Ventev 072222 Solar Powered System for PoE+ Wi-Fi Access Points Owner's Manual

Contents

Ventev 072222 Solar Powered System for PoE+ Wi-Fi Access Points

Product Information
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The Ventev Wi-Fi Solar Power System Overview
About Ventev's Wi-Fi Solar Power System: The Ventev Wi-Fi Solar Power System is a solar-powered system designed to provide power to Wi-Fi devices. It consists of a solar system controller, battery controller, and wiring components.

System Description:
The system includes a solar system controller that manages solar power generation and distribution. The battery controller charging algorithm ensures efficient charging of the system's batteries. The system wiring connects the various components and devices.

Wi-Fi Solar Power System Installation
Installation Overview: The installation process involves setting up the Wi-Fi Solar Power System. This section provides an overview of the installation process.

Required Tools:

- List of tools required for the installation process.

Before You Begin:

- Important information and steps to follow before starting the installation process.

High-level steps to assemble, install, and commission of the Ventev Wi-Fi Solar Power Systems. It is required that the batteries are either charged to full capacity before installation into the enclosure or they are installed and connected to the array and left to recharge for at least 24 hours before the active load is connected.

1. Select the optimal site. Ensure the mounting structure is positioned such that the solar array can be directed true South (not magnetic South) and will not be shaded at any time throughout the year. Note – The path of the Sun will change throughout the year and shading may occur which will significantly decrease the Wi-Fi solar systems performance.
2. Erect the pole.
3. Open the shipping packages and confirm all components and parts are on hand (reference list below).
4. Assemble the solar array mount following the direction included. Mount solar modules. Ensure the tilt angle is optimized for the geographic location of the site. Ensure the array is pointed true south (not magnetic south).
5. Assemble solar module interconnects between modules using the parallel connectors.
6. Attach the enclosure to the pole using provided U-Bolt kit. Ground the system.
7. Actuate all circuit breakers to the “off” position to interrupt DC circuits (see wire diagram on door).
8. Connect solar module array via parallel connectors to the (+) solar array circuit breaker and (-) terminal block.
9. Verify Solar Module array output polarity is correct according to door diagram.
10. Install batteries in enclosure and connect them to (+) battery circuit breaker then the (-) terminal block.
11. Actuate all circuit breakers to the “on” position in the following order: battery, solar array, load.
12. Confirm operation by monitoring solar controller lights. The LED indicators will sequence left to right followed by the green battery status indicator remaining lit.
13. Connect Ethernet cables to the PoE injector according to the door diagram.

Notice
This guide is provided for informational use only. Every effort was made to ensure the accuracy of information in this guide at the time of release. Ventev reserves the right to provide updates to the content not available at the time this guide was released.

Copyright

Trademarks

Federal Communications Commission (FCC) Notice

The Wi-Fi Solar Power System is designed to meet the limits pursuant to Part 15 of the FCC rules.

CE Compliance
The Wi-Fi Solar Power Systems are designed to be CE compliant.

Safety

Safety Instructions
Retain all safety information for future reference. The following defines precautionary safety terms used in this guide. Failure to observe these precautions when installing, using, or servicing this product violates this product's intended purpose and may result in personal injury or damage to equipment.

Safety Symbols
Safety symbols shown on the Wi-Fi Solar Power Systems must be observed when operating, servicing, or repairing the systems. Failure to comply with safety precautions shown on the Wi-Fi Solar Power System components or in this guide violates the intended use of this product.
The following safety symbols appear on the Wi-Fi Solar Power System components and in this guide:

Caution
This symbol represents a general hazard warning or caution.

Read & Understand All Instructions
Always follow basic safety precautions when installing, using, or servicing this product to reduce the risk of fire, shock, and injury to person or damage to equipment. Basic safety precautions include, but are not limited to, the following:

- Review the drawings and illustrations in this manual before proceeding. If there are any questions regarding the safe installation or operation of the system, contact Ventev. Save this document for future reference.
- Use qualified service personnel to service equipment. Servicing is required when the equipment has been damaged and does not operate normally.
- Remove all conductive jewellery or personal equipment prior to beginning installation, servicing equipment, parts, connectors, wiring or batteries.
- Limit access to modules. Solar modules generate electricity when exposed to light. Arrays of many modules can cause lethal shock and burn hazards. Only authorized, trained personnel should have access to these modules.
- Cover modules with an opaque material during installation to reduce risk of electrical shock or burns.
- Use insulated tools for electrical connections and do not touch live terminals with bare hands.

Local Code & Permits

- Contact local authorities to determine and obtain the necessary permits before installing your Wi-Fi solar power system.
- Follow requirements of applicable local and national electrical codes.

About This Guide

Purpose & Scope

The purpose of this guide is to introduce the reader to the Ventev Wi-Fi Solar Power Systems and to provide guidance in the successful installation and operation of these systems. This guide describes the enclosure components and functions, presents the operational theory and application of the systems, and provides task-based instructions for installing the Ventev Wi-Fi Solar Power System and for operating the system once installed.

