SOLAR ELECTRIC POWER SYSTEM

INSTALLATION AND OPERATION MANUAL

SK Series

12V Models

AMERESCO SOLAR

Green • Clean • Sustainable

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1. INTRODUCTION

Thank you for purchasing an Ameresco Solar, Inc. solar electric power system. Ameresco Solar is a world leader in design and marketing of solar electric power systems, with over three decades of experience and sales offices throughout the United States.

1.1 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.

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 for will result in poor system performance and possible damage to the batteries.

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.

Additionally, the solar modules must be properly oriented for the specific geographic region to maximize the solar radiation available at the site. This includes the tilt angle and alignment to True South.

While performing the installation of your Ameresco Solar system, consideration of the above factors will result in the system performing reliably to its' original specifications.

1.2 Definition of Warning Statements

DANGER: Failure to heed this warning may result in serious injury.

CAUTION: Failure to heed this warning may result in damage to the load or system equipment.

NOTE: Information or instructions that will assist in the proper installation and operation of the system.

1.3 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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2. THEORY OF OPERATION

2.1 System Overview

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

The PV array will supply current to charge the battery bank. The controller will monitor the battery voltage and limit the charging current to the battery as required. The controller will bulk charge the battery to approximately 14.1 VDC, then taper the current to maintain a float voltage around 13.7 VDC. The controller also contains a temperature probe and adjusts the charge voltage at a rate of -0.030 VDC/°C from 25°C. (Refer to the controller manual provided in the kit or document package for additional details on charge regulation.)

The controller features a Low Voltage Disconnect (LVD) function. This will disconnect the load if battery voltage falls to approximately 11.5 VDC, during abnormal situations such as continuous days of cloudy weather. This will prevent the battery from being over-discharged to a level that could shorten its life. When the battery has been charged to a voltage of 12.5-12.8 VDC, the controller will reconnect the battery to the load.

2.2 Component Descriptions

Solar Modules

12V nominal 36 cell photovoltaic modules are used in the solar power system. The modules have an open circuit voltage ranging from 20-24 VDC depending on temperature and sunlight exposure. Typical peak power voltages are around 17-18VDC.

Batteries

Deka Solar gel type batteries are used in this system. The Valve Regulated Lead Acid (VRLA) battery is specifically designed for deep cycle photovoltaic systems. Refer to the System Wiring Diagram in the appendix for battery capacity details.

Controller

A MorningStar charge controller is used in this system. The controller uses PWM control of battery charging and features temperature compensation with an internal temperature probe. Refer to the separate Morningstar manual for additional information on the controller's ratings and operation.

3. SYSTEM INSTALLATION

Perform the installation of the system in the order of and as described in the following subsections.

3.1 Overview

The SK System enclosure is pre-assembled and tested before shipping. All that is required is to mount the modules and enclosure on a pole (provided by others), install the batteries, and make the final wire terminations.

3.2 Recommended Installation Tools

Compass (magnetic or GPS)	Digital Multimeter (DMM)
Phillips & Flat Head Screwdrivers	Wire Cutters & Strippers
Socket Set	Combination Wrench Set
Electrical Tape	Cable Ties (for wire dressing)

3.3 Site Location

1. 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.
2. In order for the solar array to receive the maximum energy from the sun, the array must face True South. It is recommended to use a GPS compass to find True South. Use of a magnetic compass will require adjustment to account for magnetic declination for your location, which may be over 15 degrees off from True South in eastern or western USA.

3.4 Mechanical Assembly

WARNING: Electrical Shocks and Burns Hazard
Photovoltaic (PV) modules generate electricity when exposed to light, even when they are not connected in a circuit. Shocks and burns can result from contact with module output wiring. These hazards are increased when multiple modules are interconnected to increase array output current or voltage. Cover module front surfaces completely with an opaque cloth or other opaque material before performing any operation involving module or system electrical connections. Use appropriate safety equipment (insulated tools, insulating gloves, etc.) and procedures.

CAUTION: Module Breakage
The module glass is tempered and will shatter if exposed to impact. Avoid rough handling and lay the modules on a flat, protected surface during assembly. This will also prevent power output at the electrical terminals. Avoid shorting the terminals whenever sunlight is present on the module front surface.

