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The modules are qualified for application class II: Hazardous voltage (IEC 61730: Module rated for use in this application class are restricted to system protected from public access by fences, location, etc. Module evaluated within this application class provide protection by basic insulation, are considered to meet the requirements for safety class II. Fire rating class C and ANSI/UL 790.).
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1. Introduction

Thank you for choosing APLUS ENERGY modules. With proper installation, operation and maintenance, APLUS ENERGY modules will provide you with clean and renewable solar electricity for years. This manual contains necessary installation, maintenance, and safety information. The word “module” as used in this manual refers to one or more modules. *Retain this manual In a convenient safe place for future reference.*

■ Disclaimer of Liability

APLUS ENERGY does not assume responsibility and expressly disclaims liability for any loss, damage, or expense arising out of, or in any way connected with installation, operation, use, or maintenance by using this manual. APLUS ENERGY assumes no responsibility for any infringement of patents or other rights of third parties, which may result from use of modules. No license is granted by implication or under any patent or patent rights. The information in this manual is reliable, but does not constitute an expressed and/or implied warranty. APLUS ENERGY reserves the right to make changes to the product, specifications, or this manual without prior notice.
Note: Without any prior written authorization, APLUS ENERGY will not accept any returned modules.

■ General Information

The installation of solar modules must be performed only by skillful and qualified licensed professionals.

■ General Safety

Follow all permission, installation and inspection requirements.

- Must contact the appropriate authorities to determine, and closely follow, the permit, installation and inspection requirements that apply to your site and installation before installing any modules/system.
- The requirements of the latest National Electrical Code (USA) or Canadian Electric Code (Canada) or other national or international electrical standards must be followed for electrically ground modules for all systems of any voltage.
- Check applicable building codes to ensure that the construction or structure (roof, façade, support, etc.) where the modules are installed do have enough strength.
- Special construction or structures must be required to help provide proper installation support in case the modules are mounted on the rooftops.

- Both roof construction and module installation design have an effect on the fire resistance of a building. Improper installation can cause fire hazards. Additional devices such as ground faults, fuses, and disconnects may also be required.
- Do not use or mix different modules in the same mounting system.
- Check and follow all safety precautions of other system components.

2. Application

Photovoltaic (PV) modules are the heart of the system. One of the unique features of photovoltaic is that arrays can be assembled at any scale, powering a home, a factory, or even a town through its local utility. We suggest the maximum install altitude lower than 2000m. Your installer will advise you as what is best for your location.

Grid-connected applications include:

- *Residential Installations*
- *Commercial Installations*

Residential applications are typically 3-10 kilowatts (KW); commercial applications may range from ~100 KW to 1 megawatt (MW) or larger.

3. Mounting Site Selection

Shading: No shading year-round between the hours of 9 a.m. and 4 p.m. from trees, other buildings and common obstructions such as vents, chimneys, dormers, etc.; and a relatively south-facing roof orientation. If your roof cannot provide this, there are ground-mounted systems which provide more flexibility in locating the modules.

Most simply, the purpose of a module mounting structure is to support and hold the solar modules under the expected weather conditions for the installation site. Depending on the geography of the installation, the module mounting structure will have to withstand snow, high winds and earthquakes.
Many factors must be considered, including:
- the desired mounting location (on a roof, on the ground, on a pole),
- if on a building, the location on the roof or side of the building,
- the number of attachments allowed,
- the required tilt angle of the solar modules, and
- the type of structure used to hold the solar modules.

4. Module Tilt Angle

Solar module produces the most power when they face directly to the sun. For installations where the solar modules are mounted to a permanent structure, the solar module should be tilted for optimum winter performance. As a rule, if the system power production is adequate in the winter, it will be satisfactory during the rest of the year. The module tilt angel is measured between the solar modules and the ground. Please refer to Figure 1 and Table 1 for installation consideration.