Audience

This guide is intended for first time and experienced users. It is assumed that users have a basic understanding of electrical wiring techniques.

Conventions

A convention used throughout this guide is a light orange box that represents a note or a tip to convey related information.

1: The Ventev Wi-Fi Solar Power System Overview

This chapter presents an overview of the Ventev Wi-Fi Solar Power System architecture and wiring configurations Experienced users of Solar Power Systems will find this section provides a quick start guide in assembling and maintaining the System while those new to the product will find detailed instructions for the installation, operation, and maintaining of the system.

About Ventev's Wi-Fi Solar Power System

The Ventev Wi-Fi Solar Power System was developed to power equipment in remote locations where utility grid power is not available. By combining various solar modules, batteries, and solar controllers, and knowing the popular Wi-Fi APs in the market, the system was designed to accommodate variations in geography, power level needs, and site-specific applications. The design intent of this system is to provide reliable primary power via POE+ to a single AP. The AP is typically an industrial outdoor rated mesh radio.

The base voltage of the Ventev Wi-Fi Solar Power system is 12VDC. With the inclusion of the POE Injector, the voltage is converted to 56VDC POE.

The Wi-Fi solar power system was designed with five days of autonomy (i.e., capacity in the battery bank) with an expected 1.5Amp per hour load. AP's may operate differently and draw less power verse other OEM's. The target of five days of autonomy is intended to be a suitable balance of cost and reliability. If installed properly, this Wi-Fi solar power system is expected to provide reliable power above 95% of the time. Periods of cold weather and limited sunlight in December/January months are expected to stress the battery capacity. The charging system incorporates a Low Voltage Disconnect (LVD) that will automatically disconnect the batteries from the system to protect them. The Solar controller will re-connect the system once the voltage has reached the re-connect voltage of the LVD.

For those applications deemed critical by the end user where Wi-Fi coverage must be maintained with higher levels of reliability, a solar system with a larger array and battery bank may be needed to cover extended periods of cloudy, cold days with limited extended sunlight.

System Description

Figure 1 illustrates a typical Wi-Fi Solar Power System installation that shows a high-level description of the system components.

A. Solar Module

Solar modules provide the energy source to keep battery(s) charged. The number of modules needed depends on site specifics, such as geographic location in the country, site specific needs such as load demand, and available/access to the sun. Figure 2 is a photograph of a typical solar module.

Solar electric modules convert the sun's energy into direct current (DC) electricity. The systems contain a matrix of high performance monocrystalline or multi-crystalline modules.

The Solar modules are securely attached to the pole with adjustable fasteners to enable tilt alignment to match the latitude at which the module is installed and horizontal adjustment for maximum tracking of the sun.

FIGURE 2: Solar Module (150-Watt Monocrystalline)

B. Junction Box

The junction box provides a junction with positive and negative pigtails to connect the module(s) to the solar controller through a fused circuit inside the enclosure. Multiple solar modules are connected in parallel via MC-4 connectors to a single multi-conductor cable connected to the solar controller.

C. Module Interconnect
The Module Interconnect is a multi-conductor cable sized sufficiently to carry the current to the solar controller from the solar modules. The cable comes preconfigured with MC-4 connectors and fly leads to connect to the controller. There is a cable gland provided for the egress of the enclosure.
D. Adjustable Module Support
Structure
With two modules required for operation, the solar power system module mount is configured to provide stable/reliable mounting of the panels with the ability to tilt as needed for proper alignment. Please consult this manual for proper solar tile angle.
E. Enclosure
The enclosure houses the battery, solar controller, wiring, termination blocks and breakers are used for the system. Figure 3 shows a typical enclosure in the configured system housing two batteries, wiring, and the solar controller.
The enclosures arrive on site pre-wired, including the PoE injector, solar controller, terminal blocks, and circuit breakers mounted on DIN rails. The enclosure is typically sized to accommodate batteries which are staged in the bottom of the enclosure but shipped, kitted with the components, and not installed.
F. Enclosure Mounting Brackets
The enclosure mounting kits are used to attach the enclosure to the pole. The mounting brackets are sized to match the system, and kits provided to fit 2 3/8" and 4 1/2" OD pipes.
G. Pole System Support
The mounting poles are not part of the Wi-Fi solar power system package due to costs associated with shipping of pipe and the easy availability in local places to the deployment site. Schedule 40 pipes having a diameter of to fit 2 3/8" to 4 1/2" OD pipes are recommended. Care and consideration of the anticipated wind speeds found at the deployment site should be planned as the Wi-Fi solar power system array will generate significant wind loading.

Solar System Controller
The controller is the 'heart and brains' of the Wi-Fi solar power system. It contains a four-stage battery charging algorithm for rapid, efficient, and safe battery charging as shown in Figure 4.

