/Chargers								
MSH4024RE	4,000 W	24 VDC	120 VAC / 60 Hz	25 W	110 A	5,800 W	58 lbs	**030-02347**
MSH3012M	3,000 W	12 VDC		30 W	125 A	3,900 W	55 lbs	**030-02348**
MSH4024M	4,000 W	24 VDC		25 W	110 A	5,800 W	55 lbs	**030-02349**
Magnum Sine Wave Inverter/Chargers - EXPORT								
MS4124PE	4,100 W	24 VDC	230 VAC / 50 Hz	30 W	105 A	6,300 W	53 lbs	**030-02343**
MS4348PE	4,300 W	48 VDC		28 W	55 A	7,500 W	53 lbs	**030-02331**

Magnum Energy Modified-Square-Wave Inverter/Chargers

MM-Series Inverters for Mobile Use

The **MM Series** inverter and inverter/charger are designed for small appliances in mobile systems, boats and RV's. The **MM** is smaller, lighter, and less expensive than the **ME** while retaining all the built-in protection and reliability of ME models. The **MM1212** model uses an efficient PFC (powerfactor-corrected) charger. The **MM612** model comes with an AC transfer switch but does not have a battery charger. The easy-to-use MM Series are cost-effective and come with a 2-year warranty. Listed to UL 458. Dimensions: 16.6"H x 8.4"W x 4.7"D.

ME-AE Series Inverters for Residential Use

The **MM-AE** Series inverter/charger is designed for entertainment systems and small appliances in smaller remote homes. The **MM** is smaller, lighter, and less expensive than the **ME** while retaining all the built-in protection and reliability of ME models. The MM models use an efficient PFC (powerfactor-corrected) charger and the same charger topology as all Magnum models. The 600 and 1,500 W models have a 12 VDC input; a 1,500 W model with a 24 VDC input is also available. The powerful, easy-to-use MM-AE Series are cost-effective and comes with a 2-year warranty. Not listed. Dimensions: 16.6"H x 8.4"W x 4.7"D.

ME-Series Inverters for Mobile Use

Designed for RV use, the **ME Series** 12 VDC inverter/charger charges batteries efficiently even at low AC voltage from low-cost generators. The modified-square-wave inverter keeps the cost down and a battery-temperature sensor optimizes charging. ME inverters have three power levels and built-in ground switching required for mobile inverters that may connect to utility power. ME inverters are listed to UL 458 in the U.S.A. and Canada for RV, marine and mobile use and come with a 2-year warranty. Dimensions: 13.8"H x 12.7"W x 8"D.

RD-Series Inverters

The **RD Series** 12 VDC inverter/charger is designed specifically for off-grid use with the same chassis as the MS sine-wave inverters. Includes power-factor-corrected charger, modified-square-wave inverter and battery-temperature sensor. The RD inverters are listed to UL 1741 and include a 2-year warranty. Dimensions: 13.8"H x 12.7"W x 8"D.

Magnum Modified-Sine Wave Inverter/Chargers								
Model	Continuous output	Battery voltage	AC out volts/hertz	No load draw	Charger output	Peak AC surge	Weight	Item code
MM612	600 W	12 VDC	120 VAC / 60 Hz	10 W	N/A	1,100 W	14 lbs	**030-02308**
MM1212	1,200 W	12 VDC		16 W	70 A	2,100 W	20 lbs	**030-02309**
MM612-AE	600 W	12 VDC		10 W	30 A	1,100 W	16 lbs	**030-02302**
MM1512-AE	1,500 W	12 VDC		18 W	70 A	2,100 W	22 lbs	**030-02306**
MM1524-AE	1,500 W	24 VDC		9 W	35 A	2,650 W	22 lbs	**030-02303**
ME2012	2,000 W	12 VDC		20 W	100 A	3,700 W	37 lbs	**030-02305**
ME2512	2,500 W	12 VDC		23 W	120 A	5,000 W	41 lbs	**030-02311**
ME3112	3,100 W	12 VDC		25 W	160 A	6,000 W	46 lbs	**030-02315**
RD2212	2,200 W	12 VDC		20 W	110 A	3,700 W	37 lbs	**030-02326**
RD1824	1,800 W	24 VDC		12 W	50 A	4,000 W	35 lbs	**030-02322**
RD2824	2,800 W	24 VDC		19 W	80 A	6,000 W	42 lbs	**030-02324**
RD3924	3,900 W	24 VDC		25 W	105 A	9,000 W	53 lbs	**030-02328**

Magnum Energy Accessories and Options

The optional **ME-RC50** remote control is simple to use yet enables use of all the set-up features of the ME, MS, MS-ME, and RD Series inverters. The ME-RC50 controls the ME-AGS automatic generator start using a network connection to the inverter. This remote has convenient fingertip operation, including one-knob programming. The **ME-ARC50** advanced remote offers even more control of the setup including custom battery-charge set-points. The **ME-ARTR** has all of the functions of the ME-ARC50 and is used for paralleling PAE inverters and multiple PT-100 charge controls. An ME-RC50 can be used with the ME-ARTR as a remote display. The **MM-RC25** provides on/off control and a quick indication of inverter and charger operation for the MM and MMS inverters.

The **ME-BMK** monitors battery percentage state-of-charge (SOC), along with amps, voltage, amp-hours and min/max DC volts, and then provides this information in an easy-to-understand display via the MEARC50, or ME-RTR remotes. Kit includes a sense module, shunt, and wiring. Use the **ME-BMK-NS** if you have a Magnum panel which come with a shunt.

The **ME-MW-E** Magweb with Ethernet connects the Magnum Energy system to the Internet for remote monitoring via the data.magnumenergy.com site. This unit connects to your broadband router via Ethernet cable. It monitors the inverter, battery monitor and generator-start module. The **ME-MW-W** is similar to the Ethernet version except that it will communicate to your broadband router via a wireless bridge. Maximum range for the wireless is up to 300' if unobstructed. There is both a transmitter and receiver gateway that wires to your network. The receiver gateway requires 120 VAC power. Both units are supplied with all the needed cables. They are compatible with the ME-RC50, ME-ARC50, and ME-RTR. With the ME-RTR it can only monitor one inverter in the system.

The optional Auto Generator Start (**ME-AGS**) module automatically starts and stops most major- brand generators. The generator can automatically start based on low battery voltage or on the inside temperature, starting a generator to run an air conditioner when the temperature of an RV or cabin rises to a user-defined level. The **ME-AGS-S** is the stand-alone version of Magnum Energy's Automatic Generator Start controllers and can be used in power systems that don't have a Magnum inverter. The **ME-AGS-N** is the network version of Magnum Energy's Automatic Generator Start controllers and is set up and operated via a Magnum Energy Inverter and ME-RC50 or ME-ARC50 remote panel.

When using the ME-RC50 remote control, the ME-AGS-N has basic adjustments starting on battery voltage or temperature. When using the ME-ARC50 remote control, the ME-AGS-N has advanced start and stop settings based on: time of day, battery State-of-Charge, battery voltage, high temperature, or inverter load amps. The ME-AGS-N also includes the ability to manually turn the generator on and off, generator exercise, warm-up and cool-down.

The optional **ME-SSI** allows a series connection of two MS4024 inverters for 120/240 VAC split-phase output at 8 kW total output power.

See the charge control section for more information on the **PT-100** charge control.

Magnum Accessories and Options			
Model	**Descriptions**	**Weight**	**Item code**
MM-RC25	Remote control for MM, MM-AE, and MMS inverters	2 lbs	**030-02355**
ME-RC50	Remote control for Magnum inverters with 50' cable for all inverters	2 lbs	**030-02351**
ME-ARC50	Advanced Remote for Magnum inverters with 50'cable for ME, MS, MS- PAE, RD	2 lbs	**030-02352**
ME-ARTR	Magnum Advanced Router for parallel stacking of MS-PAE inverters and PT-100 charge controls	2 lbs	**300-02300**
ME-BMK	Battery monitor kit - ME-ARC50 or ME-RTR required with this item	4 lbs	**020-06379**
ME-BMK- NS	Battery monitor kit without Shunt- ME-ARC50 or ME-RTR required with this item	2 lbs	**020-06380**
ME-MW-W	Magweb Web-based monitoring kit - Wireless	3 lbs	**029-08000**
ME-MW-E	Magweb Web-based monitoring kit - Ethernet	3 lbs	**029-08001**
ME-AGS-N	Automatic generator start – network version for use with Magnum inverters and ME-RC50	4 lbs	**020-06377**
ME-AGS-S	Automatic generator start – standalone version	4 lbs	**020-06375**
ME-SSI	Series stacking cable kit for MS-4024 ONLY	10 lbs	**030-02362**
ME-CB	Conduit Box for ME, MS, ME-AE, and RD inverters	4 lbs	**030-02360**
ME-RC-BZ	Bezel for RC50 (standard on the ARC50)	1 lb	**310-00115**
PT-100	Magnum 100 A MPPT charge control	13.6 lbs	**020-06371**
BTS-15	Magnum battery temperature sensor w/ 15' cable	1 lb	**020-06373**

Magnum Energy MMP Mini Magnum Panel

The **MMP** - Mini Magnum Panel is an inclusive, easy-to-install panel designed to work with one Magnum Energy MS-AE, MS, RD or other inverter/charger. The MMP features a small footprint and comes prewired for fast installation. Circuit breakers and the optional remote control mount on the front of the cabinet. Dimensions are 12.5"W x 18"H x 8"D. They are listed to UL 1741 and CSA C22.2 107-01.

Each MMP includes one DC breaker – 175 A or 250 A, one AC bypass breaker – 30 A two-pole or 60 A single-pole, one AC input breaker – 30 A two-pole or 60 A single-pole, a 500 A/50 mV shunt, DIN rail provided for up to eight DC ½" DIN-mount breakers, or if the DIN rail is removed, four 1" wide surface-mount breakers (see Electrical Distribution Parts). Panels are available for inverters with 120 VAC output and 120/240 VAC output.

When used with Magnum inverters, the standard 2-year warranty is extended to a 5-year system warranty that covers these panels, inverters, remotes, and accessories.

The MP-ODE is an outdoor enclosure that holds one MS or RD inverter, the MMP, and one PT-100 charge control. It lockable, has screened vents, and is UL listed as a NEMA 3R rated enclosure. 39.25" H x 31.52" W x 13" D, 56 lbs.

MMP Mini Magnum Panel				
Model	**DC main breaker**	**AC output breaker**	**Use with**	**Item code**
MMP250-30D	250 A	30 A @120/240 VAC	MS4024-PAE	**030-02380**
MMP250-60S	250 A	60 A @ 120 VAC	All ME, MS4024, MS2812, MS2012, RD3924	**030-02381**
MMP175-30D	175 A	30 A @120/240 VAC	MS4448-PAE	**030-02382**
MMP175-60S	175 A	60 A @ 120 VAC	MS2024, MS4048, RD2824, RD1824	**030-02383**
BP-MMP	Back Plate MMP (fits 1 - MMP)			**030-02396**
Export MMP Mini Magnum Panel				
MMP250-30S-E	250 A	30 A @ 230 VAC	MS1512E, MS2712E, MS4124E	**030-02390**
MMP175-30S-E	175 A	30 A @ 230 VAC	MS4348E	**030-02391**
Magnum Panel Parts				
BR-DC175	Replacement main inverter breaker, 175 A			**053-01059**
BR-DC250	Replacement main inverter breaker, 250 A			**053-01060**
MP-ODE	MP Outdoor Enclosure			**048-03300**

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Magnum Energy MP Magnum Panels

The MP Magnum Panels are available in three sizes, each with either a 30 A two-pole 120/240 VAC output breaker or a 60 A 120 VAC output breaker. They are designed for use with two series-stacked MS4024 inverters, or up to four parallel-connected MS-PAE inverters.

The **MPSL** (Magnum panel, single enclosure, low capacity) accommodates one or two inverters with the use of an MPX Extension Box. It includes a 175 or 250 A DC breaker, a 125 A AC bypass breaker, a 500 A/50 mV shunt and inverter AC input protection, and all AC/DC wiring for dual inverters (source/load wiring not included). There is space for five 1" back-mount breakers or ten ½" DIN-mount breakers on the DC side.

The **MPSH** (Magnum panel, single enclosure, high capacity) accommodates a maximum of three inverters. One inverter can be connected directly to the MPSH. Each additional inverter requires an MPX. The MPSH includes one 175 or 250 A DC breaker, a 125 A AC bypass breaker, a 1,000 A/100 mV shunt and inverter AC input protection, and AC/DC wiring for dual inverters (source/load wiring not included). ***NOTE:*** There are no spaces for extra DC breakers in the MPSH, so it may be limited to backup systems. Use the MPDH for three or four-inverter systems with solar or other DC input.

The **MPDH** (Magnum panel, dual enclosure, high capacity) accommodates as many as four inverters with two enclosures – one for AC and one for DC connections. Two inverters can be connected to the MPDH. The third and fourth inverters require one MPX for each. The MPDH includes two 175 or 250 A DC breakers, a 125 A AC bypass breaker, a 1,000 A/100 mV shunt and inverter AC input protection, and all AC/ DC wiring for dual inverters (source/load wiring not included). There is room for seven 1" back-mount breakers or fourteen ½" DIN-mount breakers on the DC side.

Mount and connect additional inverters to MP Series Systems Panels using **MPX** Series Extension Boxes. They mate to the bottom of Magnum MS4024 or the MS-PAE inverters. The boxes include a 175 or 250 A DC breaker and wiring for an additional inverter. Left and right-hand versions mount on either side of an MP Panel. An **MP-HOOD** inverter hood (not shown) allows vertical mounting. Choose the extension box model that corresponds to the MP enclosure and which side it will be installed on.

MP Magnum Panels					
Model	**DC main breaker quantity**	**Main breaker spaces**	**AC bypass breaker assembly**	**Use with**	**Item code**
MPSL175-30D	1 - 175 A	two	60 A	MS4448-PAE	**030-02406**
MPSL250-30D	1 - 250 A	two	60 A	MS4024-PAE	**030-02384**
MPSL250-60S	1 - 250 A	two	60 A	MS4024	**030-02385**
MPSH175-30D	1 - 175 A	three	125 A	MS4448-PAE	**030-02407**
MPSH250-30D	1 - 250 A	three	125 A	MS4024-PAE	**030-02388**
MPDH175-30D	2 - 175 A	four	125 A	MS4448-PAE	**030-02408**
MPDH250-30D	2 - 250 A	four	125 A	MS4024-PAE	**030-02389**
MPXS175-30D-L	1 - 175 A	LEFT-side mounting		MPSL175-30D, MPSH175-30D	**030-02409**
MPXS175-30D-R	1 - 175 A	RIGHT-side mounting			**030-02410**
MPXS250-30D-L	1 - 250 A	LEFT-side mounting		MPSL250-30D, MPSH250-30D	**030-02399**
MPXS250-30D-R	1 - 250 A	RIGHT-side mounting			**030-02400**
MPXS250-60S-L	1 - 250 A	LEFT-side mounting		MPSL-60S	**030-02401**
MPXS250-60S-R	1 - 250 A	RIGHT-side mounting			**030-02402**
MPXD175-30D-L	1 - 175 A	LEFT-side mounting		MPHD175-30D	**030-02411**
MPXD175-30D-R	1 - 175 A	RIGHT-side mounting			**030-02412**
MPXD250-30D-L	1 - 250 A	LEFT-side mounting		MPHD250-30D	**030-02403**
MPXD250-30D-R	1 - 250 A	RIGHT-side mounting			**030-02404**
BP-S	Back plate single (fits 1 MPSL, 1 MPSH, 1 MPX)				**030-02394**
BP-D	Back plate double (fits 1 MPDH, or 1 MPSL + 1 MPX, or 1 MPSH + 1 MPX)				**030-02395**
MP-CCB	Charge-controller bracket for mounting controller on MP or MMP				**030-02405**
MPX-CB	Panel-extension conduit box (conduit box only – no AC or DC breakers, no wiring)				**030-02397**
MP-RFC	Router front-cover for MP enclosures				**310-00117**

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MPDH Panel

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Sensata Technologies

Samlex

EVO Off-Grid Inverter/Chargers

The **EVO** is a line of robust true sine-wave output inverter/chargers. The 1200 W units have a single AC input, either grid or generator. "–HW" indicates hard wired connections for the AC input and output. The larger EVO units have two AC inputs for grid and generator with priority given to the grid input. Online mode gives priority to the battery and solar input over the grid, connecting to the grid only when the battery is low. Battery charging is based on the battery condition rather than just charging time. There is external DC charging input terminals for solar charging from a separate solar charge control. This is limited to 50 A, and when used, the inverter will limit its charging from an AC source to the total battery charging limit programmed.

Nine points of internal fault protection ensures reliable operation. Programmable power save mode allows the inverter to sleep when there are no loads, drawing <8 W from the battery. Operating temperature range is -4°F (-20°C) to 140°F (60°C). These inverters are covered by a 2-year limited warranty.

Dimensions are 16.4"L x 12.8"W x 5.83"H for the 1200W units and 16.8"L x 12.8"W x 8.15"H for the larger units. The 120 VAC inverters are listed to UL1741 and 458, CSA C22.2 No. 107.1-01, and the export inverters are CE marked.

The **EVO-RC-PLUS** is a remote control and monitoring display for the EVO inverters.

Model	Continuous output	Battery voltage	AC out volts/hertz	No load draw	Charger Output	AC surge output	Weight	Item code
Samlex EVO inverters, subgke AC input								
EVO-1212F-HF	1200 W	12 VDC	120 V/60 Hz	20 W	60 A	2400 W	39 lbs	**030-07260**
EVO-1224F-HW	1200 W	24 VDC		20 W	40 A	2400 W	39 lbs	**030-07261**
EVO-1212F	1200 W	12 VDC		20 W	60 A	2400 W	39 lbs	**030-07262**
EVO-1224F	1200 W	24 VDC		20 W	40A	2400 W	39 lbs	**030-07263**
Samlex EVO Inverters, dual AC input								
EVO-2212	2200 W	12 VDC	120 V/60 Hz	30 W	100 A	**3300 W**	**59 lbs**	**030-07252**
EVO-3012	3000 W	12 VDC		30 W	130 A	**4500 W**	**64 lbs**	**030-07253**
EVO-2224	2200 W	24 VDC		25 W	70 A	**3300 W**	**57 lbs**	**030-07254**
EVO-4024	4000 W	24 VDC		25 W	110 A	**6000 W**	**64 lbs**	**030-07255**
Samlex EVO Inverters -EXPORT								
EVO-2212E	2200 W	12 VDC	230 V/50 Hz	30 W	100 A	**3300 W**	**59 lbs**	**030-07256**
EVO-3012E	3000 W	12 VDC		30 W	130 A	**4500 W**	**64 lbs**	**030-07257**
EVO-2224E	2200 W	24 VDC		30 W	70 A	**3300 W**	**57 lbs**	**030-07258**
EVO-4024E	4000 W	24 VDC		30 W	110 A	**6000 W**	**64 lbs**	**030-07259**
EVO-RC-PLUS	Digital remote control for EVO inverters						**1 lb**	**300-07200**

Samlex PST Sine Wave Off-Grid Inverters

Samlex **PST** sine-wave inverters offer a small, affordable, sine-wave inverter for remote homes, RVs and boats. The 120 VAC output is overload protected. All of these inverters have AC receptacles and low-battery alarms. If you plan to use these inverters with reactive loads, such as motors and compact fluorescent lights or other ballasted light, size the inverter for four times the continuous watts required. Keep in mind that most common batteries and cabling will not support the current needed for a 3000 Watt load connected to a 12 VDC battery. Listed to UL 458 (except PST-15S-12A). Each inverter includes a 2-year warranty.

The Samlex **RC-15A** is a remote control panel for the PST-600 and PST-1000 inverters. It has three LED indicators for overload, over-temperature, and power and includes an on/off switch. The Samlex RC-300 is a remote control panel for the PST-1500 through PST-3000 inverters. It has three LED indicators for overload, over-temperature, and power. It has an LCD display showing AC Voltage (V), AC current (A), frequency (Hz), active power (Watts), apparent power (VA) and power factor (PF) in addition to the LED indicators. Both remotes are flush-mount and come with a 15' cable to connect to the inverter. Each unit is covered by a 2-year warranty.

Samlex Sine Wave Inverters								
Model	Continuous output	Battery voltage	AC out volts/hertz	No load watts	Surge watts	Dimensions (H" x W" x D")	Weight	Item code
PST-150-12	150 W	12 VDC	120 V/60 Hz	7 W	250 W	8.3 x 5.8 x 2.5	4.2 lbs	**030-07123**
PST-300-12	300 W	12 VDC	120 V/60 Hz	8 W	500 W	8.3 x 5.8 x 2.5	4.2 lbs	**030-07126**
PST-600-12	600 W	12 VDC	120 V/60 Hz	10 W	1,000 W	11 x 9.5 x 3.5	6.8 lbs	**030-07129**
PST-1000-12	1,000 W	12 VDC	120 V/60 Hz	10 W	1,500 W	15.5 x 9.5 x 3.5	8.2 lbs	**030-07130**
PST-1500-12	1,500 W	12 VDC	120 V/60 Hz	12 W	3,000 W	16 x 11.3 x 4	12.6 lbs	**030-07128**
PST-2000-12	2,000 W	12 VDC	120 V/60 Hz	12 W	3,500 W	18.5 x 10.4 x 4.2	15.6 lbs	**030-07124**
PST-3000-12	3,000 W	12 VDC	120 V/60 Hz	19 W	6,000 W	18 x 10.4 x 5.7	21.6 lbs	**030-07116**
PST-600-24	600 W	24 VDC	120 V/60 Hz	11 W	1,000 W	11 x 9.5 x 3.5	6.8 lbs	**030-07132**
PST-1000-24	1,000 W	24 VDC	120 V/60 Hz	14 W	1,500 W	15.5 x 9.5 x 3.5	8.2 lbs	**030-07134**
PST-1500-24	1,500 W	24 VDC	120 V/60 Hz	19 W	3,000 W	16 x 11.3 x 4	12.6 lbs	**030-07127**
PST-2000-24	2,000 W	24 VDC	120 V/60 Hz	19 W	3,500 W	18.5 x 10.4 x 4.2	15.6 lbs	**030-07125**
PST-3000-24	3,000 W	24 VDC	120 V/60 Hz	24 W	6,000 W	18 x 10.4 x 5.7	21.6 lbs	**030-07117**
PST-600-48	600 W	48 VDC	120 V/60 Hz	14 W	1,000 W	11 x 9.5 x 3.5	6.8 lbs	**030-07114**
PST-1500-48	1,500 W	48 VDC	120 V/60 Hz	24 W	3,000 W	18.5 x 10.4 x 4.2	15.6 lbs	**030-07115**
RC-15A	Remote for PST-600 / PST-1000					3.54 x 2.54 x 1.1	0.1 lbs	**310-00111**
RC-300	Remote for PST-1500/PST-2000/PST-3000					4.33 x 2.56 x 0.97	0.12 lbs	**310-00118**

Morningstar

SureSine™ 300 W Off-Grid Inverters

The Morningstar SureSine™ **SI-300** pure-sine-wave inverter is designed to meet the needs of rural PV electrification requiring AC power. This inverter is also a good choice for small PV systems for telecom, remote cabins and weekend homes, as well as RV/caravans and boats. The SureSine handles a 200% surge to a maximum of 600 W.

The SureSine uses epoxy encapsulation, conformal coating, stainless-steel hardware, and an anodized aluminum enclosure to protect against harsh tropical and marine environments. AC output connection does not have an AC receptacle and must be hardwired. These inverters are covered by a two-year warranty.

Dimensions are 8.4"H x 6"W x 4.1"D. The 115 VAC inverter is UL listed for the U.S.A. and to CSA C22.2 No. 107.1-01 for Canada.

Morningstar SureSine 300 W								
Model	Continuous output	Battery voltage	AC out volts/hertz	No load draw	Standby draw	AC surge output	Weight	Item code
SI-300-115VUL	300 W	12 VDC	115 VAC/60 Hz	450 mA	55 mA	600 W	10 lbs	**030-08022**
SI-300-220V	300 W	12 VDC	220 VAC/50 Hz	450 mA	55 mA	600 W	10 lbs	**030-08033**

MidNite Solar

MidNite Solar offers pre-assembled and tested power panels using Magnum, SMA, and Schneider inverters. These power panels offer a space-saving fully-integrated power-panel system. All assemblies are thoroughly tested and crating is included.

Pre-Wired Magnum Power Panels

Magnum inverters are installed on the MidNite MNE250(175)STM-L gray steel E-Panel with an ME-RC50 remote display, a WhizBang Jr, a MidNite Classic 150 charge controller with built in DC-GFP and arc-fault detector, an MNDC array breaker, an MNDC charge- control breaker, two or three MNSPD surge arrestors, and battery-temperature sensors. (See Electrical Distribution Parts for details on these components) Also available with CL200 and CL250 charge controls. (See Charge Controllers).

The MidNite **MND3R4024PAE-UPS** is a battery-based backup system in a battery and equipment enclosure. It is made specifically for AC backup power. It has 120/240 VAC output, and is fully assembled and tested. Includes a Magnum MS4024 PAE inverter, Magnum ARC50, and MidNite Enclosure. It can hold four Group 31 or GC2 or GC2 tall batteries (batteries not included). 49”H x 39”W x 21”D.

The MidNite **MNEMS4024PAEACCPL** is a Magnum battery-based inverter system, made for AC coupling to a grid-tie inverter. It is available with 120/240 VAC output, and is fully assembled and tested. Includes a Magnum MS4024 PAE inverter, Magnum RTR router, MidNite E-Panel, two SPD surge arrestors, and GT-inverter-circuit relay. The maximum size grid-tie inverter that can be installed with this system is 3.6 kW. 30”H x 16”W x 12”D.

The MidNite **MND3RACCPLME** is a Magnum battery-based inverter system, made for AC coupling to a grid-tie inverter, in an outdoor enclosure with room for batteries. It has 120/240 VAC output, and is fully assembled and tested. Includes a Magnum MS4024 PAE inverter, Magnum RTR router, MidNite E-Panel, two SPD surge arrestors, and GT-inverter-circuit relay. This is all installed inside a MidNite MNBE-D3R battery enclosure which, in this configuration, can hold four Group 31 or GC2 or GC2 tall batteries (batteries not included). The maximum size grid-tie inverter that can be installed with this system is 3.6 kW. 49”H x 39”W x 21”D. The dimensions and weights are approximate and do not include crating.

Please note that not all grid-tie inverters are suitable for AC coupling; check with the inverter manufacturer.

MidNite Pre-Wired Magnum Power Systems				
Model	**Description**	**Inverter**	**Weight**	**Item code**
MNEMS4024CL150	Magnum 120 VAC Off-Grid 4,000 Watt 24 VDC Inverter with Classic 150	MS4024	140 lbs	**033-04301**
MNEMS4024PAECL150	Magnum 120/240 VAC Off-Grid 4,000 Watt 24 VDC Inverter with Classic 150	MS4024PAE	140 lbs	**033-04303**
MNEMS4448PAECL150	Magnum 120/240 VAC Off-Grid 4,400 Watt 48 VDC Inverter with Classic 150	MS4448PAE	140 lbs	**033-04305**
MND3R4024PAE-UPS	Magnum 120/240 VAC Off-Grid 4,000 Watt 24 VDC Inverter backup system, outdoor equipment and battery enclosure	MS4024PAE	200 lbs	**033-04330**
MidNite Pre-Wired Magnum AC Coupled Power Systems				
MNEMS4024PAEACCPL	Magnum 120/240 VAC AC-Coupled 4 kW/24 VDC Inverter system, GT inverter not included	MS4024PAE	140 lbs	**033-04322**
MND3RACCPLME	Magnum 120/240 VAC AC-Coupled 4 kW/24 VDC Inverter system, outdoor equipment and battery enclosure, GT inverter not included	MS4024PAE	200 lbs	**033-04323**

MidNite Pre-Wired Schneider-Electric Power Panels

The MidNite Schneider Electric XW+ power panels are available as pre-wired systems. The **MNXWP6848-CL150** and **MNXWP5548-CL150** include one XW+6848 or XW+5548 inverter, MidNite E-panel, SCP, four MNSPD, and one MidNite Classic 150 charge control. These are also available with CL200 or CL250 charge controls.

The MidNite **MNXWPAC6846** and **MNXWPAC5548** power panels are set up for AC-coupled systems with an existing grid-tie inverter; similar to the off-grid power panels above, but without a charge control. Each XW+6848 inverter can have up to 6 kW of grid-tie inverter capacity connected, and the XW+5548 up to 5kW of grid-tie inverter capacity connected. These are 50”H x 27”W x 12”D.

MidNite Pre-Wired Schneider-Electric Off-Grid Power Systems				
Model	**Description**	**Inverter**	**Weight**	**Item code**
MNXWP6848-CL150	Schneider XW+ single 120/240 VAC Grid-Tie or Off-Grid 6,800 W 48 VDC Inverter, Classic 150z	XW+6848	200 lbs	**033-04343**
MNXWP5548-CL150	Schneider XW+ single 120/240 VAC Grid-Tie or Off-Grid 5,500 W 48 VDC Inverter, Classic 150	XW+5548	200 lbs	**033-04360**
MidNite Pre-Wired Schneider-Electric AC-Coupled Power Systems				
MNXWPAC6848	Schneider XW+ single 120/240 VAC AC-Coupled 6,800 W 48 VDC Inverter	XW+6848	215 lbs	**033-04374**
MNXWPAC5548	Schneider XW+ single 120/240 VAC AC-Coupled 5,500 W 48 VDC Inverter	XW+5548	215 lbs	**033-04388**

The MidNite **MNSW** off-grid power panels are available with any of the SW inverters and either a KID or Classic charge controller. They come with one Schneider Electric SW inverter, Conext SCP, MidNite SW E-panel with DC breakers and AC bypass, either KID or Classic 150 charge control, WhizBangJr, and MNSPD. Also available with CL200 and CL250 charge controls.

MidNite Pre-Wired Power Systems for Schneider SW				
Model	**Description**	**Inverter**	**Weight**	**Item code**
MNSW4048-KID-B	Schneider SW single 120/240 VAC Off-Grid 3,400 W 48 VDC Inverter, KID control	SW4048	120 lbs	**033-04381**
MNSW4024-CL150	Schneider SW single 120/240 VAC Off-Grid 3,400 W 24 VDC Inverter, CL150 control	SW4024	130 lbs	**033-04367**
MNSW4048-CL150	Schneider SW single 120/240 VAC Off-Grid 3,400 W 48 VDC Inverter, CL150 control	SW4048	130 lbs	**033-04382**

AC Transformers

Use an autotransformer as a step-down to connect the 240 VAC output of a generator to the 120 VAC input on an inverter. This allows full output power of a 240 VAC generator to be used for battery charging. Autotransformers can also step-up voltage to operate 240 VAC appliances and motors from the 120 VAC output of an inverter.

OutBack Power

PSX-240 Autotransformer

The **PSX-240 Autotransformer** can be used for step-up, step-down, generator, and split-phase output balancing.

The PSX-Relay version has a relay assembly, which is required when split-phase stacking with 120/208 VAC power sources.

Both units have a built-in two-pole 20 A AC breaker and cooling fan.

OutBack Power PSX-240 Autotransformer		
Model	**Description**	**Item code**
PSX-240	6 kW autotransformer	**030-04429**
PSX-240-Relay	6 kW autotransformer with relay	**030-04430**

MidNite Solar

MNX-240 Autoformer

MidNite's 6000 Watt Autoformer (based around SMAs Toroid) is used for turning a single SMA Sunny Island inverter with 120 VAC output into an inverter with 120/240vac output. Useful for using a single Sunny Island to AC couple with grid tie inverters which have 240 VAC output. While designed to mate with an SMA Sunny Island inverter, it can be used with any inverter with 120 VAC output to power 240 VAC loads. Contains a 25A two-pole breaker.

NOTE: An E-Panel and back plate (MNESMAXW-SHORT-BP or MNESMA-TALL-BP, see (Electrical Distribution Parts section) is recommended for the proper wiring and alignment of a Sunny Island to the transformer.

MidNite Solar MNX-240 Autotransformer		
Model	**Description**	**Item code**
MNX-240	6 kW MidNite Solar autotransformer	**038-00001**

DC-DC Converters

DC-DC converters are used to power appliances requiring a different voltage than the battery bank supplies. For example, powering a 12 VDC appliance that needs to be run from a 24 VDC or 48 VDC battery bank. Using a DC-DC converter is preferred for powering loads that require a different voltage than the battery bank's system voltage as center-tapping causes cell imbalances that shorten the useful life of the battery bank.

Samlex

DC-Step-Down Power Converters

These switching DC-DC step-down power converters are designed to decrease DC voltage. They operate at high efficiency and provide regulated 13.8 VDC output from an input of 20-30 VDC. Use them to power 12 VDC lights and appliances from a 24 VDC system. These converters are covered by a 2-year warranty.

Samlex DC-Step-Down Power Converters		
Model	**13.8 VDC output max amps**	**Item code**
SDC-15	12 A	**030-08720**
SDC-23	20 A	**030-08725**
SDC-30	30 A	**030-08727**
SDC-60	60 A	**030-08729**

Isolated DC-DC Converters

These **isolated, enclosed DC-DC converters** are designed to increase or decrease DC voltage. 100 W, 200 W, and 360 W versions are available.

Samlex Isolated DC-DC Converters				
Model	**Input voltage**	**Output voltage**	**Max output amps**	**Item code**
IDC-100A-12	9-18 VDC	12.5 VDC	8 A	**030-08740**
IDC-100B-12	20-35 VDC	12.5 VDC	8 A	**030-08741**
IDC-100C-12	30-60 VDC	12.5 VDC	8 A	**030-08742**
IDC-100A-24	9/18 VDC	24.5 VDC	4 A	**030-08744**
IDC-100C-24	30-60 VDC	24.5 VDC	4 A	**030-08746**
IDC-200A-12	9-18 VDC	12.5 VDC	16 A	**030-08747**
IDC-200B-12	20-35 VDC	12.5 VDC	16 A	**030-08748**
IDC-200C-12	30-60 VDC	12.5 VDC	16 A	**030-08749**
IDC-200A-24	9-18 VDC	24.5 VDC	8 A	**030-08751**
IDC-200C-24	30-60 VDC	24.5 VDC	8 A	**030-08753**
IDC-360A-12	9-18 VDC	12.5 VDC	30 A	**030-08755**
IDC-360B-12	20-35 VDC	12.5 VDC	30 A	**030-08756**
IDC-360C-12	30-60 VDC	12.5 VDC	30 A	**030-08757**
IDC-360A-24	9-18 VDC	24.5 VDC	15 A	**030-08758**
IDC-360C-24	30-60 VDC	24.5 VDC	15 A	**030-08760**

Generator Start Controls

It is very important to prevent battery banks from being discharged too far. These specialized controllers send a start-up signal to a backup or remote power generator when the battery bank reaches a given voltage set point. It is important to note that not all start controllers work with all generators. Please contact AEE Solar to assess or confirm compatibility.

Magnum Energy

AGS - Auto Generator Start

The **Magnum Automatic Generator Start (AGS)** is designed to automatically start a generator based on low battery condition or the inside temperature of an RV, and is compatible with most major generators, including Onan, Powertech, Generac, and Weterbeke.

Battery start voltage can be set from 10-12.2 VDC or 20-24.4 VDC or 40-48.8 VDC, the start temperature from 65-95 °F, the run time from 0.5 to 25.5 hours, and the quiet time with an easy-to-set clock. Automatic Generator Start settings do not interfere with the manual start/stop operation of the generator.

Two models are available. The standalone **AGS-S** works well for installation and operation without an inverter. The networked **AGS-N** allows operation of the AGS via the ME Series remote panels. One-year warranty.

Magnum Energy Auto Generator Start		
Model	**Description**	**Item code**
AGS-S	Automatic generator start standalone	**020-06375**
AGS-N	Automatic generator start network version (for use with Magnum inverters only)	**020-06377**

Atkinson Electronics

GSCM

The **Atkinson GSCM** (generator start controller module) is a microprocessor-based generator-starting controller that receives start commands from any 12 VDC output or dry-contact switch, including an inverter or charge controller's auxiliary relay, a voltage-controlled relay, a timer, a water-tank float switch, or any user-supplied contact closure. It automatically controls a gas/propane or diesel powered generator or pump, and is sealed for harsh-environment operation.

The GSCM provides contact signal relays to start the engine and to disconnect the starter when a minimum generator frequency output is measured. It can monitor the generator operation, shutting it down and displaying the fault conditions detected. The GSCM must be manually reset after a generator fault.

The GSCM is powered by 12 to 24 VDC from a battery bank and will start generators for 12 to 48 VDC systems. For 48 VDC systems the GSCM must be powered by a 24 VDC-or-less tap on the 48 VDC battery bank, or from the generator's starting battery. The GSCM provides a 30-day exercise function that can be synchronized with a photovoltaic input to only start each 30-day period at the beginning of the solar charge day. It also has a timed relay that can be used for diesel engine glow plugs. 2-year limited warranty. Dimensions are 5.5"H x 3.3"W x 1.5"D.

GSCM-mini

The GSCM-mini generator start controllers are optimized for use with OutBack Power and other inverters and charge controllers that have a 12 VDC output from their programmable AUX relay. They support three types of three-wire generator control: momentary, maintained, or ignition. They have a fixed crank time and over and under frequency shutdown. 2-year limited warranty.

Use the GSCM-mini-I with gasoline and propane-fueled generators.

Atkinson Electronics Auto Generator Start		
Model	**Description**	**Item code**
GSCM	Generator start control module	**020-06341**
GSCM-mini-i	Generator start control module – mini-I for gasoline and propane generators	**020-06343**

Relays and Controls

The simple controls presented here enable you to automate certain functions for your renewable energy system, such as turning on/off a load or starting/stopping a generator, or inverter, based on logical conditions, such as battery voltage, time of day, or sensor reading. Relays enable a small control voltage signal to open or close a switch for a much larger voltage and current. Select relays and design your system so that it will "fail safe" if the control signal is lost.

Morningstar

Relay Driver

The **Morningstar Relay Driver** is a logic module that provides control functions such as high/low-voltage alarms, load control, and generator start functions for 12, 24 or 48 VDC battery systems. It controls four independent relay driver outputs by reading battery voltage or by digital data inputs from any Morningstar controller or inverter, which includes an RJ-11 meter port (TriStar, TriStar MPPT, SunSaver Duo, SunSaver MPPT or SureSine). Multiple Relay Drivers can connect to a single controller or to multiple devices in a MeterHUB/MeterBus network. Outputs can be used to operate any mechanical or solid-state relay with a coil voltage that is the same as the battery voltage used to power the Relay Driver. Maximum current for each output channel is 750 mA.

The Relay Driver is pre-programmed with four commonly-used settings and may be mounted to a DIN rail or a flat surface. An RS-232 port and PC software (MS View or MODBUS commands) is included for custom programming, detailed monitoring and driver control. The driver terminals can accept 16 to 24 AWG wire. Self-consumption is less than 20 mA and the unit operates from 8 to 68 VDC. The Relay Driver is highly reliable: each channel has complete electronic protections for short circuit, overcurrent, reverse polarity, as well as lightning and transient surges. LED indicators display power and status for each channel as well as faults and data sampling intervals. Operating temperature range is -40 °C to +45 °C. Dimensions are 6.4"H x 3.2"W x 1.3"D and it weighs 0.4 lb. These are covered by a 5-year warranty.

Morningstar Relay Driver		
Model	**Description**	**Item code**
RD-1	Morningstar Relay Driver	**020-01255**
RSC-1	Communications Adapter EIA-485 / RS-232	**020-01256**
HUB-1	MeterHUB	**020-01260**
DIN-1	DIN Rail Clips for Installing the Relay Driver to DIN Rails	**020-01259**

Relays

OutBack 16A Relay

DPDT 30 A Relay

This double-pole, double-throw (DPDT) relay can be used for up to 30 A at 12, 24, or 48 VDC or 120 or 240 VAC. All contact surfaces are silver alloy with gold flashing. Contact terminals are #8-32 screws, and coil terminals are #6-32 screws. Relays with 120 VAC or 240 VAC coils can be used to build simple transfer switches. Relays with DC coils can be used for remote operation of pumps and fans. By connecting a relay with a DC coil to a voltage-controlled switch, AC or DC loads may be turned on or off based on battery voltage levels.

OutBack 16 A 30 VDC/250 VAC DIN-Mount Relay

The FLEXware Relay Assembly will activate a two-wire start generator when wired to the AUX output of either an OutBack FX Inverter/Charger or an OutBack Charge Controller. The assembly consists of an LED module and a relay inserted (in one orientation) into a base. The base is mounted onto the DIN rail and will fit into the OutBack FLEXware AC enclosures.

Relays		
Description	**Coil current**	**Item code**
DPDT 30 A relay - 12 VDC coil	170 mA	**053-08281**
DPDT 30 A relay - 24 VDC coil	53 mA	**053-08287**
DPDT 30 A relay - 120 VAC coil	83 mA	**053-08278**
DPDT 30 A relay - 240 VAC coil	42 mA	**053-08284**
Omron relay SPST 10 A 12 VDC coil	44 mA	**053-08298**
OUTBACK, OBR-16-30VDC250AC-DIN, RELAY DIN 16A 30VDC/250VAC	34 mA	**030-04193**

Battery Chargers

AC input battery chargers can be used with AC generators to provide battery charging on an emergency basis or in the absence of a renewable energy source. Since proper charging is vital to battery health, a high-quality charger is recommended if you plan to charge batteries from an engine generator.

IOTA

DLS Converter/Chargers

The IOTA DLS series converter/chargers quickly and efficiently charge batteries with full rated output and then maintain the batteries using only the output required by the load or battery self-discharge, cutting back to milliamps as the battery requires. They are protected against low line-voltage spikes from the AC power source, and are reverse-polarity and short-circuit protected on the DC side. They also have current limit, thermal and overload protection.

When used as a DC power supply, the DLS converter/chargers will only supply the amount of power required by the load, with very clean output power. When not in use, it is essentially off, minimizing electricity usage.The DLS battery chargers operate very well on generator power with typical operating efficiency greater than 80%. The proportional fan control enables quiet, efficient operation. External fuses can be quickly and easily replaced and there is a socket and jumper that can be used to change the charge voltage limit to either 13.6 or 14.2 VDC (multiply by two for 24 VDC and four for 48 VDC batteries).

These converter/chargers can be wired in parallel to increase the charging amperage. For example, four 12 V/55 A chargers can be wired in parallel for 12 VDC and 220 A output. For 120 VAC / 60 Hz input the DLS-75 and DLS-27-40 models have 120 VAC-20 A AC plugs (NEMA 5-20). All other 120 VAC models have standard 15 A AC plugs (NEMA 5-15).

DLS chargers are UL-listed for the U.S.A. and Canada (except for models DLS-90, DLS-54-13, and DLS-240-27-40) and are covered by a 2-year warranty.

