

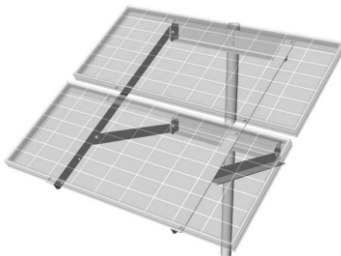


**SOLAR
ELECTRIC
SUPPLY, INC.**

Modular Autonomous Photovoltaic Power System

MAPPS™

INSTALLATION & OPERATION MANUAL



Technical Support

We strive to provide quality service and support. Please feel free to contact us at any time should a question arise as to the proper installation and operation of the system. A proper installation will help to ensure reliable system operation.

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STANDARDS AND CAUTIONS FOR SOLAR (PV) INSTALLATIONS

Installation and wiring details must be in strict conformance with local building and electrical codes. In the event no such codes are present, adherence to the National Electrical Code (NEC) is mandatory. Please read, review and understand this manual before the field installation. We recommend setting the system up in a shop first to make sure you have everything you need in the field.

Solar Electric Supply, Inc. (SES) strongly recommends that all construction and electrical wiring be performed by qualified, licensed professionals only. Double check all completed wiring for proper design voltage and polarity before energizing any equipment.

---IMPORTANT---

The procedures and diagrams in this manual should be read and understood thoroughly before attempting to assemble, wire or energize any part of this system. In addition, read all manufacturers' instructions that are packed with any equipment provided.

---WARNINGS---

Failure to comply can result in catastrophic system failure, fire or severe personal injury (even death) and the voiding of all equipment warranties whether expressed or implied.

- 1) Circuit breakers should be kept OFF during installation and wiring until system is ready for startup.
- 2) Care should be exercised to prevent dropping heavy equipment, such as batteries, enclosure and PV modules, on hands or feet.
- 3) Batteries are shipped fully charged and PV modules are energized whenever exposed to light. Therefore, do not touch both positive and negative terminals at same time, or contact both terminals with screwdriver or any other metal objects such as mounting rails.
- 4) Remove all jewelry before performing electrical wiring or testing.
- 5) Before testing for voltage or current with a meter, make sure you understand the circuit interconnections and open the proper breakers so that you do not short the battery or place PV open circuit voltage on the load.

6) Before lifting any heavy or bulky equipment, make sure you have a satisfactory way of grasping it so that moving parts do not shift and it can be lifted as far as needed without back strain or loss of grip. It is recommended that two persons be employed in performing the installations.

Important: Special Considerations, Before Beginning the Installation

To ensure proper operation of the power system, it must be installed per the instructions in Section 3.

Special care must be taken when selecting the solar module mounting location to prevent possible shadowing effects from cut hillsides, trees or utility poles. Any shading of the modules, during any period of the day, will result in a reduction in the output of the solar array and reduced system performance and must be avoided.

Connecting loads with power requirements greater than those for which the system was designed will result in poor system performance and possible damage to the batteries.

Additionally, the solar modules must be properly oriented for the specific geographic region to maximum solar radiation available at the site. This includes the tilt angle and alignment to True South (refer to Section 3.3)

1 INTRODUCTION

Thank you for purchasing a Solar Electric Supply, Inc. MAPPS solar electric power system. Solar Electric Supply Inc. is a world leader in the design and sales of solar electric power systems, with over three decades of experience. Our production facilities are located in Chandler, Arizona, with sales offices throughout the United States.

The solar electric system is designed to provide operating power to a specified load. Using loads other than those for which the system was designed will result in poor system performance and possible damage to the batteries.

System components have been carefully selected and configured for the intended application. Solar module, support structure, and battery components may be provided separately.

1.1 SYSTEM DESCRIPTION

There are three major components in the photovoltaic system: solar modules, batteries, and the system charge controller. Throughout the year, all the power to the load is provided by the solar array.

The photovoltaic array will supply current to charge the battery bank. The controller will monitor the battery terminal voltage and limit the charging current to the battery as required. As the battery voltage rises to 14.1 VDC (28.2/56.4 VDC in 24/48 VDC systems) the controller will limit the current from the solar array to maintain the battery terminal voltage and prevent the battery from being overcharged. The controller also contains a temperature probe and adjusts the charge voltage at a rate of $-0.03 \text{ VDC}/^{\circ}\text{C}$ from 25°C ($-0.06/-0.12 \text{ VDC}/^{\circ}\text{C}$ in 24/48 VDC systems). This temperature compensation feature assures the battery is properly charged in cold temperatures and not overcharged in warm temperatures. (Refer to the controller manual in the Appendix for additional details on charge regulation.)

Additionally, the controller contains a Low Voltage Disconnect (LVD). This feature will disconnect the load if battery voltage falls to a voltage of 11.5 VDC (23 VDC/46 VDC in 24/48 VDC systems). This rarely used feature could occur in situations where there are continuous days of cloudy weather or any time the system fails to provide power to the load. This feature will prevent the battery from being over-discharged to a level that could damage and shorten its life. When the battery has been charged to a voltage of 12.6 VDC (25.2 VDC/50.4 VDC in 24/48 VDC systems), the controller will reconnect the battery to the load. For 120 VAC power a sine wave inverter is included and prewired in the control enclosure.

1.2 LIST OF COMPONENTS

The MAPPS line includes the following major components in differing quantities depending on the model chosen.

- Rigid framed PV Modules, typically from one to four in 12V systems and one to eight in 24-48V systems
- Outdoor Battery/ Control Enclosure, rain-proof with sealed control/inverter compartment or Single-Duty Battery/Control Enclosure, vented rain-proof enclosure
- Side-of-Pole or Ground/tower Mounting Structure
- Charge Controller
- Sealed deep cycle Gel (36 to 265 Amp-hr) Battery(ies)
- Wiring Kits for PV array and batteries

1.3 ADDITIONAL MATERIALS NEEDED

Below is a list of the materials and hardware that the user will need to provide to complete the installation. This is a general list and may not include all items needed.

- Foundations, masts, poles, etc, to support the PV array mounting structure and the battery/ control enclosure.
- Hardware (nuts, bolts, etc.) to attach the PV array mounting structure and/or the battery/ control enclosure to the pole or other mounting structure. (Standard hardware is provided, but additional hardware may be needed.)
- Wiring & Conduit from the solar junction box or combiner to the charge/ load controller, wiring and conduit between the charge controller and the battery bank, and wiring and conduit to the user's loads. We can specify based on the distances between the above items.
- Ground rod, grounding wire and clamps.
- Cable ties for wire dressing.

1.4 RECOMMENDED TOOLS & MATERIALS

No tools have been supplied with this system. Below is a list of tools and materials recommended to complete the installation.

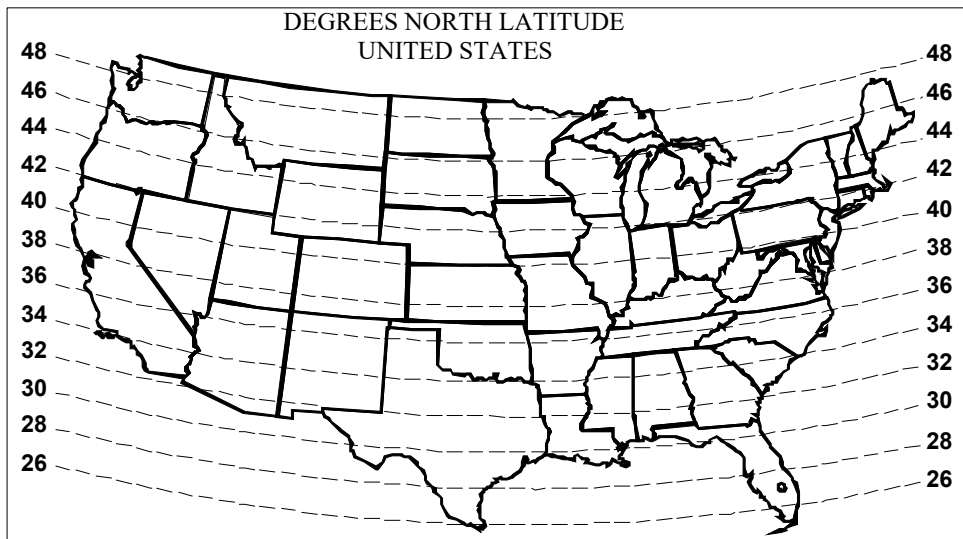
- * Digital voltmeter
- * Compass
- * Tape measure
- * Marker
- * Level
- * 6" and 10" crescent wrenches
- * Ratchet and socket set
- * Flat bladed and Phillips head screw drivers
- * 1/2" knockout tool

- * Pliers
- * Wire cutter/ stripper
- * Knife
- * Electric drill with metal bits (not required)
- * Allen wrench set
- * U Bolts or band clamps for battery enclosure (for pole mounting)
- * #6 Ground wire for solar array and battery enclosure
- * Extra ½" conduit and strain relief connectors with #10 THWN red and white for load wiring or unexpected

2 System Installation

2.1 ARRAY ORIENTATION

When the site location is in the Northern Hemisphere, solar (PV) modules should be mounted facing TRUE SOUTH using a good compass. The opposite is true for the Southern Hemisphere. Use Table 1 below to determine the Optimum Tilt Angle, in degrees, for your array. The optimum tilt angle is the site latitude + 15°. This assumes the array will remain at a fixed tilt angle throughout the year and is therefore optimized for the winter. If seasonal adjustment of the array is desired, contact SES for additional information.



While making sure that your solar module(s) will not be shaded throughout the day, also consider that the sun's angle changes throughout the year!

TILT ANGLE

Site Latitude	Near - Optimum Solar Module Tilt Angle (degrees)
0-9	15
10-20	Latitude + 5
21-45	Latitude + 10
46-65	Latitude + 15
65-90	80

Table 1

Many mounting structures cannot be adjusted to tilt angles below 30° or above 65°. If these angles are needed, contact SES for recommendations.

Do not use tilt angles below 15° unless you are able to inspect and wash the module frequently.

Shading of the photovoltaic modules will significantly reduce their energy output and consequently proper battery charging! Be sure to select an array mounting location that will not be shaded by towers, poles, buildings, vegetation (e.g. trees), or hillside cuts through the day. In order for the solar array to receive the maximum energy from the sun, the array must face TRUE South (or TRUE North in the Southern Hemisphere). It is recommended to use a GPS or a magnetic compass to find TRUE South. If using a magnetic compass ensure there are not steel objects nearby to affect the reading, also be sure to adjust for magnetic declination. (e.g. for Phoenix, AZ, true south is 12 degrees east of magnetic south). Refer to the maps below, and the diagram to the right for the magnetic declination at the site location.