FIGURE 4: Battery Controller Charging Algorithm
Battery Controller Charging Algorithm
In the bulk charge state, the battery voltage has not yet reached absorption voltage and 100% of available solar power is used to recharge the battery. Absorption voltage is the normal, fully charged state. When the battery has recharged to the absorption voltage setpoint, constant-voltage regulation is used to prevent heating and excessive battery gassing. After the battery has fully charged the controller reduces the battery voltage to a float charge (or trickle charge). Depending on battery history, the battery remains in the absorption stage for three or four hours before transitioning to the float stage.
The equalize algorithm is used for flooded battery types only. The controller will equalize a flooded battery for three (3) hours every 28 days. Equalize charging raises the battery voltage above the standard absorption voltage so that the electrolyte gases. This process prevents electrolyte stratification and equalizes the individual cell voltages within the battery.
The battery technology being used for the system is a sealed, absorbent glass mat (AGM). The controller also contains a special charging function to attempt to recover batteries that discharge too low.

The following protections are available and readily observable via LEDs on the controller faceplate:

1. 1. Solar overload. If the solar current exceeds the maximum solar rating, the controller will stop charging until the solar current returns to within its operational rating. Status will be displayed on the faceplate via the Charging Status LED and is indicated with the LED flashing red.
   2. Load Overload. If the load current exceeds the maximum load current rating, the controller will disconnect the load. The controller will then attempt to reconnect the load two times approximately 10 seconds apart. If the overload remains after these two attempts, operator intervention is required to clear the fault after normal current is verified. The fault condition will be displayed on the faceplate via the Battery Status LEDs. The Battery Status LEDs will sequence green/red, yellow until cleared.

3. Solar Module Reverse Polarity. The controller is fully protected against inadvertent reversal of lead connections. No damage to the controller will result, but the erroneous connection must be corrected for proper operation. The fault condition will be displayed on the faceplate via the Charge Status LED and is indicated by the LED being off.

4. Battery Reverse Polarity. The controller is fully protected against inadvertent reversal of lead connections. No damage to the controller will result by the battery leads are reversed, but the problem must be resolved for proper operation. The fault condition will be displayed on the faceplate via the Battery Status LEDs and is indicated by the LEDs being off.

5. Damaged Local Temperature Sensor. If the local temperature sensor is short-circuited or damaged, then charging stops to avoid over- or under-charging. This critical error requires vendor support to resolve the failure. The fault condition will be displayed on the faceplate via both the Charging Status and Battery Status LEDs and is indicated by all the LEDs being off.

2. 6. Damaged Internal Temperature Sensor. Internal temperature of the controller is monitored on the controller heat sink. Temperatures above 85°C can damage internal controller electronics, so the unit shuts off when the heat sink exceeds that temperature. When the temperature falls below 80°C, the controller resumes operation.

   7. High temperature. If the battery voltage exceeds the controller's maximum regulation limit, the solar and load will be disconnected until the voltage decreases to the high voltage reconnect threshold. LEDs on the faceplate will display this status. The fault condition will be displayed on the faceplate via the Battery Status LEDs. The Battery Status LEDs will sequence red, yellow.

   8. Solar Short Circuit. The controller is fully protected against a short circuit on the solar input power wires. Charging automatically resume when the short is cleared. The fault condition will be displayed on the faceplate via the Charging Status LED and is indicated by the LED being off.

   9. Load Short Circuit. The controller is fully protected against a short circuit on the load wiring. The controller will attempt to reconnect the load two times approximately 10 seconds apart. If the short circuit remains after these two attempts, then the fault must be cleared by removing and reapplying load power. The fault condition will be displayed on the faceplate via the Battery Status LEDs until cleared. The Battery Status LEDs will sequence green/red, yellow.

   10. Damaged Internal Temperature Sensor. This means the internal heatsink temperature sensor is damaged. It is a critical error and requires vendor support to resolve the failure. The fault condition will be displayed on the faceplate via both the Charging Status and Battery Status LEDS. The Charge Status LED will be solid red, and the Battery Status LEDs will sequence red, yellow, green.

System Wiring Review

Load from the system is connected directly to the solar controller. The controller will disconnect loads when the battery has discharged to a low state of charge and reconnect system loads when battery capacity returns. Load control is fully automatic. As the battery discharges, status LEDs on the controller faceplate will show charge levels.

The following general load control notes should be observed:

- • 20Amp controllers provide load control.

  • The controllers have a 15 V maximum voltage limit.

  • Load connection is NOT a regulated voltage output. Load terminal voltage is approximately the same as the battery voltage unless the controller is in load voltage condition where load is turned off.

  • Currents of multiple loads wired in parallel must not exceed the total current rating of the controller.

Wiring Diagram
With the enclosure delivered to the site pre-wired, solid lines in the diagram (Figure 6) indicate factory wiring, dashed lines represent wiring provided with the system but require on-site installation and connection after the solar modules are mounted and battery(s) installed. Dotted lines indicate wiring not provided in the package that are to be supplied on-site by the customer.