IOTA Battery Chargers

Model	Battery voltage	Charge current	AC input voltage	Max AC amps	Dimensions (L" x W" x H")	Weight	Item code
IOTA 120 VAC 60 HZ Converters / Battery Chargers							
DLS-15	12 VDC	15 A	120 VAC	3.7 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02112**
DLS-30	12 VDC	30 A		7.3 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02115**
DLS-45	12 VDC	45 A		11 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02118**
DLS-55	12 VDC	55 A		13.4 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02121**
DLS-75	12 VDC	75 A		18.2 A	13 x 6.7 x 3.4	7.8 lbs	**045-02124**
DLS-90	12 VDC	90 A		21.8 A	13 x 6.7 x 3.4	7.8 lbs	**045-02127**
DLS-27/15	24 VDC	15 A		7.3 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02130**
DLS-27/25	24 VDC	25 A		12.2 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02133**
DLS-27/40	24 VDC	40 A		19.5 A	13 x 6.7 x 3.4	7.8 lbs	**045-02136**
DLS-54/13	48 VDC	13 A		12.6 A	9.7 x 6.7 x 3.4	5.0 lbs	**045-02147**

IOTA IQ-4 Smart Controller

The **IQ-4** module upgrades any DLS battery charger to an automatic four-stage charger, using bulk, absorption, float charging, and equalization stages.

The Bulk Stage of the IQ4 allows the batteries to be charged from the full rated output of the charger. It will bulk charge to 14.8 VDC (multiply by two for 24 VDC and four for 48 VDC batteries). It will then absorb charge at 14.2 VDC for up to eight hours, and then drop to float charge at 13.6 VDC. If the battery remains in float stage for seven days, the IQ4 will switch the DLS charger into a pre-programmed Equalization Stage, which will cycle the battery through the Bulk and Absorption Stages before returning the battery to the Float Stage.

NOTE: The IQ-4 Smart Controllers are not recommended for generator-powered battery charging if the generator is only run for short periods of time. In this case, it's better to not taper the charging current, but instead control the charging time by limiting generator run times.

IOTA Accessories

Model	DC Voltage	Description	Item code
IQ4	12-24 VDC	Smart controller for 12 to 24 VDC chargers	**045-02103**
IQ4-54V	48 VDC	Smart controller for 48 VDC charger	**045-02104**

Diversion Loads

Wind and hydroelectric generators can be damaged if they are allowed to run without a steady load. Battery banks can also be compromised if they are overcharged. Diversion loads, usually resistive heating elements, are used to provide a safety load for when the battery bank is fully charged and cannot accept more energy. The diversion load is generally switched on by a controller, or relay, driven by battery voltage.

Low-Voltage Water Heating Elements

These low-voltage water heating elements are used as diversion loads for wind or hydroelectric systems. Use one or more of these heating elements with a charge controller designed for load diversion, such as the Morningstar TriStar PWM controllers to turn your excess power into hot water. They fit most electric water heaters with screw-in elements. One model is available for **12 and 24 VDC** systems and another for higher power **24 and 48 VDC** systems. Each unit has two elements that can be wired in series, parallel, or used individually, depending on voltage and desired current draw. See table below to determine what each element will draw at various charging voltages.

These elements have 1" NPT male pipe threads and are covered by a 2-year warranty.

If your water heater tank is designed for square flange elements, use one square flange adapter for each element.

Low-Voltage Water Heating Elements

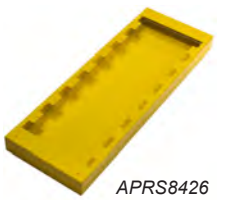
Regulation voltage			14 V		28 V		56 V		Item code
Model	Wiring	Ohms	Amps	Watts	Amps	Watts	Amps	Watts	
12/24 VDC	series	0.96 Ω	14.6 A	204 W	29.2 A	817 W	--		021-09275
	single	0.48 Ω	29.2 A	408 W	--		--		
	parallel	0.24 Ω	58.3 A	817 W	--		--		
12/24/48 VDC	series	2.48 Ω	5.6 A	79 W	11.3 A	316 W	22.6 A	1,265 W	021-09279
	single	1.24 Ω	11.3 A	158 W	22.6 A	632 W	--		
	parallel	0.62 Ω	22.6 A	316 W	45.2 A	1,265 W	--		
Square flange element adapter									021-09285

APRS World DC Air Heater Dump Loads

APRS World's dump load is a building block element. The base block is a 600 W load which can be purchased as a 12/24 VDC model or a 48 VDC model. Wall mounting boxes are required and are available for single and multiple dump loads. These dump loads are designed for safe, easy, and Code-compliant wiring.

APRS World DC Air Heater Dump Loads

Model	DC voltage	Resistance	Load amps	Weight	Item code
APRS8420	12 VDC	0.375 Ω	40 A	8 lbs	021-09340
	24 VDC	1.5 Ω	20 A		
APRS8421	48 VDC	6.0 Ω	10 A		021-09342
APRS8425	Wall mount – single 600 W dump load				021-09350
APRS8426	Wall mount for up to four 600 W dump loads				021-09351



APRS8426

APRS8426

Charge Controllers

A charge controller is used to keep the voltage across the battery within acceptable limits. The charge controller automatically tapers, stops, or diverts power when batteries become fully charged. Charge controller capacities range from 4 A to 100 A and multiple charge controllers can be used in parallel for larger systems. Some charge controllers offer additional features including charge status display, data logging, automatic battery equalization charging, generator starting, and even lighting controls.

The simplest charge controllers disconnect the power source when the battery reaches a set voltage, and turn it on when a low voltage set point is reached. Pulse Width Modulated (PWM) charge controllers turn on and off very rapidly, maintaining the batteries at full charge voltage, which results in quicker and more complete battery charging. Maximum Power Point Tracking (MPPT) charge controllers optimize the voltage of the PV array to maximize total power output then convert that to the correct voltage to charge the battery. This process significantly increases the power from a solar array, particularly in low temperatures when battery voltage is significantly below the PV array voltage. Most MPPT charge controllers work with higher array voltages, which can greatly reduce the required wire size between the array and the charge controller. While more expensive than PWM controllers, MPPT charge controllers can boost system performance by up to 30% making them very cost effective.

MPPT Charge Controllers

The table below shows **recommended maximum nameplate PV array sizes**. The wattages shown can be exceeded by up to 20% without damaging the controller, but some "clipping" of potential peak current may occur under cool, clear conditions at the peak of the day. While exceeding these wattages may reduce power harvest at peak times of the day, the total daily amp-hours delivered to the battery bank will be greater because the larger array will produce more power in less-than-peak conditions such as mornings, afternoons, and in hazy or cloudy weather.

MPPT Charge Controllers at a Glance

Model	Max output current	Maximum recommended PV array size			Max PV array voltage (V_{OC})	Item code
		12 VDC	24 VDC	48 VDC		
OutBack FLEXmax FM60	60 A	750 W	1,500 W	3,000 W	150 VDC	**020-02017**
OutBack FLEXmax FM80	80 A	1,000 W	2,000W	4,000 W	150 VDC	**020-02020**
OutBack FLEXmax Ultra FM100	100 A	--	3,000 W	6,000W	300 VDC	**020-02031**
MidNite Classic 150 or Classic SL	96 A at 12 VDC[1] 94 A at 24 VDC[1] 83 A at 48 VDC[1]	1,468 W	2,875 W	5,078 W	150 VDC[2]	**020-02405** **020-02404**
MidNite Classic 200 or Classic SL	77 A at 12 VDC[1] 74 A at 24 VDC[1] 70 A at 48 VDC[1]	1,178 W	2,264 W	4,282 W	200 VDC[2]	**020-02407** **020-02406**
MidNite Classic 250 or Classic SL	61 A at 12 VDC[1] 62 A at 24 VDC[1] 55 A at 48 VDC[1]	900 W	1,832 W	3,250 W	250 VDC[2]	**020-02409** **020-02408**
MidNite KID	30 A	450 W	900 W	1,800 W	150 VDC[2]	**020-02400**
Magnum PT-100	100 A	1,530 W	3,060 W	6,120 W	200 VDC[2]	**020-06371**
Schneider XWMPPT60-150	60 A	918 W	1,835 W	3,670 W	150 VDC	**020-08040**
Schneider XWMPPT80-600	80 A	--	2,450 W	4,900 W	600 VDC	**020-08048**
Morningstar SS-15MPPT	15 A	230 W	460 W	--	75 VDC	**020-01261**
Morningstar TS-MPPT-30	30 A	460 W	920 W	1,835 W	150 VDC	**020-01116**
Morningstar TS-MPPT-45	45 A	688 W	1,376 W	2,753 W	150 VDC	**020-01109**
Morningstar TS-MPPT-60	60 A	918 W	1,835 W	3,670 W	150 VDC	**020-01110**
Morningstar PS-MPPT-25	25 A	382 W	770 W	--	120 VDC	**020-01280**
Morningstar PS-MPPT-25M						**020-01282**
Morningstar PS-MPPT-40	40 A	765 W	1,224 W	--	120 VDC	**020-01285**
Morningstar PS-MPPT-40M						**020-01287**
Blue Sky SB3000i	30 A w / 36-cell input 22 A w / 60-cell input	400 W 290 W	--	--	50 VDC	**020-03121**
Blue Sky SB2512i-HV	25 A w / 36-cell input 20 A w / 60-cell input	340 W 270 W	--	--	50 VDC	**020-03164**
Blue Sky SB1524iX	15 / 20 A at 12 VDC 15 A at 24 VDC	270 W w / 36 cell 200 W w / 60-72-cell	400 W w / 72-cell	--	57 VDC	**020-03118**
Blue Sky SB3024iL	30 / 40 A at 12 VDC30 A at 24 VDC	540 W w / 36-cell 400 W w / 60-72-cell	900 W w / 72-cell	--	57 VDC	**020-03158**

[1]Amps shown are reduced at the higher end of the controller's array voltage range. Consult product manual for details.
[2]Absolute max open circuit voltage is the value listed, plus the nominal battery voltage.

PWM Charge Controllers

It is important to note that PWM charge controllers have limited voltage correction capabilities and should only be used with 36 or 72-cell modules (See Solar Modules) in series or parallel to match the battery voltage.

NOTE: The nominal PV array wattages listed assume 36-cell modules with an 18.0 VDC maximum power voltage (Vmp), installed in a location with nominal 1000 W per square meter solar irradiance.

Higher or lower rated module voltages, and high altitude or other locations which regularly see higher solar irradiance requires adjustment to the wattages shown. The wattages shown also include the derating to 80% required by the National Electric Code for PWM controllers (maximum rated output current times 0.8)

PWM Charge Controllers at a Glance

Model	Max output current (Amps)	Nominal PV array size			Item code
		12 VDC	24 VDC	48 VDC	
MidNite BRAT	20 A charger w/10 A load	285 W	575 W	--	**020-02435**
	30 A charger only	430 W	860 W		
Morningstar TS-45	45 A	645 W	1,290 W	2,580 W	**020-01105**
Morningstar TS-60	60 A	860 W	1,725 W	3,450 W	**020-01108**
Morningstar PS-15 Gen3 Morningstar PS-15M Gen3	15 A	215 W	430 W	--	**020-01150** **020-01151**
Morningstar PS-30 Gen3 Morningstar PS-30M Gen3	30 A	430 W	860 W	--	**020-01152** **020-01153**
Morningstar SS-6-12V Morningstar SS-6L-12V	6 A	85 W	--	--	**020-01245** **020-01248**
Morningstar SS-10-12V Morningstar SS-10L-12V	10 A	140 W	--	--	**020-01230** **020-01233**
Morningstar SS-10L-24V	10 A	--	280 W	--	**020-01236**
Morningstar SS-20L-12V	20 A	280 W	--	--	**020-01239**
Morningstar SS-20L-24V	20 A	--	560 W	--	**020-01242**
Morningstar SL-10-12V	10 A	140 W	--	--	**020-01218**
Morningstar SL-10-24V	10 A	--	280 W	--	**020-01221**
Morningstar SL-20-12V	20 A	280 W	--	--	**020-01224**
Morningstar SL-20-24V	20 A	--	560 W	--	**020-01227**
Morningstar SG-4	4.5 A	57 W	--	--	**020-01215**
Morningstar SK-6	6 A	85 W	--	--	**020-01252**
Morningstar SK-12	12 A	172 W	--	--	**020-01253**
Morningstar SSD-25RM	25 A	360 W	--	--	**020-01250**

FM80-150VDC

OutBack Power

FLEXmax MPPT Charge Controllers

The original maximum power point tracking (MPPT) charge controller, the FLEXmax, increases PV array yield by up to 30% compared to non-MPPT controllers. FLEXmax FM60 and FM80 charge controllers can operate at their maximum rated current in ambient temperatures up to 104 °F (40 °C) and can be used with battery systems from 12 to 60 VDC with PV open-circuit voltage up to 150 VDC. The controller's set points are fully adjustable to allow use with a variety of battery types and charging profiles.

Maximum PV Array Wattage				
Battery bank voltage	**Model**	**12 VDC**	**24 VDC**	**48 VDC**
Max PV array wattage	FM60-150VDC	750 W	1,500 W	3,000 W
	FM80-150VDC	1,000 W	2,000 W	4,000 W

The FLEXmax FM60 and FM80 controllers come standard with a four-line, 80-character backlit LCD screen that displays PV system performance and can also be used for programming and monitoring system operation. Integrated OutBack Power network communications and OPTICS RE compatibility allows the FLEXmax controllers to be remotely programmed, monitored and controlled via any internet connected device. On-board datalogging records the last 128 days of operation recording most parameters.

Both controllers have a programmable AUX relay that can be used for control functions such as battery-enclosure fans, generator starting, or load control. The AUX output is 200 mA at 12 VDC. Use it to power a separate relay with a 12 VDC coil if you need to control more current or to control voltages (AC or DC) other than 12 VDC.

FLEXmax FM100-300VDC MPPT Charge Controller

FM100-300VDC

OutBack Power's new FLEXmax **FM100-300VDC** medium-voltage charge controller accepts higher voltages from PV arrays to allow for longer wire runs with reduced wire sizes. It can be used to charge 24 or 48 VDC battery systems from PV arrays with voltage up to 290 VDC, but can withstand voltages up to 300 VDC without damage. Output is rated at 100 A at 25°C (with deration to 80 A at 40°C), with four-stage charging and an operating temperature range of -20 °C to +60 °C. NEMA 3R design allows for outdoor installation. Maximum PV arrays up to 6000W, except in high ambient temperatures

The FM100 can be used in negative, positive, or floating ground systems. Ample wire bending space and oversized terminals provide easier installation with larger gauge wire, and servicing and replacing all power components can be done with the unit mounted on a wall and attached to conduit. It has integrated PV ground fault detection, interruption and indication, eliminating the need to have an external GFP device. Built-in AUX relay has a 12 VDC output of up to 250 mA. An external cooling fan is included.

As the FM100 has no onboard display, an OutBack Power MATE3s or AXS Card MODBUS/TCP interface is required to program this controller and access the 128-day data-logging history, and the programming and monitoring system functions.

The **RTS** remote temperature sensor is standard with the FM100; and is optional with the FM60 and FM80. FLEXmax charge controls connected to an OutBack inverter system with a HUB can use the system RTS connected to the master inverter.

All FLEXmax charge controllers are covered by a 5-year standard warranty and are listed to UL 1741 and C22.2 No. 107.1 for the U.S.A. and Canada. The FM100 is also listed for IEC 62109-1.

OutBack MPPT Charge Controllers				
Model	**Description**	**Dimensions (H" X W" x D")**	**Weight**	**Item code**
FM80-150VDC	OutBack 80 A MPPT charge control	16.25 x 5.75 x 4	12 lbs	**020-02020**
FM60-150VDC	OutBack 60 A MPPT charge control	13.5 x 5.75 x 4	12 lbs	**020-02017**
FM100-300VDC	OutBack 100 A MPPT charge control	22 x 8.8 x 6	18.3 lbs	**020-02031**
RTS	OutBack Remote Temperature Sensor with 20' cable			**030-04190**
AXS Card	OutBack AXS communication card			**029-06501**

OutBack POWER™
member of The alpha Group™

LONGER STRINGS, LOWER COST, MORE HARVEST

Advances in modern PV module output have created a need for ***higher voltage charge controllers that allow for greater system design flexibility and increased solar harvest***. OutBack meets and exceeds that need with the FLEXmax 100—our 100A, 300VDC MPPT charge controller.

CLASS LEADING FEATURES

DESIGNED FOR PERFORMANCE

The FLEXmax 100 boasts the highest voltage input/power output combination, full NEC 2014 compliance with OutBack's FLEXware ICS Plus combiner, an environmentally sealed outdoor-rated enclosure and up to 99% efficiency.

COST SAVING BENEFITS

EASY TO INSTALL, MONITOR AND CONTROL

By enabling longer series strings and reducing balance of system components (no fuse combiners, smaller gauge wire, integrated GFDI and fast self-discharge) the FLEXmax 100 reduces installation costs while maximizing energy harvest.

Contact ***sales@outbackpower.com*** to learn more about the FLEXmax 100 charge controller.

MidNite Solar

Classic MPPT Charge Controllers

MidNite Solar's Classic charge controllers offer many useful features including arc-fault detection (not currently listed to UL 1699B) and Ground Fault Protection (GFP) which eliminates the need for a separate GFP breaker assembly.

Three models are available to accommodate solar arrays with operating voltages up to 150, 200, or 250 VDC. A feature called HyperVOC protects the controller from damage when open-circuit voltage exceeds the operating voltage by a margin equal to or less than the battery bank voltage. The table below represents maximum power only. Be sure to consult the power curves in the user's manual when sizing your PV array as allowable current varies with array voltage.

MidNite Classic Maximum PV Array Size			
Battery bank voltage → (nominal)	12 VDC	24 VDC	48 VDC
Classic 150	1,468 W	2,875 W	5,078 W
Classic 200	1,178 W	2,264 W	4,282 W
Classic 250	900 W	1,832 W	3,250 W

MidNite Solar's Classic controllers have MPPT modes for solar, wind, or hydro with user-adjustable power curves, and a learning mode for self-optimization. Classics can be stacked to act as one large controller without a separate hub. The Classic has built-in Ethernet and USB and RS-232 ports for two-way communication. Each unit has 32 MB of internal memory for data storage. Firmware is user upgradeable using downloaded files. Each unit includes a sealing kit for dusty or salt-air environments, but sealing can reduce output by up to 20%. Use MidNite 300 VDC breakers (see Electrical Distribution Parts) for power-source voltages over 150 VDC. Make sure that the breaker will fit into your DC power center, or use a separate MidNite Big Baby Box (see Electrical Distribution Parts) to accommodate the breaker. On the battery side of the controller, breakers need only be rated for the highest battery-charging voltage. The Classic controllers have two auxiliary relay outputs. AUX1 can be programmed to either be a 12 VDC output (200 mA max) or as a dry-contact relay (1 A max). AUX2 can either be a 12 VDC output, a logic input (for instance it could allow control of the Classis by a signal from a battery BMS) or a PWM signal output for diversion load control.

The **Classic SL** is a lower cost solar-only version similar to the standard Classic. They do not have wind or hydro modes. SL versions have a streamlined menu, and built in Ground Fault Protection, but no Arc Fault Detection, or auxiliary outputs. BTS sold separately for these models.

Adding a **Whiz Bang Jr** Current Sense Module and shunt to the system, enables the absorb charge to be ended according to a current set point, and provides full-featured battery monitoring. See the Midnite Solar accessories page for information on the Whiz Bang Jr.

The Classic charge controllers are listed to UL 1741 and CAN/CSA C22.2 No. 107.1:2001/09/01 Ed: 3 (R2006) and are covered by a 5-year warranty. Dimensions are 15"H x 6" W x 4" D and weight is 11 lbs for all units. Made in U.S.A.

MNGP

The **MidNite Graphics Display Panel (MNGP)** is a remote LCD display that mimics the interface on the Classic charge controllers.

MidNite Solar Classic MPPT Charge Controllers						
Model	Maximum output current at battery voltage [1]				Item code	
	12 VDC	24 VDC	48 VDC	Max operating array voltage	SL version	Full version
Classic 150	96 A	94 A	86 A	**150 VDC**	**020-02404**	**020-02405**
Classic 200	79 A	78 A	76 A	**200 VDC**	**020-02406**	**020-02407**
Classic 250	61 A	62 A	55 A	**250 VDC**	**020-02408**	**020-02409**
MNGP	MidNite Classic remote graphics display					**020-02422**
MNBTS	MidNite Battery Temperature Sensor					**020-02425**
MNNW10	MidNite 10" long communications cable					**020-02420**
MNNW3	MidNite 3' long communications cable					**020-02423**

[1] Maximum output current is reduced at higher array voltages. See manual for more detail.

MNKID-R

MNKID-M-W

Assembly Kit

KID 30 A MPPT Charge Controllers

The MidNite **KID** 30 A MPPT charge controllers are suitable for small to medium-sized renewable energy systems. The KID works with 12, 24, 36, and 48 VDC battery systems and has a 150 VDC operating limit; but is not damaged with DC voltages as high as 162 VDC, due to MidNite's HyperVOC circuitry. The KID has a three-LED bar graph, showing battery-charge status, and a keypad to access extensive menu items and set-points.

The KID controllers include a load control with load low-voltage disconnect (LVD). This can also be programmed as a lighting controller with dusk-to-dawn or various other on and off times. There is also a programmable AUX relay and two-wire automatic generator start (AGS).

Adding a **Whiz Bang Jr** Current Sense Module and shunt to the system, enables the absorb charge to be ended according to a current set point, and provides full-featured battery monitoring. See next page for more info on the Whiz Bang Jr.

Sealed electronics and passive cooling (no fans) make it ideal for use in harsh environments. There are front-panel fuses for input, battery, and load. The controller's operating temperature range is -40 ºC to +50 ºC but the controller will automatically de-rate at temperatures above 25 ºC. Add the battery-temperature sensor (BTS) to these models.

ETL Listed to UL1741 and UL458 for the U.S.A. and Canada. CE Certified. FCC Class B compliant. Dimensions are 9.25"L x 5"H (6.6"H with included wall-mount adaptor) x 3.4"D. NEMA 1 (IP64) indoor rating. Available in either white or black casing. Made in U.S.A. and has a 5-year warranty.

The **MNKID-M** Marine version comes standard with the **MNKID-M-BKT** Boat Mounting Bracket, flexible conduit, battery-temperature sensor and extra conformal coating.

MNKID-ASSY KIT comes with Boat Mounting Bracket, knobs, screws, 3' flex conduit, battery temperature sensor, and four 1/2" connectors. Available in white or black.

MNKID-CDT KIT contains two 1/2" straight connectors, two 1/2" elbow connectors and 3' flex conduit.

MidNite Solar KID Charge Controllers and Accessories		
Model	**Description**	**Item code**
MNKID-B	MidNite KID charge controller with Wall-Mount Bracket - black	**020-02400**
MNKID-W	MidNite KID charge controller with Wall-Mount Bracket - white	**020-02401**
MNKID-M-B	MidNite KID Marine charge controller with Boat-Mount Bracket - black	**020-02403**
MNKID-M-W	MidNite KID Marine charge controller with Boat-Mount Bracket - white	**020-02402**
MNBTS	Battery -temperature sensor	**020-02425**
MNKID-M-BKT-B	Boat mount bracket - black	**020-02428**
MNKID-M-BKT-W	Boat mount bracket - white	**020-02427**
MNKID-ASSY KIT-B	KID Assembly Kit - black	**020-02430**
MNKID-ASSY KIT-W	KID Assembly Kit - white	**020-02429**
MNKID-CDT KIT	KID Conduit Kit	**020-02431**
MNKID-BREAKER-30A	Replacement 30 A breaker for KID charge control	**053-03074**

BRAT 30 A PWM Charge Controllers

The MidNite **BRAT** is a PWM charge controller with either a 20 A charger and 10 A load control, or a 30 A charger without load control. Usable with 36-cell modules to charge 12 or 24 VDC battery banks (two 36-cell modules in series for 24V), or 72-cell modules for 24 VDC battery banks, with three or four-stage charging. It has no relays, fans or external heat sink, and is in a clear polycarbonate NEMA 3R outdoor enclosure with 4 LED's to display system status. The 10 A load control can be used as a low voltage disconnect or a 16-position lighting control. Provisions for manual or 30-day automatic equalize charging.

The controller's operating temperature range is -40 ºC to +60 ºC but the controller will automatically de-rate at temperatures above 25 ºC. Ambient temperature sensing for charge voltage compensation is internal to this model.

MidNite Solar BRAT Charge Controller		
Model	**Description**	**Item code**
MNBRAT	BRAT 20 A with load or 30 A without load PWM charge controller	**020-02435**

Whiz Bang Jr

The MidNite **Whiz Bang Jr** is a current-sense module that attaches to a standard Deltec 500 A /50 mV shunt and wires into the **MidNite Classic or KID** charge controllers to give amperage readings from the shunt, enabling absorb charge to stop according to a current set point. In this mode, if the battery current falls below a programmable threshold for one minute, the Classic or KID will recognize that the batteries are fully charged and switch to float mode

The Whiz Bang Jr will also provide battery monitoring functions, readable on the display screens of the Classic or KID charge controllers. Readings for instantaneous battery current, remaining temperature compensated Amp-hours, battery state-of-charge percentage, and display of the accumulated Amp Hours.

MidNite Solar Whiz Bang Jr		
Model	**Description**	**Item code**
Whiz Bang Jr	Current-sense module	**020-02426**

Magnum Energy

PT-100 Charge Controller

The **PT-100** is an MPPT(Maximum Power Point Tracker) charge control with a maximum 100 A output. It can charge 12, 24, and 48 VDC battery banks with typical 99% efficiency. It comes standard with both arc-fault detection (not currently listed to UL 1699B) and ground-fault protection (GFP) which eliminates the need for a separate GFP breaker assembly. The array open-circuit voltage can be as high as 200 VDC plus battery voltage or 240 VDC, whichever is lower. The array operating voltage is up to 187 VDC, and battery-charging voltage range is 10 to 66 VDC. The input power can exceed the rated nominal maximum array power without harm, however the controller will limit the output to its rated continuous output current into the batteries.

Rated Nominal Maximum PV Array Wattage				
Battery bank voltage	**Model**	**12 VDC**	**24 VDC**	**48 VDC**
Max PV array wattage	PT-100	1,530 W	3,060 W	6,120 W

Automatic three-stage charging (bulk, absorption and float, with manual equalization) to maximize system performance and improve battery life. Suitable for various types of batteries including flooded, AGM, gel, and lithium batteries. A battery temperature sensor is included.

An auxiliary dry-contact relay is available for control of generator start, load shedding, or similar functions. The wiring box can be separated from the control for convenient installation and ease of service. There is extensive electronic protection for PV short circuit, high voltage, over-current, and power derating with over-temperature.

A digital screen and LED indicators provide system information. There is internal data logging with harvest information data up to 255 days. Use the Magnum Energy system remote display to read this information. Firmware is user upgradeable using downloaded files.

Operating temperature range is -20°C to 60°C (-4°F to 140°F) with full rated power output up to 40°C (104°F). Proportional power reduction up to 60 °C ambient.

Use 300 VDC breakers (see Electrical Distribution Parts) for power source voltages over 150 VDC. On the battery side of the controller, breakers need only be rated for the highest battery-charging voltage.

ETL Listed to UL 1741 for the U.S.A. and Canada and CSA C22.2 No. 107.1, CE.

This charge controller has a 5-year warranty, and is made in the U.S.A

Magnum PT-100 Charge Controller				
Model	**Description**	**Dimensions (H" x W" x D")**	**Weight**	**Item code**
PT-100	Magnum 4 kW AC Load Diversion Control	15.5 x 8.5 x 4.0	13.6 lbs	**020-06371**

Schneider Electric

Schneider Electric XW-MPPT60-150 Charge Controller

The **XW-MPPT60-15**0 can be used with PV arrays at voltages up to 150 VDC and can support an output of up to 60 A for battery voltages between 12 to 60 VDC. Maximum operating voltage is 140 VDC. Maximum Power Point Tracking (MPPT) maximizes energy harvest and provides increased flexibility in module selection and string sizing.

A large aluminum heat sink eliminates the need for an internal fan for added reliability. Built-in ground fault protection (GFP) eliminates the need for a separate GFP breaker. The XW-MPPT60-150 can be mounted on the side or top of the XW power distribution panel, or used stand-alone in other PV systems. The front panel features a 2-line 16-character display and 4 buttons for configuration and system monitoring. A battery temperature sensor is included with the controller. Operating range at full rated power is -20°C to 45°C (-4°F to 113°F)

The charge controller has a configurable single-function auxiliary output (producing 5 to 13 VDC at 200 mA) that can drive a relay for load control or activate devices, such as vent fans or indicator alarms. The XW-MPPT60-150 is able to communicate its settings and activity to other Xanbus-enabled devices, such as SW and XW Series inverter/chargers, the System Control Panel II (SCP), XW Automatic Generator Start (XW-AGS), and other XW-MPPT solar charge controllers through the Xanbus network.

The dimensions are 14"H x 5"W x 5"D, weight is 12 lbs and it is covered by a 5-year warranty.

Listed to UL 1741 for the U.S.A. and Canada.

Schneider Electric XW-MPPT80-600 Charge Controller

The **XW-MPPT80-600** can accommodate open circuit voltages of up to 600 VDC, which reduces wiring needs, increases module selection and string sizing flexibility, and enables greater distance between the power source and battery bank. The MPPT PV array input window is 195 to 550 VDC, which supports an output of up to 80 A for 24 or 48 VDC battery banks. Standby power draw is less than 1 W.

The charge controller has a configurable single-function auxiliary output to drive a load control relay or to activate devices such as vent fans or indicator alarms. Full output current of 80 A is available without de-rating in ambient temperatures up to 113 °F (45 ºC). Over-temperature protection de-rates the power throughput when ambient temperatures are higher. The XW-MPPT80-600 also features protections for input over/under voltage, output over current, and back-feed (reverse current). Built-in ground-fault protection (GFP) eliminates the need for a separate GFP breaker. This unit is configurable for positive, negative, and ungrounded PV systems.

The XW-MPPT80-600 can be used with the XW power distribution panel, or stand-alone in other PV systems, with a **Square-D HU361RB** 600 VDC array disconnect. Use a 100 A breaker on the battery side of the controller.

A **battery temperature sensor** is included with the controller. The XW-MPPT80-600 is compatible with Xanbus-enabled devices, such as the SW and XW Series inverter/chargers, the System Control Panel, XW Automatic Generator Start Module, and other XW solar charge controllers through the Xanbus network. It can also be installed in a stand-alone mode with an XW System Control Panel.

XW-MPPT80-600 dimensions are 30"H x 8.63"W x 8.63"D, weight is 29.8 lbs. and it is covered by a5-year warranty. Listed to UL 1741 and CSA 107.1 for the U.S.A. and Canada.

Schneider Electric XW Charge Controllers		
Model	**Description**	**Item code**
XW-MPPT60-150	XW 60 A 150 VDC MPPT charge control	**020-08040**
XW-MPPT80-600	XW 80 A 600 VDC MPPT charge control	**020-08048**
SQD HU361RB	PV Array disconnect switch for MPPT80-600 charge controller	**053-02312**
XW SCP	XW System Control Panel - provides central user interface for Xanbus network	**300-00128**

Morningstar

TriStar MPPT 150 VDC Charge Controllers

Morningstar's TriStar **TS-MPPT-30**, **TS-MPPT-45**, and **TS-MPPT-60** solar charge controllers with TrakStar™ Technology are advanced maximum power point tracking (MPPT) controllers for photovoltaic (PV) systems up to 3.2 kW. These controllers work well in a variety of applications including: residential and commercial systems, remote telecommunications, 12 VDC RV & marine applications, traffic and highway telemetry, industrial automation & control, and solar outdoor lighting. The TS-MPPT controllers can be used with arrays having a maximum open-circuit voltage of 150 VDC and have a charging range of 8 to 72 VDC.

Optional local and remote meters provide detailed operating data, alarms and faults with three LED indicators to display system status. The TS-MPPT has a simple DIP Switch setup for plug-and-play operation or is fully programmable with a PC connection. The chassis on the TriStar controllers is isolated from the power circuits, allowing use in both negative and positive grounded systems.

The input power can exceed the rated nominal maximum array power without harm, however the controller will limit the output to its rated continuous output current into the batteries.

Extensive Networking and Communications Capabilities enable system monitoring, data logging, and remote adjustments. All models offer open standard MODBUS protocol and Morningstar's MS View software and allow a Serial RS-232 connection to a PC or laptop. In addition, the TS-MPPT-60 includes a built-in Ethernet port for a fully web-enabled interface to view data from a web browser to display up to 200 days of data logging and send email/text and messages. The TS-MPPT-60 also has a built-in RS-485 port for connecting to an EIA-485 network.

A remote temperature sensor (RTS) is included. Operating range at full rated power is -40°C to +45°C (-40°F to +113°F)

See the Morningstar Accessories page for information on the metering and other accessories for these controllers.

Dimensions: 11.4"H x 5.1"W x 5.6"D. Weight: 9.2 lbs. Listed to UL 1741. 5-year warranty.

Morningstar TriStar MPPT Charge Controllers						
Model	Description	Web enabled	Nominal maximum array power			Item code
			12 VDC	24 VDC	48 VDC	
TS-MPPT-30	TriStar MPPT 30 A charge controller	Yes*	400 W	800 W	1,600 W	**020-01116**
TS-MPPT-45	TriStar MPPT 45 A charge controller	Yes*	600 W	1,200 W	2,400 W	**020-01109**
TS-MPPT-60	TriStar MPPT 60 A charge controller	Yes	800 W	1,600 W	3,200 W	**020-01110**
TriStar MPPT 150 VDC charge controller accessories						
TS-M-2	Optional digital display for front of all TS-MPPT 150 V controls					**020-01111**
TS-RM-2	TriStar Remote Meter Display with 100' cable					**020-01112**
EMC-1	Ethernet MeterBus Converter					**020-01249**
UMC-1	Communications adapter Morningstar MeterBus to USB					**020-01251**
RTS	Remote temperature sensor (replacement – one RTS is included with the controller)					**020-01141**
GFPD-150V	DC Ground Fault Protection Device, 2-pole, 60 A, 150 VDC					**053-03164**

* Requires HUB-1

ProStar MPPT Charge Controllers

ProStar MPPT with Meter

ProStar MPPT without meter

ProStart MPPT Wire Box

The **ProStar MPPT** is a mid-range MPPT solar charge controller with TrakStar Technology™ that provides maximum power point tracking (MPPT) battery charging for 12 and 24 VDC off-grid photovoltaic (PV) systems. Maximum PV array open circuit voltage (Voc) is 120 VDC. Available with and without advanced built-in meter, these controllers can be used for industrial and smaller residential applications.

The ProStar MPPT provides continuous self-diagnostics, monitoring, and reporting of any errors through its status LED's, optional display or communication port. Three LEDs provide battery state-of-charge indication. Electronic error protections prevent damage when installation mistakes or system faults occur. Protected from overload, short-circuit, high voltage warning, reverse polarity, high temperature, and nighttime reverse current on the PV input side, and overload, short-circuit, high temperature, and reverse polarity on the load side. Also protected from battery reverse polarity. Automatic recovery without fuses.

The input power can exceed the rated nominal maximum array power without harm, however the controller will limit the output to its rated continuous output current into the batteries.

These controllers feature eight (8) adjustable settings switches, several communication ports, and terminals for voltage measurement and the optional remote battery temperature sensor. MODBUS communications protocol allows for easy programming, control, remote data access and charge synchronization. On-board data logging stores up to 256 days of detailed solar charge and load consumption data. Detailed battery programming options allow for advanced battery support for the latest Lithium, Nickel-Cadmium, Nickel-Iron and Lead-Acid battery types.

The Load Control provides low-voltage disconnect (LVD), while the Automatic PV Based Lighting Control is a field adjustable, multi-event load control allowing many options for PV lighting systems. Models with the optional meter allow adjustments to charging, lighting, and load control settings without an external computer.

A **Wire Box** accessory is available to allow conduit connections for concealed wiring (sold separately). The wire terminals are sized for #2 AWG (35mm2) wire – compliant when used with the optional Morningstar Wire Box (otherwise a maximum of #6 AWG wire).

Low Noise Design meets US Federal Communications Commission Class B specifications. High Strength polycarbonate case and extruded aluminum heatsink. Conformal coated circuit boards and marine-rated wiring terminals for corrosion protection in damp or salt-air environments. Operating temperature range: -40°C to +60°C (Meter operating range -20°C to 60°C).

5-year warranty. ETL Listed to UL1741 and UL 62109; cETL Listed to CSA-C22.2 No. 107.1

See the Morningstar Accessories page for information on the metering and other accessories for these controllers.

Morningstar SunSaver MPPT Charge Controllers					
Model	Description	Nominal max array power		Charge current	Item code
		12 VDC	24 VDC		
PS-MPPT-25	ProStar MPPT charge controller 25 A	350 W	700 W	25A	**020-01280**
PS-MPPT-25M	ProStar MPPT charge controller 25 A with Meter				**020-01282**
PS-MPPT-40	ProStar MPPT charge controller 40 A	550 W	1100 W	40A	**020-01285**
PS-MPPT-40M	ProStar MPPT charge controller 40 A with Meter				**020-01287**
PS-MPPT-WB	ProStar MPPT Wire Box				**020-01290**
UMC-1	Communications adapter Morningstar MeterBus to USB				**020-01251**
RTS	Battery-temperature sensor				**020-01141**
GFPD-150V	DC Ground Fault Protection Device, 2-pole, 60 A, 150 VDC				**053-03164**

SunSaver MPPT 15 A Charge Controller

The SunSaver MPPT (Maximum Power Point Tracking) charge controller is designed for 12 and 24 VDC battery charging from a PV array with a maximum open circuit voltage of 75 VDC. Use up to three 36-cell PV modules in series or a single 60-cell or 72-cell module to provide up to 200 W when charging a 12 VDC battery or up to 400 W when charging a 24 VDC battery. The SunSaver MPPT maximizes the output of the PV array by rapidly finding the array's peak power point with extremely fast sweeping of the entire I-V curve, providing an estimated 5-25% power boost over PWM or simple on-off controllers, especially during periods of colder temperatures and low battery voltages when it is most needed.

The controller features electronic protection from short circuit, overcurrent, reverse polarity, high temperature, high voltage, lightning, and transient surges. An adjustable low-battery load disconnect protects the battery from over-discharge. LED indicators indicate charging, low-battery and faults. The optional meter provides detailed system information, 30 days of logged data, alarms, and faults.

The **SS-15MPPT** has a simple DIP-switch setup for plug-and-play operation. There is an RJ11 jack for MeterBus connection to a MeterHub, or UMC-1. The control is fully programmable for custom and advanced programming with a PC connection using the USB MeterBus Adapter UMC-1, and Morningstar's MSView software (available for free on Morningstar's website).

The SunSaver MPPT features programmable lighting control for up to four time periods and is adjustable with respect to hours/minutes after/before – Dusk/Dawn/Solar Midnight/Solar Noon. Mounts on DIN rail with DIN-1 rail clip.

SS-15MPPT dimensions are 6.6"H x 2.75"W x 2.2"D, weight is 1.65 lbs, and it is covered by a 5-year warranty. Listed to UL 1741 CSA 107.1 for U.S.A. and Canada.

See the Morningstar Accessories page for information on the metering and other accessories for this controller.

Morningstar SunSaver MPPT Charge Controllers				
Model	**Description**	**DC system voltage**	**Charge current**	**Item code**
SS-15MPPT	SunSaver MPPT charge controller	12 or 24 VDC	15 A	**020-01261**
RM-1	SunSaver MPPT remote meter			**020-01258**
RTS	Battery-temperature sensor			**020-01141**
UMC-1	Communications adapter Morningstar MeterBus to USB			**020-01251**
DIN-1	Din-rail clip - each			**020-01259**

Morningstar

TriStar PWM Charge Controllers

The **TriStar** pulse-width modulation (PWM) controllers can operate as solar charge controllers, load controllers, or diversion regulators in 12, 24 or 48 VDC systems. They can also be custom programed for 36 VDC. Two or more controllers can be used to provide multiple functions. PWM may be changed to on/off operation to prevent telecom noise.

Two models are available with current ratings of 45 A and 60 A. Seven different set points are selectable via DIP switches for plug-and-play operation. An RS-232 communications port enables PC or laptop connection to adjust controller set points, to download internally-logged data, or to configure detailed PC data logging. A PC can communicate with the TriStar with Morningstar's MS View software. The UMC-1 communications adapter can be used to convert the MeterBus to USB.

The TriStar also has a lighting control feature with 7 DIP-switch presets or custom programmed settings with up to two ON-OFF time periods after/before dusk and dawn.

An optional **TriStar Meter-2** digital display can be mounted on the front of the controller or up to 100' away using four-conductor phone cable with RJ-11 jacks. The meters can provide in-depth system information, including 60 days of internally-logged data. They can also be connected to a MeterHub network with the **MeterHub (HUB-1)** to be displayed on a TriStar Meter or networked with a Relay Driver for relay switch operation. Battery temperature compensation may be added with the optional **Remote Temperature Sensor (RTS)**. See the Morningstar Accessories page for more information on the metering and other accessories for these controllers

Dimensions: 10.25"H x 5"W x 2.8"D. Weight: 3.5 lbs. 5-year warranty. Listed to UL 1741 for U.S.A. and Canada.

Morningstar TriStar PWM Charge Controllers				
Model	**Description**	**DC system voltage**	**Charge current**	**Item code**
TS-45	TriStar 45 charge controller	12, 24, or 48 VDC	45 A	**020-01105**
TS-60	TriStar 60 charge controller	12, 24, or 48 VDC	60 A	**020-01108**
RTS	Battery-temperature sensor			**020-01141**
TS-M-2	TriStar Meter-2 mounts on front of charge controller			**020-01111**
TS-RM-2	TriStar Remote Meter-2 display with 100' cable			**020-01112**
UMC-1	Communications adapter Morningstar MeterBus to USB			**020-01251**
GFPD-150V	DC Ground Fault Protection Device, 2-pole, 60 A, 150 VDC			**053-03164**

ProStar Gen3 PWM Charge Controllers

The **ProStar Gen3 PWM** charge controllers are Morningstar's third generation of their highly reliable mid-range PWM solar charge controllers for residential, mobile, or stand-alone power and lighting systems. They feature conformally a coated circuit board, corrosion-resistant terminals, and automatic battery select for 12 and 24 VDC systems. 4-stage charging for Bulk, Absorption, Float, and Equalizing, with 7 standard battery settings, or custom settings can be programmed in. Full nameplate current rating, both PV and load, up to 60°C continuous.

The ProStar Gen3 controllers provide continuous self-diagnostics, monitoring, and reporting of any errors through its status LED's, optional display or communication port. Electronic error protections prevent damage when installation mistakes or system faults occur. Protected from overload, short-circuit, high voltage warning, reverse polarity, high temperature, and nighttime reverse current on the PV input side, and overload, short-circuit, high temperature, and reverse polarity on the load side. They are also protected from battery reverse polarity.

MODBUS communications protocol allows for easy programming, control, remote data access and charge synchronization. On-board data logging stores up to 256 days of detailed solar charge and load consumption data. A PC can communicate with the TriStar with Morningstar's MS View software. The UMC-1 communications adapter can be used to convert the MeterBus to USB.

Load terminal connections provide Low-Voltage Disconnect and Reconnect, and can be programmed for lighting control (dusk to dawn or custom settings). Automatic PV Based Lighting Control is field adjustable with multi-event load control allowing many options for PV lighting systems. Models with the optional meter allow adjustments to charging, lighting, and load control settings without an external computer.