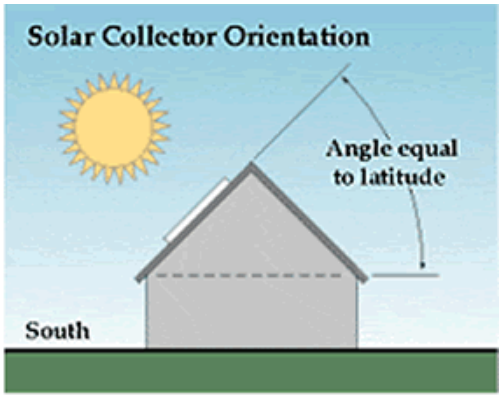

Figure 1. Module tilt angle illustration.

Table 1. Recommended Tilt Angles for a Fixed System

Month	Fixed Tilt Angle
February 21	Latitude
April 21	Latitude – 16°
August 21	Latitude
October 21	Latitude + 15°
Please change the title angles four times a year to attain maximum power output. If you do not want to change the tilt angle or are using a fixed angle, you can set up the angle at Latitude – 16°	

5. Mounting the Module

- Systems must be installed by qualified and experienced personnel only, preferably licensed professionals. The mounting system and grounding device need to meet UL 2703.
- Do not step on the module. Although APLUS ENERGY modules are quite rugged, the solar cells may be broken (and the module will no longer

work properly) if it is dropped or hit by tools or other objects.
- Sunlight shall not be *concentrated* on the module.
- The support structure and hardware must be made of durable, corrosion- and UV-resistant materials.
- A qualified structural expert should verify the load capacity of the metal rails according to the local codes such as International Building Code (IBC) and International Residential Code (IRC).

5.1. Mechanical Installation

• **Mechanical Loading.** Modules should be mounted at four symmetrical quarter points within the shaded areas as shown in Figure 2. This method offers a maximum loading of 3600Pa (Test load= Design load x Safety factor γm, Design load=2400Pa, Safety factor=1.5), the positive design load is 2400Pa and the negative design load is 1600Pa in a static state on the module surface.

• **Installation.**
The edge of each module has 16 mm width. These are used to secure the modules to the supporting structure. The Z rack(Thickness at least 1.5mm) method is recommended in case the modules will be mounted on the roof of a building. The rack distance is 50cm ◦ Use M5 self-screw and Length is 2.5inch.The applied torque should be 7 N-m to fix module to rack. The example of a roof mounted structure is shown in Fig. 2.

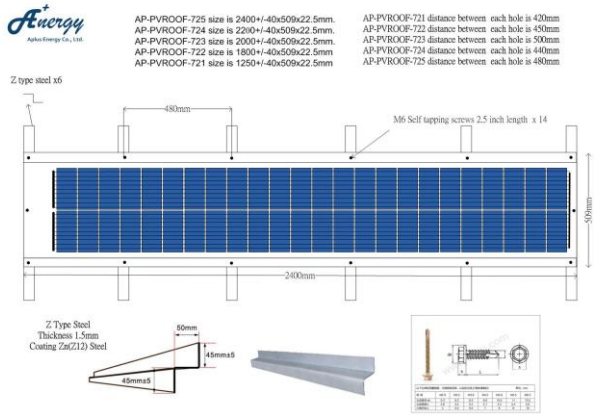

Figure 2. Schematic illustration of general module mounting at a tilt angle.

5.2. Electrical Installation

WIRING -- General

- Modules/system should be installed by qualified personnel only, preferably licensed professional electricians. PV system involves electricity and can be dangerous if the personal are not familiar with the appropriate safety procedures.
- All wiring should be done in accordance with applicable electrical codes.
- Wiring methods should be in accordance with the NEC in the USA, the CEC in Canada, or other national and/or local codes.
- A qualified, licensed professional must be used to do all wiring.
- Wiring should be protected to help ensure personnel safety and to prevent from damage.
- All modules connected in series should be of the same model number and/or type, as shown on Figure 2.
- Do not connect modules in parallel without using a connection box.
- The module connector is QC4.10 -a3c3CD by QC solar.,
- Use preassembled cables with connectors on Aplus Energy module for proper connections. Use cable size of AWG-12 of stranded wires rated with a temperature range of –40°C to +85°C. The cables are sunlight (UV) resistant and are insulated to withstand the maximum possible system open circuit voltage.
- The field wiring : Cu wiring only, insulated for 90°C min .