2: Wi-Fi Solar Power System Installation
This chapter provides detailed instructions to install the Wi-Fi Solar Power System for operation.
Installation Overview
This section describes the installation of a basic system.
Required Tools
The following tools will be needed to assemble the Wi-Fi Solar Power System:

- • Screwdriver
  • Socket and wrench set
  • Small Hammer
- • Pliers
  • Voltage meter
  • Compass

Note: There are smartphone apps that can be downloaded to assist with installation. Some examples are Solar Tilt for positioning the solar array and Sun Surveyor for site surveys. This is not an inclusive list nor are these apps mandatory for installation. You can review what is available in the appropriate Google Play.

Before You Begin
The system must be installed as described in this manual to ensure reliable operation of the systems. Confirm system load is consistent with design specifications and your established hrs/day load will not exceed the battery capacity in the targeted days of autonomy required.

Figure 7 is a copy of Ventev Solar Sizing Map from the Ventev website. Ventev's Wi-Fi solar power system is designed to broadly work in Zones A-D. For sake of simplicity and because many of the Wi-Fi access points have similar power draw characteristics, standardization upon one solar system design is thought to accommodate most customer needs. Solar sizing whereby the wattage requirements of the array and the Amp-hour capacity of the battery bank are determined in advance and are not needed during the product selection process.

Identifying a Site
Careful selection of the exact location for placement of the system is crucial to continuous and reliable system operation. Exposure to shadowing from cut hillsides, trees, utility poles or any other objects during sunlight hours will reduce power capacity and should be avoided.
To Select a Site
Shading critically affects a photovoltaic array's performance. Even a small amount of shade on a PV module can reduce the module's performance significantly. It is essential to have a clear understanding of the sun's path across the horizon from the east to the west at all times of the year.
Unfortunately, it is not possible or practical to monitor the sun exposure at a site through long-term observation. Solar contractor installation professionals have developed tools to provide quick insight to the solar window at a specific location. In principle these tools evaluate a site by creating a Sun Chart. If a site is partially shaded, the sun chart will determine the amount of available sunlight.
The sun chart will determine if the solar modules will be shaded from direct beam radiation during critical times of the day or year. Unwanted shading can occur from trees, vegetation, structures, other arrays, poles, and wires. Shading is often a greater problem during winter months when the sun's altitude is low, and shadows are longer. For locations in the northern hemisphere, shadows cast on December 21st are the worst case through-out the entire year.
As of the writing of this manual, there are smartphone apps, such as Sun Surveyor from Google Play, which provide much valued added information.

When a site is being considered, be sure that the following parameters are considered:

- • Assure the array is not shaded from 9 a.m. to 3 p.m. on any day (this is the optimum solar radiation collection time known as the solar window).
  • Assure the array is not shaded in any month of the year during the solar window.
  • Identify the obstacles that shade the array during the solar window.
  • Eliminate any shading, or move the array to avoid shading, or contact Ventev to increase the size of the array to offset losses due to shading at the site location.
  – Keeping the above factors in mind when installing the Ventev Solar Power Systems will help ensure optimal, reliable performance of your system based on the original, specified design parameters.

Helpful websites that are available:

- • http://www.magnetic-declination.com/
  • https://www.ncei.noaa.gov/maps/historical_declination/

If using a compass, be sure to adjust for the magnetic declination in your area (for example, around Hunt Valley, MD, true south is 11 degrees west of magnetic south).

Note: Magnetic declination changes over time and with location.

The map in figure 8 shows the current magnetic declination in the U.S. in 2019.

Note: An initial Site Survey is required to determine optimal tilt angle of the module for instance of worse case solar radiation (i.e., worst case in the Northern Hemisphere likely in December, so tilt angle should be latitude plus 15Deg). Record and retain as Initial Site Module Orientation Data.

Determining the Solar Module Tilt Angle
The sun's height above the horizon is called altitude, which is measured in degrees above the horizon. When the sun appears to be just rising or just setting, its altitude is 0°. When the sun is true south in the sky at 12 p.m., it will be at its highest altitude for that day. This time is called solar noon.
A location's latitude determines how high the sun appears above the horizon at solar noon throughout the year. As a result of the earth's orbit around the sun with a tilted axis, the sun is at different altitudes above the horizon at solar noon throughout the year.
Photovoltaic module(s) or arrays work best when the sun's rays shine perpendicular (90°) to the cells. When the cells are facing the sun in both azimuth and altitude, the angle of incidence is "normal," as shown in Figure 9.

Angle of Incidence on a Solar Module
Seasonal changes of the sun's altitude must be considered to optimize a system's performance. When the array is installed, it should be tilted at an angle that yields the highest value of insolation during the worst-case month in the year. This ensures that the system is designed to meet the load demand and keep the battery fully charged in the worst month for the average year. The following general guidelines outline a rule of thumb tilt angle of a solar module for different seasonal loads.