Wire terminals accept wire up to #6 AWG. The **Remote Temperature Sensor (RTS)** allows for automatic adjustment of charge settings based on the battery temperature. The optional Meter display is a high resolution, LCD, multi-lingual, backlit graphical display.

Low noise design meets US Federal Communications Commission Class B specifications. High strength polycarbonate case and extruded aluminum heatsink. Conformal coated circuit boards and marine-rated wiring terminals for corrosion protection in damp or salt-air environments. Operating temperature range: -40°C to +60°C (Meter operating range -20°C to 60°C).

ETL Listed: UL62109/CSA.107.1; IEC 62109; FCC Part-15 class B compliant.

These charge controllers are covered by a 5-year warranty.

See the Morningstar Accessories page for information on the metering and other accessories for these controllers.

Morningstar Prostar Gen3 PWM Charge Controllers				
Model	**Description**	**DC system voltage**	**Charge current**	**Item code**
PS-15 Gen3	ProStar 15 Gen3	12 or 24 VDC	15 A	**020-01150**
PS-15M Gen3	ProStar 15 Gen3 with digital display	12 or 24 VDC	15 A	**020-01151**
PS-30 Gen3	ProStar 30 Gen3	12 or 24 VDC	30 A	**020-01152**
PS-30M Gen3	ProStar 30 Gen3 w/ digital display	12 or 24 VDC	30 A	**020-01153**
UMC-1	Communications adapter Morningstar MeterBus to USB			**020-01251**
RTS	Remote temperature sensor			**020-01141**
GFPD-150V	DC Ground Fault Protection Device, 2-pole, 60 A, 150 VDC			**053-03164**

SunSaver Gen3 Charge Controllers

SunSaver Gen3 controllers are advanced PWM solar battery charging and load controllers for smaller stand-alone 12 and 24 VDC PV systems. A rugged anodized-aluminum case, marine-rated terminals, and epoxy-encapsulated electronics enhance durability. A temperature-compensation sensor in the charge controller varies full-charge voltage with temperature.

SunSavers are field-selectable for sealed or flooded batteries and have a four-stage battery charging process (including auto-equalization for flooded batteries) optimized for long battery life and improved system performance. Self-diagnostics and electronic error protection prevent damage when installation mistakes or system faults occur and reset automatically when resolved. The Gen3 controllers include a multi-color status LED as well as three battery LED indicators, which together communicate system status, battery state of charge and 13 possible error conditions. The terminal cover prevents contact with the wiring terminals. The load output connections can provide power to DC loads up to the unit's current rating, and "L" models provide low-voltage disconnect (LVD) for connected loads. Telecom mode and 15 VDC charge limit for sensitive loads.

Negative ground only. Operating temperature range of –40 °C to +60 °C.

SunSaver dimensions are 6"H x 2.2"W x 1.3"D. These Gen3 SunSaver Controllers are approved for Class 1 Div 2 for hazardous locations and are Listed to UL1741 for the U.S.A. and Canada, CSA C22.2 No. 107.1-01 certification and are covered by a 5-year warranty.

Morningstar TriStar MPPT 600 VDC Charge Controllers					
Model	**Description**	**DC system voltage**	**Charge current**	**LVD current**	**Item code**
SS-6-12V	SunSaver	12 VDC	6 A	N/A	**020-01245**
SS-6L-12V	SunSaver with LVD	12 VDC	6 A	6 A	**020-01248**
SS-10-12V	SunSaver	12 VDC	10 A	NA	**020-01230**
SS-10L-12V	SunSaver with LVD	12 VDC	10 A	10 A	**020-01233**
SS-20L-12V	SunSaver with LVD	12 VDC	20 A	20 A	**020-01239**
SS-10L-24V	SunSaver with LVD	24 VDC	10 A	10 A	**020-01236**
SS-20L-24V	SunSaver with LVD	24 VDC	20 A	20 A	**020-01242**
DIN 1	DIN-rail clip for mounting SunSaver and SunLight controllers on a DIN rail - each (two needed per controller)				**020-01259**

SunLight Charge Controller with Lighting Control

The SunLight (SL) is a SunSaver Gen2 controller that includes a rotary switch which allows it to turn on the loads after dusk for 2, 4, 6, 8, or 10 hours. One option turns loads on at dusk then off and on again before dawn. In this configuration, you can choose the following settings (in hours): 3/off/1, 4/ off/2, or 6/off/2. "On" from dusk to dawn is also possible. A test button turns light(s) on for five minutes. Covered by a 5-year warranty with dimensions of 6.6"H x 2.2"W x 1.3"D.

Morningstar SunLight Charge/Lighting Controllers					
Model	**Description**	**DC system voltage**	**Charge current**	**Load current**	**Item code**
SL-10-12V	SunLight with LVD	12 VDC	10 A	10 A	**020-01218**
SL-20-12V	SunLight with LVD		20 A	20 A	**020-01224**
SL-10-24V	SunLight with LVD	24 VDC	10 A	10 A	**020-01221**
SL-20-24V	SunLight with LVD		20 A	20 A	**020-01227**

SunGuard Charge Controller

The SunGuard **SG-4** uses the same charging circuit as the SunSaver and works well as a 12 VDC, low-power controller for up to 75 W of PV module(s). Since it is epoxy encapsulated, it can be used outdoors in harsh environments. The SunGuard's dimensions are 2.5"H x 2"W x 1.6"D with wire leads for connecting module and battery, and it is covered by a 5-year warranty.

Morningstar SunGuard Charge Controller				
Model	**Description**	**System voltage**	**Charge current**	**Item code**
SG-4	SunGuard	12 VDC	4.5 A	**020-01215**

SunKeeper Charge Controller

Morningstar's SunKeeper solar controller provides a low cost regulated output directly from the solar module to maximize battery life in small solar power applications. The SunKeeper is epoxy encapsulated and rated for outdoor use. By mounting directly to the module junction box and wiring through the junction box knockout, the connection is weather-proof. This eliminates the need for an additional housing for the controller. It's designed to mount in a ½" knockout in a PV module junction box or other enclosure.

The SunKeeper is available in 6 A or 12 A versions for small 12 VDC systems, and provides PWM three-stage charging. Includes temperature compensation at the controller or alternatively at the battery when used with the optional Remote Temperature Sensor. A bi-color LED indicates solar charging, regulation, normal nighttime operation, and any controller or system faults.

The SunKeeper has been designed with extremely efficient power electronics and is rated to 70 °C so it can be mounted behind a PV module. The SunKeeper is also certified for use in Class 1, Division 2 hazardous locations, making it well suited for solar powered oil/gas applications. It's covered by a 5-year warranty and listed to UL 1604 and CSA 22.2.

Morningstar SunGuard Charge Controller				
Model	**Description**	**System voltage**	**Charge current**	**Item code**
SK-6	SunKeeper 6	12 VDC	6 A	**020-01252**
SK-12	SunKeeper 12	12 VDC	12 A	**020-01253**
RTS	Remote battery temperature sensor			**020-01141**

SunSaver Duo RV Charge Controller

The SunSaver Duo two-battery charge controller will charge two separate and isolated batteries at the same time, such as a 'house' battery and an engine battery in an RV or yacht. This controller also includes a backlit remote meter that may be flush or surface mounted, and displays alpha-numeric and graphical information about the solar power system status. Epoxy-encapsulated electronics for environmental protection. User adjustable via DIP switch or connection to a personal computer.

Optional Remote Temperature Sensor for battery bank. Covered by a 5-year warranty.

Morningstar SunGuard Charge Controller				
Model	**Description**	**DC system voltage**	**Charge / load current**	**Item code**
SSD-25RM	SunSaver Duo with remote meter	12 VDC	25 A	**020-01250**
RTS	Remote temperature sensor			**020-01141**

Morningstar Charge Controller Accessories

Optional TriStar Meters-2 have a 2 x 16 character LCD display that shows extensive system and controller in formation, logged data, bar graph metering as well as alarms and fault codes for easy troubleshooting. The information may be shown in English, French, German, Portuguese or Spanish. The **TS-M-2** can be mounted on the front of the TS-MPPT 150 VDC controllers. The **TS-RM-2** is a remote display with a 100' cable.

The **RM-1** is an LCD 4 digit display for basic monitoring of many parameters of any Morningstar control with an RJ-11 jack. Useful for the SunSaver MPPT, SunSaver Duo, and SureSine inverter.

In addition to computer networking, Morningstar has developed the ability to set up a separate MeterBus network. The meter ports allow for communications between compatible products and Morningstar's MeterHub **HUB-1**, allowing multiple Morningstar products to communicate over an expanded MeterBus network to provide improved data monitoring, additional capabilities, and lower system cost. It enables multiple controllers to share a single TriStar meter and display individual controller data as well as aggregated data for the entire system. The HUB-1 also enables multiple controllers to share a single Relay Driver **RD-1**. See Converters and Controls for more info on the RD-1.

The **EMC-I** acts as an Ethernet gateway that serves Modbus IP, local web pages, and web monitoring services. It connects to the MeterBus port (RJ-11) and works with the PS-MPPT, SS-MPPT, SS-Duo controllers, and the SureSine inverters. This facilitates remote monitoring, configuration, and control using any type of IP based network connection. The EMC-1 has standard size DIN rail mounting on the bottom of the unit.

The **UMC-1** connects the RJ-11 MeterBus port on most Morningstar devices to USB for connection to a PC for advanced programming.

The **RSC-I** communications adapter converts an RS-232 serial connector to a standard RS-485 port and may be used to include the TS-MPPT-30, TS-MPPT-45 and TriStar (PWM) controllers and Morningstar's Relay Driver in an TIA-485 Network.

The Morningstar **GFPD-I50V** and **GFPD-600V** are advanced ground fault detection and protection devices. See the Electrical Distribution Parts section for more information..

Morningstar Accessories		
Model	**Description**	**Item code**
TS-M-2	Optional digital display for front of all TS-MPPT 150 V controls	**020-01111**
TS-RM-2	TriStar Remote Meter Display with 100' cable	**020-01112**
RM-1	Remote meter	**020-01258**
HUB-1	MeterHub controller communications HUB for up to 15 devices	**020-01260**
RD-1	Relay driver with 4 independent outputs for system control functions	**020-01255**
EMC-1	Ethernet MeterBus Converter	**020-01249**
UMC-1	Communications adapter Morningstar MeterBus to USB	**020-01251**
RSC-1	Communications adapter RS-232 to EIA-485 (For TS-MPPT-30 and TS-MPPT-45 only)	**020-01256**
RTS	Remote temperature sensor (replacement – one RTS is included with the controller)	**020-01141**
GFPD-600V	DC Ground Fault Protection Device, 2-pole, 50 A, 600 VDC	**053-03165**
GFPD-150V	DC Ground Fault Protection Device, 2-pole, 60 A, 150 VDC	**053-03164**

Blue Sky Energy

Solar Boost™ Charge Controllers

The Blue Sky Solar Boost charge controllers feature Maximum Power Point Tracking (MPPT), reverse-polarity protection, selectable charge voltage set points, and an equalize function. An optional temperature sensor provides compensation of charge voltage to further improve charge controller and battery performance. Blue Sky Energy's Integrated Power Net'", or IPN Network provides integrated charge-controller communication strategies. See next page 125 for more information on the IPN system. 5-year limited warranty. Made in USA

The **SB3024iL** is designed to charge 12 and 24 DC battery systems from a 24 VDC array (maximum open-circuit voltage is 57 VDC). Maximum charge current is 40 A output at 12 VDC and 30 A at 24 VDC. It has an auxiliary output that can serve as a 20 A load controller or as a 2 A battery charger. The **SB3024DiL** version adds a front-mounted digital display which shows battery voltage, solar current, charge current, and charge mode. A second display can be used as a remote display up to 300' away,

The SB3024 controllers are IPN network interface enabled, and include load-control outputs so they can also serve as lighting controllers. An IPNPro remote is required to enable and configure dusk-todawn lighting control. Listed to UL 1741 and CSA STD E335-1/2E. Dimensions: 6.9”H x 6.6”W x 3.4”D

The **SB 2512i-HV** is a fully automatic three-stage charge controller system. A partial IPN network interface is also included to allow use of the Universal Communication Module (UCM), and IPN-Remote and IPN-ProRemote displays. This controller is rated for 25 A maximum output with a 36-cell module, and 20 A with a 60-cell module.

The Solar Boost **SB2512iX-HV** and **SB1524iX** provide additional features including automatic or manual equalization, remote battery-temperature sensor input, full IPN network compatibility, and an auxiliary output. The user-configurable auxiliary output can serve as either a 25 A (15/20 in 1524iX) load controller or a 2 A auxiliary battery charger for a separate battery, such as the starter battery in an RV. The auxiliary output can also provide fully-adjustable dusk-to-dawn lighting control.

All three of these Solar Boost charge controllers can charge a 12 VDC battery using 36-cell modules, or by using a single 60 or 72-cell module. However, the wattage with 60 or 72-cell modules is limited to 270 W for the 2512i-HV and the 2512iX-HV, and 200W with the 1524iX. The 1524iX can be used for 24 VDC systems, however two 36-cell modules in series, or a 72-cell module should be used in 24 VDC systems with this controller, at up to 400 W. Open frame construction with conformal-coated electronics mounted to rear of 5.3" x 5.3" clear-anodized aluminum face plate. Black ABS corrosion-proof mounting box included, 2.5” deep.

Blue Sky Energy IPN Charge/Lighting Controllers

Model	Description	DC system voltage	Charge current	Max PV array voltage	Item code
SB3024iL	Charge controller	12 / 24 VDC	40 / 30 A[1]	57 VDC	**020-03158**
SB3024DiL	Controller with digital display	12 / 24 VDC	40 / 30 A[1]	57 VDC	**020-03159**
SB3024PDiL	Front cover with digital display for SB3024i – retrofit for unit without display				**020-03157**
SB2512i-HV	Charge controller	12 VDC	25 / 20 A[2]	50 VDC	**020-03164**
SB2512iX-HV	Charge controller	12 VDC	25 / 20 A[2]	50 VDC	**020-03165**
SB1524iX	Charge controller	12 or 24 VDC	20 / 15 A[2]	57 VDC	**020-03118**
930-0022-20	Battery temperature sensor				**020-03149**

[1] With 12 VDC battery / with 24 VDC battery [2] With 36-cell modules at 12 VDC / 60 or 72-cell modules at 12 or 24 VDC

Solar Boost 3000i MPPT Charge Controller

Blue Sky Energy's **SB3000i** panel-mount solar charge controller charges 12 VDC batteries at up to 30 A from conventional 36-cell 12 VDC PV modules (up to about 400 W), or with a single 60-cell PV module at up to 22 A of output current (up to about 290 W). The maximum input voltage limit is 50 VDC, so it cannot be used with72-cell modules.

Solar Boost 3000i's sophisticated three-stage charge control plus auto/manual equalization optimally charges flooded, gel and AGM lead-acid batteries. A user-configurable auxiliary output is also provided which can serve as a 20 A LVD load controller, 20 A lighting controller with LVD, or 2 A auxiliary battery charger for a second battery such as the engine-starting battery in an RV. All set-points for charge control and load control are user adjustable.

The LED display combines excellent readability with very low power consumption and includes an automatic night-time diming feature, or it may be turned off completely.

Dimensions are 6.4"W x 4.6"H x 2.2"D. Operating temperature range of -40 ºC to +45 ºC.

Blue Sky Energy RV Charge Controllers				
Model	**Description**	**System voltage**	**Max charge current**	**Item code**
SB3000i	30 / 22 A MPPT panel-mount charge controller	12 VDC	30 / 22 A*	**020-03121**
720-0011-01	Wall-mount box for SB3000i			**020-03119**
930-0022-20	Battery-temperature sensor			**020-03149**

* v30 A with 36-cell modules and 22 A with 60-cell module

IPN Remotes and Optional Controller Accessories

The **IPNPRO Remote** combines charge-controller monitoring and battery system monitoring in a single remote display, eliminating the need for a separate battery monitor. A high-accuracy calculation of remaining battery capacity compensates for a variety of factors, including charge/discharge current, battery size, type, and temperature. Information learned from past battery behavior is used to continuously improve metering accuracy. The IPN-ProRemote also monitors and controls Blue Sky's IPN-based charge controllers. It can monitor both the combined total and individual status of up to 8 IPN charge controllers on a single IPN network. Dimensions are 4½"H x 4½"W x 1½"D (11.4 cm x 11.4 cm x 3.8 cm) and it fits in a standard duplex wall-mount box.

The **IPNREM** remote display provides basic monitoring for IPN compatible charge controllers. The unit displays battery voltage, output current and charge controller system status for up to eight controllers on a single IPN network. An LED display is used to provide readability in any lighting. The charge-status indicator displays system status and battery state-of-charge. When the battery is being charged, the display toggles between battery voltage and charge-controller-output current. The current display can be configured to show the total output current from all controllers on the IPN network, or the output current from a particular controller. Multiple IPN remote displays can be placed on a single IPN network even if an IPN Pro-Remote is already present. Dimensions are 2 ½"H x 3"W x 1 ⅛"D (6.3 cm x 7.6 cm x 2.8 cm).

Blue Sky Energy IPN Network Monitors and Controller Accessories		
Model	**Description**	**Item code**
IPNPRO-S	IPN Pro-Remote display with 500 A shunt	**020-03161**
IPNPRO	IPN Pro-Remote display	**020-03162**
IPNREM	IPN-Remote	**020-03163**
930-0022-20	Battery-temperature sensor	**020-03149**

Battery Meters

Battery-capacity meters serve as a fuel gauge for a battery bank and are an important part of any battery system, both to ensure usability and to properly maintain the battery bank. Simple battery-capacity meters read the voltage across the battery bank and determine a state of charge accordingly. More sophisticated monitoring systems also use a DC shunt to monitor charge and discharge amp-hours. In both cases, it is important that they are installed and calibrated according to manufacturer's instructions to ensure accuracy. See Battery-Based Inverters for battery meters that are deployed as part of a larger power system, such as OutBack Power's FLEXnet™ DC.

MidNite Solar

Battery-Capacity Meter

Designed to simplify battery management, this **Battery-Capacity Meter** can be used on 12, 24, 36, and 48 VDC battery systems using flooded, AGM, and gel batteries. LEDs on the upper dial show present battery capacity. Three lower LEDs show the time frame of the last full charge as "less than one week," "longer than one week," or "longer than two weeks." Handy for at-a-glance readings on golf carts, forklifts, or any battery-powered devices. The meter face is 5"W x 4"H.

MidNite Solar Battery-Capacity Meter	
Description	**Item code**
MidNite Battery-Capacity Meter	**028-02260**

TM 2030 A-F

TM2030-RV-F

Bogart Engineering

TriMetric 2030 and 2030-RV

This meter operates on 12, 24 or 48 VDC. LEDs show volts, amps, and amp-hours. Amp-hours can be displayed directly or as "% full." One LED indicates charging and fully-charged states. Another LED indicates when charging or equalization is needed and warns of low battery-voltage events. The meters also record minimum and maximum voltage, days since last charge, days since last equalized, and total lifetime amp-hours withdrawn. The TriMetric can be located up to hundreds of feet away from batteries using inexpensive four-conductor twisted-pair meter wire. A shunt is required for operation. Use the 500 A shunt on a 12 VDC inverter larger than 800 W, or a 24 VDC inverter larger than 1,600 W. Use a 1,000 A, 100 mV shunt for systems with stacked inverters or where continuous current is over 300 A. The 1,000 A/100 mV shunt has the same resistance as the 500 A/50 mV shunt and may be used interchangeably. Order the shunt separately. These meters work with battery banks up to 2,500 Ah.

The positive lead to the TriMetric should be fused with the included 1 A fuse. This meter can be mounted flush or with a wire mold. Trimetric meters are made in U.S.A., have dimensions of 4.5"W x 4.75"H, and are covered by a 2-year warranty.

Shunts

Use these shunts with Bogart Engineering TriMetric Battery Monitoring systems. These shunts can also be used in other types of DC amp meters that use a remote shunt

Bogart Engineering TriMetric Amp-Hour Meters and Accessories	
Description	**Item code**
TriMetric 2030-A-F amp-hour meter	**028-00028**
TriMetric 2030-RV-F amp-hour meter	**028-00027**
Surface-mount box	**028-00026**
Shunts	
500 A/50 mV shunt	**028-09253**
100 A/100 mV shunt	**028-09245**
1,000 A/100 mV shunt	**028-09254**

500 A/50 mV shunt

AC Kilowatt-Hour Meters

These meters are like those found near a typical residential or commercial utility-service entrance and can be used to meet financing or incentive-program requirements for PV-system output metering. Be sure to verify which meters are approved by the financing provider or incentive program you are using.

'Ringless' Form 2S Meter Socket

'Ring' Style Form 2S Meter Socket

Meter Socket Sealing Ring

AC Kilowatt-Hour Meters

The ITRON LCD meter is the standard utility-grade meter seen on most homes. These reconditioned, certified, utility-grade meters are an economical means for keeping track of how much net energy is exported to the utility grid. The 028-03012 meter (Form 2S) works for 120 VAC or 120/240 VAC systems with a maximum current of less than 200 A.

AC Kilowatt-Hour Meters	
Description	**Item code**
Kilowatt hour meter Form 2S ITRON LCD Digital 240 VAC CL200	**028-03012**

Vision Meter

These utility-grade digital smart kilowatt-hour meters employ current transformers for extremely accurate measurement and long-term stability, even at low power levels. Non-volatile memory protects data in the event of a power failure.

Vision Meter Smart Kilowatt-Hour Meters	
Description	**Item code**
Vision kilowatt-hour meter form 2S	**028-03061**
Vision kilowatt-hour meter 3-phase form 14/15/16S	**028-03063**

Kilowatt-Hour Meter Sockets

The sheet-metal four-terminal 'ringless' style meter sockets are rated for 100 A, 240 VAC, and are used with a Form 2S meter for 120/240 VAC systems. Also available is the 125A rated 'ring' style meter socket, which requires a sealing ring to lock the meter in place. These ring style meter sockets are specified by some JHA's and utilities over the 'ringless' style meter sockets. These meters are all UL listed and NEMA 3R rated for outdoor use.

For three-phase systems, use the appropriate socket for the meter form. The **seven-terminal socke**t is 13"W x 19"H, rated at 200 A, 600 VAC and is used with Form 16S meters. It is a ringless socket with a lever bypass, which allows removal of the meter without interrupting service. Use this socket for the Locus Energy L-Gate 320 monitoring option. UL listed and NEMA 3R rated for outdoor use. The **closing plate** is used to cover the overhead entry into the sheet metal base when entering from either the side or the bottom.

Kilowatt-Hour Meter Sockets	
Description	**Item code**
Kilowatt-hour meter socket 2S 120/240 VAC NEMA 3R, 100 A, #12-1/0 AWG, four-terminal	**048-09220**
Kilowatt-hour meter socket 2S 120/240 VAC NEMA 3R, 125 A, #14-2/0 AWG, four-terminal, 'ring' style	**048-06512**
Kilowatt-hour meter socket 16S three-phase, four-wire Wye, seven -terminal	**048-09215**
Meter Socket Sealing Ring	**029-10001**
Closing plate	**028-03032**

Grid-Tie System Monitoring

As grid-tied solar PV systems become more popular, online monitoring is playing an increasingly important role in both residential and commercial systems. Most commercial PPA and residential leasing financiers require revenue-grade monitoring to be coupled with online reporting tools. Many incentive programs, particularly performance-based and renewable energy credit-based ones, also require accurate real-time monitoring and some form of automated reporting. Many commercial and residential customers want something they can point to when bragging about their solar PV system and an online monitoring system with a smart-phone app fits the bill nicely. Savvy installers are also finding that online monitoring enables them to be proactive in managing their brand and often pair a monitoring system with a service agreement that includes periodic cleaning and maintenance of the system. Whatever the motive, a good online monitoring system can help reinforce the value of a solar PV system for years after installation.

In addition to the proprietary monitoring offered by most inverter manufacturers, we offer a variety of solutions that work with most inverters to meet different application needs. Our monitoring partners can also set up branded solutions for your company that enable you to centrally monitor all of your installed systems while putting your brand in front of the end-users every time they view their system performance. Contact AEE Solar for details.

EnGenius ENH202

Wireless Communications

EnGenius Outdoor-Rated Long-Range Wireless Bridge

The **EnGenius ENH202** is a long-range, commercial grade, 802.11b/g/n outdoor 2.4 GHz wireless access point/client bridge for transmitting monitoring data from a ground mount or remote building directly to a wireless router. Capable of ranges as far as 2.5 miles (limited to the range of the router). For long range transmission, two units may be needed with one unit located near the router. 64/128-bit WEP data encryption and WPA/ WPA2 data security protocols are supported. A MAC address filter can be used to limit network access to specific computers or devices.

Ethernet Bridges	
Description	**Item code**
EnGenius outdoor-rated long-range wireless bridge	**029-01607**

Home Energy Monitor Kit

Solar Expansion Kit

Neur.io

Home Energy and Solar Monitoring System

This unit provides visibility above simple PV System monitoring. It allows the homeowner to view their home's utility energy usage directly on their PC or Smart Device. The Neur.io monitoring unit installs in as little as 15 minutes, with the base unit placed inside the main electric panel or in a separate enclosure. Current transformers are placed around the utility feed lines and the wires from the main solar output circuit, and the unit is then connected via WiFi to the homeowner's network. A small external antenna is provided that can be placed outside the enclosure improving signal strength.

The basic Neur.io **Home Energy Monitor (W1-HEM)** will monitor home usage. Adding the **Solar Expansion Kit (SEK-2)** provides an additional set of CT's to overlay a PV solar array output over the home's usage, and display the energy production from PV, the home's energy usage, and the energy drawn from the utility. The **Three Phase Expansion Kit (TPK-1)** upgrades the Neur.io for use with residential three-phase systems by providing an additional CT for the third phase.

- +/-1% Accuracy, down to 1 W power and 1 Wh energy
- Power consumption <2 W
- WiFi Connection 802.11 b/g/n
- Certifications UL/CSA 61010-1, FCC, IC, ETSI
- Optional in-App and portal branding with your company's logo, reminding customers of your company, and providing a link for customer referrals

Neur.io Monitoring Views over Computer, iPhone, and Android

Neur.io Home Energy Monitoring System	
Description	**Item code**
Neur.io Home Energy Monitor – Split Phase Meter/Data Logger with 2x CT's and WiFi (W1-HEM)	**029-11002**
Solar Expansion Kit – Upgrades Neur.io to also monitor a single solar array with 2x CT's (SEK-2)	**029-11006**
Three Phase Expansion Kit – Upgrades Neur.io for three-phase service ((TPEK-1)	**029-11004**

Solar-Log 350 & GE Meter

Solar-Log 370 Including Ethernet & RS-485 Ports

Solar-Log 10 Home Consumption Meter

WEB Enerest Monitoring Portal

Solar-Log Commercial Monitoring

Solar-Log

Solar-Log Residential PV Monitoring and Metering

The Solar-Log Residential PV Monitoring solution is integrated into a high-quality General Electric (GE) residential meter, and can be installed in a standard Form 2S meter socket for single-phase 120/240 VAC systems with up to 200 A output current. Direct connection and reporting is through the AT&T cellular network, with the cellular plan and portal access included for the initial five years. Additional five-year portal access and monitoring can be added at time of purchase, or in the future. Units utilizing the T-Mobile network are also available upon request. System performance can be viewed over the Solar-Log Dashboard monitoring portal, viewable on computer, iPhone, or Android devices. The monitoring system is compatible with both micro and string inverters, and certified Revenue Grade Metering (RGM) for incentive reporting.

The **Solar-Log 350 & GE Mete**r is a plug-and-play device, and does not require on-site configuration, allowing portal view of the PV plant yield and revenue-grade reporting. The **Solar-Log 350 LAN & GE Meter** allows connection where cell service is weak or unavailable. The **Solar-Log 370** offers numerous I/O ports, like Ethernet and two RS485 ports that provide access to multiple inverters, weather stations, or for additional power management current transformers to be added. Adding a Solar-Log 10 Meter to the SolarLog 370 allows the system also monitor home consumption.

Solar-Log WEB Online Monitoring Portal

Solar-Log WEB Enerest enables installers and their customers to monitor installed systems from either PC or Mac computers. The centralized control center provides easy management of an entire installed base of systems. Precautionary monitoring identifies faults quickly and easily to improve system uptime, increasing customer loyalty and revenue from service contracts. For commercial systems, damage scope analysis helps document insurance claims against loss of revenue due to system failure.

Solar-Log Smart Phone Apps

The Solar-Log Apps allow the convenient monitoring of solar PV plants from smart phones and tablets. Customized daily, monthly, and annually, and overall performance information is presented graphically and numerically in an easy-to-understand way. Both iOS (iPod / iPhone / iPad) and Android devices are supported.

Solar-Log Commercial PV Monitoring and Metering

Solar-Log also provides commercial revenue grade metering and monitoring of large PV plants. Solar-Log Revenue Grade Metering with optional direct inverter monitoring meet the requirements for incentive reporting, accounting, or billing purposes. The Solar-Log Commercial Revenue Grade Meter offers many customizable solutions to achieve the needs of fleet managers, solar PV installers, reporting agencies, utilities and end users. Packaged in an indoor/outdoor enclosure, the assembly includes a revenue grade meter, power supply, fusing blocks, shorting blocks, and RS485/422 ports. Contact AEE Solar for a custom quote for a Solar-Log commercial monitoring solution. Please be prepared to supply an electrical line drawing of the system.

Solar-Log Residential Revenue Grade Meter		
Model	**Description**	**Item code**
255850	Solar-Log 350 & GE Meter	**029-06024**
823210	Solar-Log 350 LAN & GE Meter, adds site consumption monitoring, current transducers included	**CALL**
255852	Solar-Log 370 & GE Meter, adds I/O ports allowing consumption monitoring, inverter-direct monitoring, and/or weather station through additional communication accessories, AT&T Network	**029-06026**
N/A	WEB Enerest Online Monitoring Portal and Cellular Data Plan - Yearly Subscription and Data Plan	**CALL**
N/A	Solar-Log Commercial PV Monitoring Soltutions	**CALL**
255853	Solar-Log 10 Consumption Meter, includes 2x 200A CT's (add on for Solar-Log 370 Meter, adds home consumption monitoring)	**CALL**

Fast, Accurate Shipping to Your Job Site. With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

Locus Energy

Locus Energy offers pre-packaged metering and communications hardware with web-based software to provide monitoring solutions for solar PV and thermal integrators. Locus hardware ships preconfigured to upload system performance data to hosted servers. Installers and site owners can then track energy generation via customized web portals.

Installers have access to fleet monitoring tools to streamline operations and maintenance activities. Individual site owners are given logins to portals branded by their installers so they can easily visualize and understand how their systems are performing. The datalogger can communicate over Ethernet, power line carrier (PLC), or cellular networks. Data is transmitted only in outbound sessions over open ports requiring no additional network or firewall configuration. All data feeds are stored in nonvolatile memory and then uploaded with unique identifiers to provide maximum flexibility in online data presentation. LED lights indicate communication status without installers having to log in or call home.

LGate 120

LGate 120

The **LGate 120** combines a 240 VAC revenue-grade, solid-state power meter with an integrated datalogger, communications gateway, and a 3G GSM cellular modem. These components work in conjunction to remotely monitor the performance of residential solar-energy installations regardless of panel or inverter type. The LGate 120 is a one-piece, completely-under-glass-meter, which installs easily using a standard Form 2S socket base. Performance data is uploaded in near real-time to the Locus Energy SolarOS monitoring platform, which provides a suite of tools and analytics for asset managers.

The communications gateway inside the LGate 120 supports plug-and-play connectivity through Ethernet or cellular network connection through AT&T. Additional system performance data, including inverter direct from supported inverters and meteorological sensors, can be collected directly via RS-485 or Zigbee connections.

LGate 320

LGate 320

The **LGate 320** is a three-phase 208 or 480 VAC electronic watt-hour meter for remote monitoring of light commercial solar PV systems up to 320 A. Like the LGate 120, the LGate 320 combines a revenue-grade, solid-state power meter with an advanced communications gateway which can communicate over cellular or Ethernet networks.

The meter installs easily on a Form 16S meter socket. Additional system performance data, including inverter-direct from supported inverters and meteorological sensors, can be collected directly via RS-485 or Zigbee connections.

For weather stations and three phase monitoring systems please call AEE for a custom quote.

Locus Energy LGate PV Monitoring Systems		
Model	**Residential bundles**	**Item code**
LGate-120-5YR	LGate 120 single-phase revenue-grade PV monitoring. Includes socket meter, one time set-up fee, cellular modem, & five years PV monitoring. (Note: add cellular service plan below)	**029-05243**
CPLAN-ATT-1MB-5YR	5-year cellular service plan AT&T - 1 MB (for LGate 120)	**029-05247**
Light Commercial Bundles Including Metering Hardware and Monitoring Service		
LGate-320-5YR	LGate 320 three-phase revenue-grade PV monitoring. Includes socket meter (rated up to 320 A AC), one time set-up fee, cellular modem & five years PV monitoring. (Note: add cellular service plan below)	**029-05244**
CPLAN-ATT-10MB-5YR	5-year cellular service plan AT&T - 10 MB (for LGate 320)	**029-05248**
Licensing and Data Hosting		
C-PVM-5YR	Three-phase PV data feed for five years	**CALL**
C-LOM-5YR	Three-phase load monitoring for five years	**CALL**
C-IDM-5YR	Large three-phase inverter-direct monitoring for five years	**CALL**
C-MS-IDM-5YR	Mid-size three-phase inverter-direct monitoring for five years	**CALL**

CORE datalogger

Standard Accuracy CTs

Revenue Grade Accu-CTs

Egauge PEK Powered Enclosure

WiFi Access Point

Cellular Router Kit

NEW! eGauge Consumption Level and Renewable Energy Monitoring

eGauge has upgraded its offering with the new eGauge **CORE Datalogger**. This is a 15 channel energy meter with +/-0.5% revenue grade accuracy for both residential and commercial applications. Up to 15 current transformers (CT's) can be attached to the Datalogger, logging multiple circuits and displaying on the web portal. Multiple dataloggers may be linked together and set up on one portal display if more CT inputs or output registers are needed for larger systems.

This datalogger can be mounted directly in a power distribution panel for easy access and wiring or inside a separate enclosure if space inside the panel is limited, and is directly powered from a 20 A two or three pole breaker. The optional **Homeplug PLC Adapter** enables Ethernet-over-powerline connection options for connecting to the Internet. eGague can be configured for single-phase applications, as well as 3P-208 VAC or 3P-480 VAC three-phase applications. Optional **PEK Powered Enclosure, AP100TPL WiFi Access Point, and the CR100MT Cellular Router** with up to a 5-year data plan are also available.

The eGauge CT's are installed around the service conductors to the building to determine utility supply, around the renewable energy source circuits to determine PV production, and around individual circuits for specific consumption monitoring. Users may choose which information is displayed on the portal view. **Split Core AC-CTs** are used for AC circuits, and **Solid Core DC-CTs** can be used for DC circuits. Specify amperage of circuits when ordering. Typical CT's for residential and commercial applications are listed, other ranges available upon request. **Revenue Grade AC Accu-CTs** are available with +/-0.5% Accuracy when paired with an eGauge datalogger that has been certified to higher accuracy levels.

The eGauge monitoring system can be configured to provide:

- Real-time energy consumption from utility or per-load circuits
- Renewable energy production monitoring for multiple inverters
- Establishing building benchmark and LEED points
- Analyzing and reducing peak demand
- Providing analysis for Energy Efficiency Product and system commissioning
- User-defined email or text alerts

eGauge Energy Meters		
Model	**Description**	**Item code**
A005-4115-064	CORE datalogger with Ethernet connection, +/-0.5% accuracy, and HomePlug Adapter	**029-05310**
JD-SCT-010-0050	Split-core CT – (inner diameter 0.39") AC current 0-50 A	**029-05304**
JD-SCT-024-100	Split-core CT – (inner diameter 0.94") AC current 0-100 A	**029-05305**
JD-SCT-024-200	Split-core CT – (inner diameter 0.94") AC current 0-200 A	**029-05306**
CC-ACT-020-xxx	High Accuracy CT – (inner diameter 0.79") +/- 0.2% Revenue-grade, split core AC current sensor (specify amperage rating)	**CALL**
CC-ACT-032-xxx	High Accuracy CT – (inner diameter 1.42") +/- 0.2% Revenue-grade, split core AC current sensor (specify amperage rating)	**CALL**
PEK	Powered Enclosure Kit – includes Polycarbonate Enclosure, DIN rail mounts, and power distribution for outdoor installation of an Egauge datalogger	**CALL**
AP100TPL	Wireless Access Point	**CALL**
CR100MT	Multitech Cellular Router	**CALL**
HP500TN	Homeplug PLC Adapter (Ethernet-over-powerline accessory)	**029-02285**

Batteries

Virtually all power generation systems require some form of energy storage. For grid-tied systems, the utility accepts surplus power and gives it back when needed. A battery bank is required for systems that need to function without the grid, either all of the time or during an outage. In these systems, the solar array or other charging source charges the batteries whenever they are producing power, and the batteries supply power whenever it is needed.

Battery Technologies

The most common battery technology used is **Lead-acid**, in which lead plates are used with a sulfuric acid electrolyte. The electrolyte can be fluid or absorbed in fiberglass mats (AGM), or gelled. AGM and gel batteries are together known as VRLA (Valve Regulated Lead Acid) and are sealed, do not require water addition, and do not emit gases when operated within specifications. Lead-acid batteries are relatively inexpensive and readily available compared to other battery types. New advanced lead-acid batteries have carbon additives in the negative plate to prevent sulfation at partial states of charge (PSoC), while remaining less expensive than high-technology batteries. **Lithium-ion** batteries are lighter weight and compact for their power and energy capacity. One advantage of Li-Ion batteries is their long life even when cycled heavily, and without needing to be brought to a full state of charge each cycle. This makes them particularly suitable for short to long-duration use in self-consumption systems where net-metering is unavailable or utility rate structures otherwise discourage energy exports during peak solar production hours.

Standby or Cycling Batteries

Batteries come in a wide variety of sizes and types, but the most important designation is whether they are made for daily cycle service or standby service. Automobile starting batteries should not be used for renewable energy systems.

Standby power batteries are designed to supply power to loads for occasional use, and are preferred for grid-tied solar systems with battery backup. They are optimized to supply moderate to large amounts of power only during utility power outages, and float at full charge most of the time. They are designed to use a minimal amount of energy to stay fully charged. They are not made for frequent deep discharges and have a limited cycle life but often very long calendar life when kept in float conditions. AGM batteries are most common for standby power applications as they are less expensive, have low self-discharge and require little to no manual maintenance. Deep cycle flooded batteries are not desirable for standby applications. They do not have longer life than AGM batteries when kept in float charge for long periods of time. They also have a high standby loss (often as much load as a refrigerator or more), need isolation, ventilation, and much more maintenance.

Deep cycle batteries, are designed to be repeatedly discharged by as much as 80% of their capacity and are therefore a better choice for off-grid PV systems. Even when designed to withstand deep cycling, most batteries will have a longer life if the cycles are kept shallower. Deep cycle batteries can be either flooded or sealed lead-acid variants or, increasingly, newer chemistries like lithium-ion.

Caring for Batteries

Maintenance requirements vary by battery chemistry and configuration. Additionally, some maintenance tasks, such as adding water or equalization, require on-site manual operations and/or oversight, while charge regulation, voltage checks and related measurements can be automated via sophisticated charge controllers or battery management systems, which are a de facto requirement for lithiumion batteries.

Sealed lead-acid batteries, gel cells and AGM (Absorbed Glass Mat), are often referred to as maintenance-free because they don't require watering or an equalization charge. This makes them well-suited for remote or unattended power systems. However, sealed batteries require accurate regulation to prevent overcharge and over-discharge.

Lead-acid batteries should always be recharged as soon as possible. The positive plates change from lead oxide, when charged, to lead sulfate, when discharged. The longer they remain in the lead sulfate state, the more of the plate remains lead sulfate when the battery is recharged. The portion of the plates that become “sulfated” can no longer store energy. Batteries that are deeply discharged and then only partially charged on a regular basis often fail in less than one year (except those with carbon enhancement). Always use temperature compensation when charging batteries to prevent over or under-charging. NOTE: Battery warranties do NOT cover damage due to poor maintenance or loss of capacity from sulfation.

Check the electrolyte level in wet-cell, or "flooded" batteries, at least once every three months and top-off each cell with distilled water. Do not add water to discharged batteries! Electrolyte is absorbed when batteries are discharged, so if you add water at this time and then recharge the battery, electrolyte will overflow and create a safety hazard. Keep the tops of your batteries clean and check that cables are tight. Do not tighten or remove cables while charging or soon after charging! Any spark around batteries can cause a hydrogen explosion inside the case and potentially ignite a fire or an even larger explosion if the batteries are not properly vented.

An "equalization" charge should be performed on flooded batteries whenever cells show a variation of 0.05 or more in specific gravity from each other. This is a long steady overcharge, bringing the battery to a gassing or bubbling state. Do not equalize VRLA batteries!

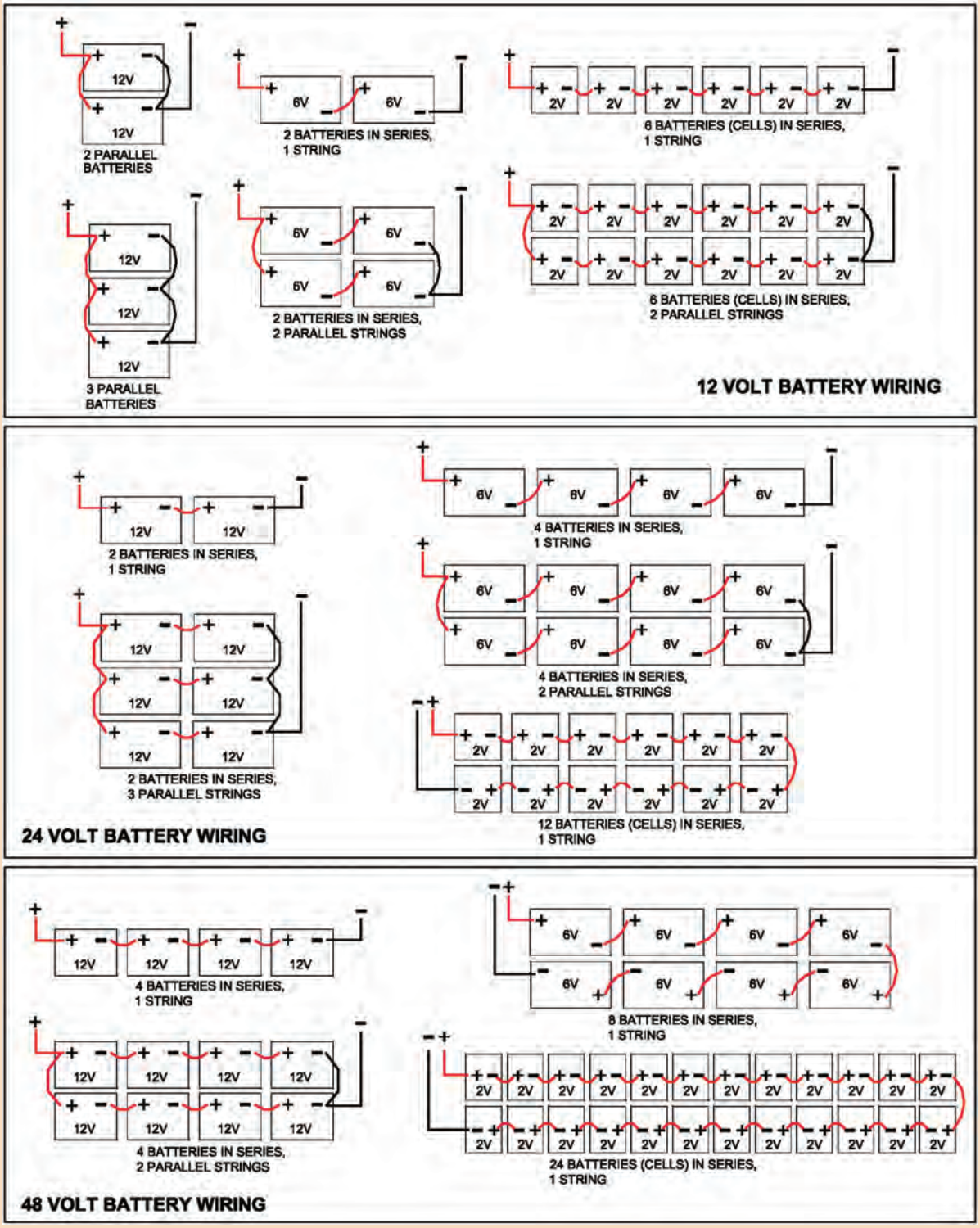
Always use extreme caution when handling batteries and electrolyte (sulfuric acid). Wear appropriate personal protective equipment, including electrical- and chemical-resistant gloves with sleeves, goggles, and acid-resistant clothing. “Battery acid” will instantly burn skin and eyes and destroy cotton and wool clothing. Similar precautions apply to other battery types - always read and adhere to manufacturer safety recommendations when handling batteries. For any type of battery, be sure to remove any metal jewelry and avoid shorting the battery terminals.