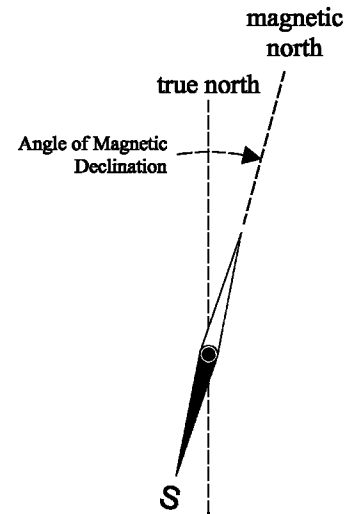
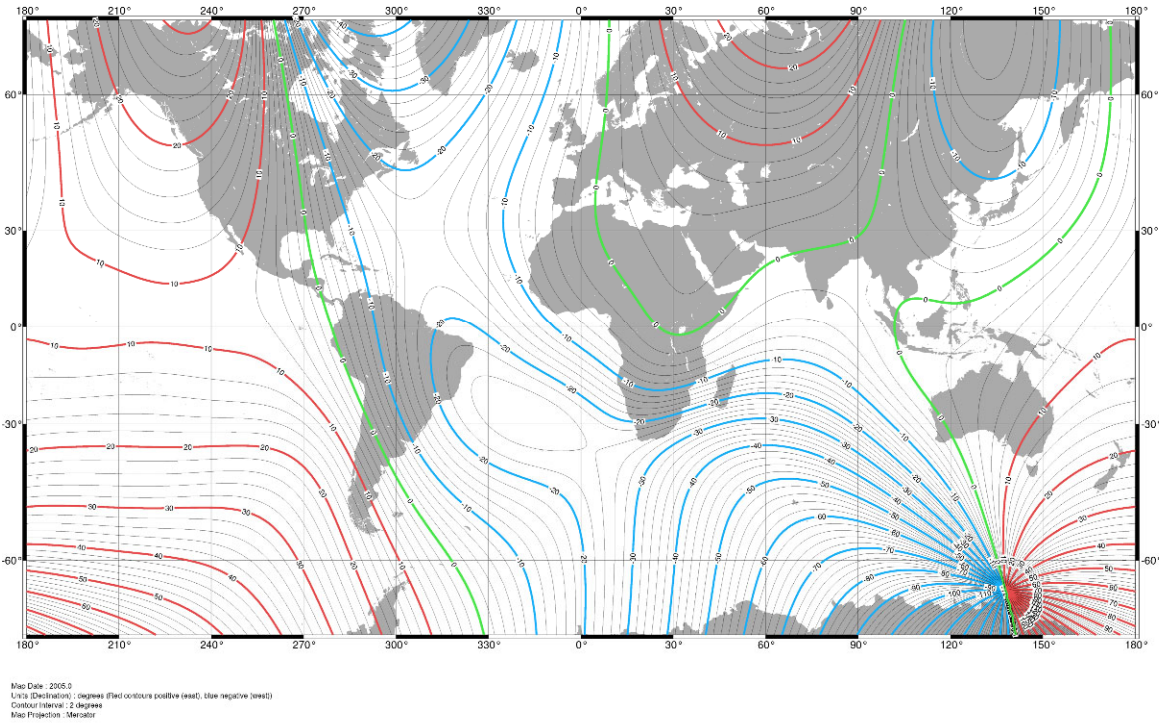


Figure 1 – True South is 12 degrees East of Magnetic South for Phoenix, AZ

US/UK World Magnetic Model -- Epoch 2005.0
Main Field Declination (D)



2.2 SOLAR ARRAY ASSEMBLY AND MOUNTING

A mounting structure is provided for attached the PV modules to an appropriate support. Instructions for assembling the mount and attaching the PV modules are provided in the mounting structure package.

For most systems you can preassemble the module(s) and mounting structure before you take it into the field.

For MAPPS with one or two solar modules a side-of-pole mount (SPM) is usually provided. This mount is designed to attach to a user-supplied pole or pipe, but can also be attached to a square mast or wall with appropriate hardware. The size and height of the pole should be chosen to ensure the array will be above any obstructions that could cause shading.

Though variations do exist, standard SPM mounts for single modules usually have only one support bracket that attaches to the pole. The module attaches to two rails. Tilt adjustment is accomplished by means of eccentric slots on the brackets between the rails and the support bracket. SPM mounts for multiple modules or the High Wind Version usually include two support brackets with cross braces between the bottom bracket and the rails attached to the top bracket. Tilt adjustment is made by varying the distance between the support brackets, sometimes in combination with telescoping cross braces. See drawings on the next page for examples.

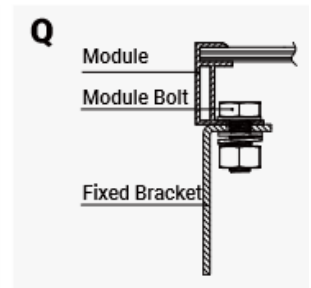
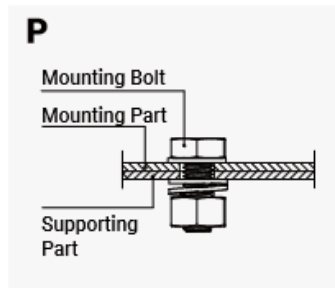
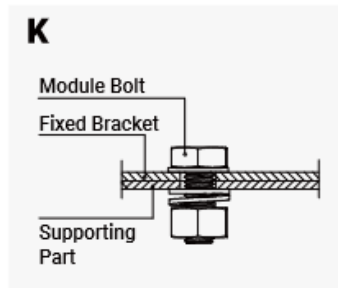
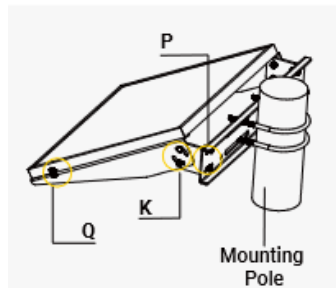
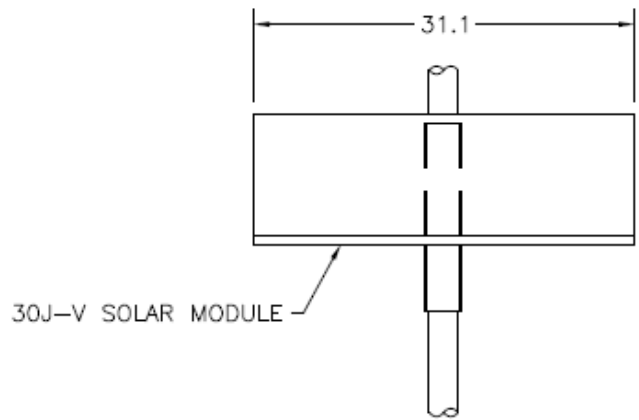
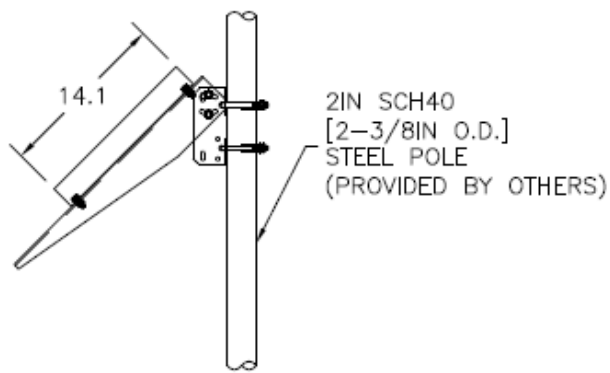
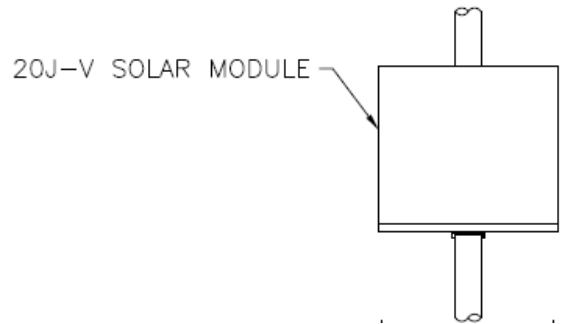
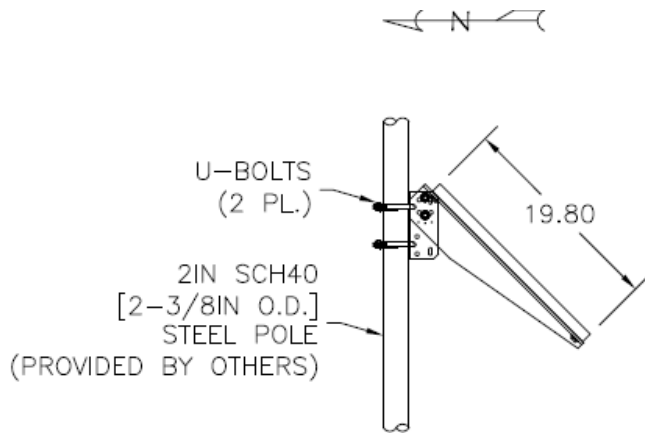
The user is responsible for any poles, masts or concrete pads, and for the proper design and construction of these supports or foundations.

Hardware has been supplied to attach the PV module(s) to the mounting structure. Be sure to use a flat washer between a lock washer and the mounting structure. This procedure will ensure good connections, minimize damage to equipment and reduce possible vibration or expansion loosening. Hardware to attach the mounting structure to a square mast, wall or other non-standard foundation may or may not be included due to the different types of installation possible.

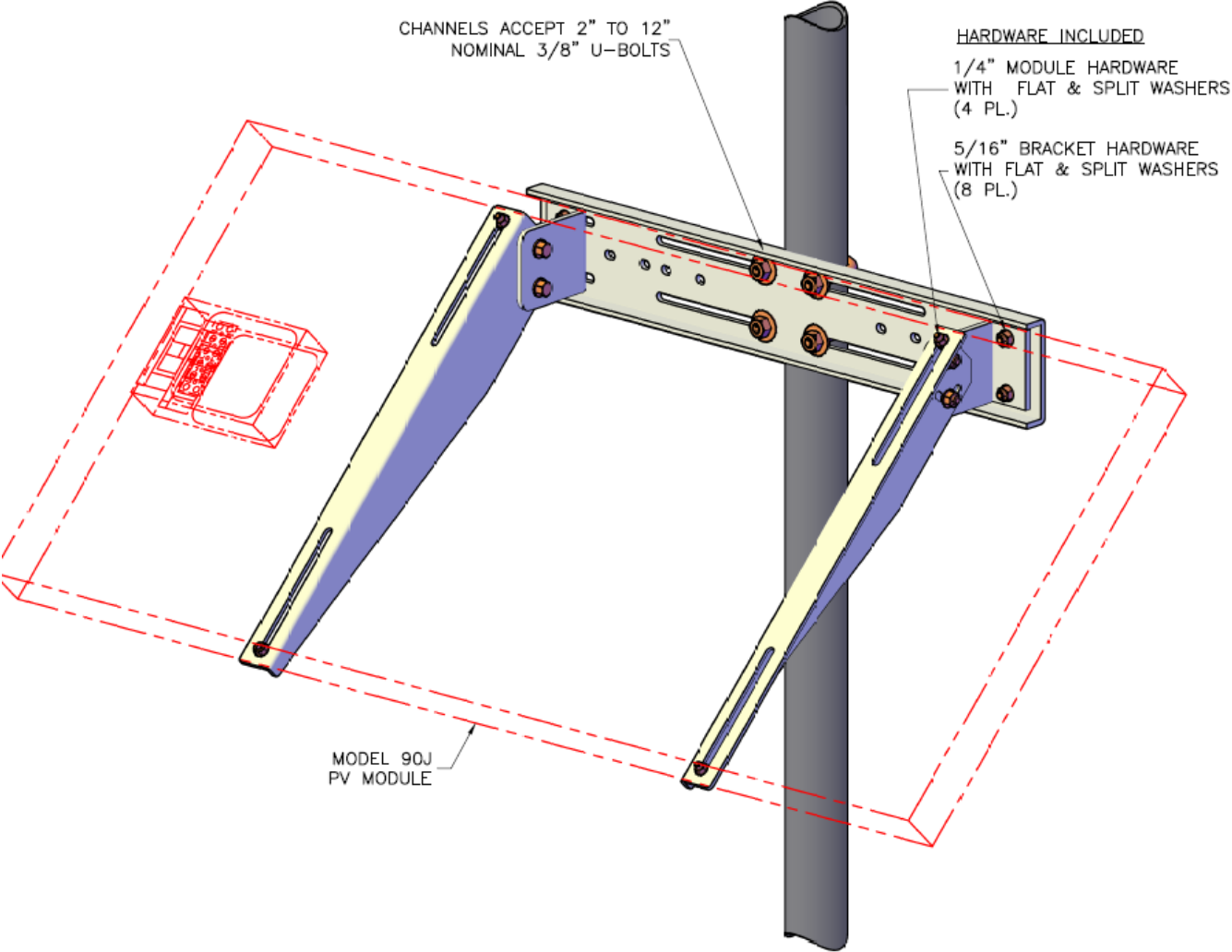
For the sake of personnel safety, the larger PV array assemblies should be installed by two people so that one can hold components in place while the other attaches the hardware.