Module Wiring

- The maximum number of modules that can be wired in series or parallel design is depending on legal requirements, maximum current and voltage ratings as indicated on the module label, the installation design, space and further specifications of additional equipment.
- When connected in series modules must all have the same amperage. When connected in parallel, the modules must all have the same voltage. The modules must not be connected together to create a voltage higher than the permitted system voltage.
- Max no. of series connected modules = Max System Voltage/Voc of the module at STC. If fuse is used, number of parallel connected modules = Max Fuse Rating/Isc at STC.
- Each AP-PVROOF-XXX series module has one (1) factory-installed bypass diodes inside the junction box. If the modules are incorrectly connected to each other, the bypass diodes, cable, or junction box may be damaged.

- The connecting cable AWG-12 standed conductor, with 64 strands and 6.3mm outer diameter.

Array Wiring

- Check local codes for electrical regulations and safety requirements.
- Do not exceed the maximum system voltage 600 Vdc rated for the AP-PVROOF-XXX modules.
- In conditions of temperatures of -20°C (-4°F) and very strong sunshine (1 kW/m^2), the system voltage may exceed 600 V if 30 pieces AP-PROOF-725 modules are connected in series (600V/33.1V_{oc} ≈ 18). Same calculations can be employed to calculate the maximum number of a module type can be connected in series). It may cause the inverter to stop functioning, or enter a self-protective mode.
- Under normal conditions, a photovoltaic module may produce more current and/or voltage than reported at the standard test conditions (STC).
- Accordingly, the values of I_{SC} (short circuit current) and V_{OC} (open circuit voltage) marked on this module should be multiplied by a factor of 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output. In the USA, refer to Section 690-8 of the National Electrical Code (NEC) for an additional multiplying factor of 125 percent (80 percent de-rating) which may be applicable.
- Use preassembled cables with connectors on Aplus Energy module for proper connections. Use cable size of AWG-12 of stranded wires rated with a temperature range of –40ºC to +105ºC and for field wiring, refer to the NEC.

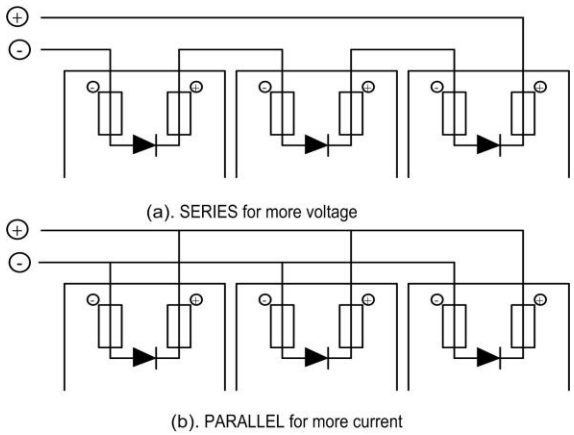

Figure 4. An illustration of connection for module.
(a).SERIES for more voltage. (b).PARALLEL for more current

The module is considered to be in compliance with IEC61730 only when the module is mounted in the manner specified by this mounting instructions.

6. Grounding

1. The AP-PVROOF-XXX series module is grounded at the end of an array. The array ground is connected to system ground for common grounding point.
2. Place a grounding label near the last extruded hole on the end of the support rail that connects to the wire tray. (as Figure 5)