Battery Wiring Diagrams (lead type batteries)

The diagrams below show typical 12 VDC, 24 VDC and 48 VDC battery wiring configurations. Batteries can deliver extremely high current. Always install overcurrent protection on any positive wiring connected to batteries.

With lead-acid batteries it's best to use one series string of batteries to get the desired voltage and capacity. If that is not possible, using up to three strings in parallel is acceptable. Note in the diagrams below, that when using parallel battery strings it's essential that the bank's output cables be connected to opposite corners of the battery bank. For instance, if using two parallel strings, connect the positive bank output to the positive output terminal of the first string, and the negative bank output to the negative output terminal of the second string (or vice-versa on the polarity). If using three strings, one output cable would attach to the first string, and the second output cable would attach to the third string. This helps insure equal current flow through all strings of the battery bank.

Using four or more parallel strings is not recommended without taking extensive care that all the strings receive the same amount of charging current and load. Large central buses should be used, with equal-length cables (hence equal resistance) between the buses and each parallel battery string. This also is a good method to use with two or three parallel strings.



Battery State-of-Charge

Battery state-of-charge (SOC) can be measured by an amp-hour meter, voltage, or by specific gravity. Some care and knowledge is required to interpret state-of-charge from voltage or specific gravity readings. We recommend amp-hour meters for all systems with batteries. An amp-hour meter is like a fuel gauge for batteries and provides all the information needed to keep batteries charged. At a glance, the user can see system voltage, current, and battery condition (see Meters and Monitoring).

Battery voltage will vary for the same state-of-charge depending on whether the battery is being charged or discharged, and what the current is in relation to the size of the battery. The table below shows typical battery voltages at each state-of-charge for various battery conditions in flooded lead-acid batteries. Voltage varies with temperature. While charging, a lower temperature will increase battery voltage. Full-charge voltage on a 12 VDC battery is 0.9 VDC higher at 32 °F than at 70 °F. While discharging, a higher temperature will increase battery voltage. There is little temperature effect while a battery is idle, though higher temperatures will increase the self-discharge rate.

Source: Ralph Heisey of Bogart Engineering.

Lead Acid (including AGM and Gel) Battery Voltage at Various States of Charge			
Battery condition at 77 °F	Nominal battery voltage		
	12 VDC	24 VDC	48 VDC
Battery during equalization charge	> 15 VDC	> 30 VDC	> 60 VDC
Battery near full charge while charging	14.4 – 15 VDC	28.8 – 30 VDC	57.6 – 60 VDC
Battery near full discharge while charging	12.3 – 13.2 VDC	24.6 – 26.4 VDC	49.2 – 52.8 VDC
Battery fully charged with light load	12.4 – 12.7 VDC	24.8 – 25.4 VDC	49.6 – 50.8 VDC
Battery fully charged with heavy load	11.5 – 12.5 VDC	23 – 25 VDC	46 – 50 VDC
No charge or discharge for six hours - 100% charged	12.7 VDC	25.4 VDC	50.8 VDC
No charge or discharge for six hours - 80% charged	12.5 VDC	25 VDC	50 VDC
No charge or discharge for six hours - 60% charged	12.2 VDC	24.4 VDC	48.8 VDC
No charge or discharge for six hours - 40% charged	11.9 VDC	23.8 VDC	47.6 VDC
No charge or discharge for six hours - 20% charged	11.6 VDC	23.2 VDC	46.4 VDC
No charge or discharge for six hours - fully discharged	11.4 VDC	22.8 VDC	45.6 VDC
Battery near full discharge while discharging	10.2 – 11.2 VDC	20.4 – 22.4 VDC	40.8 – 44.8 VDC

A **hydrometer** is very accurate at measuring battery state-of-charge in flooded lead-acid batteries if you measure the electrolyte near the plates. Unfortunately, you can only measure the electrolyte at the top of the battery, which is not always near the plates. When a battery is being charged or discharged, a chemical reaction takes place at the border between the lead plates and the electrolyte. The electrolyte changes from water to sulfuric acid while charging. The acid becomes stronger, increasing the specific gravity, as the battery charges. Near the end of the charging cycle, gas bubbles rising through the acid stir the fluid. It takes several hours for the electrolyte to mix so that you get an accurate reading at the top of the battery. Always try to take readings after the battery has been idle or slowly discharging for some time.

This table shows the battery state-of-charge corresponding to various specific gravities for a battery bank in an ambient temperature of 75 °F. Some batteries will have a different specific gravity density by design, check with the manufacturer.

Hydrometer Readings at Ambient Temperature of 75˚F	
State-of-charge	Specific gravity
100% charged	1.265
75% charged	1.239
50% charged	1.2
25% charged	1.17
Fully discharged	1.11

Worksheet: Battery Size

To properly design a battery bank, you need to account for the storage capacity required; the maximum discharge rate (the sum of all the loads which might be run simultaneously); the maximum charge rate (the current output from the solar array or wind turbine though the charge controller); and the minimum ambient temperature at which the batteries will be used. Whichever of these factors requires the largest capacity will dictate the size of the battery bank. The storage capacity of a battery, the amount of electrical energy it can hold, is usually expressed in amp-hours (Ah) or kilowatt-hours (kWh). Using one amp for 100 hours means 100 Ah have been used. The Ah capacity of a battery will change depending on the rate of discharge. The faster the power is drawn out, the less overall capacity the battery will have.

A battery bank in a PV power system should have sufficient capacity to supply needed power during the longest expected period of time when energy production is low or non-existent. This can be just overnight, or for days of cloudy weather when the solar array or energy production source cannot produce enough energy to power the loads.

If there is a source of on-demand backup power, such as a standby generator with a battery charger, the battery bank does not have to be sized for worst-case weather conditions. In an off-grid system the battery is usually sized for three or more days at 80% depth of discharge. Sizing for less than two days will degrade the system performance and require more frequent use of a backup generator.

Use this worksheet to determine what size battery bank is required for your system. Battery voltage is determined by the number of "cells" in series. All lead-acid battery cells have a nominal output of 2 VDC. Actual cell voltage varies from about 1.7 VDC at full discharge to 2.5 VDC at full charge. 12 VDC lead-acid batteries are made of six separate cells in one case. 6 VDC batteries are made of three cells in one case. Putting battery cells in parallel increases amp-hour capacity, but does not change voltage.

Lithium-ion batteries are usually made to be used only at the voltage of each unit. So for a 48 VDC system only 48 VDC batteries are used. To get more capacity multiple units are wired in parallel. Usually many parallel strings can be used. Few lithium batteries are made to be wired in series, check with the manufacturer before doing so. Lithium batteries should not be charged when they are at below freezing temperatures. They have some mass so it can take a few days of freezing temperatures to get the battery to drop below freezing itself. Lithium-ion batteries can generally be discharged regularly to nearly their full capacity, so designs can be more aggressive with fewer days of autonomy.

_____

_____ **Step 1:** Total watt-hours per day required (see Off-Grid Load Worksheet on page 8).

_____ **Step 2:** Maximum number of continuous cloudy days of desired backup (usually three or more days).

_____ **Step 3:** Multiply Step 1 result by Step 2 result.

Step 4: Divide the Step 3 result by 0.5 for 50% depth of discharge or by 0.8 for 80% depth of discharge (Using 0.5 will maintain a 50% reserve and maximize battery life, 0.8 will maintain a 20% reserve and minimize battery bank size).

_____ **Step 5:** If you are using a lead-acid battery, select the multiplier from the table that corresponds to the battery's wintertime average ambient temperature and multiply by the result from Step 4 to get total energy storage required in kilowatt-hours (Battery temperature varies over a period of many days, not day to night).

Step 6: Divide the energy storage requirement from step 5 by the DC voltage of the system (48 VDC is preferred, but sometimes 24 VDC) to get battery amp-hour (Ah) capacity needed.

Battery Bank Average Low Temperature Sizing Multiplier (lead type batteries)

Battery temperature	Multiplier
80 ºF [26.7 ºC]	1
70 ºF [21.2 ºC]	1.04
60 ºF [15.6 ºC]	1.11
50 ºF [10.0 ºC]	1.19
40 ºF [4.4 ºC]	1.3
30 ºF [-1.1 ºC]	1.4
20 ºF [-6.7 ºC]	1.59

_____ **Step 7:** Capacity of preferred battery in amp-hours.

_____ **Step 8:** Divide the Step 6 result by the Step 7 result and round up to a whole number to determine total parallel strings required. (Best to have a single series string, but not more than three parallel strings). Check battery specs to make sure the charging current will not be too high for the chosen battery).

_____ **Step 9:** Divide the system voltage (12 VDC, 24 VDC, or 48 VDC) by the voltage of the chosen battery (2 VDC, 6 VDC or 12 VDC) to determine the number of batteries in each string.

_____ **Step 10:** Multiply the Step 8 result by the Step 9 result to determine the total number of batteries needed.

OutBack Power

NEW! EnergyCell™ PLR Batteries

The OutBack EnergyCell 200PLR is a front-terminal rack-mount battery made with pure lead grids increasing life in float and cycling use. This battery is built for backup power, AC coupled, and off grid systems. It can sustain very high discharge rates for demanding backup systems. It has very low self-discharge for up to 18 month shelf life, and high charge and discharge efficiency. Maximum charge rate is 200A.

These 12 VDC batteries have M6 terminals with threaded inserts that take 6mm bolts, included. These are rated for 1,500 cycles at 50% depth of discharge. One series connection busbar is included with each battery. 3 year warranty. Made in USA. Free freight in the Continental U.S.A.

EnergyCell™ NC Battery

The OutBack EnergyCell Nano-carbon 200NC is a front-terminal rack-mount battery made with nanocarbon enhanced negative plates increasing life in float, cycling and PSoC use. This battery is built for deep cycling and partial state of charge use, ideal for off grid or self-supply systems. It has low selfdischarge for up to 6 month shelf life, and high charge and discharge efficiency. Maximum charge rate is 53A.

These 12 VDC batteries have terminals with threaded inserts that take ¼" bolts, included. These are rated for 1,500 to 2,600 cycles at 50% depth of discharge. One series connection busbar is included with each battery. 2 year warranty. Made in USA, Free freight in the Continental U.S.A.

OutBack EnergyCell Batteries and Racks

Model	Volts	Capacity				Dimensions (L" x W" x H")	Weight	Item code
		3-hr rate	8-hr rate	20-hr rate	100-hr rate			
200PLR	12 VDC	172 Ah	192 Ah	204 Ah	204 Ah	22.87 x 4.92 x 12.46	132 lbs	**040-01213**
220NC	12 VDC	132 Ah	158 Ah	178 Ah	200 Ah	22.0 x 4.95 x 12.6	131 lbs	**040-01169**

Integrated Battery Racks and Enclosures

The **IBR-2** and **IBR-3** racks are designed to work with the OutBack Power EnergyCell™ front-terminal batteries and provides best-in-class safety and ease of install. They are set up for a 48 VDC nominal battery system with one, two, or three parallel strings of EnergyCell front-terminal PLR, NC, or similar front terminal batteries. Each string is wired with 1/0 AWG cable and a 175 A circuit breaker. The enclosure is heavy powder-coated aluminum with clear polycarbonate covers for the front and electrical connections.

Racks come pre-assembled. Made in U.S.A.

OutBack Power Battery Racks and Enclosures

Model	Description	Dimensions (L" x W" x H")	Weight	Item code
IBR-3-48-175	Indoor integrated battery rack, three shelves, up to twelve front terminal batteries	27 x 24.4 x 48.6	89 lbs	**048-03000**
IBR-2-48-175	Indoor integrated battery rack, two shelves, up to eight front terminal batteries	27 x 21.3 x 33	60 lbs	**048-03001**

OutBack Power EnergyCell™ RE High-Capacity Batteries

OutBack Power's new **EnergyCell RE** high-capacity battery employs a modular design concept with an integral racking system that can be installed more quickly and easily than most Valve Regulated Lead Acid (VRLA) batteries of this size.

The Absorbed Glass Mat (AGM) cell design incorporates thick positive plates to extend battery life These are rated for 1,800 cycles at 50% depth of discharge. The maximum continuous charge rate for these is 22% of the capacity at the 20-hour rate. Each module (one or two cells depending on cell size) is encased in its own steel can and features a welded/epoxy dual-post sealed design and large copper posts to enhance performance and safety in high current applications. Unlike flooded batteries, these high capacity AGM cells provide full rated capacity from the first cycle and do not require watering or active venting.

The included racking system is deployed with four cells per shelf so a 48 VDC system typically uses six shelves. The 1600RE is three modules per shelf and eight high. The 24 VDC batteries are half as high. Terminals and connecting plates as well as clear safety covers are also included. Standard string terminations are for the top of the rack, but optional side terminations can be specified with longer lead time. 3 year warranty. Made in China.

Free freight in the Continental U.S.A.

OutBack Power EnergyCell Batteries and Racks

Model	Volts	Capacity				Dimensions (W" x D" x H")	Weight	Item code
		3-hr rate	8-hr rate	20-hr rate	100-hr rate			
800RE	48 VDC	492 Ah	600 Ah	672 Ah	810 Ah	27.4 x 23.5 x 60.7	2,622 lbs	**040-01180**
1100RE		702 Ah	864 Ah	960 Ah	1,150 Ah	37.2 x 23.5 x 60.7	3,797 lbs	**040-01181**
1300RE		822 Ah	1,008 Ah	1,148 Ah	1,340 Ah	37.2 x 26.3 x 60.7	4,330 lbs	**040-01182**
1600RE		987 Ah	1,208 Ah	1,378 Ah	1,600 Ah	33.3 x 26.3 x 78.0	5,082 lbs	**040-01183**
2000RE		1,260 Ah	1,512 Ah	1,716 Ah	2,070 Ah	44.4 x 27.5 x 74.9	6,464 lbs	**040-01184**
2200RE		1,317 Ah	1,616 Ah	1,836 Ah	2,140 Ah	55.2 x 26.3 x 60.7	6,707 lbs	**040-01185**
2700RE		1,680 Ah	2,016 Ah	2,288 Ah	2,770 Ah	56.4 x 27.5 x 74.9	8,266 lbs	**040-01186**
800RE-24	24 VDC	492 Ah	600 Ah	672 Ah	810 Ah	27.4 x 23.5 x 34.8	1,351 lbs	**040-01187**
1100RE-24		702 Ah	864 Ah	960 Ah	1,150 Ah	37.2 x 23.5 x 34.8	1,935 lbs	**040-01188**
1300RE-24		822 Ah	1,008 Ah	1,148 Ah	1,340 Ah	37.2 x 26.3 x 34.8	2,202 lbs	**040-01189**
1600RE-24		987 Ah	1,208 Ah	1,378 Ah	1,600 Ah	33.3 x 26.3 x 43.5	2,577 lbs	**040-01190**
2000RE-24		1,260 Ah	1,512 Ah	1,716 Ah	2,070 Ah	44.4 x 27.5 x 41.9	3,273 lbs	**040-01191**
2200RE-24		1,317 Ah	1,616 Ah	1,836 Ah	2,140 Ah	55.2 x 26.3 x 34.8	3,396 lbs	**040-01192**
2700RE-24		1,680 Ah	2,016 Ah	2,288 Ah	2,770 Ah	56.4 x 27.5 x 41.9	4,177 lbs	**040-01193**

Fast, Accurate Shipping to your Job Site. With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

OutBack EnergyCell™ OPzV Tubular Gel Batteries

OutBack's new EnergyCell OPzV gelled electrolyte batteries are designed for extreme deep cycle applications. The positive plates are tubular in design giving very long cycle life, which is rated at 3000 cycles at a 50% depth of discharge.

Long the standard for remote off-grid systems in Europe, these batteries are now available for import into the US. Cells are sealed for minimal maintenance and no watering. The system kits come with cell interconnects, hardware, and racks.

Available for both 24 VDC and 48 VDC systems. Three-year warranty. Made in, and shipped from, Greece.

OutBack EnergyCell OPzV Batteries

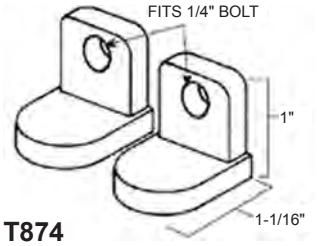
Model	Volts	Capacity				Cell Dimensions (W" x D" x H")	Cell / System Weight	Item code
		8-hr rate	20-hr rate	100-hr rate				
OPzV-450-24	24 V	334 Ah	390 Ah	463 Ah	5.71 x 8.11 x 15.04	41.3 x 22.8 x 26.1	62 / 774 lbs	**040-01200**
OPzV-750-24	24 V	567 Ah	667 Ah	802 Ah	6.54 x 8.11 x 19.61	41.3 x 22.8 x 30.7	93 / 1149 lbs	**040-01201**
OPzV-2000-24	24 V	1,387 Ah	1,632 Ah	1,987 Ah	8.27 x 10.82 x 26.5	53.2 x 37.6 x 37.6	214 / 2617 lbs	**040-01202**
OPzV-3000-24	24 V	2,171 Ah	2,529 Ah	3,001 Ah	8.43 x 15.71 x 31.46	53.2 x 33.9 x 42.5	364 / 4455 lbs	**040-01203**
OPzV-450-48	48 V	334 Ah	390 Ah	463 Ah	5.71 x 8.11 x 15.04	76.8 x 22.8 x 26.1	62 / 1547 lbs	**040-01204**
OPzV-750-48	48 V	567 Ah	667 Ah	802 Ah	6.54 x 8.11 x 19.61	88.6 x 22.8 x 30.7	93 / 2297 lbs	**040-01205**
OPzV-2000-48	48 V	1,387 Ah	1,632 Ah	1,987 Ah	8.27 x 10.82 x 26.5	106.3 x 37.6 x 37.6	214 / 5232 lbs	**040-01206**
OPzV-3000-48	48 V	2,171 Ah	2,529 Ah	3,001 Ah	8.43 x 15.71 x 31.46	106.3 x 33.9 x 42.5	364 / 8910 lbs	**040-01207**

East Penn

MK Sealed PV/Solar Batteries

MK sealed gel batteries are designed for deep cycle maintenance-free operation for the life of the battery. Sealed construction eliminates periodic watering, corrosive acid fumes, and spills. The gelled electrolytewon't stratify, so no equalization charging is required. Less than 2% per month standby loss means low discharge during transport and storage. Tank-formed plates ensure voltage matching between cells for consistent reliable performance.

These batteries are rated for 1,000 cycles at 50% depth of discharge. They can operate at temperatures from -76 to 140 °F. The maximum continuous charge rate for these is 30% of the capacity at the 20-hour rate. MK sealed gel batteries are covered by a 1-year warranty. Delivered from one of 20 MK warehouses across the U.S.A. Made in U.S.A.



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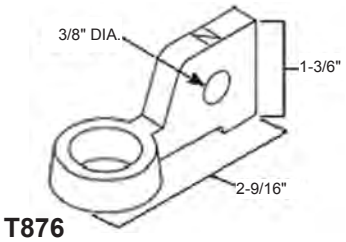

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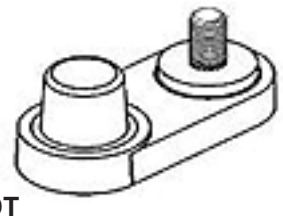
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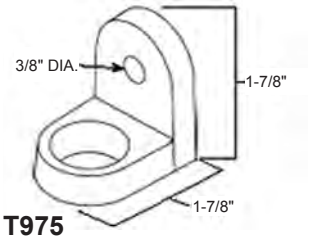

T975

MK Sealed Gel Solar Batteries									
Model	Volts	Terminal	Capacity				Dimensions (L" x W" x H")	Weight	Item code
			3-hr rate	8-hr rate	20-hr rate	100-hr rate			
8GU1	12 VDC	T874	25.5 Ah	28.5 Ah	31.2 Ah	36.1 Ah	7.8 x 5.2 x 7.3	24 lbs	**040-03015**
8G22NF	12 VDC	T881	40 Ah	46 Ah	50 Ah	57 Ah	9.38 x 5.5 x 9.25	38 lbs	**040-03018**
8G24UT	12 VDC	T881	59 Ah	66 Ah	73.6 Ah	84 Ah	10.9 x 6.8 x 9.9	53.6 lbs	**040-03022**
8G27	12 VDC	T876	70 Ah	78 Ah	86.4 Ah	99 Ah	12.75 x 6.75 x 9.75	63.2 lbs	**040-03024**
8G30H	12 VDC	T876	79 Ah	88 Ah	97.6 Ah	108 Ah	12.94 x 6.75 x 9.75	71.7 lbs	**040-03027**
8G5SHP	12 VDC	T876	88 Ah	104 Ah	125 Ah	137 Ah	13.58 x 6.77 x 11.42	85 lbs	**040-03029**[1]
8G4DLTP	12 VDC	T975	148 Ah	166 Ah	183 Ah	210 Ah	21.0 x 8.5 x 10.8	137 lbs	**040-03030**
8G8DLTP	12 VDC	T975	182 Ah	204 Ah	225 Ah	265 Ah	21.0 x 11 x 10.8	166 lbs	**040-03033**
8GGC2	6 VDC	DT	136 Ah	160 Ah	180 Ah	198 Ah	10.3 x 7.2 x 10.9	68 lbs	**040-03036**

[1] Must be shipped by truck freight as hazardous goods

Deka Unigy II AGM Industrial Batteries

The **Deka Unigy II** line features a wide range of capacities to fit the requirements of renewable energy applications. These batteries are well-suited for float applications with an occasional deep discharge, such as battery backup for grid-connected systems. These are rated for 1,800 cycles at 50% depth of discharge. These are rated for a 20-year life in backup use. The maximum continuous charge rate for these is 15% of the capacity at the 20-hour rate. The front safety shield easily clips on and off without tools for quick assembly. The modules are coated with acid-resistant paint, and each module has mounting holes for a grounding option. They come with flame retardant polyethylene cases.

The non-interlock modules require front and rear access bolts for mounting. The standard two-piece base enables anchors to be drilled and installed with base in place. They are certified to UBC 97 Zone 2B Top of Building up to eight modules high. Warranty 1 year full, 4 years pro-rata. Made in U.S.A.

Deka Unigy II Sealed Industrial Batteries								
Model	Volts	Capacity				Dimensions [1, 2] (W" x H" x D")	Weight	Item code
		3-hr rate	8-hr rate	20-hr rate	100-hr rate			
6AVR95-7	12 VDC	228 Ah	295 Ah	339 Ah	403 Ah	19 x 9.48 x 27.12	339 lbs	**040-06006-NL**
6AVR95-9	12 VDC	305 Ah	380 Ah	452 Ah	540 Ah	23.5 x 9.48 x 27.12	426 lbs	**040-06007-NL**
6AVR95-11	12VDC	381 Ah	475 Ah	564 Ah	670 Ah	28 x 9.48 x 27.12	512 lbs	**040-06008-NL**
6AVR95-13	12 VDC	457 Ah	570 Ah	678 Ah	810 Ah	32.5 x 9.48 x 27.12	600 lbs	**040-06009-NL**
6AVR95-15	12 VDC	533 Ah	665 Ah	791 Ah	941 Ah	37 x 9.48 x 27.12	688 lbs	**040-06028-NL**
3AVR95-17	6 VDC	609 Ah	760 Ah	904 Ah	1,076 Ah	21.9 x 9.48 x 27.12	404 lbs	**040-06029-NL**
3AVR95-19	6 VDC	685 Ah	855 Ah	1,016 Ah	1,210 Ah	24.15 x 9.48 x 27.12	448 lbs	**040-06030-NL**
3AVR95-21	6 VDC	761 Ah	950 Ah	1,129 Ah	1,345 Ah	26.4 x 9.48 x 27.12	491 lbs	**040-06031-NL**
3AVR95-23	6 VDC	838 Ah	1,045 Ah	1,242 Ah	1,479 Ah	28.65 x 9.48 x 27.12	535 lbs	**040-06032-NL**
3AVR95-25	6 VDC	914 Ah	1,140 Ah	1,355 Ah	1,614 Ah	30.9 x 9.48 x 27.12	578 lbs	**040-06033-NL**
3AVR95-27	6 VDC	990 Ah	1,235 Ah	1,468 Ah	1,748 Ah	33.15 x 9.48 x 27.12	618 lbs	**040-06034-NL**
3AVR95-29	6 VDC	1,066 Ah	1,330 Ah	1,581 Ah	1,882 Ah	35.4 x 9.48 x 27.12	665 lbs	**040-06035-NL**
3AVR95-31	6 VDC	1,142 Ah	1,425 Ah	1,694 Ah	2,017 Ah	37.65 x 9.48 x 27.12	705 lbs	**040-06036-NL**
3AVR95-33	6 VDC	1,218 Ah	1,520 Ah	1,807 Ah	2,151 Ah	39.9 x 9.48 x 27.12	749 lbs	**040-06037-NL**
2AVR125-33	4 VDC	1,551 Ah	2,000 Ah	2,367 Ah	2,930 Ah	27.32 x 11.7 x 31.12	753 lbs	**040-06038-IL**

[1] Height, depth and weight are slightly greater for interlock modules
[2] Overall battery height = (module height - 1.44") x # modules + 4"

MK Sealed AGM Batteries

These are completely sealed, absorbed glass mat, valve-regulated batteries with efficient recombination. AGM batteries are recommended for battery backup standby power systems where batteries are in float service with occasional deep discharges. These batteries are rated for 500 cycles at 50% depth of discharge. They can operate at temperatures from -40 to 140 °F.

Delivered from one of 20 MK warehouses across the U.S.A.

MK Sealed AGM Batteries									
Model	Volts	Terminal	Capacity				Dimensions (L" x W" x H")	Weight	Item code
			3-hr rate	8-hr rate	20-hr rate	100-hr rate			
8AU1H	12 VDC	T874	26.4 Ah	29.6 Ah	32.5 Ah	37 Ah	7.8 x 5.2 x 7.3	24 lbs	**040-03117**
8A22NF	12 VDC	T881	45 Ah	50 Ah	55 Ah	63 Ah	9.38 x 5.5 x 9.25	38 lbs	**040-03120**
8A24DT	12 VDC	T881	65 Ah	72 Ah	79 Ah	91 Ah	10.9 x 6.8 x 9.9	53.6 lbs	**040-03123**
8A27	12 VDC	T876	75 Ah	84 Ah	92 Ah	106 Ah	12.75 x 6.75 x 9.75	63.2 lbs	**040-03126**
8A31DT	12 VDC	DT	85 Ah	90 Ah	105 Ah	116 Ah	12.94 x 6.75 x 9.75	71.7 lbs	**040-03129**
8A4DLTP	12 VDC	T975	150 Ah	176 Ah	200 Ah	216 Ah	20.8 x 8.5 x 10	130 lbs	**040-03132**[1]
8A8DLTP	12 VDC	T975	182 Ah	212 Ah	245 Ah	257 Ah	20.8 x 11 x 10	161 lbs	**040-03135**[1]
8AGC2	6 VDC	DT	145 Ah	174 Ah	190 Ah	220 Ah	10.3 x 7.2 x 10.9	69 lbs	**040-03137**[1]

[1] Must be shipped by truck freight as hazardous goods

MK 8L-16 Flooded 6-Volt Deep Cycle Battery

East Penn's version of the L-16 flooded battery features flag terminals and a heavy-duty polymer case. MK SL-16 batteries are made in the U.S.A. Cycle life is 825 cycles at 50% depth of discharge. This is one of the most economical deep-cycle lead-acid batteries available. Made in U.S.A.

MK L16 Flooded Batteries								
Model	Volts	Terminal	Capacity			Dimensions (L" x W" x H")	Weight	Item code
			6-hr rate	20-hr rate	100-hr rate			
8L-16	6 VDC	DT	295 Ah	370 Ah	420 Ah	11.75 x 7 x 17.3	113 lbs	**040-01957**[1]

[1] Must be shipped by truck freight as hazardous goods

Fast, Accurate Shipping to your Job Site. With just-in-time delivery and blind drop shipping, we can ship directly to your customers, just as if it came straight from you.

LG Chem

RESU10H

The LG Chem RESU10H is a lithium-ion battery system used for solar systems requiring energy storage with daily cycling. They have the ability to cycle daily for up to 10 years as needed for self-consumption, peak load shaving, backup power and other similar systems. The **RESU10H-SEG** is the primary battery and the **RESU10H-SEG2** is the secondary battery to couple to the StorEdge inverter. The **RESU10H-DLT** is the battery used with the SMA Sunny Storage inverter.

- 9.3 kWh of usable storage capacity
- 5 kW maximum power input and output, maximum continuous output of 3.3 kW
- 7 kW peak output for 10 seconds
- Includes a BMS (Battery Management System) with over-voltage, over-current, short circuit, and reverse polarity protection to ensure complete safety.
- DC disconnect circuit breaker, and ON/OFF switch

Outdoor rated to NEMA 3R (IP55). The maximum operating temperature range is 14°F (-10°C) to 113°F (45°C), with a recommended operating temperature range is 59°F (15°C) to 86°F (30°C) for maximum life.

Listed to UL1642, UL1973, UL1741, UL1998, NEC 110.26, UN3480, IEC 62133. Ships as Hazardous materials Class 9, UN38.3 (UNDOT). Warranty is 10 years to 60% of original capacity.

NOTE: Maximum installation altitude is 6,562 ft (2000 m).

Lifting handles are highly recommended for installing these batteries. Two handles are needed to lift and install then on a wall, and can be used again on future installs. Made in Korea.

See Hybrid Inverter section for inverters that work with these LG batteries.

LG Chem Li-ION Batteries										
Model	Nom. Volts	Voltage Range	Capacity		Power (Charge and discharge			Dimensions (W" x H" x D")	Weight	Item code
			Total kWh	Usable kWh	Recomm.	Max	Peak (3 sec)			
RESU10H-SEG	400	350-520	9.8	9.3	3.3 kW	5.0 kW	7.0 kW	29.3 x 35.7 x 8.1	214	**040-11000**
RESU10H-SEG2										**040-11001**
RESU10H-DLT										**040-11015**
Handle	RESU Handle for lifting battery, each, one pair needed								4	**094-10000**
MNTPW2	Fused combiner for using two RESU HV batteries								5	**053-02944**

Discover Battery

AES LiFePO$_4$ battery

The Discover AES batteries are an excellent choice for applications needing deep cycling on a daily basis as needed for off grid, self-consumption, peak load shaving, and other similar systems. They use the commonly preferred LiFePO$_4$ chemistry for stationary energy storage. It is thermally stable and has high cycle life compared to many other Li-ION technologies. The **AES 42-48-6650** and **AES 44-24- 2800** batteries can be used with most 24 V or 48 V inverters and charge controllers.

AES batteries have a built in Battery Management System (BMS) that keeps the individual cells balanced and within the correct parameters for longest life. If operating parameters are exceeded for over 2 minutes the battery will shut down. The BMS monitors cell module voltage, battery voltage, battery current, battery temperature, and battery state of charge. It keeps a log of this data and can send out fault and warning events. There is an AEBus connection for communications between multiple batteries. Each battery has an ON/OFF switch and an internal backup fuse.

The external communication connection will work directly with Schneider Conext network systems. It reports to the Conext SCP or Combox as a battery monitor device. This connection can also be used with the Discover LYNK© monitor and communication box. Edge Cards (daughter boards) can be added to the LYNK© to enable communications to specific inverter brands. A selection of cards will become available to match popular inverter brands. Two Edge Cards can be used at one time for various inverters and charge controllers in one system. LYNK© enables closed loop communications providing adaptive, real time interaction between the Discover AES LiFePO$_4$ battery and connected inverter system. Remote reporting of battery status is available through the inverter monitoring and web services.

- Safe and robust Li chemistry type, strong steel case
- Can be used as a lead acid battery replacement with 24 volt or 48 volt nominal inverters and solar chargers
- High rate charge/discharge rated, and very high round trip efficiency
- Complete monitoring of all battery parameters is available
- Up to 20 AES batteries can be installed in parallel for up to 133kWh of storage
- Convenient wall mount bracket is available for the AES 42-48-6650

The steel enclosure is rated to IP55 (approx. NEMA 3R) but is not recommended for outdoor exposure. Terminals are post type, M8 female threads, with supplied bolts and washers. The charging temperature range is 32°F (0°C) to 113°F (45°C), with a recommended operating temperature range is 59°F (15°C) to 77°F (25°C) for maximum life and performance. 48 volt batteries are 13.7" W x 18.5" D x 14.7" H. 24 volt batteries are 13.7" W x 13.0" D x 10.8" H. Listed to IEC 62133(ed.2) pending UL1973 and UL2271. Ships as Hazardous materials Class 9, UN3480 (UNDOT).

Warranty is for 10 years service life, or throughput rating of 38MWh (42-48-6650) or 16MWh (44-24-2800) to 60% of original capacity. Made in Taiwan.

Discover AES LiFePO$_4$ batteries									
Model	Nom. Volts (actual)	Operating Volts	Capacity		Power (Charge and discharge)		Dimensions (W" x D" x H")	Weight lbs.	Item code
			Total kWh	Amp Hours	Max (Recommended)	Peak (3 sec)			
42-48-6650	48 (51.2)	44.8-59.2	6.65	130	130 A (92 A)	30 kW	13.7 x 18.5 x 14.7	192	**040-12000**
44-24-2800	24 (25.6)	22.4-29.2	2.81	110	110 A (78 A)	30 kW	13.7 x 13.0 x 10.8	88	**040-12002**
LYNK©	Communication box Various Edge Cards								**Coming soon**
BKT-6650	Wall mount bracket for 42-48-6650 battery								**040-12010**

NEW! Discover Battery Tubular Gel OPzV Batteries

Discover Battery OPzV tubular plate gel batteries are designed for extreme life deep cycle applications. Cells are valve regulated sealed for minimal maintenance and no watering. The positive plates are a tubular design giving very long cycle life, and these are rated to 2950 cycles at a 50% depth of discharge. Maximum charge current is 30% of the 10-hr rate.

Long the standard for remote off-grid systems around the world, these batteries are now available in the US. They are ideal for off grid systems and also work well for standby backup use. The system kits come with cell interconnect cables, and racks. Available for both 24 VDC and 48 VDC systems.

Meets the following standards:

- ISO 9001/14001 and OSHA 18001 standards
- IEC 60896-21: Requirements for Photovoltaic Energy
- IEC 60896-22: Requirements for Valve Regulated Lead Acid batteries
- IEC 61427: Standard for photovoltaic energy systems
- DIN 40742: Standard for stationary tubular plate cells (OPzV)
- EN 50272-1 / 50272-2: Safety Requirements for stationary batteries
- UN 2800 (US DOT Compliance)
- Eurobat “Long Life” classification

2 year warranty (4 year in standby or shallow cycle use). Made in UAE.

Discover OPzV Batteries								
Model	Volts	Capacity			Cell Dimensions (W" x D" x H")	System Dimensions (W" x D" x H")	Cell/System Weight	Item code
		10 hr rate	20 hr rate	100 hr rate				
2VRE-3200TG-24	24 V	1,150 Ah	1,265 Ah	1,610 Ah	8.3 x 9.3 x 26.9	53.2 x 22.8 x 38.2	181 / 2279 lbs	**040-08302**
2VRE-4400TG-24	24 V	1,620 Ah	1,782 Ah	2,197 Ah	8.3 x 10.9 x 32.8	53.2 x 22.8 x 44.1	247 / 3091 lbs	**040-08303**
2VRE-5900TG-24	24 V	2,160 Ah	2,376 Ah	2,927 Ah	8.5 x 15.7 x 31.9	N/A	344 / N/A lbs	**040-08304**
2VRE-3200TG-48	48 V	1,150 Ah	1,265 Ah	1,610 Ah	8.3 x 9.3 x 26.9	106.3 x 22.8 x 38.2	181 / 4541 lbs	**040-08312**
2VRE-4400TG-48	48 V	1,620 Ah	1,782 Ah	2,197 Ah	8.3 x 10.9 x 32.8	106.3 x 22.8 x 44.1	247 / 6164 lbs	**040-08313**
2VRE-5900TG-48	48 V	2,160 Ah	2,376 Ah	2,927 Ah	8.5 x 15.7 x 31.9	N/A	344 / N/A lbs	**040-08316**

Trojan Battery

Trojan Sealed Solar AGM Deep Cycle Batteries

Trojan's SAGM line of sealed AGM batteries are a deep cycle design that will work well in off-grid applications or as backup to grid-tied systems. Deep cycle technology assures high quality paste formula and separators for a long life design.

These are rated for 1,700 cycles at 50% depth of discharge. Using the IEC 61427 standard for renewable energy storage these have an 8 year life. Each cell has its own pressure vent and flame arrestor for safety. They are made with a high strength polymer case and come with low-profile threaded insert terminals for corrosion-free connections.

Four of the **SAGM 06 315** will fit into the MidNite MND3RACCPLM (AC-coupled Magnum in battery cabinet). The **SAGM 06 375** is a standard L-16 size. They feature a limited two-year warranty.

Made in the USA.

Trojan SAGM batteries							
Model	Volts	Capacity			Dimensions (L" x W" x H")	Weight lbs.	Item code
		10 hr rate	20 hr rate	100 hr rate			
SAGM 12 105	12	94	105	113	12.80 x 6.81 x 9.34	67	**040-02061**
SAGM 12 135	12	131	135	137	12.96 x 7.06 x 10.96	83	**040-02044**
SAGM 12 205	12	174	205	216	14.97 x 6.94 x 14.07	131	**040-02045**
SAGM 08 165	8	145	165	174	10.3 x 7.06 x 10.73	70	**040-02046**
SAGM 06 220	6	190	220	235	10.3 x 7.06 x 10.73	68	**040-02047**
SAGM 06 315	6	278	315	335	11.66 x 6.94 x 13.99	95	**040-02048**
SAGM 06 375	6	329	375	400	11.66 x 6.94 x 16.31	114	**040-02049**

Solar Premium Flooded Deep Cycle Lead-Acid Batteries

Trojan's Solar Premium line of deep cycle lead-acid batteries with Smart Carbon are optimized for renewable energy applications, such as solar PV, small wind, and micro-grid. They have heavy-duty separators and plates designed for longer life. Rated at 1,900 cycles at 50% depth of discharge. Using the IEC 61427 standard for renewable energy storage these batteries have an 8 year lifespan. They feature a full warranty up to two years and are prorated up to five years.

SMART CARBON

Smart Carbon™

For enhanced life and improved performance in applications operating in partial state of charge (PSOC), Trojan's Industrial and Premium Line batteries now feature Smart Carbon technology to improve performance and longevity. Trojan's propriety carbon formula, Smart Carbon, increases the electrochemically active surface area which enhances charge acceptance and efficiency in applications where the batteries are not fully recharged on a regular basis

Trojan Flooded Batteries with Smart Carbon							
Model	Volts	Capacity			Dimensions (L" x W" x H")	Weight	Item code
		10-hr rate	20-hr rate	100-hr rate			
SPRE 12 225	12 VDC	179 Ah	204 Ah	225 Ah	14.97 x 6.91 x 14.71	132 lbs	**040-02050**
SPRE 06 255	6 VDC	211 Ah	229 Ah	255 Ah	10.30 x 7.13 x 11.74	67 lbs	**040-02051**
SPRE 06 415	6 VDC	346 Ah	377 Ah	415 Ah	11.66 x 6.94 x 17.55	118 lbs	**040-02052**
SPRE 02 1255	2 VDC	1,039 Ah	1,130 Ah	1255 Ah	11.66 x 6.94 x 17.55	119 lbs	**040-02053**

Trojan Industrial Line Accessories		
Model	Description	Item code
210100	SPRE Battery Watering Kit 12 VDC with tubing, fittings, hand pump, manual	**040-09924**
210101	SPRE Battery Watering Kit 24 VDC with tubing, fittings, hand pump, manual	**040-09925**
210102	SPRE Battery Watering Kit 48 VDC with tubing, fittings, hand pump, manual	**040-09926**
210073	SPRE-2V Battery Watering Kit 12 VDC with tubing, fittings, hand pump, manual	**040-09928**
210114	SPRE-2V Battery Watering Kit 24 VDC with tubing, fittings, hand pump, manual	**040-09929**
210113	SPRE-2V Battery Watering Kit 48 VDC with tubing, fittings, hand pump, manual	**040-09930**

Rolls Battery

S-4000 Series Batteries

The **S-4000** series are flooded deep cycle batteries. The batteries in this section are the same sized as the standard L16 batteries. These are good for off-grid or deep cycle applications. Made with a high density active material and with a polypropylene case with handles. They are rated at 1,400 cycles to 50% depth of discharge. Heavy duty lead L-terminals. 3-year full warranty. Made in Canada.

Shipping requirements and free shipping threshold quantities vary by region, so be sure to indicate your commercial ship-to address when ordering. Add a "–W" for western US and "–E" for eastern US to the item code.