3.4.1 Mounting Pole Installation

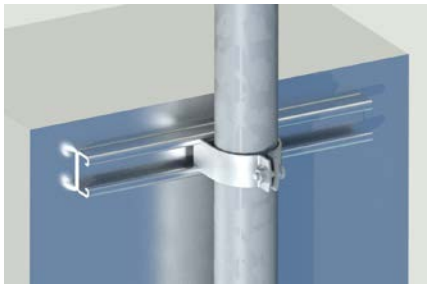
All solar equipment is to be attached to a SCH 40 steel pole (provided by others). If concrete is used, ensure it has had adequate time to cure before placing equipment on the pole. Refer to the Site Layout drawing in the Appendix for details.

3.4.2 Solar Module Support Structure Assembly

Observe the following mounting and assembly guidelines:

- Refer to the structure assembly instructions included with the structure or the drawings in the Appendix.
- Generally the array tilt angle should be set to the site latitude plus 15° for optimum standalone performance. This is typically 55° for most of the United States.
- Align the structure to True South and adjust to the correct tilt angle.

3.4.3 System Enclosure Mounting



Using the (2) pole clamps provided, attach the system enclosure below the solar module. The pole clamps slide into the slots in the enclosure mounting brackets. Refer to the Site Layout drawing in the Appendix.

3.5 System Wiring

WARNING: Electrical Hazard
Photovoltaic modules generate high voltage whenever exposed to sunlight. Voltages may be as high as 24 VDC depending on models used.

CAUTION: Electrical Hazard
Ensure all fuses are removed and all circuit breakers are in the **OFF** position before beginning any wiring.

NOTE: Wire Color Code
All pre-installed internal wiring uses the following color code unless specified otherwise in this manual. RED (+ positive), BLACK (– negative), GREEN or BARE (ground)

3.5.1 Grounding

The system enclosure should be grounded through the ground lug provided on the bottom of the enclosure. Site grounding wire and hardware are to be provided by others.

3.5.2 Array Wiring

Route the pre-wired Array cable(s) from the enclosure up the pole to the solar module(s). Depending on module type; two conductor jacketed Tray Cable may be used, or a pair of single conductor PV wires with MC4 style male/female connectors. If a module interconnect wire is included, install it between the modules first and connect as shown in the System Wiring Diagram.
For Tray Cable connections; route the cable into the module's junction box and secure the cord grip, terminate the wires at the module's terminal block.
For PV wire MC4 wiring; at the module, connect the male and female MC4 connectors to the enclosure's cables, ensure the connectors seat fully. Refer to the System Wiring Diagram in the Appendix.

3.5.3 Load Wiring

If not pre-installed in the system enclosure, route cable or conduit (provided by others) from the system enclosure to the load and secure/seal with an appropriate connector. The LOAD terminal blocks accept up to #10 AWG wire. Terminate the wires to the LOAD terminals and confirm proper polarity. Terminate wiring at the loads as appropriate. Refer to the System Wiring Diagram in the Appendix.

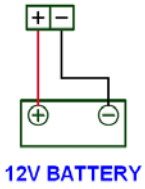
3.5.4 Battery Installation and Wiring

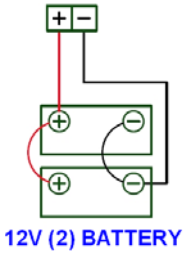
WARNING: Electrical Hazard
Batteries contain high discharge currents, use insulated tools on and around batteries. Keep all battery wiring isolated from other wires or conductive materials until all wires are connected.

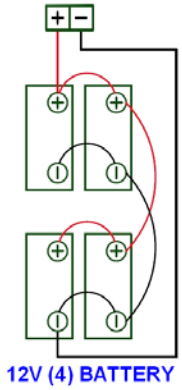
WARNING: Chemical Hazard
Batteries contain sulfuric acid which can cause burns and other serious injury. In the event of contact with sulfuric acid, flush immediately and thoroughly with water. The use of safety goggles, rubber apron, and rubber gloves is recommended.

WARNING: Explosive Hazard
Batteries can generate explosive gases, which when released, can explode and cause blindness and other serious injury. Keep sparks, flames, and smoking materials away from the battery area.

Place the battery in the enclosure and connect the battery cables to the battery; Red to positive and Black to negative. If additional batteries are used, install in the same manner. Refer to the System Wiring Diagram & Enclosure Layout in the Appendix.







3.6 System Checkout and Commissioning

At the end of the installation it is important to confirm and verify all mechanical and electrical connections. Perform the following system checkout and complete the System Installation Checklist.