- • Winter Loads Northern Hemisphere: Tilt angle = site latitude + 15°
  • Winter Loads Southern Hemisphere: Tilt angle = site latitude – 15°

The best method to determine the optimal tilt angle is to perform a site survey; contact TESSCO Technologies for assistance with these professional services.

Assembling & Mounting the Solar Module Support Structure

The load capacity, equipment size and geographic location of the Wi-Fi Solar Power System purchased has two solar modules needed. Also, mounting configurations are driven by the pole size and number of solar modules needed. Figure 10 shows various pole mounting configurations for the solar modules and how the module interconnect conduit assembly is installed in a 2-solar module mount assembly.
Figure 11 shows how the interconnect conduit assembly is installed on a two-module assembly.
Refer to the Solar Electric System in the Assembly Drawing (included with the support structure) for assembly details. Observe the following important guidelines when assembling and mounting the solar modules.

Caution
Avoid rough handling of the solar module.The module glass is tempered and may shatter upon impact. Solar modules are active when exposed to sunlight. To prevent power output at the junction box pigtails lay the solar module(s) face down on a flat, protective surface, or cover the front surface of the module with sunlight resistant material during assembly. Also, avoid shorting the connectors whenever sunlight is present on the module front surface.

Assembling & Mounting Guidelines
Figure 12 illustrates the proper orientation and wiring configuration for connecting the junction boxes of multiple modules. Be certain to position the modules such that the junction boxes are on the same side in the series. Instructions for connecting multiple modules are as follows:

1. 1. Lay the modules face down on a flat, protected surface when attaching the support rails to prevent damaging the glass and to eliminate electrical hazard.
   2. Take great care in the use of hand tools in the vicinity of modules' back surface. The module back surface materials are easily punctured, and any opening in the back surface will allow the entry of moisture which can shorten module service life. If punctures occur, seal with a non-acidic, commercial grade RTV sealant.
   3. Identify the positive pigtails coming from the junction boxes of both modules (marked by red tap by connectors) Connect these pigtails together using the MC-4 positive parallel connector as shown in Figure 12.
   4. Identify the negative pigtails coming from the junction boxes of both modules (marked by red tap by connectors) Connect these pigtails together using the MC-4 negative parallel connector as shown in Figure 12.
   5. Look for specific manufacturer's instructions in the packaging, and if found, follow them carefully.

Mounting the Battery Enclosure
The batteries are housed in the bottom of the enclosure which is attached to the pole.
Mounting Enclosure to Pole

1. 1. Take the two clamps/U-bolts from the hardware bag for the appropriate pole size, hex nuts, bolts, and washers.
   2. Position the battery box against the pole and install the clamps/U-bolts loosely using hardware described above.
   3. Position the enclosure against the north side of the pole (opposite the array, to take advantage of any shading available for reduced heat on the battery(s) and electronics in the enclosure) and tighten the bolts (Check for level before tightening), with the conduit knockouts on the bottom.

TIP: To achieve optimal battery performance, position battery enclosure such that it will see optimal shade during summer months.

System Wiring

Caution
Turn OFF all circuit breakers before beginning any wiring.

Grounding
Equipment grounding is required, this is true even in low-voltage (12 and 24 Volt) systems. A grounding electrode must be added to an ungrounded system to accommodate the equipment grounds. Equipment grounding conductors and devices need to fall within the guidelines of the following, these guidelines are superseded only by more up to date requirements, or those outside of the 50 United States and its territories. The highlights below are paraphrased from the provisions that have been established through 2011 edition of the NFPA 70®, National Electric Code® of the United States of America; more detailed guidelines can be determined by referencing the entire code book itself.

1. 1. Equipment Grounding Required: Exposed non-current carrying metal parts of PV module frames, electrical equipment, and conductor enclosures shall be grounded in accordance with
   a. 250.134 Types of Equipment Grounding Conductors, Including:
   i. A copper, aluminium, or copper-clad aluminium conductor, stranded or aluminium; insulated, covered, or bare; and in the form of a wire or a busbar of any shape
   ii. Rigid metal conduit
   iii. Intermediate metal conduit
   iv. Electrical metal tubing
   v. Listed flexible metal conduit
   vi. Listed liquid tight flexible metal
2. vii. Flexible metallic tubing where the tubing is terminated in listed fittings
   viii. Armor of Type AC cable
   ix. The copper sheath of mineral-insulated, metal-sheathed cable
   x. Type MC cable that provides an effective ground-fault current path
   xi. Cable trays
   xii. Cable bus framework
   xiii. Other listed electrically continuous metal raceways and listed auxiliary gutters
   xiv. Surface metal raceways listed for grounding
3. b. 250.136(A) Equipment Secured to Grounded Metal Supports:
   i. Electrical equipment secured to and in electrical contact with a metal rack or structure provided for its support and connected to an equipment grounding conductor
   ii. The structural metal frame of a building shall not be used as the required equipment grounding conductor for AC equipment