Rolls S-Series Batteries							
Model	Volts	Capacity			Dimensions (L" x W" x H")	Weight	Item code
		10-hr rate	20-hr rate	100-hr rate			
S-480	6 VDC	319 Ah	375 Ah	499 Ah	12.5 x 7.12 x 16.8	113 lbs	**040-02107**
S-550	6 VDC	364 Ah	428 Ah	559 Ah	12.5 x 7.12 x 16.8	123 lbs	**040-02108**
S-605	6 VDC	398 Ah	468 Ah	622 Ah	12.5 x 7.12 x 16.8	125 lbs	**040-02111**
S-1450	2 VDC	955 Ah	1,124 Ah	1,495 Ah	12.5 x 7.13 x 17	120 lbs	**040-02116**
S-1660	2 VDC	1091 Ah	1,284 Ah	1,708 Ah	12.5 x 7.13 x 17	127 lbs	**040-02117**
S-1860	2 VDC	1,228 Ah	1,445 Ah	1,922 Ah	12.5 x 7.13 x 17	130 lbs	**040-02118**

AGM Series

The AGM series is a sealed, absorbed electrolyte version of the L16-sized batteries. Maintenance is minimized, and with a low float current, these are good for shallow cycle off-grid or grid tie backup systems. Made with an ABS case with handles. Dual terminals with posts and threaded inserts, M10 stainless bolts are included. These Rolls batteries are rated at 1,200 cycles at 50% depth of discharge. 3-year full warranty.

Shipping requirements and free shipping threshold quantities vary by region, so be sure to indicate your commercial ship-to address when ordering. Add a "–W" for western US and "–E" for eastern US to the item code.

Rolls Deep Cycle AGM Batteries							
Model	Volts	Capacity			Dimensions (L" x W" x H")	Weight	Item code
		10-hr rate	20-hr rate	100-hr rate			
S6-460AGM	6 VDC	374 Ah	415 Ah	460 Ah	11.6 x 7.05 x 16.7	124 lbs	**040-02270**
S2-1275AGM	2 VDC	1040 Ah	1150 Ah	1275 Ah	11.6 x 7.05 x 16.7	126 lbs	**040-02271**

Solar-One®

HuP® Industrial Batteries

The Solar-One® battery with HuP® Technology is optimized for renewable energy systems. It has a slightly enlarged epoxy-coated steel case that allows cell removal so it can be installed by parts without a forklift or crane. Solar-One® batteries are designed with 0.310" thick positive plates and a patented technology that allows them to be rated for 4,000 cycles to 50% depth of discharge. The 10-year warranty, 7-year full replacement, and 3-year prorated, is the best in the industry.

Each Solar-One® battery is made up of six 2 VDC cells for 12 VDC and comes with stainless steel hardware, lead- plated copper busbars, a cell-lifting strap and an operator/installation manual. Order two for 24 VDC systems or four for 48 VDC systems.

Allow up to eight weeks for delivery. Free shipping to commercial locations in the Continental U.S.A.

Solar-One® HuP® Batteries						
Model	Volts	Capacity		Dimensions (L" x W" x H")	Weight	Item code
		6-hr rate	20-hr rate			
SO-6-85-17	12 VDC	680 Ah	845 Ah	40 x 7.75 x 25	742 lbs	**040-05269-A**
SO-6-85-19	12 VDC	765 Ah	950 Ah	40 x 8.25 x 25	808 lbs	**040-05272-A**
SO-6-85-21	12 VDC	850 Ah	1,055 Ah	40 x 8.75 x 25	880 lbs	**040-05275-A**
SO-6-85-23	12 VDC	935 Ah	1,160 Ah	40 x 9 x 25	959 lbs	**040-05278-A**
SO-6-85-25	12 VDC	1,020 Ah	1,270 Ah	40 x 10.25 x 25	1,036 lbs	**040-05281-A**
SO-6-85-27	12 VDC	1,105 Ah	1,375 Ah	40 x 11.25 x 25	1,102 lbs	**040-05284-A**
SO-6-85-31	12 VDC	1,275 Ah	1,585 Ah	40 x 12.75 x 25	1,252 lbs	**040-05290-A**
SO-6-85-33	12 VDC	1,360 Ah	1,690 Ah	40 x 13.5 x 25	1,336 lbs	**040-05293-A**
SO-6-100-33	12 VDC	1,600 Ah	1,990 Ah	40 x 13.5 x 28	1,550 lbs	**040-05295**
SO-6-125-33	12 VDC	2,000 Ah	2,490 Ah	40 x 13.5 x 33	1,695 lbs	**040-05296**

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MidNite Solar

Battery Enclosures

MNBE-A

MNBE-C

MNBE-D

MNBE-8D2X2

Choose the proper enclosure for the size and number of batteries needed. Use multiple enclosures, side-by-side, for larger battery banks. These are all designed for use with sealed batteries only.

The **MNBE-A**, **MNBE-C** and **MNBE-D** are grey powder-coated steel battery enclosures with locking doors and are listed for indoor use in the U.S.A. and Canada. The **MNBE-D3R** and **MNBE-8D2x2** are white aluminum outdoor enclosures.

The **MNBE-C** comes in versions with two, three or four shelves depending on which battery it is made for. Extra shelves can be added to the MNBE-C and MNBE-D.

The **MNBE-8D2x2** enclosures hold two 4D or 8D batteries on each shelf for a total of four batteries. The MNBE-8D2x2 BASIC has spaces for a single 175 A or 250 A and up to four MNDC breakers, which are not included. The **MNBE-8D2x2 DELUXE** comes with a 250 A breaker, two 12" 4/0 AWG cables, and one 36" 4/0 AWG cable for interconnecting batteries. It also has spaces for up to 4 MNDC breakers. The MNBE- 8D2x2 enclosures can be stacked two high or side-by-side.

The MNBE-A may ship via UPS, but all other sizes ship by truck freight.

MidNite Solar Battery Enclosures

Model	Battery type	Battery capacity	Shelves included	Dimensions (D" x W" x H")	Shipping dimensions	Weight	Item code
MNBE-A	27 or 31 8D	six two	two	14.5 x 27.3 x 29.5	33 x 30 x 8 knockdown	65 lbs	**048-05501**
MNBE-C	27 or 31 or GC2	twelve	three	15.5 x 34 x 58	Ships by truck on a 42 x 42 x 60 pallet One or two enclosures on each pallet	261 lbs	**048-05505** **add crate fee[1]**
MNBE-C8D	4D or 8D	four	four				**048-05509** **add crate fee[1]**
MNBE-CL16	L-16	eight	two				**048-05510** **add crate fee[1]**
MNBE-D	27, 31, GC2	eight	two	15.5 x 34 x 42	43 x 19 x 8 & 43 x 19 x 9 knockdown	117 lbs	**048-05506**
MNBE-D3R						82 lbs	**048-05507**
MNBE-8D2x2 BASIC	4D or 8D	four	two	26.3 x 28.5 x 36	43 x 19 x 8 & 43 x 19 x 9 knockdown	116 lbs	**048-05502**
MNBE-8D2x2 DELUXE						121 lbs	**048-05522**
MN-SHELF	Extra shelf for MNBE-C, MNBE-D, MNBE-D3R or MNBE-E						**048-05520**

[1] Crate fee of $100 applies, up to two enclosures on one fee

Heavy Duty Plastic Battery Enclosures

These battery enclosures are made from high-density polyethylene (HDPE), the same material used to manufacture the outside cases of batteries. A removable lid with handles allows easy access to the batteries for service. Enclosures for L-16s are made with a removable middle section that minimizes lifting when installing the batteries. The HDPE is acid resistant and very strong but easy to drill with a hole saw for adding conduit fittings or battery filling tubes. The hydrogen vent fitting on the lid should be extended to the exterior of the building. Not intended for outdoor use.

Heavy Duty Plastic Battery Enclosures

Battery type	Battery capacity	Drain	Dimensions (D" x W" x H")	Item code
L16	four	No	14 x 33 x 22.5	**048-04014**
L16	four	Yes		**048-04015**
L16	eight	No	27 x 33 x 22.5	**048-04016**
L16	eight	Yes		**048-04017**

Power Vent 12 VDC

Zephyr

Power Vent Battery Box Vent

Lead-acid batteries produce hydrogen gas when charging, but leaving a battery box lid open to vent gas in cold climates can reduce battery capacity. Proper venting and thermal management is especially important when battery boxes are placed in basements, garages and sheds. As heat rises in the structure, a low pressure area forms around the battery box and pushes cool air into the box, which forces gases out and into the structure. The Power Vent controls battery box venting, removing hydrogen gas while reducing cold air infiltration into the box. The Power Vent contains a gravity-operated damper that normally stays closed. When connected to a voltage-controlled relay, the fan operates only when the batteries are being charged and blows gas vapors out. Designed for battery banks under 2,200 Ah and charge rates under 125 A. The fan can be operated from the auxiliary relay on high-end charge controllers or by a voltage- controlled switch (see Converters and Controls). The 12 and 24 VDC units use 3 W and push air at 6 CFM. They are 4" in diameter and 7.25" long with a 2" PVC pipe socket on the inlet and outlet. The 48 VDC unit uses 6 W and pushes 8 CFM. It measures 4" in diameter and is 10" long, with a 3" PVC pipe socket on the inlet and outlet.

Zephyr Power Vent Battery Box Vents	
Description	Item code
Power Vent 12 VDC	**085-08205**
Power Vent 24 VDC	**085-08207**
Power Vent 48 VDC	**085-08209**

QuickCote

Anti-Corrosion Protectant

QuickCote offers a complete acid neutralizing coating formulated especially for battery terminals and exposed electrical connections. The 8 oz can has a brush-on applicator that will give years of use and will not clog like aerosol coatings.

QuickCote Anti-Corrosion Protectant	
Description	Item code
QuickCote 8 oz	**046-00195**

Water Miser Battery Caps

Water Misers are molded plastic “flip-top” vent caps designed to reduce and ease maintenance on flooded lead-acid batteries. There is no need to remove the caps when charging, filling, or equalizing the batteries.

When charging, the plastic pellets capture up to 90% of the moisture and acid droplets. This reduces acid fumes and corrosion, and keeps the battery tops much cleaner and dryer. Excess water is dropped back into the battery cell. Water loss is reduced, which extends time between watering. These caps fit all batteries with standard bayonet caps.

Water Miser Battery Caps	
Description	Item code
Water Miser battery cap	**040-09913**

MidNite Hydro-volt hydrometer

An easy to use, temperature-compensated and accurate hydrometer. Use for measuring the specific gravity of flooded-battery electrolyte for state-of-charge determination. Made in Switzerland.

MidNite Hydro-volt	
Description	Item code
Hydro-volt battery hydrometer	**040-09918**

Power Panels

Power panels provide a central location for mounting inverters and charge controllers in battery systems and include enclosures for wiring, over-current protection, ground-fault and surge protection, bypasses and related hardware. See Battery-Based Inverters for OutBack FLEXware™ power panels as well as prewired OutBack Power and MidNite Solar power systems.

MNE STM Series E-Panel (Inverter Not Included)

MidNite Solar

E-Panel

The MidNite Solar **E-Panel** can help streamline the installation of battery-based inverters. They come standard with the basic overcurrent protection and disconnects required to install your renewable energy system in compliance with the NEC. They are internally pre-wired and labeled to save time and hassle in the field. E-Panels are listed to applicable UL and CSA standards for the U.S.A. and Canada. Made in U.S.A. See Battery-Based Inverters for pre-assembled power panels using E-Panels with inverters and charge controllers installed.

MidNite Solar E-Panels for Magnum Inverters

Magnum inverters are mounted on a unique hinged door to minimize system footprint. Mounting brackets are included to aid in one-person installations. They come with a main breaker, inverter connection, a 500 A/50 mV shunt for battery monitoring systems, an AC input and bypass, PV input busbars, DIN rails, three panel-mount breaker knockouts (120 VAC versions only), ground bus, remote display mounting brackets, a charge controller bracket, a wall-mount bracket and other hardware. 120/240 VAC models are for Magnum MS-PAE inverters..

MidNite Solar E-Panels for Magnum Inverters		
Model	**Description**	**Item code**
MNE175ALM-L	White aluminum chassis with 175 A inverter breaker	**034-05168**
MNE250ALM-L	White aluminum chassis with 250 A inverter breaker	**034-05166**
MNE175STM-L-240	White steel chassis with 175 A inverter breaker 120/240 VAC	**034-05167**
MNE250STM-L-240	White steel chassis with 250 A inverter breaker 120/240 VAC	**034-05169**

MNE AL-PLUS Series E-Panel (Inverter And Controller Not Included)

MidNite Solar E-Panels for OutBack Inverters

OutBack inverters are mounted on a hinged door to minimize system footprint. They come standard with a left-hand hinge, allowing the charge controller to be mounted on the right. The **STS** version has additional space for the OutBack AC box with a surge arrestor for grid-tie applications, and the **AL-PLUS** version has room to mount an inverter and a charge controller on the door. Right-hand hinged doors are available by special order. Mounting brackets are included to aid in one-person installations. A main breaker, inverter cables, a 500 A/50 mV shunt for battery monitoring systems, a 175 A AC power- distribution block, a 50 A AC-input disconnect for a generator or utility input, and a 50 A AC bypass switch are included and pre-wired. E-Panels for OutBack inverters also include a mounting bracket for an OutBack FM-series controller. Cutouts for mounting up to five additional 13 mm DIN-mount breakers are provided, as are cutouts for GFCI-style AC outlets and three panel-mount DC breaker slots. Circuit breakers and DC GFP are sold separately. Export models also available.

MidNite Solar E-Panels for OutBack Inverters		
Model	**Description**	**Item code**
MNE175STS-L	Gray steel stretched chassis with 175 A inverter breaker 15" wide – left hinge	**034-05131**
MNE250STS-L	Gray steel stretched chassis with 250 A inverter breaker 15" wide – left hinge	**034-05135**
MNE125AL-PLUS	White alum wide chassis with 125 A inverter breaker with charge-controller mount	**034-05147**
MNE175AL-PLUS	White alum wide chassis with 175 A inverter breaker with charge-controller mount	**034-05148**
MNE250AL-PLUS	White alum wide chassis with 250 A inverter breaker with charge-controller mount	**034-05149**

MidNite Solar E-Panel for Schneider Electric Conext XW+

The **MNE250XWP-SINGLE** or **MNE175XWP-SINGLE** is mounted directly below the XW+ inverter. It includes a 250 A, or 175 A inverter/battery breaker, AC inputs for generator and utility, knockouts for up to seven DIN-mount breakers and 12 panel-mount breakers, and a 500 A shunt. Tin-plated copper busbars connect to the XW's battery terminals. There are busbars for AC inputs, AC output, neutral, ground, PV + in, PV - in, Bat +, and Bat - covered by a metal dead-front behind the reversible door. Charge controllers mount to either or both sides. The AC bypass can be configured as input and output on/off as well as AC bypass. The XW MPPT controller requires no mounting bracket. **FM60**, **FM80**, and **Classic** controllers require right or left E-Panel charge controller **mounting brackets**. A right-hand bracket is included. The color-matched enclosure is 16"W x 17"H x 8.5"D, and weighs 38 lbs.

See Battery-Based Inverters for pre-assembled power panels using E-Panel with inverters and charge controllers installed.

MidNite Solar E-Panels for Schneider Electric Conext XW+ Inverters		
Model	**Description**	**Item code**
MNE250XWP-SINGLE	E-Panel for one XW+ inverter, 250 A main DC breaker	**034-05181**

MidNite Solar E-Panel for Schneider Electric Conext SW

The **MNE250SW** or **MNE175SW** is mounted next to the SW inverter. It includes a 250 A, or 175 A inverter/battery breaker. There are knockouts for up to 6 DIN-mount breakers and 4 panel-mount breakers, and a 500 A shunt. Tin-plated copper busbars connect to the SW's battery terminals. There are busbars for AC inputs, AC output, neutral, ground, PV + in, PV - in, Bat +, and Bat -. There are knockouts on top for two charge controllers. The color-matched enclosure is 17.6"W x 15.2"H x 7.5"D, and weighs 23 lbs. Export models available.

The **MNSW-SLIDER-30** has 30 A input and 50 A output/bypass breakers for a single-inverter installation.

The **MNSW-BACKPLATE** will mount both the SW E-panel and one SW inverter. Dimensions are 20"H x 33"L x 1.5"D, and weighs 15 lbs.

See Battery-Based Inverters for pre-assembled power panels using E-Panel with inverters and charge controllers installed.

MidNite Solar E-Panels for Schneider Electric Conext SW Inverters		
Model	**Description**	**Item code**
MNE250SW	E-Panel for one SW inverter, 250 A main DC breaker	**034-05188**
MNE175SW	E-Panel for one SW inverter, 175 A main DC breaker	**034-05189**
MNSW-BACKPLATE	Backplate for one SW E-panel and inverter	**034-05190**
MNSW-SLIDER-30	AC breakers and bypass assy for 120/240 VAC, 30 A breakers, 50 A bypass	**034-05192**

MNDC

MNDC PLUS

MNDC-C

MidNite Solar Mini-DC Disconnect Power Center (MNDC)

Use this small DC disconnect, which includes the inverter breaker (not in the MNDC-C), to provide overcurrent protection for any single inverter. The **MNDC** comes with a DIN rail for five additional DC breakers for DC loads, a charge controller disconnect, and a battery-status monitor. They also include a ground bus, and a 5/16" bonding battery-negative stud. Mounting holes for a 500 A shunt are built in. The white powder-coated aluminum chassis measures 18"H x 10"W x 5"D and weighs 7 lbs. Three main-breaker sizes are available. Left-side main-breaker placement is available by special order.

The **MNDC Plus version** has an additional DIN rail allowing up to ten DIN-mount breakers. Two DIN rail cover plates and two panel-mount plates are included. The panel-mount plates allow for mounting the 3/4" 150 VDC breakers that range from 60 A to 100 A. Additional configurations include: an MNDCGFP80 with four panel-mount breakers, or one MNDC-GFP, one 3/4" panel-mount breaker and five DIN-mount breakers with a 125-250 A inverter breaker. Circuit breakers and DC GFP are sold separately. Mounting is provided for a 500 A shunt and an MNTBB-R terminal busbar. Battery-negative stud and ground busbar included.

The **MNDC-C** comes with an adapter attached to mount one of the smaller single-pole panel mount breakers, available in sizes from 1 A to 100 A (3/4 inch MNEDC panel mount breaker not included). Chassis is white powder coated aluminum with 5 DIN rail breaker slots or 3 panel mount breaker slots.

MidNite Mini-DC Disconnect Power Center (MNDC)		
Model	**Description**	**Item code**
MNDC-C	Mini DC disconnect with space for 3/4" panel-mount breaker	**053-00094**
MNDC125	125 A Mini DC disconnect	**053-00091**
MNDC175	175 A Mini DC disconnect	**053-00092**
MNDC250	250 A Mini DC disconnect	**053-00093**
MNDC125-Plus	125 A Mini DC disconnect Plus version	**053-00096**
MNDC175-Plus	175 A Mini DC disconnect Plus version	**053-00097**
MNDC250-Plus	250 A Mini DC disconnect Plus version	**053-00098**

MidNite Solar Charge Controller Mounting Brackets

Right or left side charge control brackets, used to mount OutBack Power, Schneider Electric, and MidNite Classic MPPT controllers to the side of an E-Panel. These controller mounting brackets work with all MidNite E-Panels EXCEPT the Schneider Electric SW E-Panel and the Nottagutter.

MidNite Solar Charge Controller Mounting Brackets		
Model	**Description**	**Item code**
MNCCB-L	Charge controller mounting bracket – Left-side mounting	**034-05183**
MNCCB-R	Charge controller mounting bracket – Right-side mounting	**034-05179**


Baby Box


Big Baby Box


Quad Box


MNDC-15


MN Battery Combiner

MidNite Solar Breaker Boxes and Wiring Accessories

The **Baby Box** and **Big Baby Box** are small general purpose breaker boxes that will hold up to four DIN-mount breakers from 1 to 63 A. The Big Baby Box also includes a ground box lug and mounting provisions for a short insulated busbar. The Big Baby Box's dimensions are 9"H x 5"W x 4"D, and it weighs 3 lbs. The **MNEDC Quad** is the same size as the Big Baby but holds up to 4 MNEDC-type panel-mount AC/DC breakers or panel-mount GFP breakers. The **MNDC15** is a general-use enclosure that will hold up to 15 MNEDC type panel-mount breakers, and one larger 175 or 250 A breaker on the end. These breakers are sold separately. The MNDC15 dimensions are 23"H x 12"W x 3.5"D, and it weighs 25 lbs. These breaker boxes are listed to applicable UL standards.

The **MNBCB-1000/100** Battery Combiner can be used to combine circuits from multiple inverters or battery strings or both. There are spaces for six large 175 A or 250 A breakers on both ends. 35.5” W x 22”H x 9.75”D, and weighs 50 lbs. The **MNBCB-1000/50** is similar, but has a shunt with the correct ratio for the SMA Sunny Island system.

Add the **MNBCB-Busbar** for more connections, useful for the inverter side of the shunt. It has five 3/8” studs and hole for the shunt connection and comes with red and white insulators.

Busbars

These UL-listed busbars can be used in the Mini-DC Disconnect above. Each **MNT** bar has colored insulation, four 1/0 AWG and eleven 6 AWG usable wire slots with 10-32 UNF screws, and is 4.63" long. The **MNS** is a shorter version, useful for PV + input on the narrow OB E-Panel, Big Baby Box, Quad box and for a separate PV busbar for charge controllers. The MNS has four 6 AWG and two 1/0 AWG wire slots. The MNG ground busbar is 3.45" long with green screws and has two 1/0 AWG and seven 6 AWG wire slots with mounting screws. The **MNIBIGBUSBAR** is a pair for positive and negative with five battery connections and six small wires. The **MNSHUNT** has four studs besides the shunt connection.

The **MNBREAKERADAPTER** allows the mounting of a 3/4"-wide panel-mount breaker in a 1” breaker space.

MidNite Breaker Boxes and Busbars		
Model	**Description**	**Item code**
Big Baby Box	Big Baby Box breaker center holds 4 DIN DC breakers	**053-00088**
MNEDC QUAD	Quad breaker center holds 4 MNEDC 3/4" DC breakers	**053-00087**
MNDC-15	Circuit breaker box for 15 panel mount and one large panel mount breaker	**053-00086**
MNBCB-1000/100	Combiner for multiple inverters or battery strings w/ 1,000 A 100 mv shunt	**034-00006**
MNBCB-1000/50	Combiner for multiple inverters or battery strings w/ 1,000 A 50 mv shunt for SMA Sunny Island and Schneider Conext Battery Monitor	**034-00009**
MNBCB Busbar	1000 A bus bar for the Battery Combiner	**053-00118**
MNTBB-R	Long red terminal busbar	**053-00105**
MNTBB-B	Long black terminal busbar	**053-00106**
MNTBB-W	Long white terminal busbar	**053-00107**
MNGBB	Long ground busbar - 3.45" long	**053-00100**
MNSBB-R	Short red terminal busbar	**053-00108**
MNSBB-B	Short black terminal busbar	**053-00109**
MNSBB-W	Short white terminal busbar	**053-00110**
Big Busbar	Big busbar with 5 studs, insulator mounts, aux terminal bar, 280 A	**053-00115**
Shunt Busbar	Shunt busbar with 4 studs and short aux terminal bar	**053-00117**
MNBreaker Adapter	Adapter to mount a 3/4" panel mount breaker in a larger breaker space	**053-03106**


Long Terminal Busbar


Short Terminal Busbar


Big Busbar


Shunt Busbar

Fuses and Breakers

Fuses and breakers are designed to prevent excessive current from overheating conductors or devices by opening the circuit. Specialized breakers can also be deployed to open the circuit in case of ground or arc-fault conditions. Fuses and breakers should be sized according to NEC and/or manufacturer guidelines to ensure that they open the circuit before conductors or equipment can become damaged. See Reference for typical ampacity limits by wire size.

Morningstar

DC Ground-Fault Protection Devices

These two GFPD devices from Morningstar Corp. have more advanced safety features than the traditional method of breaking the grounded conductor bond. It detects a current imbalance between the conductors and breaks both conductors in the faulted circuit, isolating the circuit. It does not break the grounded conductor bond to ground and allows unaffected controller circuits to continue to function normally. The battery and DC loads in the system will continue to function in a safe grounded manner. The trip threshold is 300 mA for extra safety and is more accurate than a breaker-type GFP. There is visual and audible trip notification, LED status, and a test button. It does require a small amount of power from the system battery bank at 12 VDC to 48 VDC. Both units are listed to UL 1741, additionally the **GFPD-150V** is listed to UL-489 and the **GFPD-600V** is listed to UL-1077.

DC Ground Fault Protection Devices						
Model	Poles	Current	Voltage rating	Dimensions (H" x W' x D")	Weight	Item code
GFPD-150V	two	60 A	150 VDC	10.6 x 5.1 x 4.4	5 lbs	**053-03164**
GFPD-600V	two	50 A	600 VDC	14.1 x 8.7 x 4.2	9 lbs	**053-03165**

Circuit Breakers

DC Ground-Fault-Protection Circuit Breakers

These breakers use a trip mechanism to connect battery negative and earth ground to open the larger breaker in case of a ground fault. The NEC requires DC ground-fault protection on all solar installations. The DIN rail mount GFPs will mount in the Magnum MMP and MidNite E-Panels. The panel-mount GFPs will mount in the OutBack FLEXware enclosures and one or two poles in MidNite E-Panels. The 100 A unit can be used normally as a two-pole GFP, or with ungrounded arrays breaking positive and negative, or shunt tripped by a signal from a MidNite Classic charge controller or MNBDM.

DC Ground Fault Protection Circuit Breakers						
Amps	Poles	Mount type	Voltage rating	Width	Model	Item code
80 A	one	Panel with ¼" studs	150 VDC	1.5"	PNL-GFDI-80	**053-03144**
80 A	two	Panel with ¼" studs	150 VDC	2.25"	PNL-GFDI-80D	**053-03145**
80 A	four	Panel with ¼" studs	150 VDC	3.75"	PNL-GFDI-80Q	**053-03146**
63 A	one	DIN rail with screw lugs	150 VDC	1"	MNDC-GFP63	**053-03147**
80 A	one	Panel with ¼" studs	150 VDC	1.5"	MNDC-GFP80	**053-03148**
50 A	one	DIN rail with screw lugs	300 VDC	2"	MNDC-GFP50-300	**053-03149**
100 A	two	Panel with ¼" studs	150 VDC	3"	MNDC-GFP100RT-2P	**053-03150**

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DIN-mount AC Circuit Breakers

These are DIN-mount AC breakers with set-screw compression terminals for 14 to 2 AWG wire. Use these for AC in OutBack Power FLEXware and MidNite Solar E-Panels.

DIN-mount AC Circuit Breakers						
Amps	**Poles**	**Voltage rating**	**Width**	**Vendor**	**Vendor part Number**	**Item code**
15 A	one	120 VAC	0.5"	OutBack	DIN-15-AC	**053-03061**
15 A	two	120/240 VAC	1"	OutBack	DIN-15D-AC	**053-03062**
20 A	one	120 VAC	0.5"	OutBack	DIN-20-AC	**053-03063**
20 A	two	120/240 VAC	1"	OutBack	DIN-20D-AC	**053-03064**
25 A	two	120/240 VAC	1"	OutBack	DIN-25D-AC	**053-03065**
30 A	one	120 VAC	0.5”	MidNite	MNEAC30	**053-03171**
30 A	two	120/240 VAC	1"	MidNite	MNEAC30-2P	**053-03175**
35 A	two	120/240 VAC	1"	MidNite	MNEAC35-2P	**053-03176**
40 A	one	120 VAC	0.5”	MidNite	MNEAC40	**053-03172**
40 A	two	120/240 VAC	1"	MidNite	MNEAC40-2P	**053-03177**
50 A	one	120 VAC	0.5”	MidNite	MNEAC50	**053-03173**
50 A	two	120/240 VAC	1"	MidNite	MNEAC50-2P	**053-03178**
60 A	one	120 VAC	0.5”	MidNite	MNEAC60	**053-03174**
60 A	two	120/240 VAC	1"	MidNite	MNEAC60-2P	**053-03179**
10 A	one	277 VAC	0.5"	OutBack	DIN-10-AC-277	**053-03060**
15 A	one	277 VAC	0.5"	OutBack	DIN-15-AC-277	**053-03066**
30 A	one	277 VAC	0.5"	OutBack	DIN-30-AC-277	**053-03067**
30 A	two	277 VAC	1"	OutBack	DIN-30D-AC-480	**053-03068**
50 A	one	277 VAC	0.5"	OutBack	DIN-50-AC-277	**053-03070**
50 A	two	277 VAC	1"	OutBack	DIN-50D-AC-480	**053-03071**
60 A	one	277 VAC	0.5"	OutBack	DIN-60-AC-277	**053-03073**
60 A	two	277/480 VAC	1"	OutBack	DIN-60D-AC-480	**053-03036**

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Need assistance? Call your AEE Solar rep, or Sales Support at **800-777-6609**.

DIN-mount DC Circuit Breakers

DIN-mount breakers fit MidNite Solar and Magnum Energy enclosures, and MidNite Solar and OutBack Power PV array combiners. These breakers are polarized, so the positive wire from the power source needs to be connected to the "+" side of the breaker. The maximum PV array voltage must not exceed the voltage rating of the breakers used. The 600 VDC breakers also have a remote-trip actuator, useful for rapid shutdown.

DIN-mount 150 VDC Circuit Breakers				
Amps	**Voltage rating**	**Width**	**MidNite model**	**Item code**
1 A	150 VDC	0.5"	MNEPV1	**053-03033**
2 A	150 VDC	0.5"	MNEPV2	**053-03034**
3 A	150 VDC	0.5"	MNEPV3	**053-03024**
4 A	150 VDC	0.5"	MNEPV4	**053-03020**
5 A	150 VDC	0.5"	MNEPV5	**053-03025**
6 A	150 VDC	0.5"	MNEPV6	**053-03021**
8 A	150 VDC	0.5"	MNEPV8	**053-03022**
9 A	150 VDC	0.5"	MNEPV9	**053-03023**
10 A	150 VDC	0.5"	MNEPV10	**053-03026**
12 A	150 VDC	0.5"	MNEPV12	**053-03027**
15 A	150 VDC	0.5"	MNEPV15	**053-03029**
20 A	150 VDC	0.5"	MNEPV20	**053-03030**
30 A	150 VDC	0.5"	MNEPV30	**053-03032**
40 A	150 VDC	0.5"	MNEPV40	**053-03039**
50 A	150 VDC	0.5"	MNEPV50	**053-03035**
60 A	150 VDC	0.5"	MNEPV60	**053-03037**
63 A	150 VDC	0.5"	MNEPV63	**053-03038**
80 A	150 VDC	1.0"	MNEPV80	**053-03133**
100 A	150 VDC	1.0"	MNEPV100	**053-03134**

DIN-mount 300 VDC Circuit Breakers					
Amps	**Mount type**	**Voltage rating**	**Width**	**MidNite model**	**Item code**
7 A	DIN rail with screw lugs	300 VDC	1"	MNEPV7-300	**053-03107**
10 A	DIN rail with screw lugs	300 VDC	1"	MNEPV10-300	**053-03110**
12 A	DIN rail with screw lugs	300 VDC	1"	MNEPV12-300	**053-03112**
15 A	DIN rail with screw lugs	300 VDC	1"	MNEPV15-300	**053-03115**
20 A	DIN rail with screw lugs	300 VDC	1"	MNEPV20-300	**053-03120**
30 A	DIN rail with screw lugs	300 VDC	1"	MNEPV30-300	**053-03125**
50 A	DIN rail with screw lugs	300 VDC	1"	MNEPV50-300	**053-03130**
DIN-mount 600 VDC Circuit Breakers					
16 A	DIN rail with screw lugs	600 VDC	2"	MNEPV16-600-RT	**053-03116**
20 A	DIN rail with screw lugs	600 VDC	2"	MNEPV20-600-RT	**053-03121**

Panel-mount AC/DC Circuit Breakers

These are single-pole ¾"-wide breakers with ¼" stud connections and require ring terminals on wires connected to them. These breakers can be used for DC protection in OutBack Power FLEXware and Radian GSLC enclosures, and MidNite E-Panels (three spaces), or as AC breakers in the OutBack Power FLEXware 250. The two-pole AC and MidNite 300 VDC breakers are double width and take two spaces. The OutBack 300 VDC single pole take one space and the two pole breakers take two spaces each. The AC breakers are for use with the Radian inverter GSLC panels. The 300 VDC two pole breakers can be used to meet 2017 code to break both the positive and negative PV legs. OutBack Power breaker models ending in "RT" are remote trip breakers that can be used with the ICS+ system for rapid shutdown, see OutBack ICS+ pages later in this section.

Panel-mount AC/DC Circuit Breakers							
Amps	Poles	AC voltage rating	DC voltage rating	Width	Vendor	Vendor part Number	Item code
1 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-1-AC/DC	**053-03135**
5 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-5-AC/DC	**053-03136**
10 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-10-AC/DC	**053-03137**
15 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-15-AC/DC	**053-03138**
20 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-20-AC/DC	**053-03139**
30 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-30-AC/DC	**053-03140**
40 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-40-AC/DC	**053-03141**
50 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-50-AC/DC	**053-03142**
60 A	one	120 VAC	150 VDC	0.75"	OutBack	PNL-60-AC/DC	**053-03143**
70 A	one	--	150 VDC	0.75"	OutBack	PNL-70-AC/DC	**053-03151**
80 A	one	--	150 VDC	0.75"	OutBack	PNL-80-DC	**053-03152**
90 A	one	--	150 VDC	0.75"	MidNite	MNEDC-90	**053-03156**
100 A	one	--	150 VDC	0.75"	MidNite	MNEDC-100	**053-03153**
30 A	one	--	300 VDC	1.5"	MidNite	MNEDC30-300	**053-03126**
60 A	one	--	300 VDC	1.5"	MidNite	MNEDC60-300	**053-03132**
80 A	one	--	300 VDC	1.5"	MidNite	MNEDC80-300	**053-03131**
30 A	one	250 VAC	--	0.75"	OutBack	PNL-30-AC	**053-16998**
50 A	one	250 VAC	--	0.75"	OutBack	PNL-50D-AC-250	**053-16999**
50 A	two	240 VAC	--	1.5"	OutBack	PNL-50D-AC-120/240	**053-17004**
75 A	one	--	300 VDC	1.5"	OutBack	PNL-75-DC-RT	**053-01062**
75 A	two	--	300 VDC	2.2"	OutBack	PNL-75D-DC-RT	**053-01063**
75 A	four	--	300 VDC	3.8"	OutBack	PNL-75Q-DC-RT	**053-01064**
40 A	one	–	300 VDC	0.75"	OutBack	PNL-40-300VDC	**053-17014**
60 A	one	–	300 VDC	0.75"	OutBack	PNL-60-300VDC	**053-17015**
80 A	one	–	300 VDC	0.75"	OutBack	PNL-80-300VDC	**053-17011**
100 A	one	–	300 VDC	0.75"	OutBack	PNL-100-300VDC	**053-17012**
125 A	one	–	300 VDC	0.75"	OutBack	PNL-125-300VDC	**053-17013**
40 A	two	–	300 VDC	1.5"	OutBack	PNL-40D-300VDC	**053-17016**
60 A	two	–	300 VDC	1.5"	OutBack	PNL-60D-300VDC	**053-17017**
80 A	two	–	300 VDC	1.5"	OutBack	PNL-80D-300VDC	**053-17018**

CD and GJ Panel-mount DC Circuit Breakers

These are single-pole panel-mount breakers with stud terminals that require ring terminals on the wires connected to them (except the three items with lugs). Breakers up through 80 A can be used in the Conext XW+ Distribution Panel. The 100 A and larger DC breakers fit in the OutBack Power FLEXware enclosures and MidNite E-Panels. Rated for 125 VDC only (except the 60 A lug breaker, which is rated at 160 VDC). MidNite breaker models ending in "RT" are remote trip breakers that can be used with the MNBDM for rapid shutdown.

Panel-mount DC Circuit Breakers CD and GJ							
Amps	Poles	Stud size	Voltage rating	Width	Vendor	Vendor part Number	Item code
60 A	one	1/0 AWG	160 VDC	1"	Schneider	BKR 60	**053-01038**
80 A	one	1/0 AWG	125 VDC	1"	Schneider	BKR 80	**053-01039**
100 A	one	1/0 AWG	125 VDC	1"	Schneider	BKR 100	**053-01034**
100 A	one	5/16"	125 VDC	1"	OutBack	PNL-100-DC	**053-01050**
125 A	one	5/16"	125 VDC	1"	OutBack	PNL-125-DC	**053-01052**
125 A	one	5/16"	125 VDC	1"	MidNite	MNEDC125RT	**053-01047**
175 A	one	3/8"	125 VDC	1.5"	OutBack	PNL-175-DC	**053-01053**
250 A	one	3/8"	125 VDC	1.5"	OutBack	PNL-250-DC	**053-01054**
175 A	one	3/8"	125 VDC	1.5"	MidNite	MNEDC175	**053-01067**
250 A	one	3/8"	125 VDC	1.5"	MidNite	MNEDC250	**053-01068**
175 A	one	3/8"	125 VDC	1.5"	MidNite	MNEDC175RT	**053-01048**
250 A	one	3/8"	125 VDC	1.5"	MidNite	MNEDC250RT	**053-01049**

CF and GJ Surface (Back) Mount DC Circuit Breakers

The **BR-DC175** and **BR-DC250** function as the inverter's DC disconnect switch and can be used as the battery-to-inverter circuit protection. Each breaker includes two 3/8-16 front facing Hex head bolts with washers, and a back mount kit for installing this breaker inside Magnum Energy MP enclosures. This kit consists of two mounting straps and two #10-32 x 3.5" Torx screws to attach the DC breaker to a mounting panel.

The DC breaker **BR-DC75-BM** and **BR-DC100-BM** are commonly used as disconnects for charge controllers and DC loads. These breakers can back-mountable and use a front accessible pressure terminal connectors that can accept 14 to 0 AWG wire.

These breakers are rated for use in systems up to 125 VDC.

CF and GJ Surface (Back) Mount DC Circuit Breakers					
Amps	Terminal	DC voltage rating	Width	Generic model	Item code
175 A	3/8" stud	125 VDC	1.5"	BR-DC175	**053-01059**
250 A	3/8" stud	125 VDC	1.5"	BR-DC250	**053-01060**
75 A	0 AWG Lug	125 VDC	1"	BR-DC75-BM	**053-01069**
100 A	0 AWG Lug	125 VDC	1"	BR-DC100-BM	**053-01070**

Note: These breakers must be mounted in a vertical position to meet the specified trip current and trip delay curve.

Square D QOU Pass-Through Circuit Breakers

QOU circuit breakers are designed for surface or DIN mounting. They are UL-listed for DC branch circuits up to 48 VDC (not for use in 48 VDC systems) and can be used for 120 VAC (single-pole) and 120/240 VAC (two-pole). Circuit breakers in 10 A to 30 A sizes can handle one or two 14 to 10 AWG or one 8 AWG wire. Circuit breakers in 40 A to 70 A sizes will handle 8 to 2 AWG wire.

Square D QOU (DIN or Surface Mount) Pass-Through Circuit Breakers						
Poles	Amps	AC voltage rating	DC voltage rating[1]	Width	Model	Item code
One	30 A	120 VAC	48 VDC	0.75"	QOU130	**053-02024**
	60 A	120 VAC	48 VDC	0.75"	QOU160	**053-02042**
Two	30 A	120/240 VAC	48 VDC	1.5"	QOU230	**053-02027**
	60 A	120/240 VAC	48 VDC	1.5"	QOU260	**053-02045**

[1]Not rated for use in 48 VDC systems

Fuses

600 and 1,000 VDC Midget Fuses and DIN Rail Mount Fuse Holders

The fuse holder and fuses below fit MidNite Solar MNPV and OutBack Power FLEXPV and other 600 and 1,000 VDC array combiners, but these fuse holders do NOT fit SolaDeck combiners. These fuses are also used in the integrated combiners in many commercial grid-tie inverters.

Midget Fuses		
Amps	Item code	
	600 VDC	1000 VDC[1]
1 A	–	**053-03166**
2 A	**053-03052**	–
4 A	**053-03051**	–
6 A	**053-03050**	–
8 A	**053-03048**	–
10 A	**053-03046**	–
12 A	**053-03044**	–
15 A	–	**053-03167**
20 A	–	**053-03168**
30 A	–	**053-03169**

[1]In most situations 1000VDC fuse can be used in 600VDC applications.

Fuse Holders	
Description	Item code
CHM1 Fuse Holder - 600 V 30 A Max - DIN-mount	**053-03040**
USM1-DC1000 Fuse Holder 1000 VDC – DIN-mount	**053-03170**

Class-R Fuses

The **250 VAC/125 VDC** Class R fuses can be used in AC circuits up to 250 VAC or DC circuits up to 125 VDC. The **600 VAC/VDC** fuses can be used for AC or DC circuits. They have the high amp interrupting capacity (AIC) required for fusing circuits powered by batteries. They can be used to protect wiring to small inverters (100-700 W) and wiring from charging sources. These UL-listed fuses can be used in fused safety disconnect switches and most large system sub-array combiners.

Class-R Fuses		
Amps	Item code	
	250 VAC/125 VDC	600 VAC/VDC
30 A	**053-02456**	**053-02459**
40 A	**053-02462**	**053-02463**
50 A	**053-02465**	**053-02466**
60 A	**053-02468**	**053-02471**
100 A	**053-02474**	**053-02477**
125 A	**053-02478**	–
150 A	**053-02479**	**053-02482**
200 A	–	**053-02483**

Class-T Fuse Blocks with Fuses

Use these single-pole fuse blocks to fuse inverters or other large loads. A 5/16" stud-mount at each end of the fuse allows connection of a cable with a ring-lug terminal end. To connect an inverter, order two cables with lugs on both ends: one to go from the battery to the fuse and one to go from the fuse to the inverter. Class T fuses exceed the 10,000 A interrupting capacity (AIC) required to protect Square-D brand circuit breakers in DC load centers. They are UL-listed for up to 160 VDC and NEC compliant for inverter use. A fuse comes installed in the block. Order spare fuses separately.

Class-T Fuse Holders and Fuses		
Model	Description	Item code
FB1-200	200 A fuse and holder with studs	**053-02526**
FB2-300	300 A fuse and holder with studs	**053-02544**
FB2-400	400 A fuse and holder with studs	**053-02559**

Class-T JJN Fuses

These Class T fuses are rated for 160 VDC and 300 VAC as protection for circuit breakers, load centers, and inverters where high available short- circuit currents are possible. These fuses fit the fuse blocks described above.

Class-T Fuses		
Model	Description	Item code
JJN110	110 A replacement fuse	**053-02509**
JJN200	200 A replacement fuse	**053-02520**
JJN300	300 A replacement fuse	**053-02538**
JJN400	400 A replacement fuse	**053-02556**

Surge Protection

Photovoltaic, wind, and hydroelectric systems usually have long runs of exposed wire that can pick up surges from lightning, even if it is not a direct lightning strike. These power surges can damage sensitive electronic components in meters, charge controllers, and inverters. Surges can also damage telephone, audio, and video equipment connected to the power system. It is a good idea to install surge protection on all incoming wires in the system, including incoming photovoltaic, wind, or hydroelectric power lines; AC generator lines; and telephone and antenna leads. Proper grounding is absolutely necessary for lightning protection to be effective. In the event of a direct strike, damage may occur, even with surge protectors installed. Type 1 heavy-duty surge protectors are recommended when a direct lightning strike is possible on the installation.