1. Confirm the proper tilt angle and orientation of the solar array; ensure it is facing true south (and adjusted for magnetic declination if a magnetic compass is used).
2. Ensure all mechanical fasteners are tight and secure.
3. At the controller assembly, check the voltage and polarity of the battery. The voltage should be approximately 12.5 VDC.
4. At the controller assembly, record the open circuit voltage (Voc) and short circuit current (Isc) of the array input. Confirm proper polarity.
5. Switch ON the BATTERY circuit breaker (or install fuse). Switch on the ARRAY circuit breaker if present. Verify the green "CHARGING" indicator on the controller is lit. If it is not lit, go back and check the connections.
6. Switch on the LOAD circuit breaker (if present), switch on the load(s) and verify its' proper operation. Ensure the load is operating within the energy design of the system. If needed perform a series current draw.

SYSTEM INSTALLATION CHECKLIST AND START-UP DATA TABLE

1. Array facing true south _____ (Yes/No)
   Array at correct tilt angle _____ (Yes/No)

2. All mechanical fasteners tight _____ (Yes/No)

3. Record the initial battery voltage at the controller.
   Battery _____ VDC

4. Record the array open circuit voltage and short circuit current at the controller.
   Open Circuit Voltage _____ VDC
   Short Circuit Current _____ A

5. Controller Operation:
   Charging LED illuminated _____ (Yes/No)
   Load Disconnect LED illuminated _____ (Yes/No)

6. Load operating properly _____ (Yes/No)

INSTALLATION IS NOW COMPLETE

Tested By: _____ **Date:** _____

Approved By: _____ **Date:** _____

4. RECOMMENDED MAINTENANCE

Although the solar electric power system should require minimal maintenance a few minutes time every 3-6 months can help to maintain the performance of the system and extend its service life.

4.1 Solar Array

The solar array should not need to be completely cleaned unless the dirt build-up is particularly bad. Special care should be taken to look for and remove any bird drops or mud as these essentially shade the module and reduce the output current. When cleaning the front surface of the array use a soft non-abrasive cloth or brush and water. Avoid the use of any cleaning products that may leave residue on the module or promote corrosion on the structure and its' fasteners.

4.2 Batteries

Inspect the battery for corrosion at the terminals and wire connections, clean or replace terminals if they are damaged. Measure and record battery voltage.

4.3 System Wiring

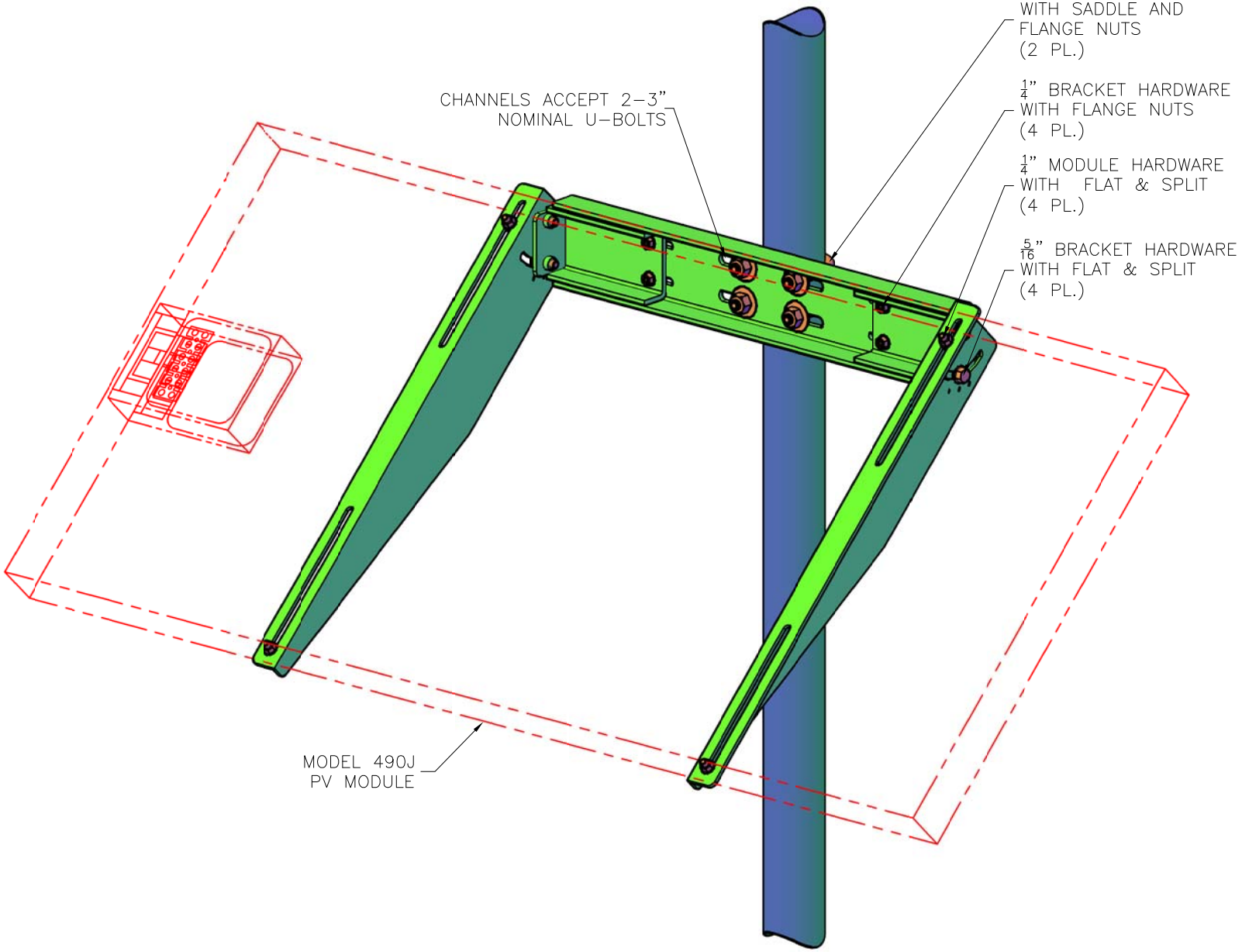
Inspect all internal and external wiring for damage or corrosion at the system enclosure, repair or replace as necessary. Re-tighten all accessible wiring connections.