2. Equipment Grounding Conductor Required: An equipment grounding conductor between a PV array and other equipment shall be required in accordance with 250.110.
3. Structure as Equipment Grounding Conductor: Devices listed for grounding the metallic frames of PV modules or other equipment shall be permitted to bond the exposed metal surfaces or other equipment to mounting structures. Metallic mounting structures, other than building steel, used for grounding purposes shall be identified as equipment-grounding conductors or shall have identified bonding jumpers or devices connected between the separate metallic sections and shall be bonded to the grounding system.
4. Photovoltaic Mounting Systems and Devices: Devices and systems used for mounting PV modules that are also used to provide grounding fog the module frames shall be identified for the purpose of grounding PV modules.
5. Adjacent Modules: Devices identified and listed for bonding the metallic frames of PV modules shall be permitted to bond the exposed metallic frames of PV modules to the metallic frames of adjacent PV modules.
6. All Conductors Together: Equipment grounding conductors for the PV array and structure (where installed) shall

be contained within the same raceway or cable or otherwise run with the PV array circuit conductors when those circuit conductors leave the vicinity of the PV array.

Load Wiring

1. 1. Locate the wiring diagram on the door.
   2. Connect an Ethernet cable from the AP radio to the PoE Out port on the PoE injector.
   3. Connect an Ethernet cable from the WLAN of the network to the Data In port on the PoE injector as required.

Array Wiring

The Solar Module has a junction box with two pigtails located on the back side of the module. All wiring and electrical connections should comply with the National Electrical Code (NEC), Article 690 Solar Photovoltaic (PV) Systems.

The following figure illustrates the module wiring configuration of the Solar Power Systems. To determine the module wiring configuration for your system, locate the wiring diagram on the door of the enclosure for your system and compare the module wiring to your system.

Caution

Turn OFF all circuit breakers before beginning any wiring. Keep solar modules face down on a flat surface and/or cover the module(s) face with a sun protective cover while wiring. Shorting solar module terminals together can damage the modules, so use care in handling connected wiring.

Multiple Modules Wired in Parallel

Multiple modules wired in parallel as illustrated in Figure 13 enables power wattage to be incrementally increased while retaining the voltage levels of each individual module (i.e., If the modules in the figure are 12 volts each, then 12 volts are presented to the Solar Controller with the power capacity of both panels combined.

The steps involved in wiring multiple modules in parallel include:

1. 1. Connect the junction box pigtails on the modules with the MC-4 parallel connectors as shown in Figure 12.
   2. Locate the hole in the back or bottom of the battery enclosure.
   3. Remove the strain relief locknut from the conduit end. Insert the array cable end into the battery enclosure, replace the locknut, and tighten.
   4. Identify the array cable with the female MC-4 connector. This is the positive cable. Connect the fly lead end of the cable inside the enclosure to the solar array circuit breaker.
   5. Identify the array cable with the male MC-4 connector. This is the negative cable. Connect the fly lead end of the cable inside the enclosure to the solar array terminal block (negative).
   6. Connect the array cable with the female MC-4 connector to the positive parallel attached to the positive module pigtails (marked by red tap by connectors) as shown in Figure 13.
   7. Connect the array cable with the male MC-4 connector to the negative parallel attached to the negative module pigtails as shown in Figure 13.

Wiring & Installing the Battery

Battery(s) are shipped separately and not installed in the enclosure before shipment. Observe the following guidelines when working with batteries.

Caution

Electrical Burn Hazard

A short-circuited battery can produce thousands of amperes that will melt hand tools and cause severe burns. Take great care when handling the batteries and installing their interconnection wiring.

Caution
Wear eye protection and gloves. Remove all metal that can encounter the battery terminals.
Caution
Use extreme care in placing the battery(s) into the enclosure, being careful not to short battery terminals to the enclosure casing.

TIP: Keep the array, batteries, and loads as close together as possible. Due to electrical resistance of the interconnect wires, the electrical output drops over long distances. Shorter distances between the components of the PV power system minimize voltage drop and will also reduce wiring costs.
NOTE: Consult the wiring diagram on the enclosure door of the delivered system to determine the configuration of the battery(s) supplied. Locate that configuration in this section then follow the installation instructions herein for your system.

Multiple 12 Volt Batteries in Parallel
Connecting 12 Volt batteries are in parallel enables incremental increase in amp-hour capacity. For example, two 125Amp-Hour batteries connected in parallel increases total capacity to 250Amp-Hours. Figure 14 shows the wiring configuration for parallel battery connection.