MidNite Surge-Protector Device

MNSPD FMB

MidNite Solar

MidNite Surge-Protector Device (MNSPD)

The **MidNite Solar Surge-Protector Device (MNSPD)** is a Type 2 device designed for both AC and DC systems and provides protection to service panels, load centers, or where the SPD is directly connected to the electronic device requiring protection. Maximum protection will only be achieved if the SPD is properly installed.

The MidNite Solar SPD is offered in four versions to maximize the required protection level. Protection is achieved by reducing the clamping voltage to a safe voltage that your system can sustain without damaging the electronics. The MidNite Solar SPD voltage rating should be chosen according to the nominal voltage of the system. Response time is 8/20 µs to clamp 128,000 A. There are two LEDs in each unit that will indicate when the unit is functioning correctly and there is voltage to it.

Install the **MNSPD-115** for surge protection on wires coming from a 12, 24, or 48 VDC PV array, DC wind generator or DC hydroelectric turbine. The **MNSPD-300-DC** unit works well for systems rated at 150 VDC and larger systems with sources up to 300 VDC. The **MNSPD-300-AC** can be used on 120/240 VAC split-phase or two legs each on 208 VAC circuits. The **MNSPD-600** is designed for high-voltage grid-tie PV arrays, or two legs each on 480 VAC circuits. Lightning protection can be installed in a combiner box, DC or AC load center or grid-tie inverter. These devices can be used on your AC load center to protect your equipment from surges from the utility lines and on AC wiring running outside of the building, to generators, to pumps, or to outbuildings. These surge arrestors mount in a ½" knockout and are covered by a five-year material and workmanship warranty.

MidNite Solar Surge Protector Devices				
Model	**Description**	**Nominal DC voltage**	**Nominal AC voltage**	**Item code**
MNSPD-115	Surge-Protector Device	0-115 VDC	--	**053-04141**
MNSPD-300-DC	Surge-Protector Device	0-300 VDC	--	**053-04143**
MNSPD-300-AC	Surge-Protector Device	--	120/240 or 208 VAC	**053-04142**
MNSPD-600	Surge-Protector Device	0-600 VDC	480 VAC	**053-04146**
MNSPD FMB	Flush-mount box for SPD			**053-04140**

Citel

Citel DS2xxDC Off-Grid Surge Arrestors

The Citel **DS2xxDC** series is designed to protect the charge controller and other system electronics in 12 VDC, 24 VDC, 48 VDC, 150 VDC and 250 VDC off-grid PV systems. The maximum voltage should not be exceeded in any conditions; use the next higher rated unit if necessary. DS2xxDC series protectors automatically reset after each lightning surge or electrical transient. These DIN-mount surge arrestors offer superior protection for charge controllers and inverters in low-voltage DC systems.

Citel DS50PV and DS60VGPV Grid-Tie Surge Arrestor

The **DS50PV-600** is designed to protect the solar array at the solar PV array combiner box for a utility-interactive PV system. The DIN-mount DS50PV is designed for moderate lightning areas and has replaceable modules. Use the DS50PV-600 for systems with inverters that have an upper limit of up to 600 VDC. The **DS60VGPV-1000 (1500G)** are DIN-mount heavy-duty surge protectors, recommended for high lightning areas. Use the **DS60VGPV-1000** for systems with inverters that have an upper limit of up to 600 VDC or 1,000 VDC. Use the **DS60VGPV-1500G/51** for systems with inverters that have an upper limit of up to 1,500 VDC. The use of a surge protector is recommended at both ends of the DC power supply line (solar array side and inverter/converter side).

DC Citel Surge Arrestors				
Model	**Maximum volts**	**Max surge rating**	**Width**	**Item code**
DS220-12DC	24 VDC	20 kA 8/20 µs	0.7" (18 mm)	**053-04234**
DS220-24DC	38 VDC	20 kA 8/20 µs	0.7" (18 mm)	**053-04235**
DS230-48DC	65 VDC	30 kA 8/20 µs	0.7" (18 mm)	**053-04236**
DS240-130DC	180 VDC	40 kA 8/20 µs	0.7" (18 mm)	**053-04237**
DS50PV-600	680 VDC	40 kA 8/20 µs	1.4" (36 mm)	**053-04219**
DS60VGPV-1000	1,200 VDC	40 kA 8/20 µs	2.8" (72 mm)	**053-04231**
DS60VGPV-1500G/51	1,500 VDC	40 kA 8/20 µs	2.8" (72 mm)	**053-04239**

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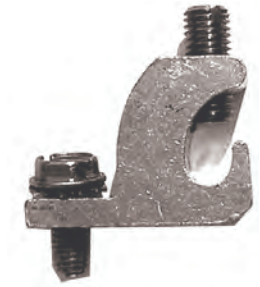
Grounding

Proper equipment grounding helps to ensure that any electrical faults that may develop in a PV system have minimal opportunities to cause fires or electrical shocks. It is just as important to be familiar with NEC 250's general grounding requirements when installing PV as it is to know 690. Jurisdictions and inspectors may vary on the grounding equipment and techniques they consider acceptable, so it is also important to know what your inspector will be looking for.

SnapNrack, as well as some other mounting system brands, now offer UL 2703 listed racking packages that incorporate much of the equipment grounding by bonding modules and related gear to the rails. However, not all equipment is considered compatible or likely to be accepted by a particular inspector, so it's important to have some other options like those offered here.



Lay-in Lugs for Module Grounding

These UL -listed tin-plated copper lugs have stainless-steel set screws and come with either stainless-steel thread-forming screws and lock washers, or a longer thread-cutting stainless steel screw with stainless-steel star-washer captive on the nut. Consult the module manufacturer's installation guide to see which type(s) meet NEC requirements for connecting a continuous ground wire to that module. Available in packages of ten.

Lay-in Lugs	
Description	**Item code**
Bag of ten lay-in lugs with screws	**051-03414**
Bag of ten lay-in lugs with long screws and nuts	**051-03418**

Tyco Grounding Connector

This all-stainless steel grounding lug is like a split bolt with a mounting stud and can be used on most modules and mounting rails. The mounting stud is 8 AWG and comes with a star washer captive on the nut. It takes 6 or 8 AWG solid copper ground wire. Use this grounding lug where corrosion is a consideration. Listed to UL 467.

Tyco Grounding Connector	
Description	**Item code**
Tyco solar grounding connector	**051-03420**

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Array Combiners

Array combiners are used to electrically combine the output of multiple series strings of PV modules into a single wire to simplify the connection to an inverter or charge controller. They typically include string-level overcurrent protection and sometimes host other functions such as monitoring, a disconnect, or even AFCI and remote shutdown. It is important that the combiner used be rated for the worst-case voltage and current the array can output.

OutBack Power

FLEXware PV Combiners

The **FLEXware PV8** and **PV12** accommodate overcurrent protection requirements for off-grid and grid-connected applications. The DIN rail can be fitted with 150 VDC circuit breakers for low-voltage PV arrays or 600 VDC fuse holders for higher voltage grid-tie arrays and charge controllers. Rated NEMA 3R, the powder-coated aluminum chassis can be mounted on a wall, a sloped roof, or a pole. Dual output lugs allow connection for up to 2/0 AWG wire. An easily-removable flame-retardant polycarbonate deadfront panel prevents accidental contact with live terminals. **FWPV8** has one output circuit and **FWPV12** can be configured to have one or two output circuits. Negative and ground terminal busbars are included. The two output circuits can be used for fuses in both the negative and positive legs for up to four strings into transformerless inverters. Limited to 15 A breakers or fuses. Listed to UL 1741.

FLEXware ICS PV Combiners

The **FLEXware ICS PV** combiners come with or without fuse holders pre-installed in the combiner, and include distribution blocks and cable gland. The **FWPV6** can be used with up to six strings at 600 VDC. Fuse holders need to be added in the quantity needed. The **FWPV6-FH600** comes with six touch-safe midget fuse holders, and **FWPV4-FH600** comes with four touch-safe midget fuse holders. Listed to UL 1741.

OutBack FLEXware PV Combiners					
Model	**# of breakers**	**# of fuse holders**	**Dimensions (L" x W" x H")**	**Weight**	**Item code**
FWPV8	eight (not incl.)	six (not incl.)	15.2 x 9.2 x 3.9	4.4 lbs	**053-03012**
FWPV12	twelve (not incl.)	eight (not incl.)	15.2 x 12.7 x 3.9	5.9 lbs	**053-03014**
OutBack FLEXware ICS PV Combiners					
FWPV6	--	six (not incl.)	11.5 x 8.25 x 3.75	2.5 lbs	**053-03006**
FWPV6-FH600	--	six	11.5 x 8.25 x 3.75	3.2 lbs	**053-03007**
FWPV4-FH600	--	four	11.5 x 8.25 x 3.75	3.5 lbs	**053-03008**

FLEXware ICS Plus Combiner Solution

The **FLEXware ICS Plus** system will offer a complete UL-listed solution to meet the 2014 NEC requirements for arc fault protection (AFCI), rapid shutdown, and combiner DC disconnect. Used with OutBack power conversion and energy storage equipment, it represents the only end-to-end single manufacturer UL-1741 and UL-1699B solution on the market for battery-based systems.

The **FWPV6-FH600-SDA** combiner has six string capacity, and includes UL-1699B listed AFCI, manual disconnect (lockable in the off position), and rapid shutdown capability. Outdoor rated NEMA 3R that can be mounted vertical to horizontal with external mounting feet. Rated for 15A or 20A fuses and combined capacity of 96A and 600VDC. Includes six 600 VDC DIN-mounted fuse holders (fuses not included see fuse section). The **FWPV6-FH600-SD** combiner is the same but does not include the AFCI.

The **RSI** is the rapid shutdown initiation device. This is installed in an accessible location where the first responders on site can use it to shut down the solar system. The RSI also will indicate a rapid shutdown or arc fault shutdown with LED status. The system is manually shutdown, or reset, by turning the disconnect handle. The auxiliary contacts in the RSI can also be used to signal the inverter in the system to shutdown using the inverters remote on/off switch.

The **BKR-CTRL-DC** is the power supply and control for the relay-trip breakers **PNL-75-DC-RT, PNL-75D-DC-RT**, or **PNL-75Q-DC-RT** installed in the power center to disconnect the charge control end of the PV circuit on rapid shutdown. The **BKR-CTRL-DC** can be installed in a panel breaker space or surface mounted and can power up to two relay-trip breakers and six ICSPlus combiner boxes. The relay-trip breakers install in place of the array breakers in the power center and act to disconnect the PV output circuits from the potential back feed from the charge controls. They are available with one, two, or four poles for the same number of combiners and charge controls. Each breaker takes up the number of spaces that there are poles plus one more.

OutBack Power FLEXware ICSPLUS Kits		
Model	**Description**	**Item code**
ICSPLUS-1	ICSPlus system, includes one FWPV6-FH600-SDA combiner, one RSI initiator, one BKR-CTRL-DC breaker control, and one PNL-75-DC-RT single breaker	**053-03315**
ICSPLUS-2	ICSPlus system, includes two FWPV6-FH600-SDA combiners, one RSI initiator, one BKR-CTRL-DC breaker control, and one PNL-75D-DC-RT dual breaker	**053-03316**
ICSPLUS-4	ICSPlus system, includes four FWPV6-FH600-SDA combiners, one RSI initiator, one BKR-CTRL-DC breaker control, and one PNL-75Q-DC-RT quad breaker	**053-03317**
SkyBox RSD-1	ICS Plus PV rapid shutdown package for SkyBox. Compatible with up to three strings of PV source circuits. Includes one FWPV3-FH600-S2D shutdown box, one RSI, and one power supply.	**053-03313**

OutBack Power FLEXware ICSPLUS Components				
Model	**Description**	**Dimensions (L" x W" x H")**	**Weight**	**Item code**
FWPV6-FH600-SDA	Six string combiner, AFCI, Disco, RSD	19.5 x 15.5 x 4.5	12 lbs	**053-03318**
RSI	Rapid Shutdown Initiator	14.1 x 7.3 x 3.75	4 lbs	**053-03320**
BKR-CTRL-DC	DC Breaker Control & Power Supply	0.75 to 2.0 Wide	--	**053-03321**
PNL-75-DC-RT	Relay-Trip Breaker Single circuit	1.5 Wide	--	**053-01062**
PNL-75D-DC-RT	Relay-Trip Breaker Dual circuits	2.2 Wide	--	**053-01063**
PNL-75Q-DC-RT	Relay-Trip Breaker Four circuits	3.8 Wide	--	**053-01064**

MNPV3

MNPV6 with 150VDC breakers and with 600VDC fuses

MidNite Solar

MNPV Combiners

These powder-coated aluminum rainproof array combiners will accept DIN-mount 150 V circuit breakers, MidNite 300 VDC breakers, Midnite 600 VDC breakers, or 600 VDC fuse holders for grid-tie arrays. A plastic cover provides a dead front for safety and can be knocked out for either breakers or fuse holders. Both a negative and ground busbar are included. The aluminum NEMA 3R enclosures are approved to be mounted at angles from 90° to 14° (vertical to 3/12 slope). Listed to UL 1741 for the U.S.A. and Canada. Breakers and fuse holders are not included.

The **MNPV3** will accept three single-pole 150 VDC (MNEPV) breakers or two 600/1,000 VDC fuse holders. Includes a 60 A positive busbar, six-position PV-negative busbar and a six-position ground busbar. A single 300 VDC breaker from 7 to 50 A may be installed as a disconnect (no combining busbar).

The **MNPV6** will accept six single-pole 150 VDC breakers or four 600/1,000 VDC fuse holders. Includes 15-position PV-negative bus bar, 14-position ground busbar, 120 A positive bus bar for breakers and 80 A busbar for fuses. The positive busbar may be split to support two grid-tie inverters or two charge controllers. Most charge controllers and grid-tie inverters can have a common negative PV bus (except Schneider XW and BlueSky).

The **MNPV6-250** will hold up to three single-pole 300 VDC circuit breakers for charge controllers accepting input voltages up to 300 VDC.

The **MNPV12** will accept 12 single-pole 150 VDC breakers or ten 600/1,000 positive VDC fuse holders. It includes a 15-position PV-negative busbar, 15-position ground bus bar, and two 200 A Plus busbars for breakers or fuses. Positive busbars can be combined or separated to support two grid-tie inverters or two charge controllers. Most charge controllers and grid-tie inverters can have a common negative PV bus (except Schneider XW and BlueSky).

The **MNPV12-250** will hold up to six single-pole 300 VDC circuit breakers for charge controllers accepting input voltages up to 300 VDC.

The **MNPVxx-1000** combiners use 1,000 VDC fuse holders and fuses, which are not included and must be added. The MNPV10-1000 only can be split into two output circuits.

MidNite PV Combiners without Disconnect											
Model	PV source circuit options					Output circuits		Max output wire size	MNPV combiner dimensions (L" x W" x H")	Weight	Item code
	Max # 150 VDC breakers	Max # 300 VDC breakers	Max # 600 VDC breakers	Max # 600 VDC fuses	Max # 1,000 VDC fuses	Max # output circuits	Max current output				
MNPV3	three	--	--	two	--	one	60 A	1/0 AWG	10.5 x 4.5 x 3.5	2 lbs	**053-03017**
MNPV6	six	--	one	four	--	two[1]	120 - 80[2] A	1/0 AWG	13.5 x 8 x 3.5	4 lbs	**053-03018**
MNPV6-250	--	three	--	--	--	one	120 A	1/0 AWG	13.5 x 8 x 3.5	4 lbs	**053-03081**
MNPV12	twelve	--	two	ten	--	two	200 A	2/0 AWG	14.5 x 12 x 3.5	6 lbs	**053-03015**
MNPV12-250	--	six	--	--	--	two	168 A	2/0 AWG	14.5 x 12 x 3.5	6 lbs	**053-03082**
MNPV2-1000	--	--	--	--	two	one	40 A	1/0 AWG	10.5 x 4.5 x 3.5	2 lbs	**053-03078**
MNPV4-1000	--	--	--	--	four	one	80 A	1/0 AWG	13.5 x 8 x 3.5	4 lbs	**053-03079**
MNPV10-1000	--	--	--	--	ten	two	200 A	1/0 AWG	14.7 x 12.2 x 3.5	6 lbs	**053-02960**

[1] Only with breakers, and one negative busbar
[2] 120 A for 150 VDC breakers and 80 A with 600 VDC fuses

MidNite Solar Rapid Shutdown Components

The firefighter-approved **MNBirdhouse1** remote actuator should be installed in a visible, easily accessible location so that the array combiners can safely be disconnected from the ground when necessary. The hard-wired connection to the disconnect combiners provides positive feedback that the disconnect on the roof has actually been thrown. One MNBirdhouse1 can be used to disconnect multiple combiners. The MNBirdhouse1 has a speaker and will announce when it is safe to climb onto the roof, and during the day it will inform that there is still voltage present up to the combiner. At night, it will announce that there is no PV voltage present. The MNBirdhouse1 is powered by multiple redundant sources. It is available in either red or gray. Each combiner can be powered using the array with the **MNDiscoPSB** power supply that will also power the MNBirdhouse1. The MNBirdhouse1 also comes with an indoor 120 VAC power supply that can be used as a DC supply, and has an internal backup battery. The power draw of the MNBirdhouse1 is only 1 W. Use the special **MNCAT5-600** 600 V CAT5 USE-2 compliant wire to connect the Birdhouse and combiners.

The **MNBDM** battery disconnect module can be used to power a remote actuating breaker to disconnect circuits including battery, charge controller, or generator circuits. Can be used in 24, 36, and 48 VDC systems.

The **MNFX-CABLE** should be used in the MNBirdhouse1 when there are no combiners connected to it.

For DC-coupled Rapid-Shutdown systems using PV charge controllers, use a disconnecting combiner (Birdhouse-ready with PSB installed) at the PV array, and one of the 75A SOB units at the charge controllers's input, along with a Birdhouse1 unit. This is required to meet the NEC requirement for capacitor bleed-down from the charge controller.

MidNite PV Disconnect Combiner Accessories

Model	Description	Dimensions (L" x W" x H")	Item code
MNBirdhouse1-Red	Emergency remote disconnect switch - Red	12.1 x 8.3 x 4.6	**053-02985**
MNBirdhouse1-Gray	Emergency remote disconnect switch - Gray	12.1 x 8.3 x 4.6	**053-02959**
MNDiscoPSB	Power supply for disconnect combiners	9.5 x 4 x 3.25	**053-02987**
MNBDM	Power supply for remote-actuated breakers	4 x 2 x 1.25	**053-02958**
MNFX-CABLE	Terminal for use in Birdhouse when no PSB combiner is used	--	**053-02956**
MNCAT5-600	Communication cable 600 V CAT5 USE-2 outdoor wire, per foot	--	**053-02983**

MidNite Solar MNPV Combiners with Disconnect Switch

The **MidNite Disco** line of PV combiners with disconnects are made to meet NEC 2014 Rapid Shutdown requirements. The disconnect handle is bright red for visibility and can be locked in the off position. Several models can be configured for bi-polar or non-isolated inverters where both the positive and negative legs of the array need circuit protection. Models are available for 150 VDC, 300 VDC, or 600 VDC arrays. All of the combiners are made from powder-coated aluminum for long life in harsh conditions. A clear see-through dead front is supplied with all Disco combiners. Models are available with either NEMA 3R or NEMA 4X ratings. Many of these come with a shunt-trip disconnect and when supplied with the PSB circuit board, are compatible with the MidNite Rapid-Shutdown system to meet NEC 2014 requirements. Breaker versions do not include breakers. **HV** versions come with fuse holders except for the **MNPV4HV Disco 3R Basic** which needs fuse holders added.

The MidNite **DLTL** disconnect combiners have both dual-string fusing and dual-channel output. These work for inverters with ungrounded conductors and dual-MPPT input channels which are becoming common. Both the positive and negative legs are fused, and the fuse holders are included. They are also available with the Rapid-Shutdown PSB circuit board installed.

The MidNite **SOB** disconnect boxes, are not actually combiners but are used to transition from array to conduit wiring with an array disconnect. They have either two or four poles, so can disconnect dual channel output, either one or two strings. These work for inverters with grounded or ungrounded conductors and dual-MPPT input channels. The MNSOB boxes with suffix "-75A" are rated at 75A per pole for use with combined circuits. They are also available with the Rapid-Shutdown PSB circuit board installed.

The MidNite **MNPV6-DISCO AC MICRO** is a basic disconnecting combiner for up to three 120/240 VAC micro-inverter circuits. The disconnect handle is bright red for visibility and can be locked in the off position. Made form powder-coated aluminum for long life in any environment. Add two pole AC DIN mount breakers. Add one two-pole breaker for each micro-inverter circuit, up to three circuits.

MidNite PV Disconnect Combiners

Model	PV source circuit options				Outputs	MNPV combiner dimensions (L" x W" x H")	Weight	Birdhouse compatible?	Item code	Item code w/ PSB
	Max # 150 VDC breakers	Max # 300 VDC breakers	Max # 600 VDC breakers	Max # 600 VDC fuses	Max # output circuits					
MNPV6 Disco	six	--	one	--	two	13.2 x 8 x 6.2	6 lbs	No	**053-03000**	--
MNPV6-250 Disco	--	three	--	--	one	13.2 x 8 x 6.2	6 lbs	No	**053-03001**	--
MNPV4HV Disco 3R Basic	--	--	--	four	one	13.7 x 10.4 x 4.4	8 lbs	No	**053-02990**	--
MNPV4HV Disco 3R Dlx[1]	--	--	--	four	one	13.7 x 10.4 x 4.4	10 lbs	Yes	**053-02991**	**053-02972**
MNPV6HV Disco 4X[1]	--	--	--	six	one	16.8 x 12.4 x 5.6	14 lbs	Yes	**053-02992**	**053-02973**
MNPV8HV Disco 3R[1]	--	--	--	eight	two	18.5 x 14 x 4.6	16 lbs	Yes	**–**	**053-02974**
MNPV8HV Disco 4X[1]	--	--	--	eight	two	19.5 x 14.8 x 5.8	18 lbs	Yes	**–**	**053-02975**
MNPV8HV-DLTL-3R	--	--	--	eight	two	19.5 x 14.8 x 5.8	18 lbs	Yes	**–**	**053-02977**
MNPV8HV-DLTL-4X	--	--	--	eight	two	19.5 x 14.8 x 5.8	18 lbs	Yes	**–**	**053-02978**
MNSOB 3R-2P	--	--	--	--	two	13.7 x 10.4 x 4.4	10 lbs	Yes	**–**	**053-02962**
MNSOB 4X-2P	--	--	--	--	two	16.8 x 12.4 x 5.6	14 lbs	Yes	**–**	**053-02966**
MNSOB 3R-4P	--	--	--	--	four	13.7 x 10.4 x 4.4	10 lbs	Yes	**–**	**053-02967**
MNSOB 4X-4P	--	--	--	--	four	16.8 x 12.4 x 5.6	14 lbs	Yes	**–**	**053-02968**
MNSOB 3R-2P-75A	--	--	--	--	two	13.7 x 10.4 x 4.4	10 lbs	Yes	**–**	**053-02948**
MNSOB 4X-4P-75A	--	--	--	--	four	16.8 x 12.4 x 5.6	14 lbs	Yes	**–**	**053-02950**
MNPV6-DISCO AC MICRO	Disconnecting combiner three 20 A AC circuits, add breakers					13.2 x 8 x 6.2	7 lbs	N/A	**053-02984**	**--**

[1] Combiner includes Surge Protection (SPD) model SPD600.

NEW! MidNite Solar - Little Shut-Off Box system

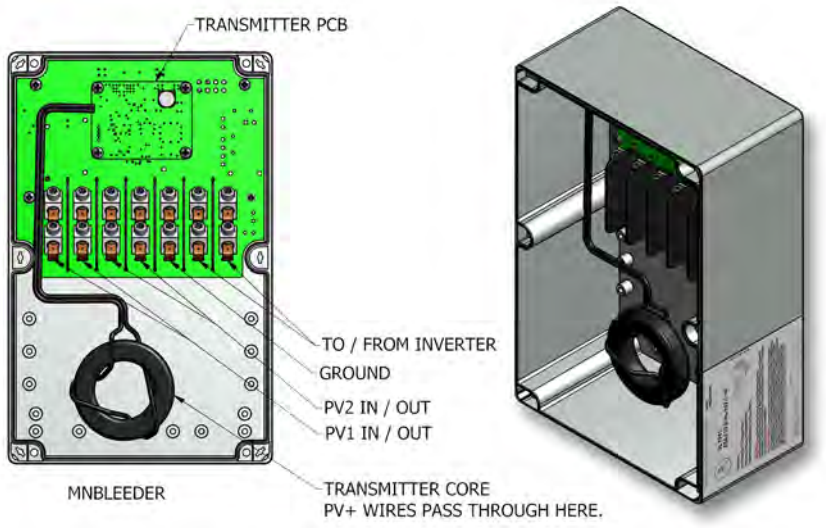
The **MidNite Little Shut-Off Box** system is a simple rapid shutdown system that does not require any extra wiring between the grid tie inverter and the PV array. One receiver is used with each inverter to meet NEC 2014 and NEC 2017 code up to the end of 2018. One transmitter can be used with up to six strings. To meet the 2017 NEC code starting in 2019 one receiver is installed per module. The transmitter sends a keep-alive signal over the PV output circuit to tell the receivers to turn on. When the transmitter is disconnected from power, or by a separate shut off button, it turns off and the signal is interrupted and the receivers turn off. Safety is enhanced since any time the transmitter is not on, or should fail, the array will be shut down. Restoring power to the transmitter will turn the system back on.

The **MNLSOB-T1-600** transmitter is powered by a 250 mA 12 volt DC power supply. The **MNLSOB-T1-AC** transmitter is powered a 90 to 305 volt AC source drawing 3 watts. The MNLSOB-R1-600 is the receiver unit installed at the array and wired into any of the modules in a string for shutdown, or for module level shutdown onto each module. It is rated for a string voltage up to 600 VDC and modules with maximum 80 Voc each. The MNLSOB-R1-1000 is the same as the 600 volt unit but made to work in a string up to 1000 VDC.

The **MNBLEEDER** is an outdoor enclosure that has one MNLSOB-T1-AC transmitter and will also bleed down the capacitors in many grid tie inverters. This may be needed to reduce the voltage in the PV output circuit fast enough to meet the NEC 2017 requirement of <30 volts within 30 seconds. The MNBLEEDER will work with one or two PV output circuits and is rated for PV circuits up to 1000 VDC and 12 A each. It does require a 90 volt to 300 volt AC source which is also the trigger for rapid shutdown. This enclosure is wall mounted and is 9.92"H x 6.38"W x 4.69"D.

Note: At the present time this system does not work with charge controllers, only with grid tie inverters.

MidNite Solar Little Shut-Off Box Accessories		
Model	**Description**	**Item code**
MNLSOB-T1-600	Transmitter 12 VDC input	**053-04000**
MNLSOB-T1-AC	Transmitter 90 to 305 VAC input	**053-04001**
MNLSOB-R1-600	Array shutoff receiver, 600 VDC, 12 A	**053-04002**
MNLSOB-R1-1000	Array shutoff receiver, 1000 VDC, 12 A	**053-04003**
MNBLEEDER	Transmitter 90 to 300 VAC input, and inverter bleed down, in NEMA 4X enclosure	**053-04004**



SolaDeck

PV Roof-Mount Enclosure/Combiner

The new **SolaDeck 0799** enclosures are NEMA 3R and listed to the UL 1741 standard. All SolaDeck models are seamless with a roofing industry approved flashing. SolaDeck parts are all made from 18-gauge galvanized steel with a powder-coated finish (Gray or Black) providing a professional look. The 0799 Soladeck Enclosure is also available in Stainless steel. The overall depth of the enclosure is 3". Every enclosure has an 8" long 35mm din rail installed for fuse holders, breakers or terminal blocks and include a 5-position ground bar. There are 5 knockouts inside the enclosure (3) - 1/2", (1) - 3/4" and (1) - 1" for cable or conduit to penetrate the roof deck. The SolaDeck base has dimple locations to enter the enclosure above the roof deck with conduit or gland fittings. These dimple locations can be punched or drilled out. Corner dimples will accept up to 1" fittings or conduit, the 3 center dimples will accept up to ¾" fittings or conduit.

SolaDeck model **0766-41D** is 6" deep for use on deep tile and concrete tile roof systems This model comes with a 30" square dead soft aluminum flashing and can be used with AC or DC combiner or pass through kits.

All SolaDeck enclosures can be used for combiner or pass through applications for both DC or AC systems. SolaDeck parts are now rated up to 1000 VDC at 180 amps, and up to 480 VAC at 60 amps.

Combiner and pass through kits are available and include the necessary components to either combine strings, circuits or to transition PV wire to THHN wire and pass-through. To make pass-through connections inside a SolaDeck, use one of **PASS-THRU** kits. These kits include din rail mount terminal blocks that can be used with 16 to 6 AWG wire and hardware to hold them in place. Each terminal is 8mm wide. Kits also include gland fittings, end plates and rail stops. See the next page for SolaDeck combiner and pass-through kits. You can also use fuse holder kits to pass through or combine strings.

SolaDeck PV Roof-Mount Enclosures and Accessories		
Model	**Description**	**Item code**
0799-5G	SolaDeck gray powder coated enclosure, 5 position ground	**053-00236**
SD-0766-41 AD	SolaDeck enclosure combiner AC/DC deep tile roof, large soft flashing	**053-00224**
0784 BB	Positive busbar for four fuse holders	**053-00227**
0785 BB	Negative busbar for four terminals	**053-00228**
0784 FBB-2	Positive busbar for two fuse holders	**053-00229**
0785 TBB-2	Negative busbar for two terminals	**053-00230**
1452	Fuse holder for DIN-mount 600 VAC/DC	**053-00240**
0784 AC 2K	Dual busbar kit for two AC branch circuits 240 V	**053-00232**
0784 AC 3K	Dual busbar kit for three AC branch circuits 240 V	**053-00233**
1440.080	Distribution block 80 A three-pole primary 14-4 AWG, four-pole secondary 14-100AWG	**053-00241**
1440	Distribution block 175 A two-pole primary 8-2/0 AWG, four-pole secondary 14-8 AWG	**053-00243**

SolaDeck Combiner Kits

These kits simplify selection of combiner-box components. Select a kit that has the configuration you need for the parts that will allow you to put it together. The combiner kits come with fuse holders and 15 A fuses. All kits come with strain-relief fittings.

SolaDeck Pass-Through and Combiner Kits		
Model	**Description**	**Item code**
DC Pass-Through Kits		
01601	SolaDeck DC pass-through kit for one string	**053-00250**
01602	SolaDeck DC pass-through kit for two strings	**053-00251**
01603	SolaDeck DC pass-through kit for three strings	**053-00252**
01604	SolaDeck DC pass-through kit for four strings	**053-00253**
01605	SolaDeck DC pass-through kit for five strings	**053-00254**
DC Fused Combiner Kits		
0786K-2C	SolaDeck DC combiner kit for two strings	**053-00259**
0786K-3C	SolaDeck DC combiner kit for three strings	**053-00260**
0786K-4C	SolaDeck DC combiner kit for four strings	**053-00261**
0786K-5C	SolaDeck DC combiner kit for five strings	**053-00262**
DC Dual Fused Combiner Kits		
01632	SolaDeck DC combiner kit for two strings, both positive and negative fused	**053-00273**
01633	SolaDeck DC combiner kit for three strings, both positive and negative fused	**053-00274**
01634	SolaDeck DC combiner kit for four strings, both positive and negative fused	**053-00275**
AC Pass-Through Kits		
01611	SolaDeck AC pass-through kit for one string	**053-00255**
01612	SolaDeck AC pass-through kit for two strings	**053-00256**
01613	SolaDeck AC pass-through kit for three strings	**053-00257**
01614	SolaDeck AC pass-through kit for four strings	**053-00258**

Disconnects

Disconnect switches provide a means for safely opening a circuit between the power supply and any loads that may be present. Some disconnects also offer fusing, remotely-actuated contactors or other specialized functions. The NEC requires listed disconnects in a variety of situations. Be sure to choose a disconnect that is rated for the AC or DC voltage and current that may be present on the circuit.

Square-D

240 V and 600 V NEMA 3R Safety Switch Disconnects

For inverters that do not include a DC disconnect, or when an additional DC disconnect is required, one of these 600 VDC disconnects can be used. Many utilities require an AC disconnect between a grid-tie inverter and the AC load center, close to the AC service entrance, and with a visible and lockable handle.

The Square-D 600 VDC-rated 30 A, 60 A, and 100 A three-pole safety switches are rated by Square-D to handle one 600 VDC circuit per pole for PV (although they are not UL-listed for this purpose). The 30 A switch is rated for 16 A short-circuit current (I_{sc} at PV module STC) for non-fused versions, and 12.8 A (I_{sc}) for fused versions. The 60 A switch is rated for 48 A (I_{sc}) for non-fused versions and 38 A (I_{sc}) for fused versions. The 100 A switch is rated for 80 A (I_{sc}) for non-fused versions and 64 A (I_{sc}) for fused versions.

All of the Square-D 600 VDC non-fused disconnects are rated for disconnecting one circuit at full rated current using two poles in series. Fused disconnects are rated for 80% of switch current rating at up to 600 VDC.

Use Class-R fuses of the proper voltage and amperage for fused disconnects. 600 V fuses will not fit into 240 VDC disconnects, and 250 VAC/125 VDC fuses will not fit into 600 V disconnects, and vice-versa.

Heavy-Duty (HD) switches are rated for "Service duty". Use the fused versions for AC line-side taps.

Square-D Disconnects									
Amps	**AC/DC**	**Fused**	**Poles**	**Neutral kit**	**Ground kit**	**Dimensions (H" x W" x D")**	**Weight**	**Model**	**Item code**
600 VAC or DC 3-Pole NEMA 3R Heavy-Duty Switches									
30 A	Yes	No	three	SN03	GTK03	14.88 x 6.63 x 4.88	9.3 lbs	HU361RB	**053-02312**
30 A	Yes	Yes	three	SN03	GTK03	14.88 x 6.63 x 4.88	9.8 lbs	H361RB	**053-02313**
60 A	Yes	No	three	SN0610	GTK0610	17.50 x 9 x 6.38	16 lbs	HU362RB	**053-02339**
60 A	Yes	Yes	three	SN0610	GTK0610	17.50 x 9 x 6.38	16 lbs	H362RB	**053-02341**

[1] Uses two poles (and two fuses) in series for 600 VDC, no PV rating per pole.
[2] Switches are rated for 250 VDC, but available fuses are only rated for 125 VDC.

AC-Only NEMA 3R Safety Switch Disconnects

Use these General-Duty Square-D AC safety switches for single-phase or three-phase grid-tie inverter outputs if you are back-feeding a circuit breaker to make the connection to the service panel. They can also be used as a disconnect for the AC output of off-grid inverters.

Use Class-R 250 VAC/125 VDC fuses with the fused versions of these disconnects. 60 A and larger General-Duty switches are rated for "Service Duty".

Square-D NEMA 3R General-Duty Switches - 240 V Max AC Only									
Amps	AC/DC	Fused	Poles	Neutral kit	Ground kit	Dimensions (H" x W" x D")	Weight	Model	Item code
30 A	AC only	No	two	SN03	PK3GTA1	9.63 x 7.25 x 3.75	4.4 lbs	DU221RB	**053-02318**
30 A	AC only	Yes	two	included	PK3GTA1	9.63 x 7.25 x 3.75	4.5 lbs	D221NRB	**053-02326**
30 A	AC only	No	three	SN03	PK3GTA1	9.63 x 7.25 x 3.75	4.7 lbs	DU321RB	**053-02319**
60 A	AC only	Yes	two	included	GTK03	14.88 x 6.63 x 4.88	9.7 lbs	D222NRB	**053-02334**
60 A	AC only	No	three	SN03	PK3GTA1	9.63 x 7.25 x 3.75	5.0 lbs	DU322RB	**053-02342**
100 A	AC only	Yes	two	included	GTK0610	17.50 x 8.50 x 6.50	16 lbs	D223NRB	**053-02358**
100 A	AC only	No	three	SN0610	GTK0610	17.50 x 8.50 x 6.50	15 lbs	DU323RB	**053-02359**
100 A	AC only	Yes	three	included	GTK0610	17.50 x 8.50 x 6.50	16 lbs	D323NRB	**053-02361**
200 A	AC only	Yes	two	included	PKOGTA2	29.25 x 17.25 x 8.25	29 lbs	D224NRB	**053-02371**

SN0610 Neutral busbar

SN20A Neutral busbar

PKOGTA2 Ground busbar

Square-D Disconnect Accessories

The **neutral** and **ground** busbars are used to land these conductors in the disconnect switch box. Appropriate busbars for each disconnect are identified in the tables above.

Square-D Disconnect Switch Accessories	
Description	Item code
SN03 Neutral busbar	**053-02389**
SN0610 Neutral busbar	**053-02381**
GTK03 Ground busbar	**053-02387**
PK3GTA1 Ground busbar	**053-02395**
GTK0610 Ground busbar	**053-02386**
PKOGTA2 Ground busbar	**053-02388**

Insulated Cable Connector Blocks

This insulated connector is molded for a precise fit and supplied with removable access plugs over the hex screws. Available with two to four wire-entry ports on one side for 14 to 4 AWG wire. This can be used to transition from exposed PV-wire cables to conduit wiring on roof to PV arrays or for any parallel wiring connection. Use the two-pole units just to splice two wires together (one in and one out). The three-pole block can be used to splice two wires together, such as two strings of PV modules, with a single wire output. The four-pole block can be used to splice three wires together with a single wire output.

Use one block for positive and one block for negative in DC circuits. Use one block for each phase, and one block for the neutral, in AC circuits. UL-listed for 600 Volts.

Insulated Cable Connector Blocks		
Number of poles	**Wire range**	**Item code**
two	14 to 4 AWG	**054-01142**
three	14 to 4 AWG	**054-01143**
four	14 to 4 AWG	**054-01144**

IPC-4/0-6 AWG

IPC-4/0-2/0 AWG

Wire Connectors and J-Boxes

Piercing Tap Connectors are for making wire connections where termination is not possible or desirable. General purpose Rigid Non-Metallic Conduit Junction Boxes are rated NEMA 6P and are UL Listed.

Insulated Cable Connector Blocks		
Description	**Wire range**	**Item code**
Insulation-piercing tap connector, silicone filled, 600 V, IPC-4/0-6 AWG	Main 4 to 4/0 AWG tap 14 to 6 AWG stranded	**157-04550**
Insulation-piercing tap connector, silicone filled, 600 V, IPC-4/0-2/0 AWG	Main 4 to 4/0 AWG tap 6 to 2/0 AWG stranded	**157-04551**
Rigid non-metallic NEMA 6P J-box 6" x 6" x 4"		**048-06595**
Rigid non-metallic NEMA 6P J-box 6" x 6" x 6"		**048-06600**
Rigid non-metallic NEMA 6P J-box 8" x 8" x 4"		**048-06610**
Rigid non-metallic NEMA 6P J-box 12" x 12" x 6"		**048-06620**

Waterproof Strain Reliefs

Use the 1/2" NPT threaded connectors to provide a waterproof entrance or exit for wiring on PV module junction boxes and outdoor combiner boxes. Use the 3/4" NPT connector for cables up to 5/8" diameter Made of Nylon with Buna-N seals. Resistant to salt water, and most mild chemicals and oils, these strain reliefs are noncorrosive and suitable for direct-burial installations. The oval-hole 1/2" strain relief works for two-conductor TC cable used for module interconnects, PV outputs, Q cable, or UF cable. The 1/2" thread, two-hole strain relief, 054-03242, is rated for up to 1,000 VDC and can be used with PV Wire up to 0.27" outside diameter. UL-listed for use in NEMA 4, 6 and 12 applications.

Waterproof Strain Reliefs		
Description	**Fits cable size**	**Item code**
½" thread with one round hole	USE 12 to 10 AWG	**054-03243**
½" thread with two round holes	USE 12 to 10 AWG	**054-03252**
½" thread with two round holes	PV WIRE 0.20" to 0.27" diameter	**054-03242**
½" thread with one round hole	0.25" to 0.5" diameter wire	**054-03241**
½" thread with one oval hole	14/2, 12/2, 10/2 TC	**054-03257**
¾" thread with one round hole	0.4" to 0.7" diameter cable	**054-03261**
¾ " thread with two round holes	PV WIRE 0.20" to 0.35" diameter	**054-03247**
1" thread with five round holes	PV WIRE 0.10" to 0.33" diameter	**054-03255**
Steel lock nut ½"		**054-03238**
Steel lock nut ¾"		**054-03244**

Power Distribution Blocks

Use these two-pole blocks to split primary power into secondary circuits, or join cables from a solar array to a power lead-in cable. Just install cables and tighten the set screws. Terminal blocks are made of zinc-plated aluminum for use with aluminum or copper conductors. Primary side accepts one large cable; secondary side accepts six smaller cables. UL recognized for up to 600 VDC.

Power Distribution Blocks					
Primary wire size	Taps	Secondary wire size	Taps	Rating	Item code
2/0 to 8 AWG	one	14 to 6 AWG	six	175 A	**054-01024**
6/0 to 6 AWG	one	14 to 4 AWG	six	350 A	**054-01027**

Splicer Blocks

Use these blocks to splice wires of up to 2/0 AWG. The terminal blocks are made of zinc-plated aluminum, for use with aluminum or copper conductors. Two-pole and three-pole blocks have one connection on each side. UL recognized for up to 600 VDC.

Splicer Blocks			
Wire size	Poles	Rating	Item code
8 to 2/0 AWG	two	175 A	**054-01030**
8 to 2/0 AWG	three	175 A	**054-01033**

MidNite Solar Manual Transfer Switch

These 120/240 VAC manual transfer switches have a neutral busbar and ground box lug terminal. Dimensions are 9" H x 5" W x 4" D. It can be used with up to 6 AWG wire to connect utility power and a generator to inverters with one AC input.

Manual Transfer Switch		
Description	Weight	Item code
Dual 30 amp 240 VAC transfer switch	4 lbs	**053-07851**
Dual 60 amp 240 VAC transfer switch	4 lbs	**053-07853**

Battery Cables

Why Use Larger Cable?

Low-voltage power systems with inverters can have very high current through the cables that connect the inverter to the batteries. Large AC loads like microwave ovens, toasters, irons, and washers can cause an inverter operating on a 12 VDC battery system to draw over 100 A. Large motors may draw 300 to 500 A during startup. When cables between batteries, and from the battery bank to the inverter, are too small the current available to the inverter is limited and it may fail to supply larger loads. Properly sized cables also impose less resistance, reducing voltage drop, and thereby help maximize system efficiency.

Circuits protected by 250 A breakers or 400 A fuses should use 4/0 AWG cables. Use 2/0 AWG cables for 175 A breakers and 200 A fuses. Use 2 AWG cables for 110 A or smaller fuses or breakers.

See the table showing recommended cables sizes for inverters in the Reference section.

Plated Copper Lugs

These UL listed lugs are made from tin-plated copper tubing with 3/8" ring. Solder or crimp to stranded cable.

Plated Copper Lugs	
Description	**Item code**
Copper lug 3/8" ring 2 AWG	**051-03234**
Copper lug 3/8" ring 2/0 AWG	**051-03231**
Copper lug 3/8" ring 4/0 AWG	**051-03228**

Heat Shrink Tubing

Use heat shrink tubing to insulate copper lugs and compression terminals. Tubing shrinks and the glue inside melts when heated with a heat gun or torch, sealing wires against corrosion and moisture. Maximum shrinkage is listed below. Sold in 6" lengths.