5. SYSTEM TROUBLESHOOTING

If the system is not functioning correctly, there are a few simple steps to isolate the problem. The following are some of the typical factors that contribute to the failure of the system to operate within design parameters:

1. Load greater than system design – Installing loads greater than the system was designed for will reduce the performance of the system and damage the batteries. Excessive load operation can either be power, current, or operating time. Daily load energy consumption should be checked to verify it is within the operation parameters of the system. If the load is greater than the system design, the load should be decreased or the system size increased (e.g. array, battery, controller, etc.)
2. Shading – Even partial shading of the solar module can result in zero output from the module and will result in reduced system performance. Incorrect orientation or tilt angle – Refer to the installation instructions in Section 3 for proper orientation, alignment, and tilt adjustment. Incorrect alignment of the solar array will result in reduced array output and system performance.
3. Battery failure may be caused by several factors: age, controller failure, or excessive load operation. If the battery is more than 5 years old is probably nearing the end of its' service life and may need to be replaced. A capacity test can confirm the ability of the battery to support the load. If the battery is relatively new (1 to 2 years old) the system should be checked for proper operation by performing the System Checkout in section 3.6.

APPENDIX



1. LANDSCAPE MODULE ORIENTATION SHOWN, FOR MODELS: VLS-85W AND 490J.

NOTES:

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REV	REVISED BY	ORD	DATE

REVISIONS

OWNERSHIP

AMERESCO SOLAR
CHANDLER, AZ

SPM1-MULTI-V3 LANDSCAPE

SPM/440-490J,VLS-50-85W,1/ ADJUSTABLE/ ALUMINUM/ NONE/2"-3"

MATERIAL: N/A

FINISH: N/A

UNITS: UNLESS OTHERWISE SPECIFIED: PRIMARY UNITS ARE: INCHES SECONDARY UNITS ARE: [mm]