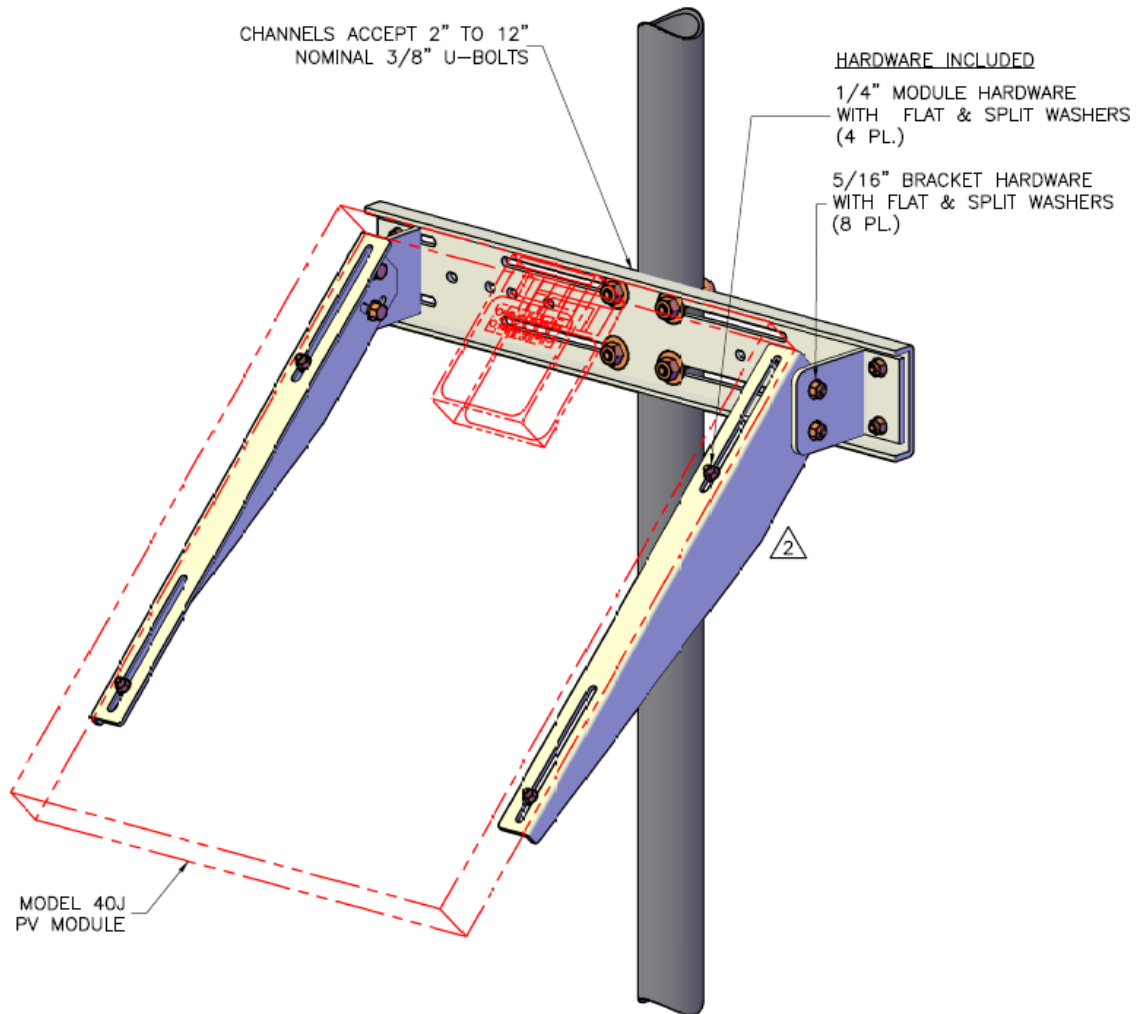
If heavy lifting equipment is available, the array and mounting structure may be pre-assembled and wired on the ground and lifted into place.

HPM 10-30 for 10-30 Watt Solar Module Mounting Structures:



Standard SPM1-Multi Mounting Structure for 40-100 Watt Solar Modules:





2. RAILS MUST BE FLIPPED INWARD AS SHOWN FOR SOME MODULES.
 1. PORTRAIT MODULE ORIENTATION SHOWN, FOR MODELS: 40J, VLS-50W, 65J.
 NOTES:

SPM-1 for 50-90 Watt Solar Module Mounting Structures-High Wind Version:

- ① Solar Panel
- ② Panel Kit Rail
- ③ Leg Kit
- ④ L-Bracket (Foot)
- ⑤ C-Channels (2X4X)
- ⑥ U-Bolts (not supplied)

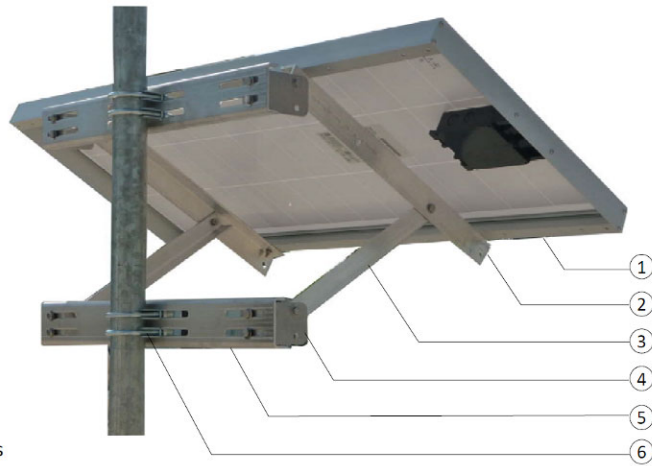


Figure 1. Mounting kit components

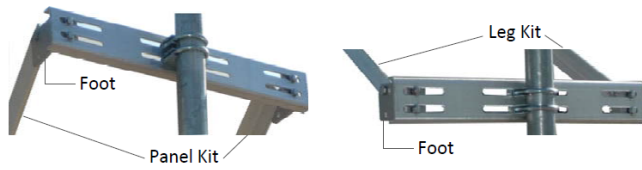
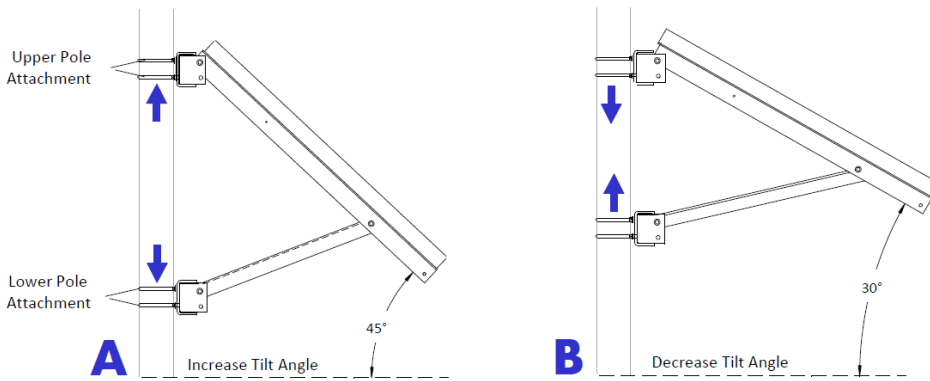


Figure 2. Attach the C-Channels to pole using U-Bolts.

SITE LATITUDE: (In Degrees)	FIXED TILT ANGLE
0° TO 15°	15°
15° TO 25°	SAME AS LATITUDE
25° TO 30°	SAME AS LATITUDE +5°
30° TO 35°	SAME AS LATITUDE +10°
35° TO 40°	SAME AS LATITUDE +15°
40° +	SAME AS LATITUDE +20°

Table 1:



SPM-2 Mounting Structure for two 50-90 Watt Solar Modules:

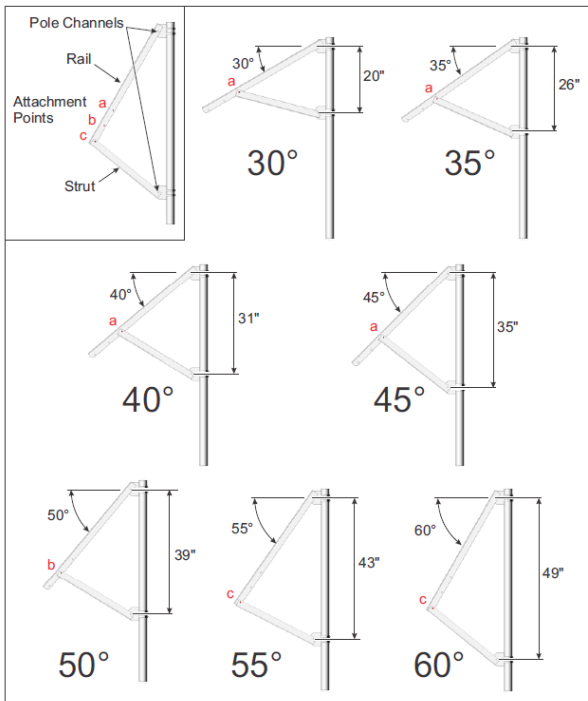


Figure 1-1: Module Tilt Angles and Pole Channel Spacing

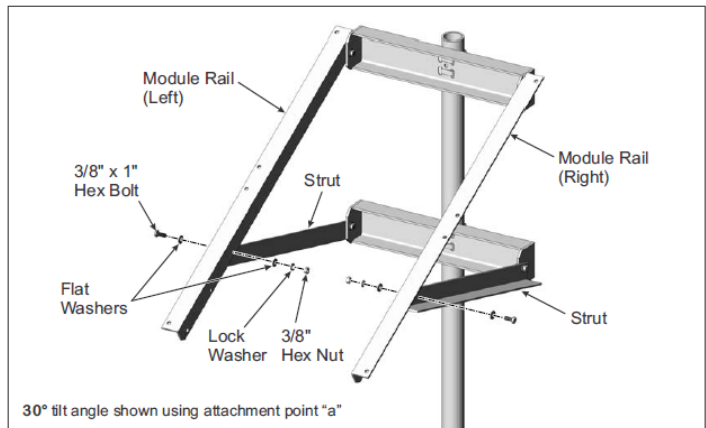


Figure 4-1: Joining Module Rails to Struts

SPM-2 Mounting Structure for two 120-180 Watt Solar Modules:

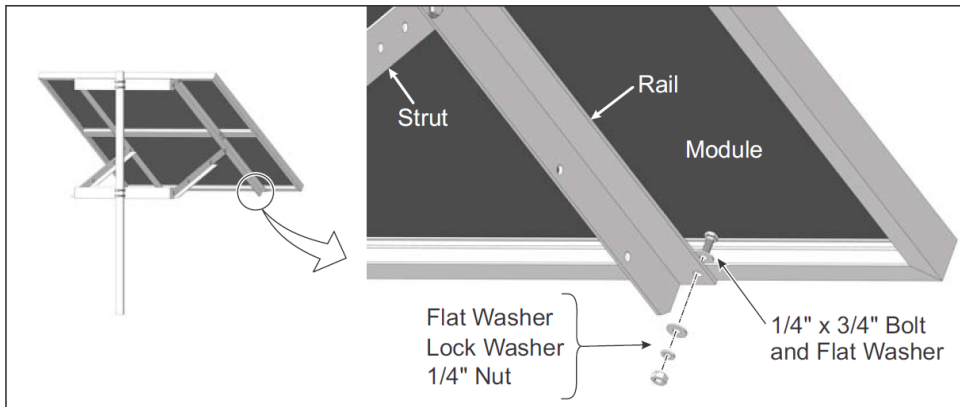


Figure 7-1: Attaching Module to Rail

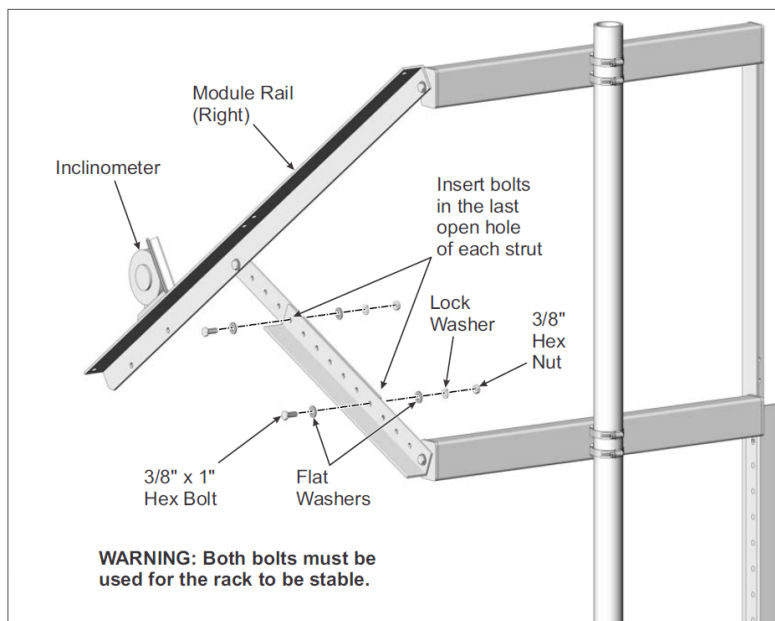
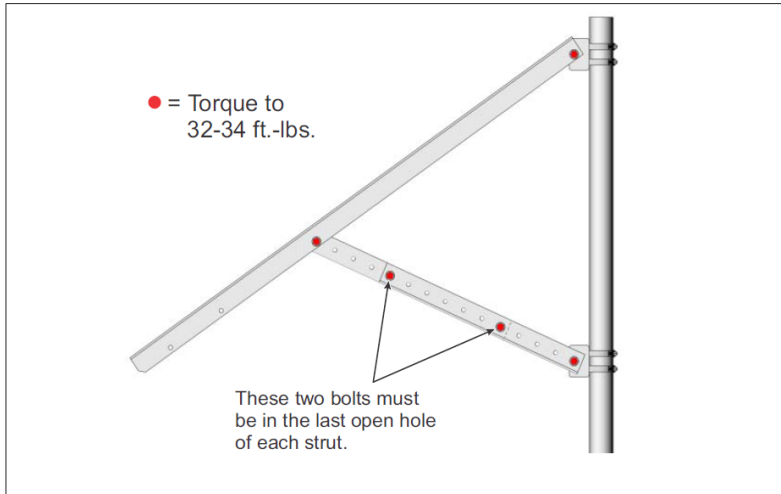


Figure 5-1: Joining the Two Halves of the Expandable Struts

2.3 SOLAR ARRAY WIRING

For best results follow the manufacturer's instructions and cautions packaged with the PV module(s) or the module wiring drawings included as an appendix to this manual. You can pre-wire and test the array before taking it into the field. Measure the open circuit voltage (approx. 20 Volts in a 12 volt system and approx. 40 volts in a 24 Volt system) and the short circuit current of the prewired solar array to make sure you have wired it correctly. Be sure and place the array in full sun for this electrical test, facing South and perpendicular to the angle of the sun.

1. All wiring should be performed according to NEC code requirements.
2. To ensure compliance with listing requirements, use the conduit, connectors and wire supplied with the wiring kit.

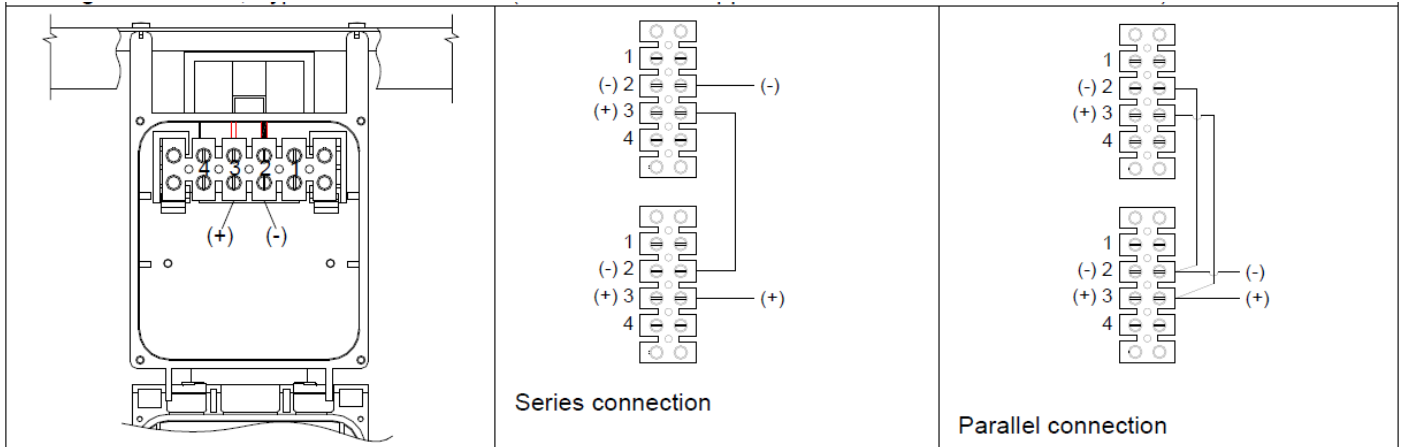
3. Tighten wire connection screws in the J-box to 20 in-lb.
4. Tighten J-box lid screws to 4-6 in-lb. DO NOT OVERTIGHTEN the lid screws.
5. Attach user supplied bare copper wire to the center screw hole on one rail of each module using the self-tapping screw provided with the module. Secure the ground wire to the conduit or pole, route the braid to the ground rod and attach it with proper grounding clamps.

Small solar modules (5W and 10W) are provided with integral 2-conductor pigtail wiring rated for outdoor use. If the module must be elevated to prevent shading from obstructions, the wires may not be long enough to reach the control enclosure. For this case, outdoor-rated USE cable has been provided. The wire must be heat shrink wrapped to seal against water intrusion. Small modules used in 24V MAPPS will also require butt splicing to make the series connection between modules. Use tie-wraps or other devices to secure the wires and prevent damage due to high or gusty winds.

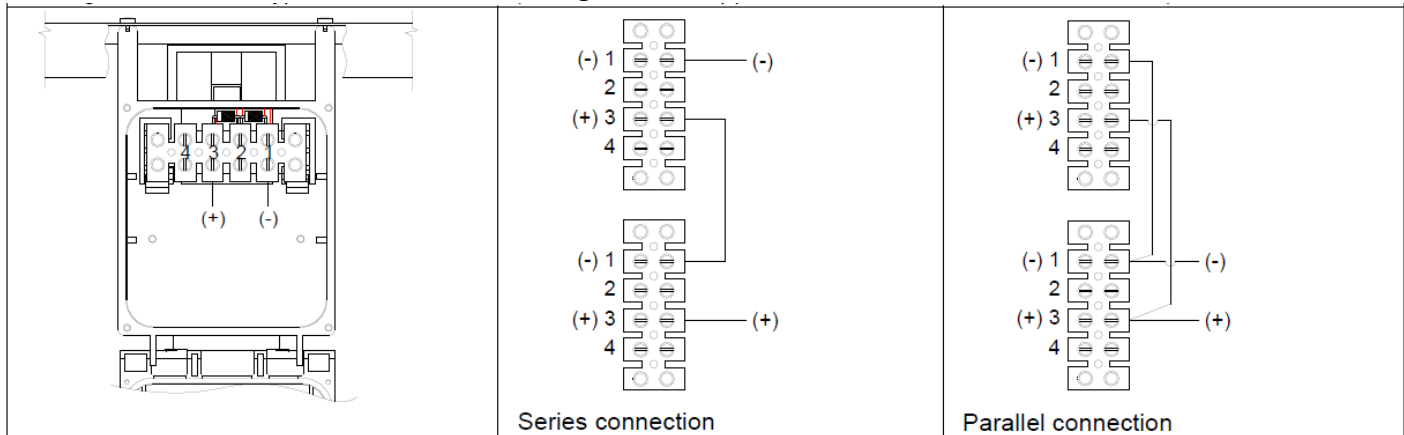
SES solar modules are provided with conduit-ready junction boxes or loose MC cables. We provide the conduit & wire or MC cables to get to a combiner box. The installer needs to supply conduit & wire from the solar array to the control enclosure. The drawings provided with your system illustrate the interconnection and wire routing for 12, 24 & 48V MAPPS. Do not connect more than two wires to any module terminal. Refer to the manufacturer's instructions in the module boxes for specific details.

For modules with MC cables: simply connect the matching polarized connector on the output cables. Ensure the connectors seat completely. For 48V MAPPS systems connect the modules in series by connecting the negative MC connector from one module to the positive MC connector of the other, and then the output cable to the open connectors. At the controller (or combiner box) use a voltmeter to ensure the correct polarity of the array output cables.