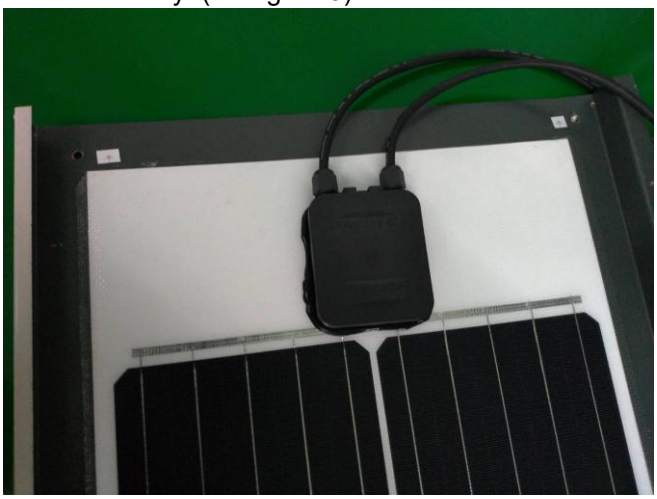

Figure 5. Grounding Labels

3. Attach a ground ring terminal(Figure6) use crimping tool to the end of the 10 AWG Copper Wire and torque to 3.0 -3.5 N·M (27 - 31 in·Lbs).. The AWG-10 of stranded wires rated with a temperature range of –40ºC to +105ºC and for field wiring, refer to the NEC. The cables are sunlight (UV) resistant and are insulated to withstand the maximum possible system open circuit voltage. The ground wiring : Cu wiring only, insulated for 90ºC min . Ground the array per NEC requirements

Figure 6, Ground ring terminal

4. Using an M6 screw secure the grounding ring terminal to the extruded hole in the support rail and tighten to 3.0 -3.5 N·M (27 - 31 in·Lbs).
5. If an array extends beyond one panel, the support rails and the wire trays are bonded together through the riser of the Base Support.
6. Bare copper wire should not come in direct contact with gavalume wire tray or pans. Insulated copper wire can be used in the wire tray.

Grounding-

Size and earth the equipment grounding conductor in accordance with local requirements or the NEC. Attach the equipment grounding conductor to the module frame using the hole and hardware provided. Note that a stainless steel flat washer is used between the ground wire and the module frame (see picture below Figure 7). This washer is used to avoid corrosion due to dissimilar metals. Tighten the screw securely. The material of screw is SUS, its finish is Cu; The dimension of screw is 13x3x3mm; The thread pitch of screw is #10-32.

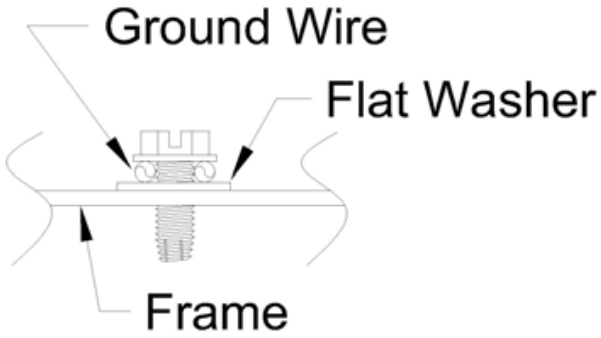

Figure7. Example of acceptable ground connection

7. Diodes

One bypass diode (Type:PVS1545), is installed in the junction box on the backside of our solar modules for minimizing potential problems or damages that may be caused by shading. However, it is advisable to have your system installer implement proper blocking diodes for your system when using a battery bank. The blocking diodes can prevent nighttime battery discharging and prevent modules from loss of array output and being damaged or destroyed by reverse current flow.

8. Specifications

Each AP-PVROOF-XXX series module is designed to meet high design criteria for best performance and reliability.

8.1. Physical Specification

The AP-PVROOF-725 size is 2400+/-40x509x22.5mm.
The AP-PVROOF-724 size is 2200+/-40x509x22.5mm.
The AP-PVROOF-723 size is 2000+/-40x509x22.5mm.
The AP-PVROOF-722 size is 1800+/-40x509x22.5mm
The AP-PVROOF-721 size is 1250+/-40x509x22.5mm