To Install & Wire Multiple Batteries in Parallel

1. 1. Remove the appropriate punch-outs from the battery labels to indicate the month and year of installation (6=2008). This step is very important for tracking battery performance and warranty information.
   2. Set the batteries into the enclosure.
   3. Connect the RED leads to the POSITIVE (+) terminals of each battery using the bolts, washers and nuts provided. Tighten battery connections to 100 in-lbs. Take care not to short circuit the battery terminals with the wrench to the negative terminal or to the enclosure casing.
   4. Connect the BLACK leads to the NEGATIVE (-) terminals of the battery in the same manner, observing the same precautions.
   5. Make sure the battery terminals are completely covered by the insolating hoods.C

3: Problem Resolution
This chapter describes how to resolve problems with the Wi-Fi Solar Power System. Topics discussed include the following:
System Verification & Problem Resolution
System performance below design expectations usually results in one or more of the following:

1. 1. A load exceeding initial design estimates. If the load is operated daily for more hours than specified in the original system design, load failure may result.
   2. Excessive load current draw. If the applied load draws more current than specified in the system design, load-operating time may be reduced or load down time may be experienced.
   3. System component damage or malfunction may be a result of one of the following reasons:
   • A physically damaged solar module will produce less or no power (depending on the severity of the damage).
   • The solar controller may experience malfunction due to excessive current, such as a lightning strike.
   • Excessive load operation may result in permanent battery damage for example, excessive deep discharge.
   • Loose or damaged wiring can cause severe voltage drop (power loss) or an open circuit of the array, battery, or load.
   • The Wi-Fi solar power system site must be inspected regularly for damage. Damage may be a result of vandalism, wildlife, or lightning strike. The inspection frequency is site specific, depending on wildlife and/or public personnel activity in the vicinity.

4. System autonomy is the consecutive number of days that the battery subsystem is required to meet the load demand with no energy production from the solar module (or solar array), Poor sunlight conditions, such as ice/snow build-up on the solar module (or solar array), for consecutive days beyond autonomy design expectations, will result in non-operation of the load.
5. Shading of the solar modules during any period of the day will result in reduced system energy output. Shading can result from improper installation of the solar modules near trees, hillsides, or utility poles. Shading can also result from excessive dirt or bird droppings on the solar modules. The solar modules must be inspected and cleaned at regular intervals suitable to the conditions of the specific installation site.
6. Incorrect orientation or tilt angle of the solar modules will result in reduced energy conversion and reduced load operating time. If the array mounting hardware becomes loosened, high winds may alter its orientation. Always check the mounting fasteners for tightness and module orientation for proper directional orientation during site visits.

Technical Support
If you are unable to resolve issues after referring to this manual, please contact technical support for additional help: Ventev Innovations (A division of TESSCO Technologies)

- • Address: 10999 McCormick Rd, Hunt Valley, MD 21031
  • Phone: +1(800)759-9996

Theory of Operation
Simply stated, batteries are used to power the remote load's needs and solar energy is used to keep the batteries charged. However, the application of remote Wi-Fi solar power systems presents a complex and varying set of challenges.
Solar modules, power controller, and batteries are the three primary components of the Wi-Fi Solar Power System. With the partial state of charge, deep cycle batteries, recharged by solar modules, providing PoE power for customers' remote equipment, the power controller optimizes control of battery recharging while protecting components during the extremes of solar energy availability as well as protecting the battery from damage due to overcharging. The controller monitors local temperature and adjusts battery charging to minimize incorrect over or under charging.
Figure 1 illustrates a complete Wi-Fi solar power system installation. The solar array is a group of solar modules that converts solar energy to electric power to keep the battery(s) charged. Depending on load needs, single or multiple solar modules create a solar array. The solar array supplies current through a solar controller to a bank of batteries to keep the batteries charged. Since the solar array is sized to power 100% of the load throughout the year, the solar modules are sized to match worst expected weather conditions (least amount of available sunlight) and mounted to maximize year-round exposure.
The solar controller monitors battery terminal voltage and passes the current through from the solar modules to the battery bank to maintain charge on the batteries. As the battery voltage rises to 14.0 VDC, the controller limits the amount of current provided to the battery to prevent overcharging. As the terminal voltage drops, the controller will pass more current to the battery to maintain the terminal voltage. Since these systems are at sites with all weather conditions, the controller will also adjust this voltage for temperature compensation.
In situations where the battery voltage level could fall below 11.5VDC, such as continuous days of cloudy weather, the controller is designed to disconnect the load. When the battery charges to a voltage of 12.6VDC, the controller will reconnect the batteries to the load. This feature prevents discharging the battery to a level that could damage and shorten battery life.

4: Maintenance
This chapter describes how to maintain the Wi-Fi Solar Power System. Topics
discussed include the following:
Solar Array
The solar array converts sun energy to DC current at the design voltage (12 and 24 Volts in the Ventev Systems). Optimal operational efficiency requires the modules be kept clean and free of dust and debris and have full sun

access dawn to dusk. The modules are mounted in fixed positions and should be orientated to face due South with tilting of the modules matching the average sun elevation (varies with the seasons) at the specific site. Solar maintenance activities include:

1. 1. Clean the front surface of the solar modules with water and a suitable, non-abrasive extension brush. Avoid the use of any cleaning fluids that might leave a residue on the glass surface or promote corrosion of the support structure and its fasteners. Frequency of this activity is site and seasonal specific. Output from the solar modules that are professionally cleaned have upwards of 12% higher output power. Periods of rain showers tend to help keep the modules clean, whereas dusty periods or site locations dictate needs for more frequent cleaning.
   2. Confirm the correct orientation and tilt angle of the array is consistent with the initial site orientation data established at the beginning of the project during the site survey. Assure mechanical fasteners are tight.
   3. Inspect all electrical connections for looseness or corrosion.
   4. Inspect the module back surface for damage or punctures. Seal any punctures that are found with a commercial grade non-acidic RTV sealant. If significant impact damage is observed, replace the affected solar module.