Heat Shrink Tubing		
Description	**Shrinks to**	**Item code**
Heat shrink tubing 1/2" x 6" black	3/16"	**051-01132-B**
Heat shrink tubing 1/2" x 6" red	3/16"	**051-01132-R**
Heat shrink tubing 3/4" x 6" black	1/4"	**051-01135-B**
Heat shrink tubing 3/4" x 6" red	1/4"	**051-01135-R**
Heat shrink tubing 1" x 6" black	3/8"	**051-01137-B**
Heat shrink tubing 1" x 6" red	3/8"	**051-01137-R**

UL Listed Battery Cable

This fine-stranded, very flexible cable is UL listed for use as battery cable. It is rated MTW or THW or AWM, 600 V, sunlight resistant, direct burial, 105 °C. 2, 2/0 and 4/0 AWG sizes are available with red or black insulation.

UL Listed Battery Cable	
Description	**Item code**
X-Flex battery cable 4/0 AWG black	**050-01470**
X-Flex battery cable 4/0 AWG red	**050-01472**
X-Flex battery cable 2/0 AWG black	**050-01476**
X-Flex battery cable 2/0 AWG red	**050-01478**
X-Flex battery cable 2 AWG black	**050-01487**
X-Flex battery cable 2 AWG red	**050-01488**

Battery Cables with Lugs

Use these cables between a battery bank and inverter, fuse, or power center. They have flexible stranded UL-listed copper wire and 3/8" diameter lugs. Lug barrels are covered with glue-filled heat-shrink tubing. Cables are marked in red heat-shrink tubing for positive and white heat-shrink tubing on black wire for negative. **Append –R to the item number for a red cable with red ends (positive), -B for a black cable with black ends (negative). For example, a red 4/0 AWG cable with a 2' length would be 052-04002-R.**

Battery Cables with Two Lugs		
Cable	**Length**	**Item code**
4/0 AWG	2'	**052-04002**
	3'	**052-04003**
	4'	**052-04004**
	5'	**052-04005**
	6'	**052-04006**
	8'	**052-04008**
	10'	**052-04010**
	12'	**052-04012**
	15'	**052-04015**
2/0 AWG	2'	**052-02002**
	3'	**052-02003**
	4'	**052-02004**
	5'	**052-02005**
	6'	**052-02006**
	8'	**052-02008**
	10'	**052-02010**
	12'	**052-02012**
	15'	**052-02015**

Battery Interconnects

Use these cables between individual battery cells or between battery strings. Cables with red ends are for positive battery parallel jumpers. Cables with black ends are for negative battery parallel jumpers. Cables with red on both ends, or red and black ends, are used for series battery interconnects. ***When ordering, append "-R" to the item number for red (positive or series connection), "-B" for black (negative). For example, a red 9" cable used to connect positive cells in parallel would be 052-05122-R..***

Battery Interconnects		
Wire size	**Length of cable**	**Item code**
2 AWG	12"	**052-05118**
2/0 AWG	9"	**052-05122**
2/0 AWG	12"	**052-05121**
2/0 AWG	20"	**052-05124**
4/0 AWG	12"	**052-05142**
4/0 AWG	20"	**052-05145**

Array Cables and Connectors

Grid-tie modules generally ship with attached cables that are listed to UL 1703 with the module. The cable connectors on these are fully waterproof when connected, touch-protected and designed for up to 1,000 VDC and 30 A, but cannot be safely disconnected when under load.

Our output cables are made with 10 AWG PV Wire and can be used in solar arrays up to 1,000 VDC. All of our array output cables are made with PV wire that is listed to UL 854, which is required by the NEC for use with transformerless inverters (See bulk PV Wire description on previous page for more information).

Additionally, we stock the MultiContact Solarline 2 MC4 and Amphenol H4 crimp-on connectors for use with 10 AWG PV stranded wire. Proper crimping to the wire and insulator assembly requires special crimping and assembly tools (see Tools).

PV Wire Array Cables

These **Output Cables** feature MultiContact Solarline 2 MC4 connectors are compatible with many module brands to connect strings to junction boxes or grid-tie inverters. They have a male connector on one end and a female connector on the other end, so they can be used to extend the cables on the modules or be cut in half and used to connect to a roof-top J-box or combiner. For example, if you need a 30' male and a 20' female, order a 50' cable. Made with black 10 AWG 1,000 VDC rated PV Wire cable. Adapters also available to change connector type from MC4 to H4 or from H4 to MC4 if needed.

PV Wire Array Cables	
Cable length	**MC4 Cables**
6'	**052-09800**
15'	**052-09801**
50'	**052-09802**
100'	**052-09803**
MC4 to H4 Output Cable Adapters	
H4 male to MC4 female adapter, 6" length	**052-09804**
H4 female to MC4 male adapter, 6" length	**052-09805**

Amphenol Helios H4 Connectors

The 1,000 VDC-rated Amphenol Helios H4 connector includes the pins and can be made quickly with the proper crimp tool, enabling custom length cables to be made at the job site. A special crimping tool and wrench set are required to assemble the connector (See Tools). These connectors are for use with 10 AWG PV wire and Amphenol H4 connectors are fully compatible with and can be used the newer Amphenol UTX/H4 connectors. Sold in combo packs of 25 male and female connectors including pins.

Amphenol Helios H4 Connectors	
Description	**Item code**
Amphenol Helios H4 male connector, Combo pack of 25 male and female connectors	**097-01412**

MC4-Solarline 2 Cable Connectors

These 1,500 VDC-rated MC4 connectors include pins and can be assembled quickly enabling custom length cables to be made at the job site. A UL listed, MultiContact crimping tool must be used to retain UL Listing for field assembly at 1,000 VDC (See Tools). These connectors are for use with 10-12 AWG PV wire and sold in packs of 25, including pins. Male and female connectors sold separately.

MC4-Solarline 2 Connectors	
Description	**Item code**
Male MC4 locking connector for PV wire, Pack of 25	**097-01411**
Female MC4 locking connector for PV wire, Pack of 25	**097-01413**

MC4-Solarline 2 Branch Connectors

These waterproof Y-connectors make it possible to parallel wire PV modules with Multi-Contact output cables. Branch connectors are rated for maximum current of 30 A and maximum voltage of 600 VDC.

MC4-Solarline 2 Branch Connectors	
Description	**Item code**
Solarline 2 branch cable coupler female - two male	**052-09403**
Solarline 2 branch cable coupler male - two female	**052-09404**

Wire-Management Hardware

As most experienced PV installers will attest, good wire management is a hallmark of high-quality installations, and its lack can lead to inspectors and customers alike looking for other potential issues. Cables and wires should be kept off the roof or ground and water should not be allowed to pool at the entrances of enclosures, splices and junction boxes. Given that a solar PV system is designed to last for 25 years or more, it is vital to use wire-management hardware that will hold up in the environment and allow deployment with minimal strain on the components. For more wire management products refer to the SnapNrack section of the catalog.

Stainless Steel Cable Clip

Stainless-steel cable clips

Use these clips to keep PV-Wire module-interconnect cables and PV-array output cables neatly secured to module frames so they do not drop below the array. These clips are available in packs of 100.

The **SnapNrack Smart Clip I & II** are not like traditional wire clips, the Smart Clip holds wires securely above the module flange, preventing them from being loosened or damaged. The Smart Clips are available in two configurations for securing 1or 2 module leads. These clips are available in packs of 100.

Smart Clip I

Stainless steel cable clips for PV wire	
Description	**Item code**
Stainless steel cable clips, Pack of 100	**052-09125**
SnapNrack Smart Clip I, Pack of 100	**052-09128**
SnapNrack Smart Clip II, Pack of 100	**052-09129**

Cable Ties

Specially designed for prolonged use in extreme outdoor environments, these Cable Ties are made from UV-stabilized polyamide material to ensure long-term performance. The tensile strength of these ties varies according to the width.

Cable Ties

Cable Ties					
Strength	**Max bundle**	**Length**	**Width**	**Quantity**	**Item code**
30 lbs	1.38" (35 mm)	5.9" (150 mm)	0.14" (3.5 mm)	100	**052-09152**
50 lbs	1.97" (50 mm)	7.9" (200 mm)	0.18" (4.6 mm)	100	**052-09153**
50 lbs	4.33" (110 mm)	15.35" (390 mm)	0.18" (4.6 mm)	100	**052-09154**

Bulk Wire

PV Wire Sunlight Resistant Cable

This single-conductor wire features heat and moisture resistant, crosslinked-polyethylene insulation (XLPE) (Type PV wire, USE-2, RHH, RHW, RHW-2). Rated for direct burial or in conduit this cable is sunlight resistant, flame retardant, and rated for temperatures from -40 to 90°C. This cable is listed to UL 854 as Type PV Wire, USE-2 1,500 V..

PV Wire Sunlight Resistant Cable				
Lenght	**Black**		**Red**	
	AWG 10	**AWG 12**	**AWG 10**	**AWG 12**
500'	**050-01149**	—	**050-01116**	—
1000'	**050-01112**	**050-01107**	**050-01109**	**050-01105**
1500'	**050-01113**	—	**050-01110**	—
2000'	**050-01114**	**050-01108**	**050-01111**	**050-01106**

PV Cable Assembly Tools

Crimp-on PV cable connectors (See Wire and Cable section) require special tools to properly attach the connectors. Single-purpose tools from **Multi-Contact** or **Amphenol** work with only that type of connector and are often the best option for installers who work only with modules that have that same connector type. For those who encounter several different types of connectors, one of the **Rennsteig** tool sets that have a set of dies and positioners can be more convenient and economical than carrying a different tool for each connector type.

MC4 and Helios Crimp Tools

The Multi-Contact MC4 **crimping tool** is used to assemble MC4 (Solarline 2) locking connectors with 10 or 12 AWG stranded wire. A set of two plastic wrenches is used to tighten the sealing nut in the connector and to unlock the male and female connector. The Amphenol Helios H4 Crimp Tool, Wrench, and Assembly/Disconnect Tool are used with the Helios H4 connectors, and are similar to the MC4 tools.

Multi-Contact MC4 & Amphenol H4 Tools	
Description	**Item code**
MC Solarline 2 MC4 pin crimper for 10/12 AWG wire	**094-00104**
MC Solarline 2 MC4 open-end spanner set, Pack of 2	**094-00112**
Amphenol Helios H4 Crimp Tool, 2.5 mm – 6 mm	**094-00007**
Amphenol Helios H4 Wrench and Disconnect Tool	**094-00008**

Rennsteig

Crimping Tool Sets and Accessories

These Rennsteig tool sets are helpful for installers who wish to make their own extensions and connections. The tools presented here cover the most popular connectors, including those using MC4 or Amphenol H4 connectors. Tools for crimping other connector types are available upon request. All of these tools are made in Germany.

The **Solar Crimp Tools** include the preassembled tool frame, die, and pin locator, but no case. Additional dies and pin locators can be added to expand the tool. The **Insulation Stripper** strips and removes the insulation in a single motion. The **blades** are replaceable. The **Wire Cutter** features a specially curved set of shears that cuts stranded wire without significant deformation. The **Dies** and **Pin Locators** are interchangeable and can be used as replacements or supplements to the individual Crimp Tools.

Rennsteig Kits, Sets and Crimping Tools				
Description	**Connector type**	**Wire size**	**Model**	**Item code**
Solar Crimp Tool	MC4 Solarline 2	12/10/8 AWG	624 1193 3 1	**094-00144**
Solar Crimp Tool	Amphenol H4	14/12/10/8 AWG	624 1194 3 1	**094-00135**
Insulation Stripper	NA	16/14/12/10 AWG	707-226-1-6US	**094-00128**
Replacement Blades			708 226 1 3 0	**094-00138**
Wire Cutter			700-016-36	**094-00129**
Die only	MC4 Solarline 2	12/10/8 AWG	624 570 3 0	**094-00126**
Pin Locator only			624 194 0 01	**094-00132**
Die only	Amphenol H4	14/12/10/8 AWG	624 1194 3 0	**094-00130**
Pin Locator only			624 1194 0 01	**094-00131**

System Survey and Commissioning Tools

Commissioning a PV system is an important final step in the installation process, and it's worth doing properly and consistently. Commissioning standards, such as IEC 62446 and related NABCEP guidelines, provide visual and physical inspections as well as electrical tests that should be performed prior to activating a new PV system. Common electrical tests made during commissioning include: continuity, phasing, and voltage for AC circuits; continuity of grounding conductors; DC circuit polarity verification; string I-V curves; string open-circuit voltage; string short circuit current; insulation resistance testing of PV source and output circuits; and, finally, a full-up system functionality test. With proper documentation, these same tests can be repeated periodically as systems age to ensure that they are operating efficiently.

Seaward Solar

Solar Installation Testers

PV210 Solar PV Tester and I-V Tracer

The PV210 provides a highly efficient and effective test and diagnostic solution for PV systems, carrying out all commissioning tests required by IEC 62446:2016 and performing fast and accurate measurement of I-V curves in accordance with IEC 61829:2015.

With direct connection to individual PV modules or strings using the supplied lead sets, tests can be conducted easily and within a matter of seconds at the press of a single button.

A high contrast display is clearly visible in direct sunlight and shows open circuit voltage (up to 1,000 VDC), short circuit current, maximum power point voltage, current and power, as well as the fill factor of the PV module or system under test, and insulation resistance (as part of an auto sequence or a discrete probe to probe measurement). If the measured curve deviates from the expected profile, the PV210 alerts the user to this, identifying the need for further analysis.

Detailed and colour I-V and power curves, can be viewed instantly once data is transferred to the PVMobile Android App using wireless NFC connectivity. PVMobile displays measured I-V and power curves for visual analysis of the curve shape, enabling common problems such as shading, defective cells or poor electrical connections to be identified.

The PV210 has memory to store up to 999 complete test records, and USB connectivity enables these to be downloaded to a PC. Seaward's **SolarCert Elements** software program (supplied separately) can then be used to automate generation of test certificates and documentation.

The connectors feature non-accessible conductive parts for safe use with PV systems that may be energized. The PV210 can also wirelessly receive and record irradiance and temperature measurements from the **Solar Survey 200R** in real-time as electrical tests are conducted.

PV150 Solar Installation Tester

The all-in-one PV installation tester, using simple direct connections to PV systems, performs open circuit voltage (up to 1,000 VDC), short circuit current, and insulation resistance tests with a single button press. It can also be used to perform operating current (using the supplied current clamp) and Earth continuity measurements as well as determine voltage polarity.

The PV150 solar PV tester has memory to store up to 200 complete test records, and USB connectivity enables these to be downloaded to a PC. Seaward's SolarCert Elements software program (supplied separately) can then be used to automate generation of test certificates and documentation.

The connectors feature non-accessible conductive parts for safe use with PV systems that may be energized. The PV150 can also wirelessly receive and record irradiance and temperature measurements from the **Solar Survey 200R** in real-time as electrical tests are conducted.

Solar Installation Test Kits

PV210 Solar Link Installation Test Kit

The **PV210 Solar Link Kit** includes everything needed to test to the IEC 62446 system commissioning standard, measurement of I-V curves in accordance with IEC 61829:2015, as well as the latest NABCEP recommendations.

The **PV210 Kit** includes: a PV210 solar installation tester and I-V Tracer, AC/DC current clamp, Solar Survey 200R irradiance meter with SolarLink, carry bag, MC4 test lead adaptors, red and black test leads, test probe with detachable alligator clips, Quick Start Guide, support software CD, and calibration certificate.

PV150 Solar Link Installation Test Kit

The **PV150 Solar Link Kit** includes everything needed to test to the IEC 62446 system commissioning standard as well as the latest NABCEP recommendations.

The **PV150 Kit** includes: a PV150 solar installation tester, AC/DC current clamp, Solar Survey 200R irradiance meter with SolarLink, carry bag, MC4 test lead adaptors, red and black test leads, test probe with detachable alligator clips, Quick Start Guide, support software CD, and calibration certificate.

Solar Survey Multifunction Solar Irradiance Meters

This handheld solar irradiance meter includes a built-in inclinometer to measure roof pitch, compass to measure roof orientation, and thermometer to measure ambient air and module temperature. This meters displays irradiance measurements in either W/m2 or BTU/hr-ft2, so they work for both solar photovoltaic (PV) and solar thermal applications.

The photovoltaic reference cell provides a more representative measurement of solar energy and greater accuracy and repeatability than irradiance meters that use simple photo diode detectors. The **Solar Survey 200R** irradiance meter incorporates a display hold feature, which enables the user to more easily capture readings in difficult locations.

The 200R can wirelessly give the PV150 or PV210 Solar Installation Testers real-time irradiance, ambient temperature, and PV module temperature measurement results simultaneous to electrical tests, as required by MCS and IEC 62446 standards. The Testers can then download the data into the SolarCert Elements software program. The 200R also includes data logging with a USB interface for data download to a PC. This allows for irradiance and temperature to be recorded at user-defined intervals over a number of hours or days. The collected data can then be downloaded to a PC for analysis or for inclusion in solar installation reports.

Solar Power Clamp

Seaward's **Solar Power Clamp** is a specialized power meter that clamps over the cable to measure the AC or DC current. If a PV system isn't generating the expected level of power under known irradiance and temperature conditions, this may indicate a fault with one or more components in the system. In addition to power and efficiency measurements, the harmonic analysis function of the Solar Power Clamp can be used as a means of detecting faults within the inverter. This unit includes two MC4 test leads.

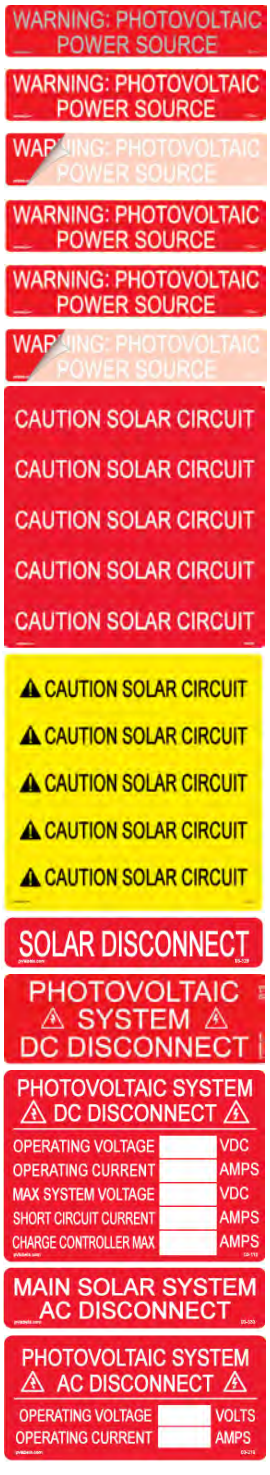
Solar Power Clamp functions include: DC power measurement, AC and AC+DC true continuous power (RMS) reading, power factor, total harmonic distortion and harmonics 1 – 25, phase rotation indication, current and voltage measurement, smart data hold and peak hold, and non-contact voltage indicator.

Seaward Solar Commissioning Tools		
Description	**Seaward Part Number**	**Item code**
PV210 Solar Link Kit (Includes PV210, Solar Survey 200R, AC/DC current clamp, 2x MC4 Test Leads, 2x test leads/ probes and alligator clips, quick start guide and CD-ROM, Carry Bag, Calibration Cert, and accessories)	389A918	**094-00293**
PV150 Solar Link Kit (Includes PV150, Solar Survey 200R, AC/DC current clamp, 2x MC4 Test Leads, 2x test leads/ probes and alligator clips, quick start guide and CD-ROM, Carry Bag, Calibration Cert, and accessories)	388A917	**094-00279**
PV150 Installation Tester (Tester only)	388A916	**094-00282**
Solar Survey 100 irradiance meter	396A910	**094-00290**
Solar Survey 200R irradiance meter (allows SolarLink wireless data transfer to PV210 or PV150 tester)	396A916	**094-00295**
Solar Power Clamp (includes MC4 test leads for DC power measurements)	396A961	**094-00292**

Solar Safety Labels

The NEC and International Fire Code (IFC) require specific components of a PV system to be labeled for the safety of operators, maintenance, and emergency responder personnel. The Code also requires these labels to be appropriately weather resistant (IFC 605.11.1.1.3) and durable (NEC 110.21). These labels are UV and weather resistant and should meet Code requirements in most jurisdictions. Note that some jurisdictions may still require engraved placards. The labels are designed to permanently adhere to metallic, baked enamel, and powder-coated surfaces in most outdoor environments.

Local jurisdictions and company policies often call for unique language or types of labels that are not available in preprinted form. If this is a frequent requirement, a label printing system can be an economical way to get exactly what you need when you need it. The ability to produce custom labels also presents opportunities for branding as well as organization, theft prevention, and identification.

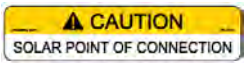


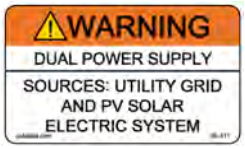
PV Labels

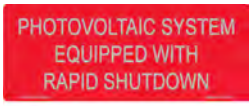
Preprinted Solar and Safety Labels

Our new partnership with PV Labels has allowed AEE Solar to stock and list in our catalog the most common and demanded solar labels below. Other labels and also phenolic placards are available upon request to meet specific JHA requirements. The language and letter height on these Standard Labels is designed to meet NEC 110, NEC 690 and IFC 605 requirements, and have been updated for NEC 2014 compliance. Reflective Labels are available for disconnect and conduit markers as required by the Code. The Fill-In-The-Blank Labels have white blanks that can be filled in with system parameters either ahead of time or in the field using a permanent marker so long as transparent laminate is then placed over them. The labels will remain adhered in temperatures down to -40 °C and as high as 175 °F [79 °C] but must be applied when temperatures are above 50 °F [10 °C]. UL 969 Recognized.

Conduit, Disconnect, and Combiner Box Labels				
Placement[1]	**Label text**	**Dimensions**	**Pkg qty**	**Item code**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (red w/ white lettering)	5-3/4" x 1-1/8"	10	**188-09224**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (red w/ white lettering, reflective)	5-3/4" x 1-1/8"	10	**188-09238**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (red w/ white lettering, w/ paint mask)	5-3/4" x 1-1/8"	10	**188-09225**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (red w/ white lettering)	5-3/4" x 1-1/8"	10	**188-09217**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (red w/ white lettering, reflective)	5-3/4" x 1-1/8"	10	**188-09218**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (red w/ white lettering, w/ paint mask)	5-3/4" x 1-1/8"	10	**188-09219**
Combiners, Conduit, and Enclosures	WARNING: PHOTOVOLTAIC POWER SOURCE (yellow w/ black lettering)	5-3/4" x 1-1/8"	10	**188-09220**
Conduit	CAUTION SOLAR CIRCUIT (red w/ white lettering, wraps around conduit up to 2" in diameter)	5-3/4" x 5-3/4"	10	**188-09234**
Conduit	CAUTION SOLAR CIRCUIT (yellow w/ black lettering, wraps around conduit up to 2" in diameter)	5-3/4" x 5-3/4"	10	**188-09233**
Solar Disconnecting Means	SOLAR DISCONNECT (red w/ white lettering)	4" x 3/4"	10	**188-09221**
Solar DC Disconnect	Photovoltaic System DC Disconnect (red w/ white lettering)	5" x 1-3/4"	10	**188-09222**
Inverter or Charge Controller DC Disconnect	Photovoltaic System DC Disconnect (red w/ white lettering with fillable blanks)	4" x 3"	10	**188-09236**
Main Solar AC Disconnect	Photovoltaic System AC Disconnect (red w/ white lettering)	4" x 1"	10	**188-09223**
Inverter or System AC Disconnect	Photovoltaic System AC Disconnect (red w/ white lettering with fillable blanks)	4" x 2"	10	**188-09237**







Conduit, Disconnect, and Combiner Box Labels				
Placement[1]	**Label text**	**Dimensions**	**Pkg qty**	**Item code**
Enclosures, Disconnects, and Electrical Panels	WARNING-ELECTRIC SHOCK HAZARD-DO NOT TOUCH TERMINALS-LINE AND LOAD MAY BE ENERGIZED (orange and white)	4" X 3"	10	**188-09228**
Combiners, Enclosures, Disconnects, and Electrical Panels	WARNING-ELECTRIC SHOCK HAZARD-DC CONDUTORS ARE UNGROUNDED AND MAY BE ENERGIZED (orange and white)	4" X 3"	10	**188-09240**
Combiners, Enclosures, Disconnects, and Electrical Panels	PHOTOVOLTAIC MODULES PRODUCE DC VOLTAGE WHEN EXPOSED TO SUNLIGHT (red w/ white letters)	4" x 2"	10	**188-09227**
AC Electical Panel and Point of Connection Labels				
Placement[1]	**Label text**	**Dimensions**	**Pkg qty**	**Item code**
Solar PV Point of Connection to Utility	CAUTION-SOLAR POINT OF CONNECTION (yellow and white)	4" X 1"	10	**188-09231**
Solar PV Point of Connection to Utility, Main Electrical Panel	DUAL POWER SUPPLY-SOURCES UTILITY GRID AND PV SOLAR ELECTRIC SYSTEM (orange and white)	4" x 2"	10	**188-09226**
Solar PV Point of Connection to Utility, Main Electrical Panel	DUAL POWER SUPPLY-SOURCES UTILITY GRID AND PV SOLAR ELECTRIC SYSTEM (orange and white)	2-3/4" x 1-5/8""	10	**188-09239**
Main Electrical Panel Breaker, if it has been downsized for PV Installation	DO NOT UPSIZE MAIN BREAKER-BREAKER HAS BEEN DOWNSIZED (red w/ white letters)	4" x 1"	10	**188-09232**
PV Inverter, PV Point of Connection to Utility, Main Electrical Panel, and/or Rapid Shutdown Initiator Device	PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN (red w/ white letters, reflective)	5-3/4" x 2-1/4""	10	**188-09242**
PV Inverter or System Output Breaker, in main or subpanel	WARNING-INVERTER OUTPUT CONNECTION-DO NOT RELOCATE THIS OVERCURRENT DEVICE (orange and white)	2-3/4" x 1-5/8"	10	**188-09241**
PV Inverter or System Output Breaker, in main or subpanel	PV SOLAR BREAKER-DO NOT RELOCATE THIS OVERCURRENT DEVICE (red w/ white letters)	2" x 1""	10	**188-09230**
Inverter	WARNING-IF A GROUND FAULT IS INDICAED NORMALLY GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGIZED (orange and white)	4" x 3"	10	**188-09229**

[1] Placement suggestions are the most common applications for the given label; it is, by no means, an exhaustive list of where the label may be required.

Solar Label Convenience Kits

For convenience, pre-cut Safety Label Kits are available that can be kitted per job. Several kits are available for labeling different types and sizes of PV installations. The **Single PV DC String Label Inverter Kit** can be used for an installation utilizing a single string inverter, and has DC, AC, and conduit labels.

If installing a system with multiple string inverters, order one **Multiple PV DC String Inverter Label Kit** for each inverter and one **PV AC Label Kit**. The DC label kit has specific labeling for string inverter, while the AC label kit will contain interconnection labels, and labels for the main electric panel and the PV combining subpanel.

However, if utilizing microinverters, where there is no high voltage DC Strings, a single **PV AC Label Kit** should contain the labels needed for these installations.

Additional labels may be required to meet your specific instllaton and inspection requirements.

Solar Label Convenience Kits			
Label Kit Name and Purpose	**Part Number**	**Included Labels**	
		Label	**Quantity**
Single PV DC String Inverter Label Kit (for one single DC string inverter)	**188-09244**	03-110 – PV DC Disconnect System Label 02-317 – PV System Equipped with Rapid Shutdown 05-100 – Elec. Shock Hazard-Do Not Touch Terminals 05-101 – Elec. Shock Hazard-If Ground Fault is Indicated 05-346 – Elec. Shock Hazard-Line and Load May be Energized 02-210 – PV AC Disconnect System Label 05-338 – Caution: Solar Point of Connection 05-211 – Dual Power Sources-Utility and PV Electric Systems 05-412 – Inverter Output-Do Not Relocate 03-344 – PV Solar Breaker-Do Not Relocate 02-314 – Warning: Photovoltaic Power Source (conduit)	1 2 1 1 1 1 1 1 1 1 10
Multiple PV DC String Inverter Label Kit (order one kit per inverter, and also order the PV AC Label Kit for AC specific labels)	**188-09245**	188-09236 - PV System DC Disconnect Label (w/blanks) 188-09242 - PV System Equipped with Rapid Shutdown 188-09228 - Elec. Shock Hazard-Line and Load May Be Energized 188-09229 - Elec. Shock Hazard-If Ground Fault is Indicated 188-09240 - Elec. Shock Hazard-DC Conductors may be Energized 188-09224 - Warning: Photovolyaic Power Source (conduit)	1 1 1 1 1 10
PV AC Label Kit (for Microinverter systems, or for systems with multiple string inverters)	**188-09246**	02-317 – PV System Equipped with Rapid Shutdown 02-210 – PV AC Disconnect System Label 05-338 – Caution: Solar Point of Connection 05-211 – Dual Power Sources-Utility and PV Electric Systems 05-412 – Inverter Output-Do Not Relocate 03-344 – PV Solar Breaker-Do Not Relocate 05-355 – PV System Combiner Panel-Do Not Add Loads 02-314 – Warning: Photovoltaic Power Source (conduit)	1 1 1 1 1 1 1 10

NEC2017 Compliant Labels

We have identified several labels that are changing for the NEC2017 Code Cycle. Utilize these label 10-packs when needed combined with the above convenience kits for compliance with NEC2017 code.

NEC2017 Code Compliant Labels				
Placement[1]	**Label text**	**Dimensions**	**Pkg qty**	**Item code**
Rapid Shutdown Initiation Device	RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM (red w/ white lettering)	5.25" x 1.8"	10	**188-09253**
DC Disconnecting Device	Direct Current Photovoltaic Power Source Label red w/ white lettering, w/ fillable blanks - 2017 version)	4" x 2"	10	**188-09257**
Point of Utility Connection	Solar PV System Equipped with Rapid Shutdown (NEC2017 version for module level RSD systems)	6" x 3.5"	10	**188-09255**
Point of Utility Connection	Solar PV System Equipped with Rapid Shutdown (NEC2017 version for string level RSD systems)	6" x 3.5"	10	**188-09256**
Enclosures, Disconnects, and Electrical Panels	WARNING: TERMINALS ON LINE AND LOAD SIDE MAY BE ENERGIZED (orange and white, NEC2017 version)	4" x 2"	10	**188-09254**

Reference

Maximum Ampacities for Wire

The table below shows allowable ampacities of conductors (wires) in conduit, raceway, and cable or directly buried, in an ambient temperature of 30 °C (86 °F). National Electrical Code (NEC) allows rounding up cable ampacity to the next size standard fuse or breaker.

For ambient temperatures above 30 °C (86 °F), multiply the allowable ampacities shown at right by the correction factor listed under the insulation temperature rating below.

Maximum Ampacity of Copper and Aluminum Conductors at 30 °C				
Wire size	Copper conductor-temperature rating (A)		Aluminum conductor-temperature rating (A)	
	75 °C (167 °F)	90 °C (194 °F)	75 °C (167 °F)	90 °C (194 °F)
[1]14 AWG	20 A	25 A	--	--
[1]12 AWG	25 A	30 A	20 A	25 A
[1]10 AWG	35 A	40 A	30 A	35 A
8 AWG	50 A	55 A	40 A	45 A
6 AWG	65 A	75 A	50 A	60 A
4 AWG	85 A	95 A	65 A	75 A
2 AWG	115 A	130 A	90 A	100 A
1 AWG	130 A	150 A	100 A	115 A
1/0 AWG	150 A	170 A	120 A	135 A
2/0 AWG	175 A	195 A	135 A	150 A
3/0 AWG	200 A	225 A	155 A	175 A
4/0 AWG	230 A	260 A	180 A	205 A

[1]NEC specifies that the overcurrent-protection device not exceed 30 A for 10 AWG wire, 20 A for 12 AWG wire, and 15 A for 14 AWG wire.

Temperature-Correction Factors for Ampacity			
Temperature range		75 °F insulation	90 °F insulation
31-35 °C	87-95 °F	0.94	0.96
36-40 °C	96-104 °F	0.88	0.91
41-45 °C	105-113 °F	0.82	0.87
46-50 °C	114-122 °F	0.75	0.82
51-55 °C	123-131 °F	0.67	0.76
56-60 °C	132-140 °F	0.58	0.71

Recommended Inverter Cable and Overcurrent Protection

Use this table to determine cable size and fuse or breaker size for common battery-based inverter models. Smaller cable sizes can be used if fuse or breaker size is reduced, but this can cause nuisance-tripping if the inverter is running near its maximum output. Larger cables may be necessary if the distance from the inverter to the battery is greater than 10'.

Use this table to choose the correct inverter breaker or fuse size required when choosing a pre-assembled power center that contains an over-current protection device (fuse or circuit breaker). Examples are MidNite Solar's E-Panels, Magnum Energy's MP and MMP panels, and OutBack Power's FLEXware power centers.

AEE Solar stocks battery-to-inverter cables in 2, 2/0 and 4/0 AWG.

Cable and Overcurrent Protection Sizing					
Inverter input voltage	Continuous watts	Max inverter input	Fuse size	Circuit breaker	Recommended wire size
12 VDC	300 W	40 A	50 A	50 A	4 AWG
	600 W	80 A	110 A	100 A	2 AWG
	800 W	107 A	110 A	110 A	2 AWG
	1,000 W	135 A	200 A	175 A	2/0 AWG
	1,500 W	200 A	300 A	250 A	4/0 AWG
	2,000 W	265 A	300 A	250 A	4/0 AWG
	2,400 W	320 A	400 A	250* A	4/0 AWG
	2,500 W	334 A	400 A	250* A	4/0 AWG
	2,800 W	382 A	400 A	250* A	4/0 AWG
	3,000 W	400 A	400 A	250* A	4/0 AWG
24 VDC	600 W	40 A	50 A	50 A	6 AWG
	800 W	54 A	70 A	75 A	4 AWG
	1,000 W	67 A	80 A	75 A	2 AWG
	1,500 W	100 A	110 A	110 A	2/0 AWG
	2,000 W	135 A	200 A	175 A	2/0 AWG
	2,400 W	160 A	200 A	175 A	2/0 AWG
	2,500 W	167 A	200 A	175 A	2/0 AWG
	3,000 W	200 A	300 A	250 A	4/0 AWG
	3,500 W	230 A	300 A	250 A	4/0 AWG
	4,000 W	265 A	300 A	250 A	4/0 AWG
48 VDC	3,000 W	100 A	110 A	110 A	2/0 AWG
	3,600 W	120 A	200 A	125 A	2/0 AWG
	4,000 W	135 A	200 A	175 A	2/0 AWG
	4,500 W	155 A	200 A	175 A	2/0 AWG
	5,500 W	185 A	200 A	250 A	4/0 AWG
	6,800 W	200 A	300 A	250 A	4/0 AWG
	8,000 W	270 A	400 A	175 A (2 each)	2/0 AWG (2 each)

*These amperages exceed the capacity of a 250 A breaker and 4/0 AWG cable. Use two 2/0 AWG cables with two 175 A breakers if possible, or reduce loads to prevent tripping the breaker or blowing the fuse.

Wire Loss Tables for 12 VDC and 24 VDC Systems

Use this table to determine the maximum distance from power source to load for 2% voltage drop. If a 4% loss is acceptable, the distance can be doubled, but do not exceed 2% drop for wire between PV modules and batteries. A 4% to 5% loss is acceptable between batteries and lighting circuits in most cases.

Note that a 24 VDC array can be placed much further from the battery bank than a 12 VDC array of the same wattage size because the voltage is doubled and the current is cut in half. This increases distance by a factor of four with the same wire gauge.

12 VDC System Maximum Wire Runs										
AMPS	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	2 AWG	1/0 AWG	2/0 AWG	4/0 AWG
2% voltage drop										
1 A	45'	70'	115'	180'	290'	456'	720'	--	--	--
2 A	22.5'	35'	57.5'	90'	145'	228'	360'	580'	720'	1,060'
4 A	10'	17.5'	27.5'	45'	72.5'	114'	180'	290'	360'	580'
6 A	7.5'	12'	17.5'	30'	47.5'	75'	120'	193'	243'	380'
8 A	5.5'	8.5'	15'	22.5'	35.5'	57'	90'	145'	180'	290'
10 A	4.5'	7'	12'	18'	28.5'	45.5'	72.5'	115'	145'	230'
15 A	3'	4.5'	7'	12'	19'	30'	48'	76.5'	96'	150'
20 A	2'	3.5'	5.5'	9'	14.5'	22.5'	36'	57.5'	72.5'	116'
25 A	1.8'	2.8'	4.5'	7'	11.5'	18'	29'	46'	58'	92'
30 A	1.5'	2.4'	3.5'	6'	9.5'	15'	24'	38.5'	48.5'	77'
40 A	--	--	2.8'	4.5'	7'	11.5'	18'	29'	36'	56'
50 A	--	--	2.3'	3.6'	5.5'	9'	14.5'	23'	29'	46'
100 A	--	--	--	--	2.9'	4.6'	7.2'	11.5'	14.5'	23'
150 A	--	--	--	--	--	--	4.8'	7.7'	9.7'	15'
200 A	--	--	--	--	--	--	3.6'	5.8'	7.3'	11'

24 VDC System Maximum Wire Runs										
AMPS	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	2 AWG	1/0 AWG	2/0 AWG	4/0 AWG
2% voltage drop										
1 A	90'	140'	230'	360'	580'	912'	1,440'	--	--	--
2 A	45'	70'	115'	180'	290'	456'	720'	1,160'	1,440'	2,120'
4 A	20'	35'	55'	90'	145'	228'	360'	580'	720'	1,160'
6 A	15'	24'	35'	60'	95'	150'	240'	386'	486'	760'
8 A	11'	17'	30'	45'	71'	114'	180'	290'	360'	580'
10 A	9'	14'	24'	36'	57'	91'	145'	230'	290'	460'
15 A	6'	9'	14'	24'	38'	60'	96'	153'	192'	300'
20 A	4'	7'	11'	18'	29'	45'	72'	115'	145'	232'
25 A	3.6'	5.6'	9'	14'	23'	36'	58'	92'	116'	184'
30 A	3'	4.8'	7'	12'	19'	30'	48'	77'	97'	154'
40 A	--	--	5.6 '	9'	14'	23'	36'	58'	72'	112'
50 A	--	--	4.6'	7.2'	11'	18'	29'	46'	58'	92'
100 A	--	--	--	--	5.8'	9.2'	14.4'	23'	29'	46'
150 A	--	--	--	--	--	--	9.6'	15.4'	19.4'	30'
200 A	--	--	--	--	--	--	7.2'	11.6'	14.6'	22'

Wire Loss Tables - 48 V and 120 V

Use these tables to determine the maximum distance one-way in feet of two-conductor copper wire from power source to load for 2% voltage drop in 48 VDC and 120 VDC system wiring. You can go twice the distance where a 4% loss is acceptable but do not exceed 2% drop for wire between PV modules and batteries. A 4 to 5% loss is acceptable between batteries and lighting circuits in most cases.

48 VDC System Maximum Wire Runs										
AMPS	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	2 AWG	1/0 AWG	2/0 AWG	4/0 AWG
2% voltage drop										
1 A	180'	280'	460'	720'	1,160'	1,824'	2,880'	--	--	--
2 A	90'	140'	230'	360'	580'	912'	1,440'	2,320'	2,880'	4,240'
4 A	40'	70'	110'	180'	290'	456'	720'	1,160'	1,440'	2,320'
6 A	30'	48'	70'	120'	190'	300'	480'	772'	972'	1,520'
8 A	22'	34'	60'	90'	142'	228'	360'	580'	720'	1,160'
10 A	18'	28 '	48'	72'	114'	182'	290'	460'	580'	920'
5 A	12'	18'	28'	48'	76'	120'	192'	306'	384'	600'
20 A	8'	14'	22'	36'	58'	90'	144'	230'	290'	464'
25 A	7.2'	11.2'	18'	28'	46'	72'	116'	184'	232'	368'
30 A	6'	9.6'	14'	24'	38'	60'	96'	154'	194'	308'
40 A	--	--	11.2'	18'	28'	46'	72'	116'	144'	224'
50 A	--	--	9.2'	14.4'	22'	36'	58'	92'	116'	184'
100 A	--	--	--	--	11.6'	18.4'	28.8'	46'	58'	92'
150 A	--	--	--	--	--	--	19.2'	30.8'	38.8'	60'
200 A	--	--	--	--	--	--	14.4'	23.2'	29.2 '	44'

120 VDC System Maximum Wire Runs										
AMPS	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	4 AWG	2 AWG	1/0 AWG	2/0 AWG	4/0 AWG
2% voltage drop										
1 A	450'	700'	1,150'	1,800'	2,900'	4,560'	7,200'	--	--	--
2 A	225'	350'	575'	900'	1,450'	2,280'	3,600'	5,800'	7,200'	10,600'
4 A	100'	175'	275'	450'	725'	1,140'	1,800'	2,900'	3,600'	5,800'
6 A	75'	120'	175'	300'	475'	750'	1,200'	1,930'	2,430'	3,800'
8 A	55'	85'	150'	225'	355'	570'	900'	1,450'	1,800'	2,900'
10 A	45'	70'	120'	180'	285'	455'	725'	1,150'	1,450'	2,300'
15 A	30'	45'	70'	120'	190'	300'	480'	765'	960'	1,500'
20 A	20'	35'	55'	90'	145'	225'	360'	575'	725'	1,160'
25 A	18'	28'	45'	70'	115'	180'	290'	460'	580'	920'
30 A	15'	24'	35'	60'	95'	150'	240'	385'	485'	770'
40 A	--	--	28'	45'	70'	115'	180'	290'	360'	560'
50 A	--	--	23'	36'	55'	90'	145'	230'	290'	460'
100 A	--	--	--	18'	29'	46'	72'	115'	145'	230'
150 A	--	--	--	--	--	--	48'	77'	97'	150'
200 A	--	--	--	--	--	--	36'	58'	73'	110'

Solar Insolation

This table shows solar insolation in kilowatt-hours per square meter per day in many U.S. locations, known as “sun-hours" per day. To find average sun-hours per day in your area, check local weather data, look at the maps on the following pages, or find a city in the table below that has similar latitude and weather to your location.

For year-round autonomy, use the low figure. For autonomy in summer only, use the high number. For a utility grid-tie system with net metering, use the average figures.