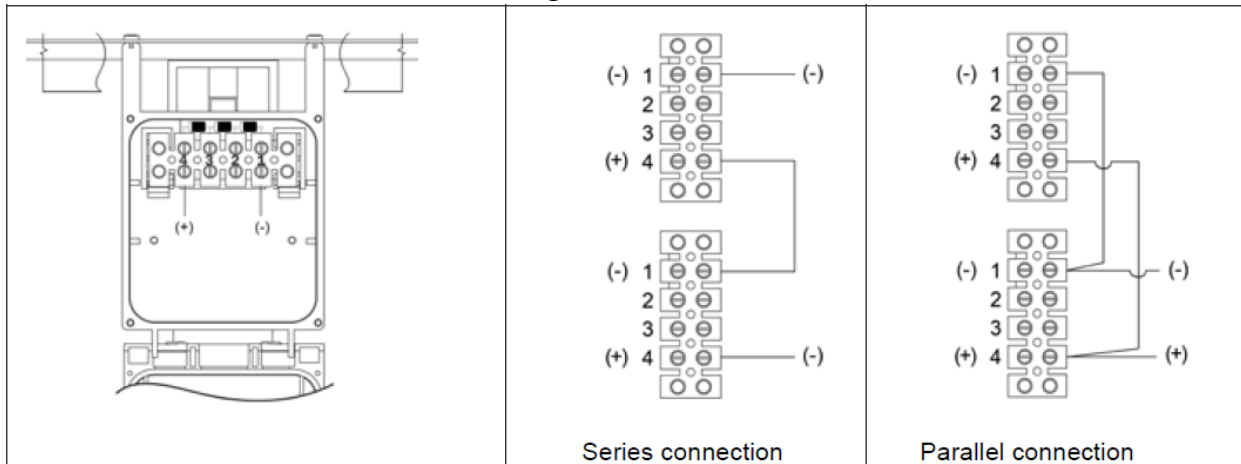
SES 10-30 Watt Module Junction Box Wiring:



SES 50-180 Watt Module Junction Box Wiring:

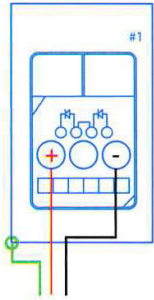


SES 200J Watt Module Junction Box Wiring:

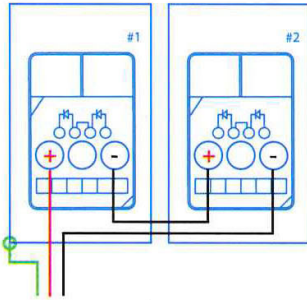


PV Panel Wiring (bottom view)

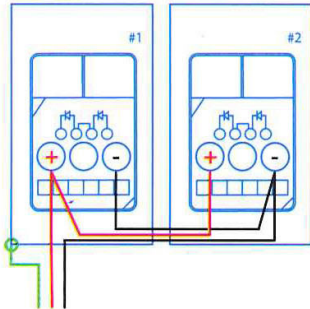
12 VDC



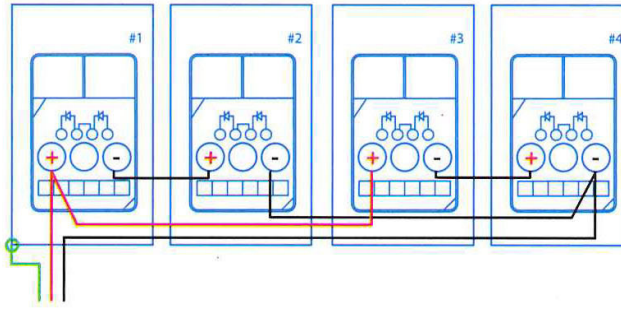
24 VDC



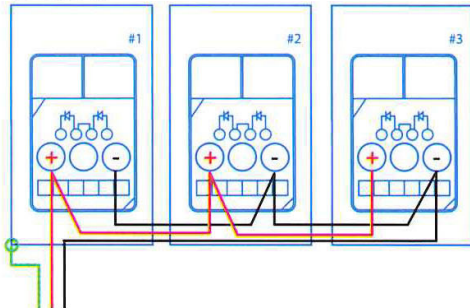
12 VDC



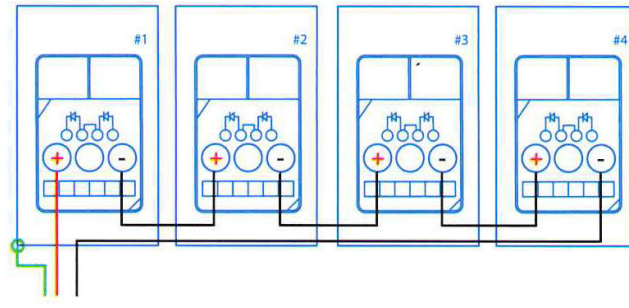
24 VDC



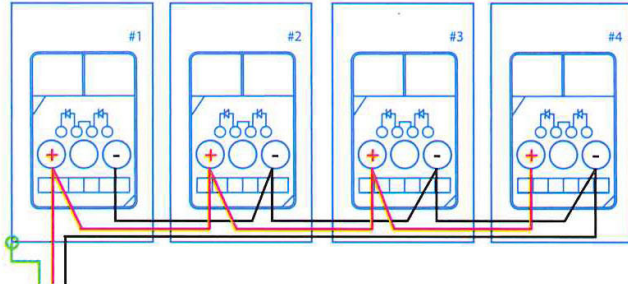
12 VDC



48 VDC



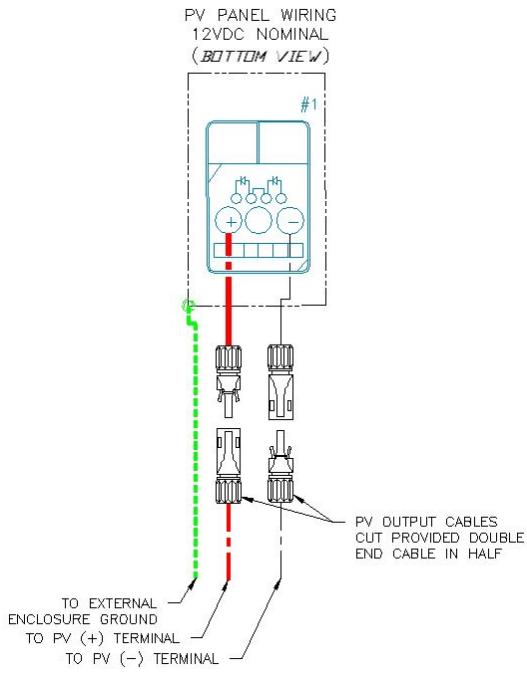
12 VDC



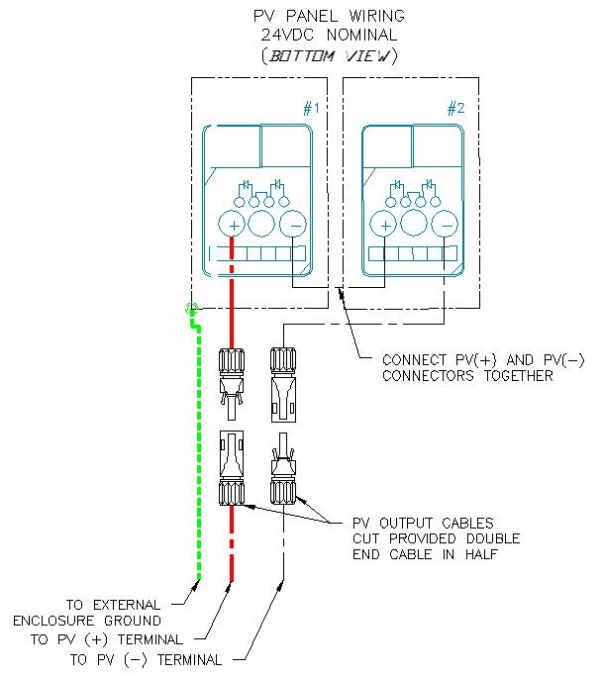
Wiring Legend

- RED - POSITIVE
- BLACK - NEGATIVE
- GREEN - GROUND

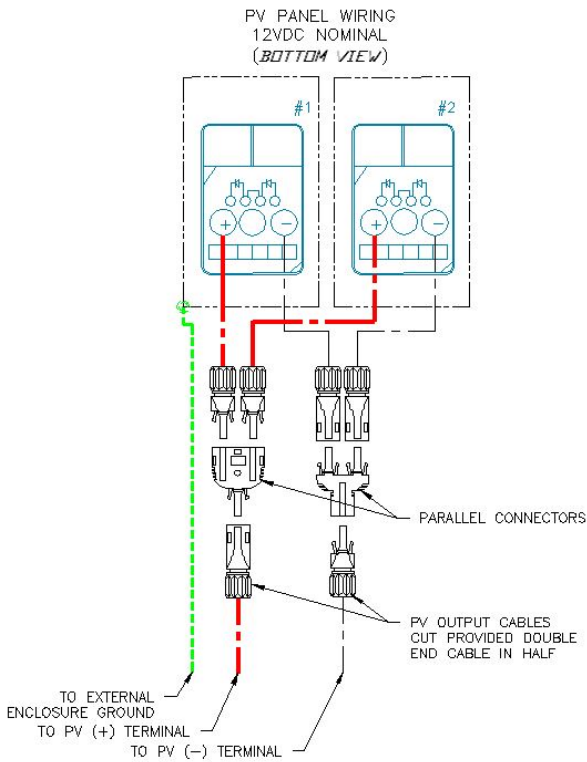
Single module with quick connectors



Two modules with quick connectors



Two modules with quick connectors and parallel connectors



3 BATTERY & CONTROL ENCLOSURES

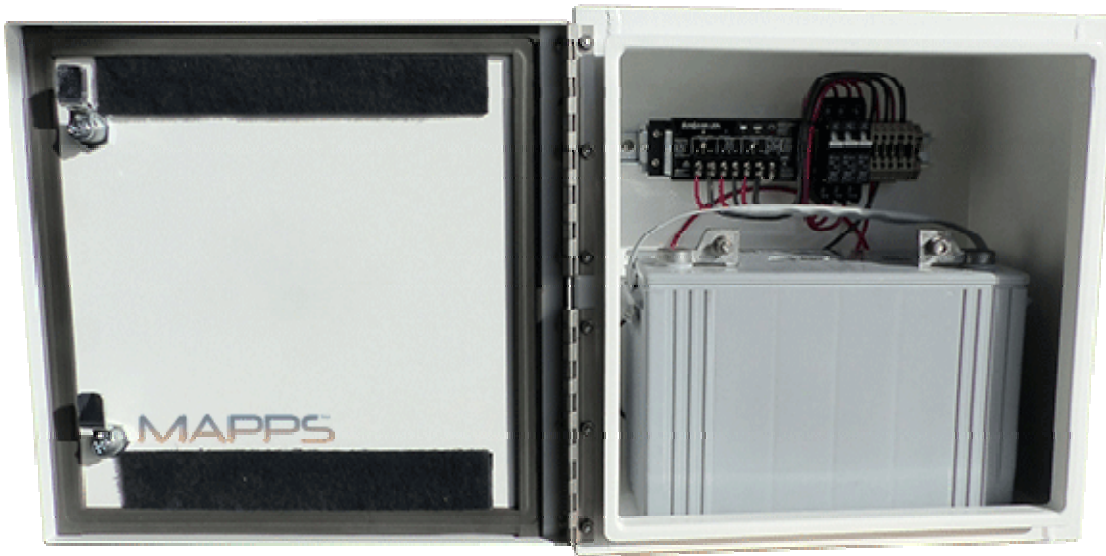
3.1 ENCLOSURE DESCRIPTION

Our smaller systems use a MAPPS Battery/ Control Enclosure, a locking, vented, rainproof, outdoor enclosure which house the control panel, the battery bank and optional load equipment.

The battery enclosures shown below are supplied in different sizes depending on the number of batteries and their size.