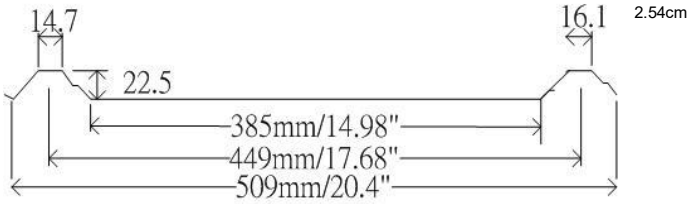

Figure 8, Physical profile

Rib profile: 2.25Cm (0.89 inch) tall integral “snap” lock design with fastening flange
Width: Standard panel width is 44.9Cm(17.67 inches). Other widths available by location.
Profile: Standard panel profile is “striated”. Flat Pan (Smooth Profile) is also available(Figure 8).
Panel lengths: Standard lengths available from 3 to 7 feet. Longer lengths are available.
Materials: Available in 22 gauge AZ-150 or Z275 Galvalume coated steel.
Finishes: Available in unpainted Galvalume (with clear acrylic coating) or factory applied colored finishes. Siliconized Modified Polyester finish is available with 24 gauge option. Kynar 500 Flouropolymer finish is available in 24 gauge steel and 0.032” aluminum options. Refer to color selection charts for finish choices.
More detailed information of physical dimension for each module type is available(Figure 9).
Panel Fasteners: Fasteners are applied through the fastening flange located on the male leg of panel. For most wood substrates the recommended fastener is a #10-12 x 1 inch long pancake head wood screw. Fasteners for wood should be of sufficient length to penetrate the substrate by ¼ inch or be imbedded into sheathing by ¾ inch.

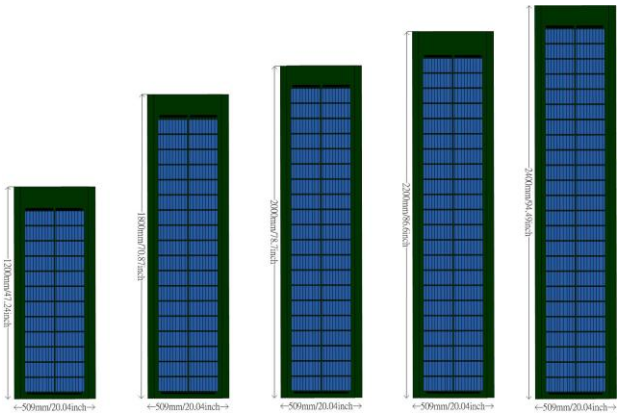

Figure 9. Schematic drawings showing the general configurations of a module

8.2. Electrical Specification

The representative electrical (current voltage, I-V) parameters at the standard test conditions (STC) and relevant safety features for each of AP-PVROOF-XXX series modules are shown in Table 3 below. Use these data to determine your module need, system requirements, and connections as well. It is advisable that you use a licensed professional to assist you. Again, you should check local codes for electrical regulations and safety requirements before installing a PV system.

Table 3. AP-PVROOF-xxx Typical Electrical Specifications

Model Number xxx	721	722	723	724	725
Rated Maximum Power at STC (Watts)	85	140	155	175	190
Open Circuit Voltage at STC (V dc)	17.6 V	26.4V	29.3V	32.3V	35.2V
Short Circuit Current at STC (A dc)	6.77	6.77A	6.77A	6.77A	6.77A
Maximun power Voltage at STC (V dc)	14.9 V	22.3V	24.8V	27.3V	29.8.V
Maximum power Current at STC (A dc)	6.45A	6.45A	6.45A	6.45A	6.45A
No. of Bypass Diodes	1	1	1	1	1
Maximum System Voltage	600Vdc	600Vdc	600Vdc	600Vdc	600Vdc
Series Fuse Rating (Amps)	15A	15A	15A	15A	15A

Standard test conditions (1000 W/m2, (25 ±2) ℃, AM 1.5 according to IEC 60904-3).

Irradiance	V_{oc} (V)	I_{sc} (A)	V_{mp} (V)	I_{mp} (A)	P_{max} (W)	FF(%)
800W/m2	15.08	7.851	12.17	7.420	90.3	76.30

Perf. at low irradiance (at 25 degree C)IV

Irradiance	V_{oc} (V)	I_{sc} (A)	V_{mp} (V)	I_{mp} (A)	P_{max} (W)	FF(%)
200W/m2	14.97	1.930	12.83	1.851	23.8	82.26

Temperature Coefficient of Isc: 0.066%/℃
Temperature Coefficient of Voc:- 0.282%/℃
Power Temperature Coefficient:- 0.374%/℃

9. Maintenance

Solar modules normally require very little maintenance. It is not uncommon for remote site to be checked but once per year. Under most conditions, normal rainfall is sufficient to keep the module's front glass clean. If dirt build-up becomes excessive, clean the glass surface with soft cloth using mild detergent and water. Modules that are mounted flat (0º tilt angle) should be cleaned more often, as they will not self-clean as effectively as modules mounted at 15º tilt or greater. Once a year check the tightness of terminal screws and the general condition of the wiring and connection cables. Also, check to be sure that mounting hardware is tight. Loose screw bolts could result in a damaged module or array. Have your installer or licensed professional to conduct the periodic inspection and maintenance.