State	City	High	Low	Avg
AK	Fairbanks	5.87	2.12	3.99
	Matanuska	5.24	1.74	3.55
AL	Montgomery	4.69	3.37	4.23
AR	Bethel	6.29	2.37	3.81
	Little Rock	5.29	3.88	4.69
AZ	Tucson	7.42	6.01	6.57
	Page	7.30	5.65	6.36
	Phoenix	7.13	5.78	6.58
CA	Santa Maria	6.52	5.42	5.94
	Riverside	6.35	5.35	5.87
	Davis	6.09	3.31	5.10
	Fresno	6.19	3.42	5.38
	Los Angeles	6.14	5.03	5.62
	Soda Springs	6.47	4.40	5.60
	La Jolla	5.24	4.29	4.77
	Inyokern	8.70	6.87	7.66
CO	Granby	7.47	5.15	5.69
	Grand Lake	5.86	3.56	5.08
	Grand Junction	6.34	5.23	5.85
	Boulder	5.72	4.44	4.87
DC	Washington	4.69	3.37	4.23
FL	Apalachicola	5.98	4.92	5.49
	Belie Is.	5.31	4.58	4.99
	Miami	6.26	5.05	5.62
	Gainesville	5.81	4.71	5.27
	Tampa	6.16	5.26	5.67
GA	Atlanta	5.16	4.09	4.74
	Griffin	5.41	4.26	4.99
HI	Honolulu	6.71	5.59	6.02
IA	Ames	4.80	3.73	4.40
ID	Boise	5.83	3.33	4.92
	Twin Falls	5.42	3.42	4.70
IL	Chicago	4.08	1.47	3.14
IN	Indianapolis	5.02	2.55	4.21
KS	Manhattan	5.08	3.62	4.57
	Dodge City	6.50	4.20	5.60
KY	Lexington	5.97	3.60	4.94
LA	Lake Charles	5.73	4.29	4.93
	New Orleans	5.71	3.63	4.92
	Shreveport	4.99	3.87	4.63
MA	E. Wareham	4.48	3.06	3.99
	Boston	4.27	2.99	3.84
	Blue Hill	4.38	3.33	4.05
	Natick	4.62	3.09	4.10
	Lynn	4.60	2.33	3.79
MD	Silver Hill	4.71	3.84	4.47
ME	Caribou	5.62	2.57	4.19
	Portland	5.23	3.56	4.51
MI	Sault Ste. Marie	4.83	2.33	4.20
	E. Lansing	4.71	2.70	4
MN	St. Cloud	5.43	3.53	4.53
MO	Columbia	5.50	3.97	4.73
	St. Louis	4.87	3.24	4.38
MS	Meridian	4.86	3.64	4.43
MT	Glasgow	5.97	4.09	5.15
	Great Falls	5.70	3.66	4.93
	Summit	5.17	2.36	3.99
NM	Albuquerque	7.16	6.21	6.77
NB	Lincoln	5.40	4.38	4.79
	N. Omaha	5.28	4.26	4.90
NC	Cape Hatteras	5.81	4.69	5.31
	Greensboro	5.05	4	4.71
ND	Bismarck	5.48	3.97	5.01
NJ	Sea Brook	4.76	3.20	4.21
NV	Las Vegas	7.13	5.84	6.41
	Ely	6.48	5.49	5.98
NY	Binghamton	3.93	1.62	3.16
	Ithaca	4.57	2.29	3.79
NY	Schenectady	3.92	2.53	3.55
	Rochester	4.22	1.58	3.31
	New York City	4.97	3.03	4.08
OH	Columbus	5.26	2.66	4.15
	Cleveland	4.79	1.99	3.94
OK	Stillwater	5.52	4.22	4.99
	Oklahoma City	6.26	4.98	5.59
OR	Astoria	4.67	1.99	3.72
	Corvallis	5.71	1.90	4.03
	Medford	5.84	2.02	4.51
PA	Pittsburgh	4.19	1.45	3.28
	State College	4.44	2.79	3.91
RI	Newport	4.69	3.58	4.23
SC	Charleston	5.72	4.23	5.06
SD	Rapid City	5.91	3.84	5.23
TN	Nashville	5.20	3.14	4.45
	Oak Ridge	5.06	3.22	4.37
TX	San Antonio	5.88	4.65	5.30
	Brownsville	5.49	4.42	4.92
	El Paso	7.42	5.87	6.72
	Midland	6.33	5.23	5.83
	Fort Worth	6.00	4.80	5.43
UT	Salt Lake City	6.09	3.78	5.26
	Flaming Gorge	6.63	5.48	5.83
VA	Richmond	4.50	3.37	4.13
WA	Seattle	4.83	1.60	3.57
	Richland	6.13	2.01	4.44
	Pullman	6.07	2.90	4.73
	Spokane	5.53	1.16	4.48
	Prosser	6.21	3.06	5.03
WI	Madison	4.85	3.28	4.29
WV	Charleston	4.12	2.47	3.65
WY	Lander	6.81	5.50	6.06

These maps show the average value of total solar energy received in peak-sun-hours per day on an optimally-tilted surface during the **month with the lowest solar radiation (not the yearly average)**. This is the best number to use in off-grid system design where the electrical demand is continuous or is not expected to vary seasonally and the system must be designed to operate year-round (Use this number for line 3 in the Off-Grid Solar-Array Sizing Worksheet in the System Design section).

South America

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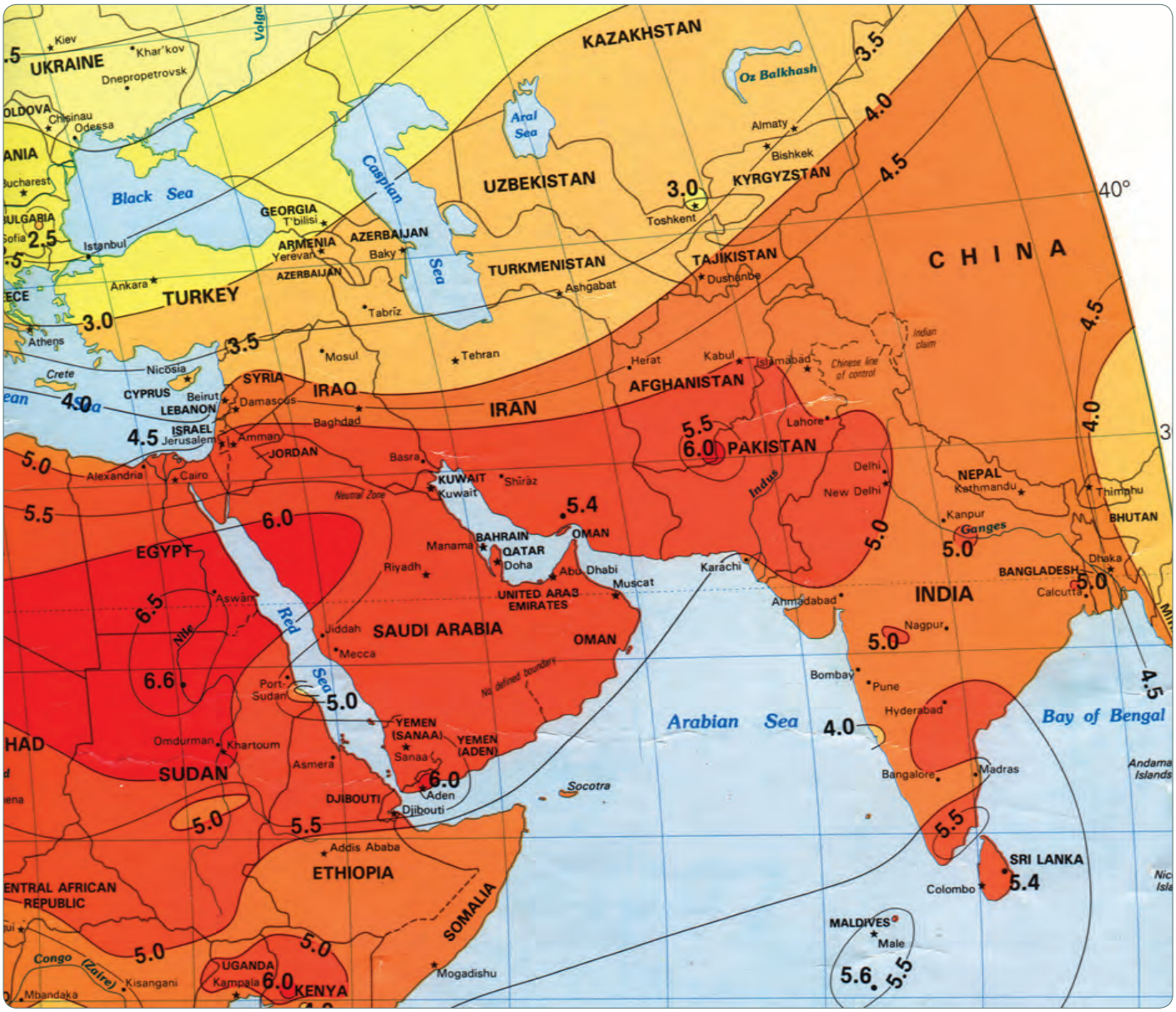
Africa

India



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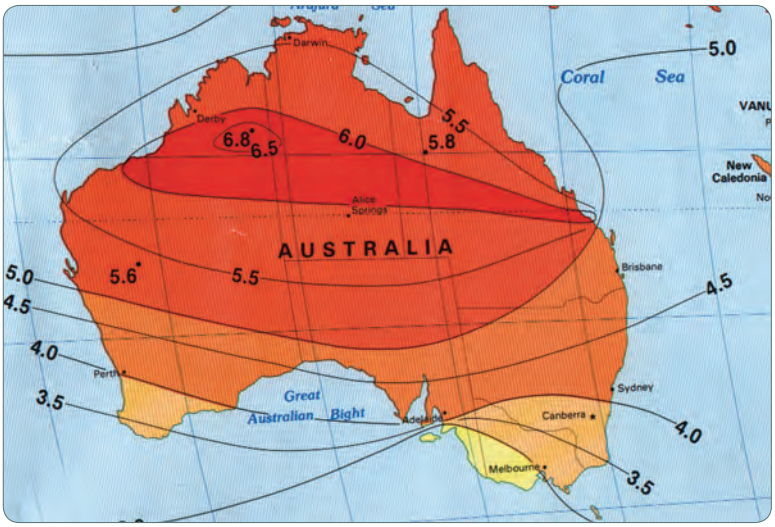
Asia

Australia



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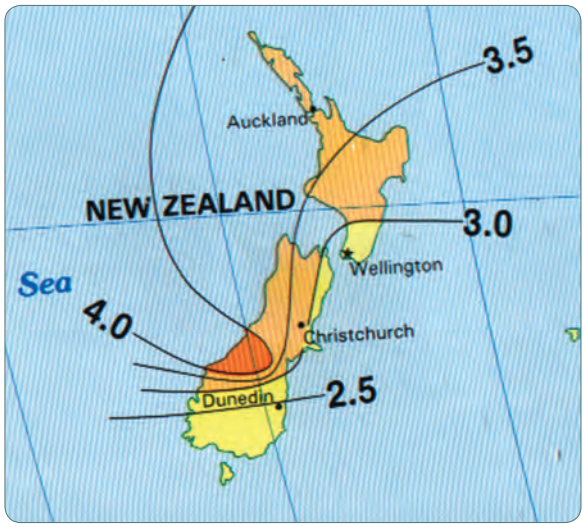

Glossary

Absorbed Glass Mat (AGM): A valve-regulated lead-acid battery with the electrolyte suspended in a fiberglass matrix. (See also: Lead-acid battery)

Alternating Current (AC): An electric current which switches voltage polarity at a given frequency; the US electrical grid supplies AC electricity with a frequency of 60 Hz.

American National Standards Institute (ANSI): Originally established by multiple engineering societies and several government agencies as the American Engineering Standards Committee, ANSI is responsible for reviewing, approving and maintaining standards for measurements, manufacturing and safety.

Ampere (A or Amp): The standard unit of electrical current, equal to 1 Coulomb per second.

Anode: The proper term for the "negative" terminal in a discharging battery, an anode is any material or component that acts as a current input point for an electrochemical reaction. The anode eventually dissolves in such reactions and coats the positively charged cathode material. Recharging a battery effectively reverses the anode and cathode. (See also: Cathode)

Anodized: Refers to metal components, such as aluminum module frames or rails, that have a thick layer of oxidation to protect them from the environment. Anodized components are typically also sealed and can be dyed as well.

Arc-Fault Circuit Interrupter (AFCI): A device designed to detect an unintended electrical arc and disconnect the power before the arc starts a fire.

American Society of Civil Engineers (ASCE): The oldest national engineering society, ASCE publishes a wide variety of engineering standards and recommendations, such as wind-loading guidance and soil mechanics data.

Amorphous silicon (a-Si): A non-crystalline form of silicon used in some thin-film transistors and PV cells.

Authority Having Jurisdiction (AHJ): The state or local agency responsible for permitting and inspection of new construction or electrical installations.

Azimuth: For PV systems, the azimuth is the angle between a line normal to the face of the PV modules and true North. Ideal azimuth for PV arrays in the Northern hemisphere is typically 180°.

Back Plate: A specialized wall-mount bracket for mounting inverters or power systems.

Back Sheet: The material, usually high-density polyethylene, that protects the rear surface of a PV module.

Balance of System (BOS): All parts needed to complete the PV system that are not expressly called out. i.e. "modules, inverter and BOS."

Ballasted mounting: Typically refers to PV mounting systems on flat roofs that use ballast blocks or stones to reduce the number of roof penetrations.

Battery: A device that stores electrical energy by converting it to chemical energy. Several chemistries and form-factors are used for batteries. (See also: Lead-acid battery, Lithium-ion battery, Sodium-ion battery, Nickel-iron battery)

Battery Backup: A battery bank and inverter used to provide power during a grid outage.

Battery-based inverter: An inverter that converts DC power from a battery bank into AC power suitable for use by common loads or for export to the grid. Typically, battery-based inverters must be installed with batteries in order to function and may or may not be grid interactive. (See also: Inverter, Grid-interactive)

Battery Management System (BMS): A computer-controlled-electronics package that ensures a battery bank is properly charged and discharged. Many advanced chemistries, such as lithium-ion, require a BMS for safety and longevity.

Bonding (electrical): Bonding refers to the practice of electrically connecting all exposed metal components so that they can be reliably connected to ground for safety. Also referred to as equipment grounding.

British Standard (BS) 6290: A safety standard relating to stationary lead-acid batteries that specifies mechanical, electrical and material requirements.

Bronze anodized: Typically refers to aluminum rail or other mounting components that are anodized with a dark bronze dye so as to appear black. (See also Anodized)

Bus/busbar: A conductor used to distribute current between multiple sources and loads, analogous to a manifold.

Cathode: The proper term for the "positive" terminal of a discharging battery, a cathode is the material and/or point where current leaves an electrochemical reaction.

Cell: A photovoltaic cell generates a DC voltage (usually ~0.5 V) when exposed to light. Cells are typically assembled into modules prior to use.

California Energy Commission (CEC): The CEC is California's primary energy policy and planning agency. It is responsible for energy forecasting, setting energy efficiency standards, supporting, promoting and developing renewable energy technologies and resources, certifying thermal power plants and responding to energy emergencies.

Canadian Standards Association (CSA): Now CSA Group, CSA is a standards organization similar to Underwriters' Laboratories (See UL) in the U.S.A. Like UL, CSA also performs certification testing as an NRTL to its own and many other US and Canadian standards.

Combiner: A bus assembly used to connect module strings in parallel. Usually includes overcurrent protection for each string. May be integrated with inverter or in separate enclosure.

Composition (Comp) shingle: Also known as asphalt shingles, this thin, flexible roofing material is common on sloped residential roofs and is relatively easy to work with.

CSA 22: Also known as the Canadian Electrical Code, CSA 22.1 contains prescriptive standards for electrical and related work while CSA 22.2 contains safety and testing standards for related equipment. Analogous to the NEC and associated UL standards used in the U.S.A.

Class I Division 2 (Cl-D2): Usually encountered in oil & gas extraction applications, special equipment certification (typically by Factory Mutual) is required to operate in a Class I environment – where flammable gasses or vapors are likely to be present in sufficient concentrations to ignite. Division refers to whether the flammables are normally present (Division 1) or only in abnormal conditions (Division 2). Certification testing is designed to verify that the product does not present an ignition source, such as a spark or hot surface.

Cradle to Cradle™ (C2C): A product standard that evaluates products with respect to material health and reutilization, energy and carbon management, water stewardship and social fairness.

Current transducer (CT): A current sensor that generates a voltage signal proportional to the current passing through a conductor it is placed around. Most revenue-grade metering systems use CTs.

Demand Charge: Part of a utility rate structure that assesses a fixed charge based on the peak kW demand, usually sustained for 15 minutes or more.

Derate Factor (Derate): Can apply to any reduction of a device's safety or output ratings when normal operating conditions (usually temperature) are exceeded. Often also applied to a value used in the PVWatts calculator where it represents losses in the system due to the difference between the PV module's nameplate DC ratings, and actual expected output in real-world conditions, module mismatch, losses in diodes, connections and wiring, module soiling, array shading, tracking error, system aging, and the inverter efficiency at maximum power. The default 0.82 derate is based on 14% systemic losses and 96% inverter efficiency.

Direct Current (DC): An electric current with constant voltage; PV modules and batteries supply DC electricity.

Dual in-line package (DIP) switch: A manual switch packaged in a group on a circuit board; typically used to customize an electrical device, such as a charge controller, by changing settings or logic.

Delta: A three-phase power configuration where transformers or loads are connected between each of the current-carrying lines. (See also: Three-phase power)

Deutsches Institut für Normung (DIN) rail: A standard rail used to mount circuit breakers or other control equipment in enclosures or racks. Several DIN standards are used globally, but the top hat EN 50022 profile is most common in the U.S.A.

Disconnect (Disco): A switch that electrically isolates a given component or portion of a system from the load or generator. i.e. Most inverters feature a DC Disco that isolates the PV array from the inverter.

Dynamic load: A load who's direction and amplitude changes with time, i.e. a PV module in gusty winds will tend to flex toward and away from the roof.

Electric Current: The flow of an electric charge, typically carried by electrons through a conductor; analogous to the flow of liquid through a pipe.

Electrolyte: Any substance that forms an electrically conductive solution with water. While electrolytes such as sulfuric acid are vital to battery chemistry, others, such as salt water or even rain, are the primary cause of corrosion in metal components.

Energy: The ability of a system to perform work; the standard unit of energy is the Joule, but electrical energy is most often measured in kilowatt-hours.

Equalization charge (Equalize): A sustained charge cycle intended to "boil" the electrolyte in a flooded battery in order to prevent or correct stratification of varying electrolyte concentration.

Flash test: A test performed on PV modules to determine their nameplate capacity. The flash test is performed under standard test conditions (1,000 W/m^2 of light at 25 °C) typically at the factory or by an NRTL.

Flashing: Thin pieces of material, usually aluminum or steel, used to prevent water intrusion through a roofing system at joints and transitions.

Federal Communications Commission (FCC) Part 15: Properly known as the Code of Federal Regulations, Title 47, part 15, "FCC Part 15" regulates unlicensed radio emissions, such as those from power electronics like inverters. Any product sold in the U.S.A. that emits radio energy, but doesn't require a license to operate, must comply with 47 CFR 15.

Float Charge: A low-current charge applied to a battery bank at roughly the rate of self-discharge. Float charge voltage is regulated to prevent overcharging the battery.

Flooded battery: Refers to battery types where the electrolyte is in liquid form and can be added to or spilled. Typically applied to traditional lead-acid batteries, but also describes some nickel-iron batteries.

Functional Grounding: A functionally grounded system is one which has an electrical reference to ground which is not solidly grounded, such as when a breaker or resistor is in line between the equipment and the grounding point.

Galvanized: Refers to iron or steel that has been coated with zinc to prevent corrosion. The zinc provides both a protective layer as well as a sacrificial anode to both prevent and mitigate rust formation.

Galvanic corrosion: Dissimilar metals, such as copper and steel, brought into contact by a conductive electrolyte, such as rain or salt-spray, will react much like a battery and dissolve the anode into the electrolyte. This is why equipment grounding methods must prevent dissimilar metals from coming into contact with one another.

Grid: The electric grid is an electric distribution system that provides power to connected loads from geographically-dispersed generators.

Grid-interactive: Able to export power to the electrical grid. Usually refers to a battery-based "Hybrid" or "dual-function" inverter that can operate with or without a grid connection.

Grid-Support: Inverters capable of meeting the interconnection standards as laid out in UL 1741 Supplement A

Grid-tied: Connected to the electrical grid; usually referring to a PV system.

Hanger bolt: A specialized fastener used for mounting structures that has wood-screw thread on the bottom and machine thread on the top.

Harmonic: A whole-number multiple of a fundamental frequency. i.e. an inverter outputting 60 Hz may have harmonic outputs at 120 Hz, 180 Hz and so on, so distortions caused by certain types of loads (battery chargers, variable frequency drives, etc.) will also have effects at each of the higher harmonic frequencies.

Harmonic Distortion: The extent to which certain types of electrical loads can cause increased peak currents, heating and EMF emissions in an inverter or other AC power source.

Head: The vertical distance, typically expressed in feet, between a water source and where it is being delivered. Also used as a shorthand for pressure, 1 foot of head = .43 psi.

Hybrid Inverter: A battery inverter that can interconnect with the grid for net metering.

IEEE 1547: The Standard for Interconnecting Distributed Resources with Electric Power Systems establishes acceptable frequency and voltage windows, and related parameters, that govern how and when a generator or inverter can feed into the electrical grid. Compliance with IEEE 1547 is part of the UL 1741 test standard.

IEEE 929: IEEE's Recommended Practice for Utility Interface of Photovoltaic (PV) Systems contains guidance to ensure that grid-tied PV systems are safe and effective.

IEEE C62.41: IEEE's Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits provides guidance for testing whether a given device can withstand surge voltage.

IEC 60034: IEC's standard for rotating electrical machines, such as motors and generators.

IEC 60896: This section of IEC's battery standard covers stationary lead-acid batteries. Various subsections cover materials and test protocols.

IEC 61000: Refers to IEC standards starting with 61, which covers most electrical devices.

IEC 61215: The IEC standard for testing PV modules, analogous to UL 1703.

IEC 62109: The IEC standard defining minimum requirements for power-conversion equipment in PV systems. IEC 62109 is analogous to UL 1741, but includes performance requirements as well as safety standards.

IEC 62509: The IEC standard that establishes minimum requirements for function and performance of battery charge controllers used with lead-acid batteries in PV systems.

IEC 62446: IEC's Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection defines the minimal tests, inspections and documentation that should be presented to a customer upon completion of a PV installation.

Institute of Electrical and Electronics Engineers (IEEE): The largest association of electrical engineers, IEEE is very active in the development of codes and standards. While not typically binding as such, IEEE standards are often incorporated into IEC, UL, ANSI and other standards that are referenced by building and electrical codes.

International Electrotechnical Commission (IEC): The leading global standards developer and publisher. IEC standards are commonly referred to in the European Union and other parts of the world, much like UL standards in the U.S.A. While IEC standards are not binding in the U.S.A., they are often incorporated, in part or in whole, into UL, ANSI and other standards that are referenced by building and electrical codes.

International Fire Code (IFC): A comprehensive fire safety code, similar to the NFPA, parts of which are i ncorporated into the building codes of some jurisdictions in the U.S.A.

Inspector: A Code inspector is a representative of the AHJ who physically inspects construction or electrical installations to determine whether they are compliant with the standards of the jurisdiction.

Inverter: A device that converts DC electric power into AC power for use by AC loads and/or for export to the electric grid.

Ingress Protection (IP ##): The IP rating specifies the level of environmental protection provided by an enclosure. The first number rates protection from particulates (e.g. dust) from zero to six, with zero being unprotected and six being completely protected. The second number rates protection against liquid ingress from zero (no protection) to eight, which denotes fully submersible. IP 67 is typical for module junction boxes.

Insolation: The amount of solar energy received over a unit of time per a unit of surface area. Often expressed as sun-hours, which is equivalent to kWh/m^2. Most solar resource maps provide sun-hours per day. (See also: Irradiance)

Irradiance: The amount of electromagnetic or solar power received by a unit surface area. Standard solar irradiance is considered to be 1,000 W/m^2, also referred to as one sun. (See also: insolation)

Junction Box (J-box): A container for electrical connections that protects them from weather and/or tampering. Many types of electrical j-box are used for PV installation and modules typically feature a sealed j-box on the back which connects the output leads to the positive and negative bus.

Jurisdiction Having Authority (JHA): See: Authority Having Jurisdiction.

Kilowatt (kW): A commonly used unit of power equal to 1,000 W. A PV system is typically referred to by the kilowatt rating of either the modules or inverter

Kilowatt-hour (kWh): A common unit of energy used to express the consumption or production of electrical power over time, especially for billing purposes. A PV system which produces 1 kW consistently for 1 hour will have produced 1 kWh.

Laminate: A subassembly of a PV module consisting of the cells, busses, encapsulant, glass and back sheet.

Lead-acid battery: A rechargeable battery which makes use of the conversion between lead-oxide and lead-sulfate in sulfuric acid to charge and discharge. Common variants include flooded, sealed and valve-regulated.

Listed: Certified by an NRTL as meeting the requirements of a given standard. PV modules must be listed to UL 1703 and inverters must be listed to UL 1741 per NEC article 690.

Lithium-ion (Li-ion) battery: A rechargeable battery which relies on the transfer of lithium ions to charge and discharge. Lithium-ion batteries offer higher energy and power density than most other battery chemistries but require sophisticated battery management systems to operate.

Lithium-cobalt-oxide ($LiCoO_2$): Most notably used by Tesla for both EVs and stationary power, $LiCoO_2$ batteries provide greater energy density than other common lithium chemistries, but are susceptible to thermal runaway when overcharged or over-heated.

Lithium-iron-phosphate ($LiFePO_4$) battery: Common in power tools and most stationary energy storage with lithium-ion batteries, $LiFePO_4$ batteries provide less energy density than their cobalt counterparts, but offer improved safety and cycle life due to greater thermal stability.

Marked: Products listed by an NRTL are allowed to bare the mark of that laboratory. Inspectors look for these marks whenever a listing is required by the Code.

Maximum-Power Point (MPP): The corresponding voltage and current that yields maximum power from a PV cell, module, or array in the given conditions. The MPP will vary according to available light and cell temperature.

Maximum-Power-Point-Tracking (MPPT): A feature of most grid-tie inverters, optimizers and MPPT charge controllers that continually seeks the maximum-power point of the module or array to ensure maximum energy harvest.

Meter: An electric meter is used to measure the amount of energy produced or consumed. (see also: Meter form, Revenue-grade metering)

Meter form number: The meter form designation, i.e. Form 2S, Form 16S, etc, describes the number and arrangement of meter terminals as well as the number and internal connection of meter elements.

Microinverter: A small inverter used with a single module.

Mill-finish: Typically refers to stamped or extruded metals that have been formed but not polished, anodized, painted nor otherwise finished.

Modbus: Originally developed by Modicon (now part of Schneider Electric) and maintained by the non-profit Modbus Organization, Modbus is an open serial-communications protocol commonly used for communication between industrial devices and controllers. Most PV inverters use Modbus to communicate with third-party monitoring or control platforms.

Module-Level Power Electronics (MLPE): Refers to optimizers or microinverters used with each module. (See also: Microinverters, Optimizers)

Module: An assembly of PV cells (usually 36, 60 or 72 in series) that outputs a DC voltage when exposed to light. "AC modules" incorporate a microinverter to output AC power.

Monocrystalline (mono): Refers to wafers or cells made from a single crystal of silicon, which tend to have higher efficiencies than multi-crystalline cells.

Multicrystalline: Commonly referred to as "poly-crystalline," this refers to wafers or cells that are made from a silicon casting, which tends to have lower production costs than the monocrystalline process.

National Electrical Code (NEC): Also known as NFPA 70, the NEC is a standard published by the National Fire Protection Association (NFPA) for the safe installation of electrical wiring and related equipment. It is generally adopted with or without modification by states or city/county AHJs. Article 690 addresses solar PV installation specifically but many other sections, such as article 250, apply as well.

Nationally Recognized Testing Laboratory (NRTL): Laboratories designated by the federal Occupational Safety & Health Administration (OSHA) to test products for adherence to applicable standards. Solar products sold in the U.S.A. are most often Listed by Underwriters' Laboratories (UL) or Intertek (ETL).

Nameplate Capacity: The nominal output or throughput of a device or machine. PV modules typically have a nameplate capacity based on the output of the module at standard test conditions as determined by a "flash test"

National Electrical Manufacturers Association (NEMA): An association of electrical equipment and medical imaging manufacturers, NEMA provides standards for electrical connectors and Enclosures. (See also: NEMA enclosure types, Ingress protection)

NEMA enclosure types: Defined in the NEMA ICS 6 Enclosures Standard, common NEMA enclosure types include NEMA 1 – indoor use only, NEMA 3/3R – weather resistant and 4 – watertight. X (as in NEMA 4X) denotes additional corrosion resistance.

Net Energy Metering (NEM): The prevalent utility billing mechanism for distributed energy systems, such as solar PV, which credits energy exported to the grid at the same (retail) rate as energy consumed from the grid. Such systems are said to be "net metered."

Network Equipment Building System (NEBS): Developed by Bell Labs, NEBS provides a standard for communications equipment used in a central office and is now managed by Telcordia. NEBS has three levels that each refer to various parts of the GR-63-CORE and GR-1089-CORE standards. Level 1 concerns just personnel and equipment safety while Levels 2 and 3 expand to cover operability and reliability requirements.

Non-isolated: Most transformerless inverters are "ungrounded" on the DC side in that there is no "neutral" wire. Rather, both the positive and negative inputs have an absolute voltage and require combiner boxes with overcurrent protection on both legs.

Normal Operating Cell Temperature (NOCT): The temperature of a particular PV cell when operated at 800 W/m^2 of irradiance in average 20 °C ambient air with a 1 m/s average wind velocity across the back of the module. In order to better understand the performance of a PV module through a variety of operating conditions, the NOCT is typically measured by an NRTL for a sample set and reported on the module data sheet.

Off-grid: Not connected to the electrical grid; usually referring to a standalone PV or wind system on a home or industrial site. See also: Grid

Ohm (Ω): The standard unit of electrical resistance; a circuit with 1 Ω resistance will induce 1 A of current when 1 V of electric potential is applied.

Ohm's Law (V=IR): The mathematical relationship between the current (I), voltage (V) and resistance (R) of an electric circuit.

Open-circuit voltage (V_{oc}): The absolute difference in electrical potential across a device, such as a battery or PV module, when it is not connected in a circuit. For PV modules, V_{OC} is typically measured and reported at standard test conditions and must be corrected for actual temperature and irradiance.

Optimizer: module-level power-electronics device that provides MPPT and monitoring for each individual module in the array.

Panel:

- Several PV modules mounted together on a single rail set.
- An electrical load center or breaker access point.
- A solar-radiation collector used for a solar hot-water system.
- See: Module

Parallel: Electrical wiring scheme where the positive leads/terminals from multiple modules, batteries or strings are connected together to increase current.

Partial State of Charge (PSoC): PSoC refers to the status of batteries that are less than fully charged. Lead-acid batteries can experience irreversible sulfation if in a PSoC condition for more than a week or two. (See also: Sulfation)

Photovoltaic (PV): Famously characterized by Einstein, the photovoltaic effect is the physical phenomenon at the heart of all technology for generating electricity from light. See also: Cell and Module

Powder coated: A type of surface coating that is applied as a powder then cured at elevated temperatures. Powder coating can provide thicker layers in a single coat than is achievable from liquid paints and is often used for metal components, such as steel racking or metal enclosures.

Power: The rate at which work is performed or energy converted from one type to another.

Power factor: The ratio, from -1 to 1, of real power (ability to do work) going to the load vs. apparent power (V x I) in the circuit. A power factor less than 1 indicates that voltage and current waveforms are out of phase, leading to losses in the power system.

Polyamide 6,6 (PA66): More commonly known as Nylon 66, PA66 is a common industrial polymer often used in molded parts for its high strength and dimensional stability. The addition of carbon to improve UV resistance typically renders it black.

Polycrystalline (poly): See Multi-crystalline.

Polysilicon (poly-Si): Typically refers to the purified silicon feedstock used to produce multicrystalline and monocrystalline silicon wafers, the precursors to PV cells.

PV-direct (or Array-direct): A type of off-grid system where the load is run directly from a PV module or array rather than from a battery bank.

PV System: Usually refers to complete system and includes all components necessary for energy production: modules, inverter, racking, etc.

Photovoltaics for Utility Scale Applications (PVU.S.A.): A joint government/industry project in the 1980's that included a 650 kW PV array in Davis, CA and another in Kerman, CA. The project led to a number valuable insights and established some of the earliest benchmarks and best practices for utility-scale solar, most notably the PTC module rating.

PVU.S.A. Test Conditions (PTC): Developed by the PVU.S.A. project to better characterize field performance of PV modules, PTC tests are performed at 1,000 W/m^2 with 20 °C ambient temperature and a 1 m/s average wind speed. The California Energy Commission lists PTC values in the equipment listings for the CSI incentive program.

Quarter points: The ideal mounting points for a beam (or PV module frame) are 25% of the total length from each end. i.e. if a module frame is 1 m long, the quarter points are located 25 cm from each end. This is typically where the mounting holes in the bottom flange of the module are located.

Racking: Typically refers to the module mounting system, which fixes the PV modules to a roof, carport or other ground-mount structure.

Rapid Shutdown (RSD): Article 690.12 in both the NEC 2014 and NEC 2017 codes require a means of rapid shutdown, accessible to emergency responders, that can limit the DC voltage in PV system conductors on or in a building. Most module-level power electronics are inherently compliant, but string inverters and other systems typically require a separate device.

Rate Structure: The calculation method used by the electric utility to determine how a rate payer's electricity use is billed. Common rate structures include "flat" $/kWh rates, "tiered" rates that increase as more energy is consumed and "time-of-use (TOU)" rates which vary throughout the day. Commercial rate structures often include demand charges based on peak kW use.

Relay: An electrically-operated switch where a low-voltage/low power control signal is used to switch a much larger load or power source. A wide variety of relay types are used for different applications.

Remote Temperature Sensor (RTS): Also referred to as a battery temperature sensor (BTS) this is a temperature probe, usually a thermocouple, used to measure the operating temperature of a battery so that the associated charge controller can adjust charging voltage appropriately. A missing or improperly installed RTS is the leading cause of premature battery failure.

Revenue-Grade Metering (RGM): RGM as a requirement or capability typically refers to an electric meter that meets ANSI C12.20 standards. RGM can be Class .5 (± 0.5%) or Class .2 (± 0.2%). Which class is required depends on whose revenue you're interested in.

Recommended Standard (RS)-485: Officially known as TIA-485-A, the RS-485 standard is maintained by the Telecommunications Industry Association (TIA) and defines the electrical characteristics of the signal generator and receiver in a local communications network. Most solar inverter communication gear is compliant to RS-485 regardless of protocol.

Rectifier: An electrical device that converts AC into DC power.

Registered Jack (RJ): A standardized telecommunications network interface for voice and data signals.

RJ-11: This four-pin connector is most commonly used for single-line telephone jacks but is often adapted for use with proprietary Datacom systems, such as connecting temperature sensors to battery-based inverters.

RJ-45: Also specified by IEEE 802, this eight-pin connector is used world-wide for Ethernet devices and often for many RS485/Modbus devices used in PV installations.

S-Tile: A type of roof tile, usually terra cotta or ceramic, with an "S" shaped cross-sectional profile. This type of roofing material requires special care and often special attachment hardware to prevent breaking the tiles and/or leaving the under layer exposed.

Self-Consumption: In solar industry parlance, self-consumption refers to an application were all PV electricity generated on site is consumed rather than exported to the grid – as distinct from net-metered applications. Most self-consumption applications require batteries.

Self-Discharge: Batteries slowly lose charge over time, even when no loads are applied. The rate of self-discharge increases with temperature and varies according to battery type and chemistry.

Series: Electrical wiring scheme where the positive lead/terminal from a module or battery is connected to the negative lead lead/terminal of the next one to increase the voltage of the resulting string.

Shake: Typically refers to a wooden roofing material. Primarily used for aesthetic reasons, shake roofs can become fire hazards and are not recommended for use with PV systems.

Short Circuit Current (I_{SC}): In solar PV applications, I_{SC} usually refers to the prospective short-circuit current or available fault current. In this case, it represents the maximum electrical current that a device, such as a battery or PV module, can output. I_{SC} is typically measured and reported at standard test conditions and may need to be adjusted for expected temperature, irradiance, etc. I_{SC} is important to know for sizing current-carrying components such as breakers, wires, charge controllers and inverters.

Sodium-ion battery: A type of rechargeable battery that uses sodium ions as charge carriers. While comparable to lead-acid batteries in terms of size and weight, sodium-ion batteries have much longer cycle life, can remain at low states of charge for extended periods without damage and can be manufactured without hazardous or toxic materials. Aquion Energy is the first commercial manufacturer of sodium-ion batteries.

Standard Test Conditions (STC): Typically refers to the conditions, (1,000 W/m^2 of light at 25 °C) under which, a PV module's nameplate capacity is measured. More broadly, the term can refer to any set of conditions deemed standard for rating a particular device.

Static Load: A load that is steady or fixed for a long period of time, i.e. snow or constant wind on a PV module.

String: A group of modules or batteries wired in series is a string.

Sulfation: The crystallization of lead sulfate on the plates of lead-acid batteries. Sulfation typically results from leaving the battery at a partial state of charge for an extended period of time.

Sun-hour: A unit of solar insolation equivalent to 1 kWh/m^2. (See also: Insolation)

SunSpec Alliance: A solar/storage distributed energy trade alliance dedicated to establishing standards, protocols and related documents that improve the interoperability of solar and energy storage equipment.

Three-phase power (3-P or 3Φ): Commonly used for larger, non-residential loads, a three-phase power system applies an AC current using three separate conductors with the voltage waveform offset by one-third of the period. This arrangement enables much greater power delivery using fewer conductors since each of the conductors can serve as a return path for the others. (See also: Wye and Delta)

Transformerless (TL): Most inverter manufacturers have transitioned to topologies that use high-speed switching to avoid the need for a transformer. These inverters are typically non-isolated.

Telcordia Technologies: Formerly known as Bellcore and now a subsidiary of Ericsson, Telcordia provides technology and other standards for the telecommunications industry.

Telcordia SR4228: Now GR-4228, this standard covers the design, testing, installation and maintenance of VRLA batteries used in telecommunications backup applications.

Thin-film PV: Refers to a class of photovoltaic cells that are produced by depositing nm or µm-thick layers of PV material on a metal, glass or polymer substrate. Popular thin-film PV chemistries include Amorphous silicon (a-Si), Cadmium telluride (CdTe or Cad-tel), Copper indium gallium selenide (CIGS) and Gallium Arsenide (GaAs).

Tilt Angle (Array tilt): Typically refers to the angle between a line normal to the face of the PV modules and flat ground. Tilt is an important variable when determining expected kWh production of a PV array.

Ungrounded System: See Non-isolated.

Uniform Building Code (UBC): Now the International Building Code, the UBC is published by the International Council of Building Officials and contains construction and materials standards for buildings.

Underwriter's Laboratory (UL): Both an NRTL and a creator of safety-related testing standards, UL standards are some of the most referenced in the NEC and related safety codes. (See also: Marked, Listed)

UL 1004: The NEC-referenced test standard for motors and generators, including wind turbines.

UL 1703: The NEC-referenced test standard for PV modules includes tests for fire resistance, electrical insulation, etc. The tests are designed to demonstrate safety of the module in operation or failure conditions. (See also: Listed)

UL 1741: The NEC-referenced test standard for inverters and related equipment incorporates IEEE 1547 interconnection requirements as well as additional safety requirements. (See also: Listed)

UL 2703: The NEC-referenced test standard for PV module racking and grounding systems.

UL 1699B: The NEC-referenced standard for Arc-Fault Circuit Interrupt (AFCI) devices.

UL 1998: A safety standard for software used in programmable embedded microprocessors that is primarily concerned with preventing fires.

UL 467: The NEC-referenced standard for grounding and bonding equipment.

UL 508A: The NFPA-referenced standard for industrial control panels.

UL 60950: The NEC-referenced standard for IT equipment.

UL 1564: Standard for Industrial Battery Chargers.

UL 1236: Standard for Battery Chargers for Charging Engine-Starter Batteries.

UL 458: Standard for Power Converters/Inverters and Power Converter/Inverter Systems for Land Vehicles and Marine Crafts.

Valve-Regulated Lead Acid (VRLA): A type of "sealed" lead-acid battery where the electrolyte is suspended in some form and outgassing is regulated by check valves on the lid; includes Gel and AGM battery types.

Volt (V): The standard unit of electric potential; One V of potential with an electric current of 1 A will dissipate 1 W of power between the points, across which, it is measured.

Watt (W): The standard unit of power; equal to 1 Joule/second.

Washer, Electrical Equipment Bonding (WEEB): Used to bond solar modules to aluminum solar mounting rails, eliminating the need for a bare copper wire to each module.

Wild AC: Wind turbines with brushless AC generators often output voltage and frequency that varies with wind speed. Wild AC typically must be rectified before it can be used by loads.

Wye: A three-phase power configuration where three current-carrying lines use a common reference point and/or neutral line. (See also: Three-phase power)

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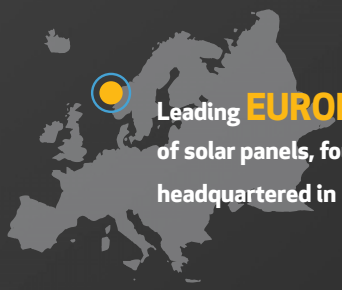

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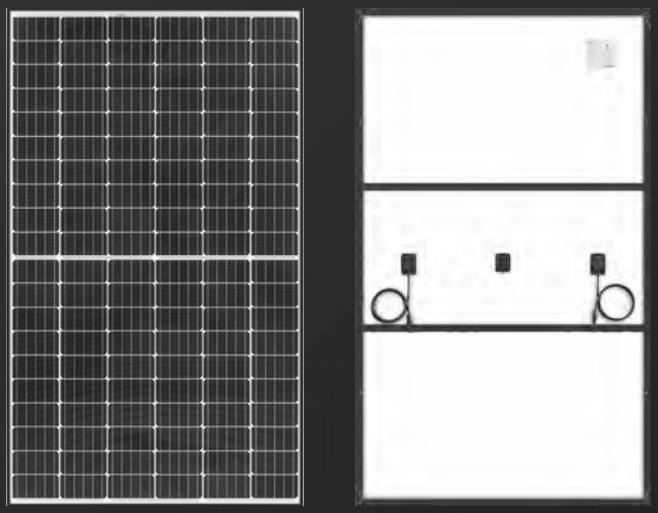

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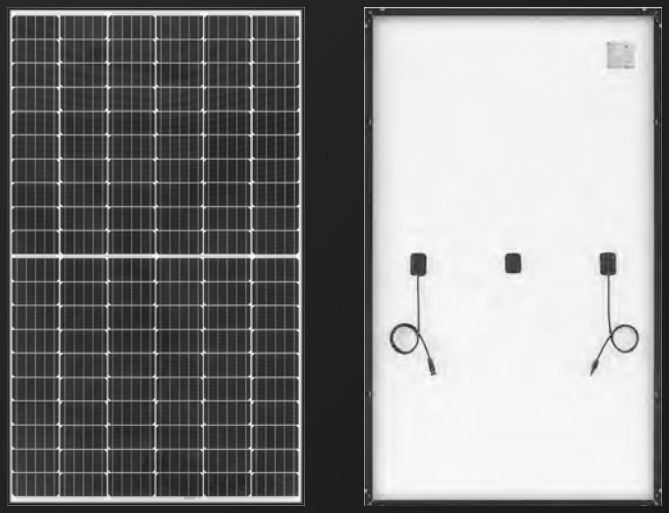

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