MAPPS AL-POL-1-G31N NEMA 3R Battery and Solar Control Enclosure:

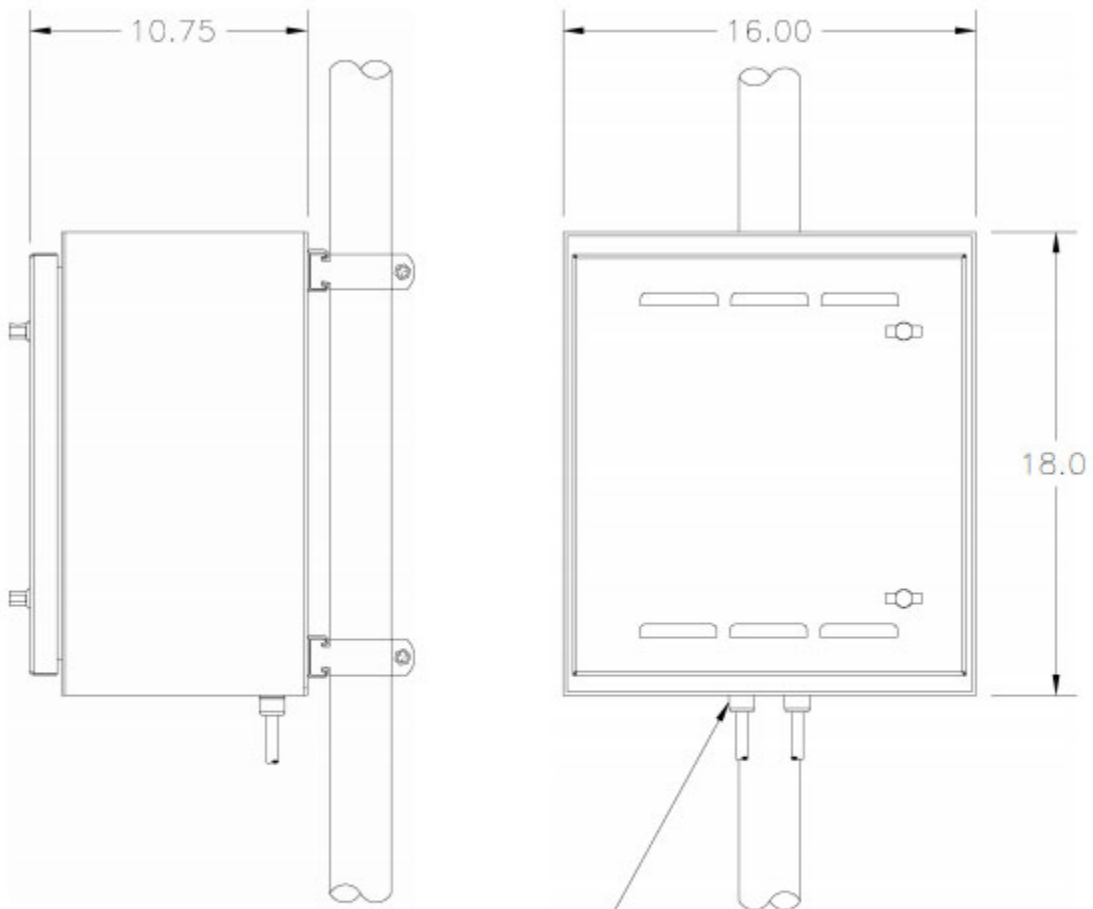
This battery enclosure accommodates one Group 31 battery and control electronics:



The AL-POL-1-G31N is available in standard aluminum finish.



Optional polyester white powder coat available.



1/2" CONDUIT HOLE (2 PL.)
(CONDUIT MAY BE
PROVIDED SEPARATELY
OR BY OTHERS)

MAPPS AL-POL-2-G31N Weatherproof NEMA 3R Battery Enclosure:



Up to two 8G31 batteries may be mounted in the enclosure with a Sun saver, Sunlight or Prostar controller.



The standard AL-POL-2-G31N enclosure is mill finish aluminum.



The AL-POL-2-G31N features dual welded strut channels for attaching pipe clamps to various pole sizes.



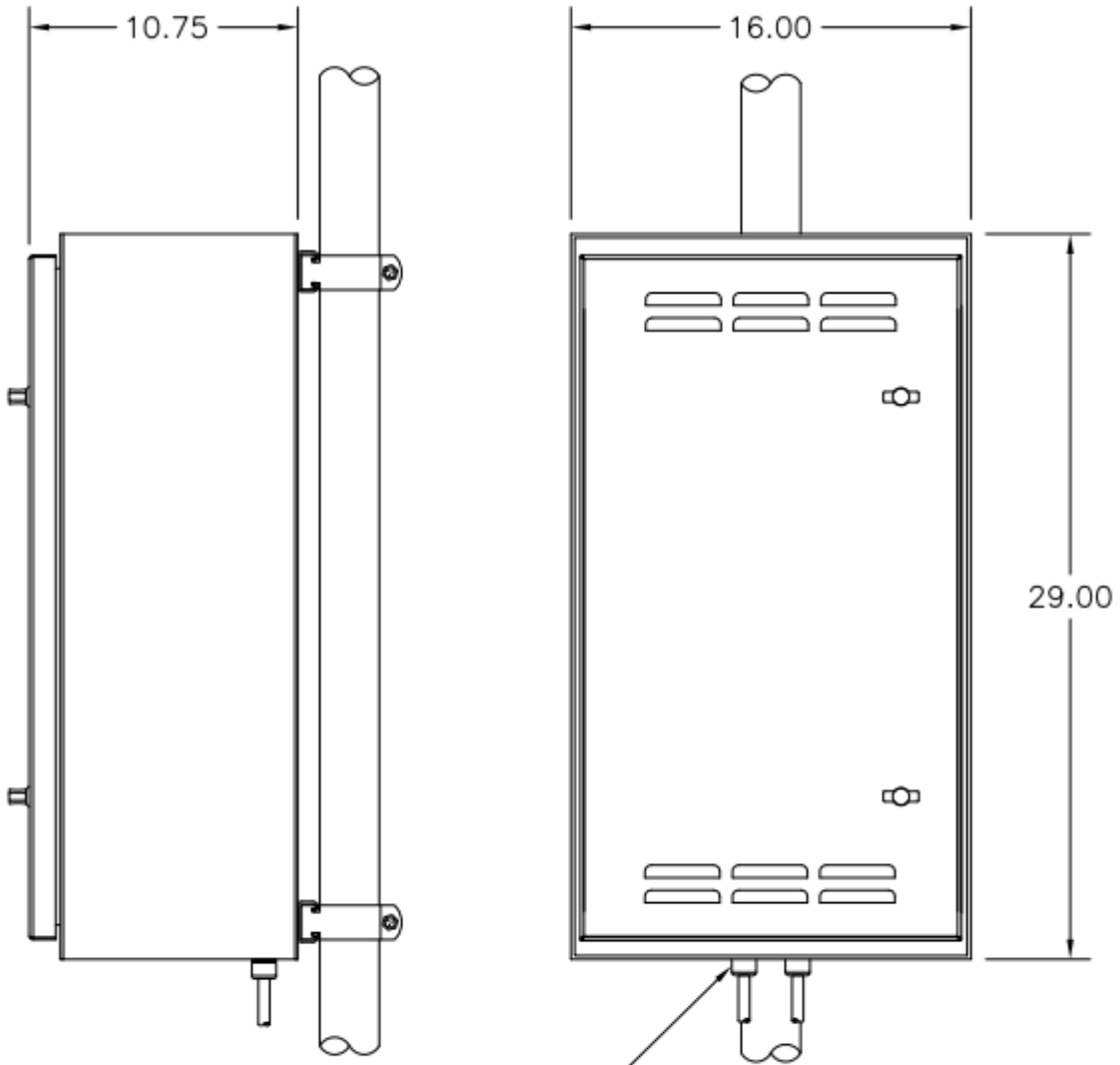
MAPPS

Using one Group 31 battery leaves plenty of room for electronic equipment.



MAPPS

This pole-mounted enclosure has an optional white powder coat.



1/2" CONDUIT HOLE (2 PL.)
(CONDUIT MAY BE
PROVIDED SEPARATELY
OR BY OTHERS)

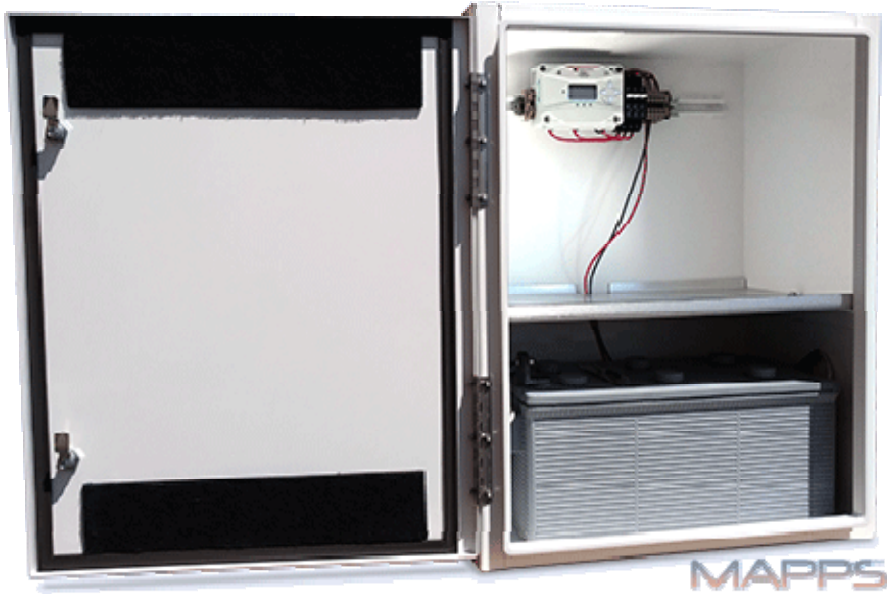
MAPPS AL-POL-2-8G8DN NEMA 3R Large Battery Enclosure:



This enclosure holds up to two Deka Solar 8G8D gel cell batteries with ProStar charge control.