TOLLERENCES: 0.0 ± 0.1; 0.00 ± 0.03; 0.000 ± 0.015

THIRD ANGLE PROJECTION

MISC

APPROVALS	NAME	DATE
DRAWN	E. RIVAS	19.NOV.12
APPROVED	R. RALLO	20.NOV.12

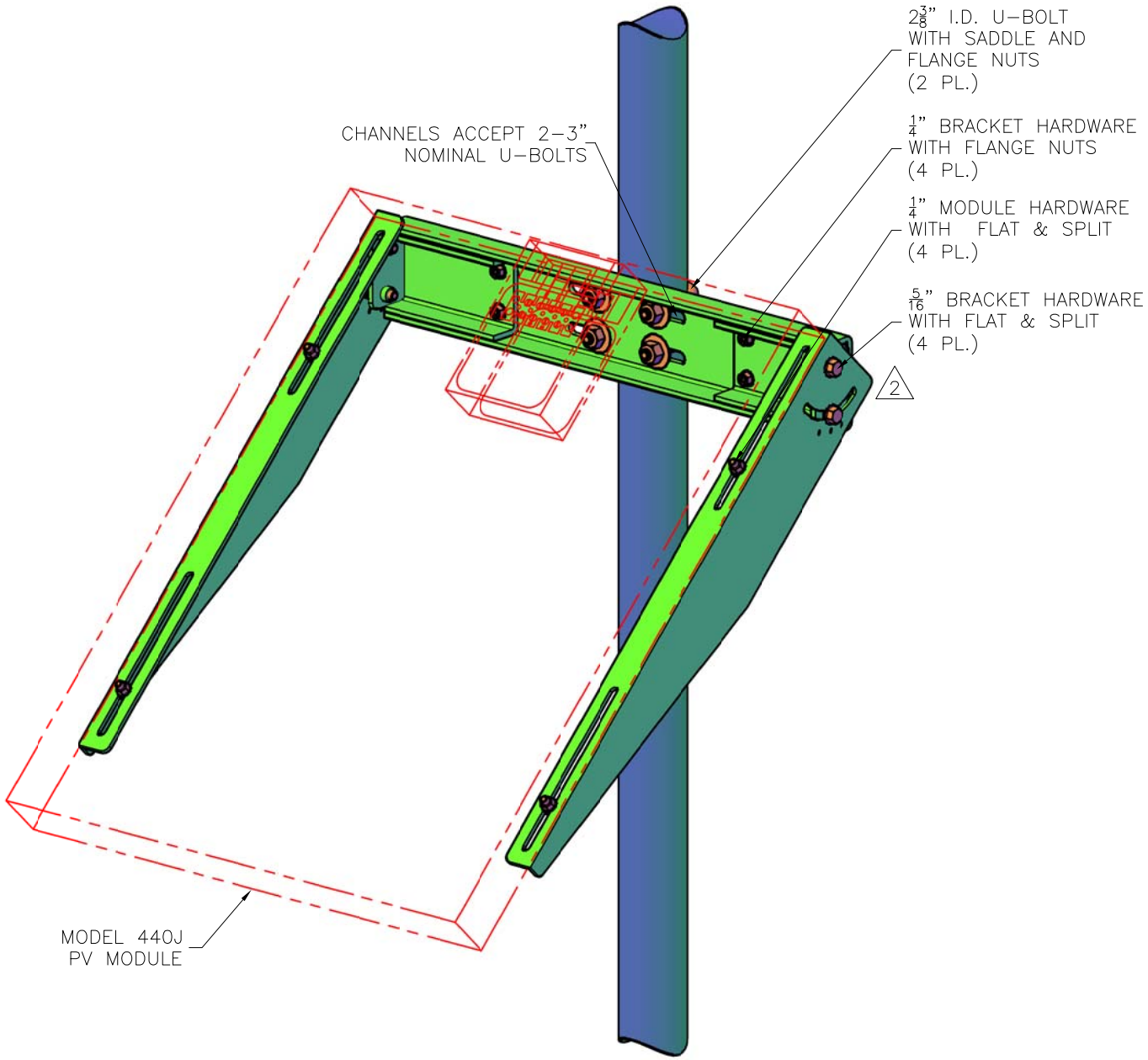
SCALE: N/A

DRAWING NUMBER: SPM1MULTI

B.O.M. NUMBER: -

SHEET 1 OF 2

SIZE: A



2. RAILS MUST BE FLIPPED INWARD AS SHOWN FOR 440J.
1. PORTRAIT MODULE ORIENTATION SHOWN, FOR MODELS: VLS-50W, 440J, 450J, AND 365J.
NOTES:

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REV	REVISED BY	ORD	DATE

REVISIONS

OWNERSHIP

AMERESCO SOLAR
CHANDLER, AZ

SPM1-MULTI-V3 PORTRAIT

SPM/440-490J,VLS-50-85W,1/
ADJUSTABLE/ ALUMINUM/
NONE/2"-4"

MATERIAL: N/A

FINISH: N/A

UNITS: UNLESS OTHERWISE SPECIFIED:
PRIMARY UNITS ARE: INCHES
SECONDARY UNITS ARE: [mm]

TOLLERENCES:
0.0 ± 0.1
0.00 ± 0.03
0.000 ± 0.015

THIRD ANGLE PROJECTION

MISC

APPROVALS	NAME	DATE
DRAWN	E. RIVAS	19.NOV.12
APPROVED	R. RALLO	20.NOV.12

SCALE: N/A

DRAWING NUMBER: SPM1MULTI

B.O.M. NUMBER: -

SHEET 2 OF 2

SIZE: A