10. Package and shipping

Carton packing description(Figure 10): Place protection cover on the four center of the module. Load module on the pallet, load the most thirdty modules on one pallet. Wrap all goods with wood plate to fix for shipping in car or containers.

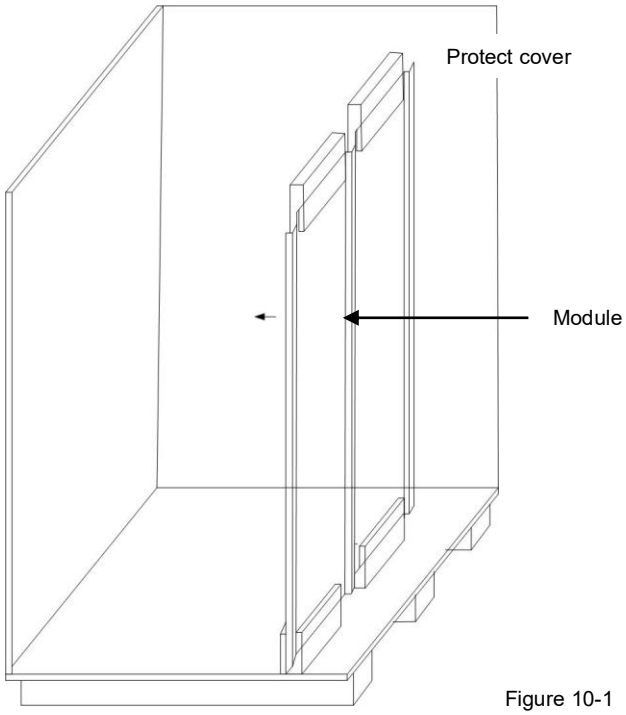

Figure 10-1

Figure 10-2

11. Other Warnings

- ❖ Solar modules are live electrical power sources when exposed to the light. Do not touch live terminals with bare hands. Use insulated tools for electrical connections.
- ❖ Arrays of many modules can generate high voltage and/or current, which can cause lethal electrical shock and burn hazards.
- ❖ Solar modules should be covered with an opaque material during installation to avoid shock or burn.
- ❖ The backside of the module shall not be exposed to direct sunlight.

12. Other Reminders

❖ **Permits.** Before installing your solar system, contact local authorities to determine the necessary permits for installation and inspection requirements.
❖ **Inspection.** Follow closely the requirements of applicable national and local electrical safety as well as building codes.
❖ **Safe-Keep.** Do not step on the module. The front plate can be broken (and the module will no longer work properly) if it is dropped or hit by tools or other objects. The module frame is made of anodized aluminum, and therefore corrosion can occur if the module is subject to a salt water environment with contact to rack of another type of metal (i.e., electrolytic corrosion).
❖ **Battery.** When solar modules are used to charge batteries, the battery bank must be installed in a manner which will protect the performance of the system and safety of its users. The battery bank should be placed away from the main flow of people and animal traffic. Select a battery site that is protected from sunlight, rain, snow, debris, and is well ventilated. Most batteries generate hydrogen gas when charging, which is explosive. Do not light matches or create sparks near the battery bank. When a battery bank is installed outdoors, it should be placed in an insulated and ventilated case specifically designed for the purpose.
❖ Any slope less than 2 in/ft (167mm/mm) required to maintain a fire class rating C.
❖ artificially concentrated sunlight shall not be directed on the module or panel.

◎ Please consult your dealer or the manufacturer concerning the warranty of your modules. If you have any further questions, your dealer will gladly assist you.