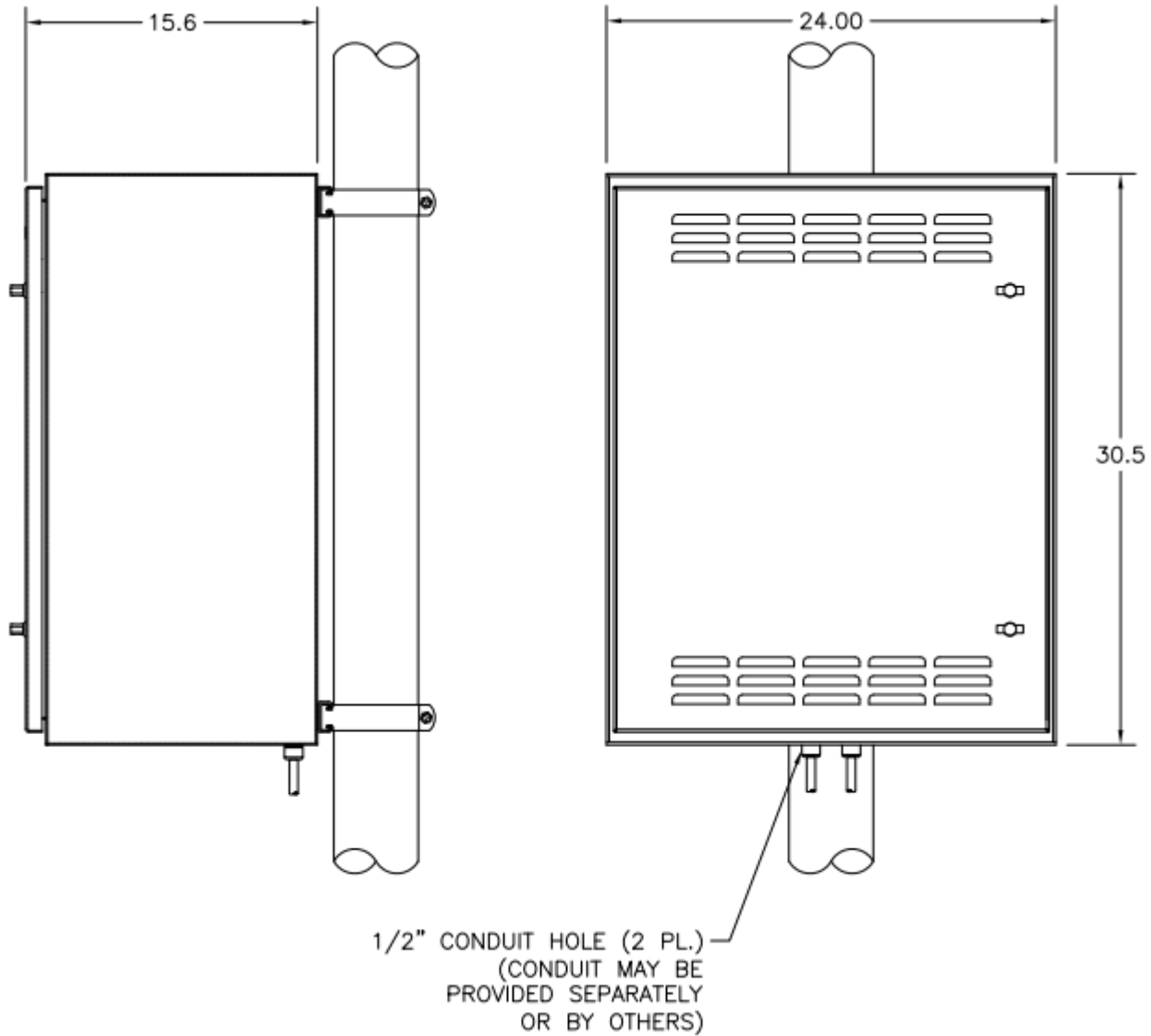


The enclosure can also hold 6 Deka Solar 8G31 gel cell batteries with ProStar charge control.



The AL-POL-2-8G8DN shown with optional powder coated white paint and ProStar charge controller, load center with breakers and one Group 8D gel battery leaving plenty of room for radio and monitoring equipment.





The enclosure can be mounted to the side of a pole or a wall. Hardware is provided for mounting the enclosure to the side of a pole. **HOWEVER, U Bolts or band clamps are not provided and must be supplied by the installer as we do not know the pole size they are being mounted on.**

3.2 ENCLOSURE PREPARATION

Prior to mounting the enclosure on a pole or other structure, prepare the enclosure for acceptance of conduit and wiring as described below.

PREPARATION GUIDE

1. The single battery enclosure usually has the solar and load conduit and wiring already attached and prewired. For the larger enclosures, remove one of the 1/2" knockouts from the enclosure and insert the sealtite connector to accept the array conduit.
2. Remove additional knockouts, as needed, and insert fittings for user supplied external loads.
- 3 For transmitter applications, drill a hole of the appropriate size for the antenna cable fitting.
4. Secure all wires and remove loose objects from inside the enclosure. Close the door prior to mounting.

3.3 MOUNTING THE ENCLOSURE

The enclosure should be lifted and mounted by two persons. These battery enclosures may also be lifted by machinery using lifting eyes. If you pre-install the batteries, make sure they are strapped down or secured to prevent their shifting or falling out.

INSTALLATION GUIDE

1. U-bolts and nuts are NOT provided for mounting to a circular pole. (You will need to provide different hardware if you are attaching to a square pole or a wall.)
2. Position the enclosure at the desired height, and insert the U-bolt in the back holes of the crown. Attach flat and lock washers and nuts to the u-bolt, and tighten.
3. Repeat Step 2 for the enclosure base.

3.4 INSTALLING THE BATTERY BANK

CAUTION: Batteries are shipped fully charged and special care must be taken not to short the terminals to each other or to the battery enclosure. Use insulated tools, remove watches and jewelry and work methodically, not fast!

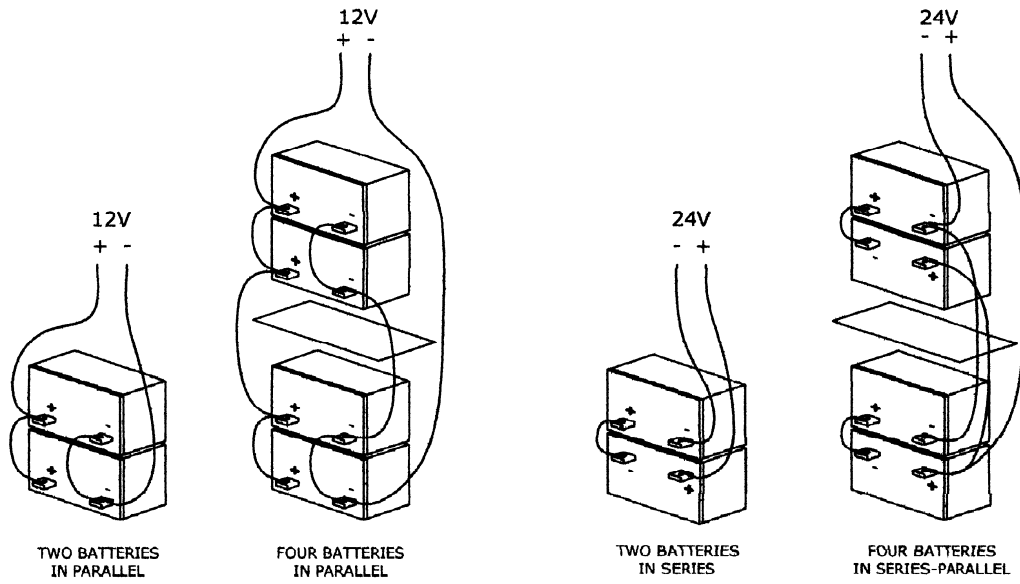
Battery cables for interconnecting the batteries are included. Follow the wiring instructions below for interconnection of a 12 or 24 volt system. Also included is a wire harness for connecting the battery bank to the control panel. If you have white and red wires, use the red for positive and white for negative.

All batteries are to be mounted upright with the terminals facing up. In some of the enclosures the batteries are mounted on top of each other with a foam separator.

INSTALLATION GUIDE

1. Place the battery(ies) in the enclosure battery compartment.
2. Follow the diagrams below for interconnecting multiple batteries. Make series connections first using the short black cables provided and the supplied hardware (typically 1/4" or 5/16"). Tighten to 12 ft-lbs torque.
3. Make parallel connections between battery pairs using the longer cables for the positive terminals and the longer cables for the negative terminals.
4. Attach the ring terminals of the battery cables from the control compartment to the battery terminals, as shown for your application. If you have parallel batteries or battery strings, make these connections to opposite corners of the battery bank to ensure balanced battery charging and discharging. Tighten to 12 ft-lbs torque.

TYPICAL SERIES-PARALLEL WIRING FOR MULTIPLE BATTERIES



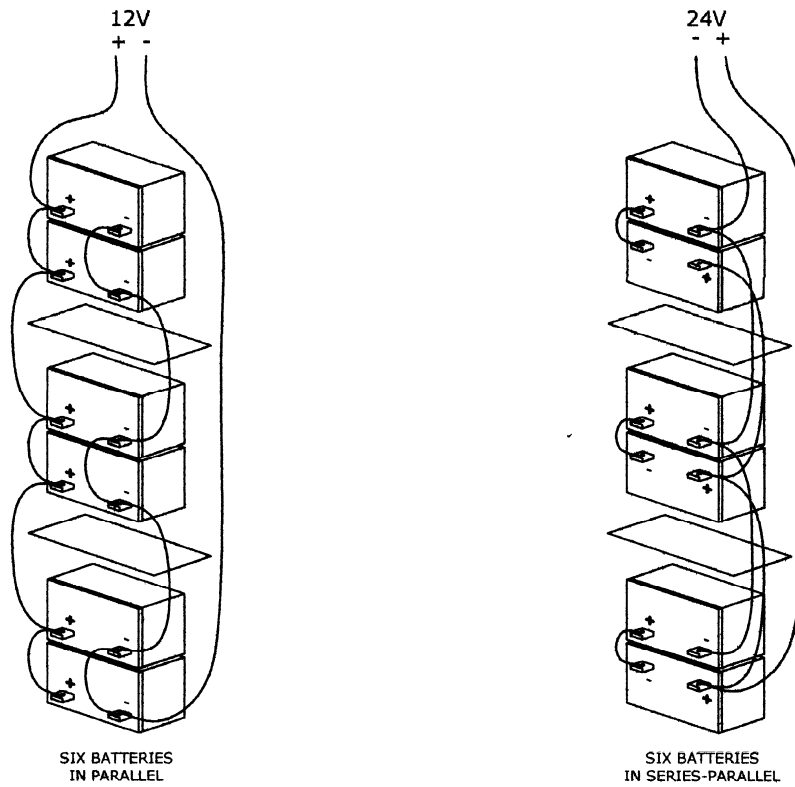
TWO BATTERIES
IN PARALLEL

FOUR BATTERIES
IN PARALLEL

TWO BATTERIES
IN SERIES

FOUR BATTERIES
IN SERIES-PARALLEL

USE RED WIRES FOR PARALLELING POSITIVES.
USE BLACK WIRES FOR PARALLELING NEGATIVES.
USE BLACK WIRES FOR SERIES CONNECTIONS.



SIX BATTERIES
IN PARALLEL

SIX BATTERIES
IN SERIES-PARALLEL

3.5 CONTROL PANEL WIRING

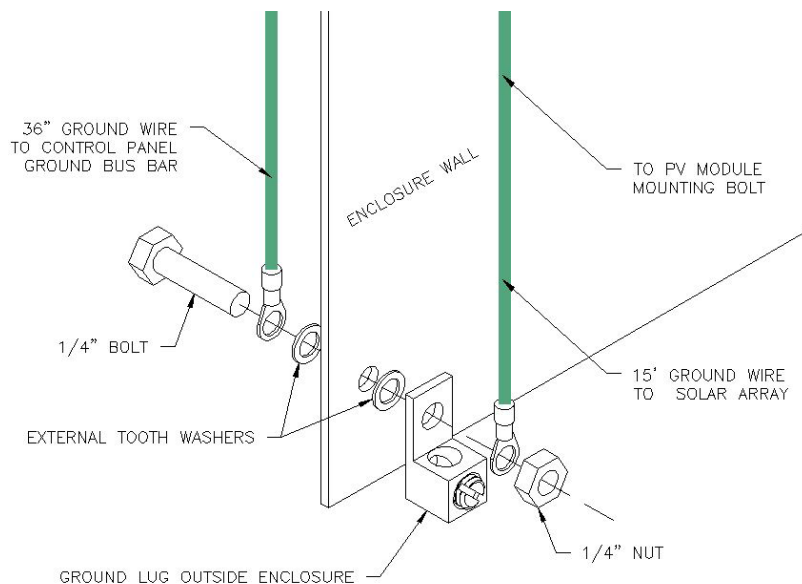
For the connections to the terminal blocks, tighten to 10 in-lbs torque

INSTALLATION GUIDE

1. To avoid equipment damage, first turn OFF all circuit breakers.
2. Pre-wire and route the 4 foot battery to control panel wires to the battery compartment. Feed the wires through the two hole strain relief connector.
3. Connect the White wire to the Batt Negative terminal on the control panel and the end with the ring terminal to the negative terminal on the battery.
4. Connect the Red wire to the Batt Positive circuit breaker on the control panel and the end with the ring terminal to the positive terminal on the battery
3. The solar array output to the battery enclosure is either a length of conduit with strain relief connectors and red and white wires inside, or a length of TC sunlight resistant cable with strain relief connectors. Punch one of the ½" knockouts by the control compartment and install the solar output connectors and feed the wire inside the enclosure. Connect the array wires to the Control Panel "ARRAY" terminals: White (or black) to Array Minus and Red to Array Plus.
4. Route the load wiring into the control compartment using conduit and strain relief connectors. Connect the load wiring to the "LOAD" terminals. (The sum of all loads, including any pre-mounted loads, can not exceed the circuit breaker rating.)
5. The panel ground has also been pre-wired to the enclosure ground lug. Make the final ground connection from the ground lug on the control panel to the ground rod with using a #8 ground wire. (Ground wire and hardware not included.)

3.6 GROUNDING

The enclosure should be ground using a ground lug installed on the side of the enclosure. Site ground and ground wire are the responsibility of others.



4 SYSTEM OPERATION

4.1 SYSTEM CHECKOUT AND STARTUP

Prior to turning on the system, check all wiring and connections to ensure the wires are correctly placed, the polarities are correct, and wires are tightly secured. Check the attachments of the mounting structure and battery enclosure to the pole or mounting surface.

Note: It is important that the following procedure be done during daylight hours.

1. Connect the BATTERY first. Use care that bare wires do not touch the metal case of the controller.
2. Connect the SOLAR (PV array) next. The green LED indicator will light if sunlight is present.
3. Connect the LOAD last. If this model includes an LVD and the red LED indicator lights, the battery capacity is low and should be charged before completing the system installation.
4. The SunSaver controller is shipped with a jumper installed. This sets the controller for charging SEALED batteries, DO NOT REMOVE. See the SunSaver manual shipped with the system control panel for specific operating instructions.
5. The Sunlight controller (if ordered) features a load control channel for night time operation of lighting loads with automatic dusk to dawn operation or set the timer on the controller for a set run time. The controller uses the solar module as the photosensor. See the Sunlight manual shipped with the system control panel for operating instructions.

Charging Status LED:

The green LED indicator will light whenever sunlight is available for battery charging. The green LED will turn off at night. Because the SunSaver and Sunlight uses a PWM constant voltage charging process, there is usually some amount of energy going into the battery at all times. Although the charging current falls to very low levels when the battery reaches full charge, the green LED will continue to stay ON (during the daytime). This is to indicate that the controller is working and that energy is available from the PV array for charging. A red LED indicates a fault or error.

Battery Status LEDs:

The controller includes an automatic load disconnect (LVD) feature, and green, yellow, and red LED status indicators. A green solid or flashing LED indicates the battery is almost full and the charge controller is regulating. A solid yellow LED indicates the battery is at approximately a 50% State of Charge (SOC). A solid red LED indicates the battery SOC has fallen below the LVD setpoint and the load has been disconnected. This indicates that the controller has disconnected the load to protect the battery from further discharge and possible damage. After some period of recharging the battery such that it recovers to approximately 40 to 50 percent of its rated capacity, the load will automatically be reconnected and the red LED will turn off. If the green, yellow, and red LEDs are flashing in a sequence, this indicates a wiring fault, load overload, or error condition.

NOTE: If the battery voltage is below 23.0 volts, the load has been automatically disconnected due to a very low battery charge condition, and the battery must be recharged.

NOTE: If the battery voltage is between 23 and 24 volts, the SunSaver and Sunlight will sometimes power-up during initial installation in the LVD (load disconnected) state. This will automatically clear when the battery voltage rises above 25.2 volts. The LVD can also be reset manually only if the battery voltage is above 23 volts. First connect the SOLAR array (see step 5 below). Next disconnect and then reconnect the BATTERY positive wire. The red LED will turn off to indicate that the LVD has been reset.

POLARITY PROTECTION

The SunSaver and Sunlight controllers are generally protected from reversed connections, but the system operator and other equipment will be at risk when polarities (+ and -) are reversed. Carefully check before making each connection to be certain the polarity is correct.

Please refer to the Morningstar controller manual provided with this system for further installation tips and for troubleshooting and testing instructions.

4.2 PRINCIPLES OF OPERATION

The MAPPS system will operate automatically with no need for operator intervention under normal conditions. With normal daylight illumination, the PV array is capable of producing sufficient voltage and current to charge the battery bank. The “charging” light indicates the battery is being charged by the PV array. During this time the load will be satisfied as needed and the battery will receive the excess current. At night, all energy to the load will be provided by the battery. The “charging” light will be off as there will be no current from the PV array.

CONTROLLER OPERATION

- 100% Solid State

All power switching is done with FETs. No mechanical relays are used in the controller.

- Battery Charge Regulation

SunSaver and Sunlight controls use an advanced series PWM charge control for constant voltage battery charging. A true 0 to 100% PWM duty cycle is very fast and stable for positive charge control under all system conditions.

- Temperature Compensation

A sensor next to the green LED measures ambient temperature conditions. The SunSaver and Sunlight controls correct the constant voltage setpoint -0.03 (-0.06 for 24V, -0.12 for 48V) mV per $^{\circ}\text{C}$ with a 25°C reference. This correction matches the battery charging to the changing electrochemical properties of the battery, and works best if the battery and controller are in a similar thermal environment.

- Sealed / Flooded Select

Flooded batteries require more vigorous charging to avoid stratification, and sealed batteries require precise control to avoid outgassing. The SunSaver and Sunlight controls constant voltage setpoints are 14.4 (or 28.8) volts for flooded batteries, and 14.1 (or 28.2) volts for sealed batteries.

- Low Voltage Disconnect (LVD)

The automatic load disconnect is an option. If the battery falls below 11.5 (or 23.0) volts, the load is disconnected from the battery to protect against harmful deep discharges. A 2-second delay prevents load disconnects from transients. The load is automatically reconnected when the battery voltage recovers to 12.6 (or 25.2) volts.

- Parallel Controllers

The SunSaver and Sunlight controllers work very well in parallel configurations.

No blocking diodes are required. The only constraint is that each controller must have an independent and separate PV subarray and load. Make sure that each SunSaver/Sunlight rating for PV and load current is not exceeded.

- Reverse Current

The SunSaver and Sunlight control prevents the battery from discharging through the PV array at night. There is no need to install a blocking diode for this purpose.

- Noise

The SunSaver's circuit minimizes switching noise and filters all noise output to extremely low levels when the system is properly grounded. If noise is present in a telecom load, it is most likely a grounding problem in the system.

5 MAINTENANCE

Proper maintenance of this system is vital for long term, reliable operation. For the photovoltaic array, batteries and controls a quarterly visit should be adequate. Maintenance visits should include a general inspection to check for any wear due to the elements: sun, wind, rain, etc. The attachments and interconnections should be checked for tightness.

The photovoltaic array may only require some periodic cleaning depending on local conditions. Arrays with tilt angles less than 20° may require frequent cleaning. Dust, if allowed to accumulate, can reduce the power output of the solar module(s).

The batteries are sealed using a gelled electrolyte and will require no maintenance. However, they should be inspected during each visit to ensure that temperature overstress does not cause bulging or cracks, and the terminals checked for corrosion.

The enclosure and electronics should be checked for signs of water intrusion or condensation damage. Some water can enter the rain-proof battery compartment under severe driven-rain conditions; however, the water should drain through the weep hole.

Once a year the inspection should include tightening all electrical and mechanical connections even if they appear sound.

**MAPPS Photovoltaic System
LIMITED ONE YEAR WARRANTY
Solar Electric Supply, Inc. (SES)**

1. SES warrants this MAPPS PV SYSTEM for a period of one (1) years from the date of shipment from its factory. This warranty is valid against defects in materials and workmanship for the one (1) year warranty period. It is not valid against defects resulting from, but not limited to:
 - Misuse and/or abuse, neglect or accident.
 - Exceeding the unit's design limits.
 - Improper installation, including, but not limited to, improper environmental protection and improper hook-up.
 - Acts of God, including lightning, floods, earthquakes, fire and high winds.
 - Damage in handling, including damage encountered during shipment.
2. This warranty shall be considered void if the warranted product is in anyway opened or altered. The warranty will be void if any eyelet, rivets, or other fasteners used to seal the unit are removed or altered, or if the unit's serial number is in any way removed, altered, replaced, defaced or rendered illegible.
3. The one (1) year term of this warranty does not apply to equipment where another manufacturers' warranty is available. The time limit for this warranty may be for less than the SES limited warranty. SES will assist the claimant in attempts to seek warranty claims for such equipment, where appropriate. The following warranties apply:

• Battery(s)	One year limited Warranty
• Solar Module	10-20 Year Limited Warranty see Data sheet
• Inverter	One Year Warranty
• Charge Controller	Five Year Limited Warranty

Please refer to the manufacturers' warranty sheet(s) provided with the SES instruction manual.

1. SES cannot assume responsibility for any damages to any system components used in conjunction with SES products nor for claims for personal injury or property damage resulting from the use of SES products or the improper operation thereof or consequential damages arising from the products or use of the products.
2. SES cannot guaranty compatibility of its products with other components used in conjunction with SES products, including, but not limited to, solar modules, batteries, and system interconnects, and such loads as inverters, transmitters, and other loads which produce "noise" or electromagnetic interference, in excess of the levels to which SES products are compatible.
3. Warranty repair and/or evaluation will be provided only at the California facility of SES . Units for such repair and/or evaluation must be returned freight prepaid to SES with a written description of any apparent defects. SES will not be required at any time to visit the installation site wherein SES' products are subject to warranty repair and/or evaluation.
4. Only SES is authorized to repair any of its products, and they reserve the right to repair or replace any unit returned for warranty repair. The party returning a unit for repair is responsible for proper packaging and for shipping and insurance charges, as well as any other charges encountered, in shipping to and SES..
5. Purchaser's exclusive remedy for any and all SES or damages resulting from the date of sale of this product including, but not limited to, any allegations of breach of warranty, breach of contract, negligence or strict liability, shall be limited, at SES option, to either the return of the purchase price or the replacement of the particular product for which claim is made and proved. In no event shall SES be liable to purchaser or purchaser's customers or to anyone else for any punitive, special, consequential, incidental or indirect loss SES or damages resulting from the sale of the product, whether based upon loss of goodwill, lost profits, work stoppages, impairments of other goods, breach of contract, or otherwise.
6. This warranty supersedes all other warranties and may only be modified by statement in writing, signed by SES .
7. Warranty terms effective as of March 1, 2007

REPAIR INFORMATION

Directions for returning units needing repair:

1. Be sure you speak with SES Technical Assistance before returning any product. The return of a unit will not be accepted unless prior authorization has been given by P&R . Once Technical Assistance has determined that you should send the product back, do the following:
 - Obtain an RMA# from SES Customer Service.
2. Include the following information with your returned item:
 - Name / Company Name
 - Return Address : (For USA/Canada: UPS Deliverable. Avoid PO Boxes)
 - Daytime Phone
 - Description of the problem or failure
 - Specify amount of repair charges you will pre-approve. (we will contact you if repair charges are larger than this amount.)
3. Box up unit with copy of sales receipt (if available).
4. Call us for return address :

Solar Electric Supply, Inc.
831-462-8243 Phone
contact@solarelectricsupply.com