Battery Bank & Charge Controller

The solar controller maintains and controls battery charge by passing through energy from the solar controllers.

Important Battery Facts

Batteries store direct current electrical energy in chemical form for later use. In a solar power system, the energy is used at night and during periods of cloudy weather. Since a solar module system's power output varies throughout any given day, a battery storage system can provide a relatively constant source of power when the module is producing minimal power during periods of reduced insolation. Batteries can even power the loads when the solar array is disconnected for repair and maintenance. The lead acid-battery is the most commonly used type in the United States in both solar power system applications and in the automotive industry. Starting (sometimes called SLI, for starting, lighting, ignition) batteries are commonly used to start engines. Engine starters need very large starting currents for a very short time. In the construction of starting batteries, there are many thin lead plates for maximum surface area. The plates are composed of a Lead "sponge", similar in appearance to a very fine foam sponge. This gives a large surface area, but if deep cycled, this sponge will quickly be consumed and fall to the bottom of the cells. Generally, automotive batteries will fail after 30-150 deep cycles if deep cycled, while they may last for thousands of cycles in normal starting use (2-5% discharge).

Deep cycle batteries are designed to be discharged to as much as 80% time after time and have much thicker lead plates. The major difference between a true deep cycle solar battery and others is that the plates are SOLID Lead plates – not sponge. It is often impossible to tell the difference between the automotive and solar deep cell battery from the outside. However, it is critical to understand the differences between battery construction and use when specifying a system. Automotive batteries do not work well and have limited life if used in Wi-Fi solar power systems.

Most battery manufacturers specify battery capacity in amp-hours. Many factors can affect battery capacity, including rate of discharge (from the load), depth of discharge, temperature, age, and recharging characteristics.

Life Expectancy

Most people think of life expectance in terms of years. Battery manufacturers, however, specify life expectancy in terms of a quantity of cycles. Batteries loose capacity over time and are considered to be at the end of their life when 20% of their original capacity is lost.

Depth of discharge (DOD) refers to the percentage of original of a battery's rated amp-hour capacity that has been used. By contrast, say a battery experienced shallow cycling of only 25% DOD would be expected to last 4000 cycles at 25°C (77°F), the same battery cycled to 80% DOD would last 1500 cycles. With one cycle per day, the shallowly cycled battery would last for approximately 11 years while the deeply cycled battery would last for approximately four years.

It is recommended that the battery voltage be monitored on routine basis to assure that it is operating within design expectations. A battery voltage with a consistent downward tracking float voltage can be an early indicator that the battery is starting to near end of life. At a minimum, check battery voltage routinely to assure that the system voltage is trending flat not downward.

Environmental Conditions

Batteries are sensitive to their environment and are particularly affected by the temperature of that environment. Higher voltage charge termination points are required to complete charging as a battery's temperature drops (the opposite is true in warmer temperatures). Ventev power systems contain solar charge controllers that have an onboard temperature compensation feature which automatically adjusts battery charge voltage based upon a battery's temperature.
The battery capacity will decrease at lower (than 25°C, 77°F) temperatures and increase at higher temperatures. A battery at 32°F may be able to achieve only 65 to 85% of its fully rated capacity; at -22°F it may achieve only 50%. For this reason, it is critical to assure that the system load on a Wi-Fi solar power system is properly sized for the correct Latitude, Solar Map Zone, and Load. A system undersized in any way may not operate well in colder temperatures.
Although battery capacity decreases as temperature drops below 77°F, battery life increases. Conversely, battery capacity increases with higher temperatures, but battery life shortens. Many manufacturers claim a 50% loss in life for every 15°F increase over the standard 77°F cell temperature. For this reason, it is essential, for example, in Zone A, Southern California, and Southern Texas that battery life is monitored more frequently than other parts of the country. As far as capacity versus battery life, this tends to even out in most systems, as part of their lives is spent in higher temperatures and part in lower temperatures.

Battery maintenance activities include:

1. 1. Periodically check all battery terminal connections for looseness and corrosion. Clean corroded terminals and tighten connections.
   2. With a voltmeter, routinely measure and log the battery(s) voltage.
   3. If the battery voltage has trended downward over time to near 80% capacity, initiate actions for battery replacement or contact Tessco customer support.

System Wiring
System wiring should seldom cause a problem, but situations can arise whereby terminal corrosion can be detected before serious failures occur.
During site visits:

1. 1. Check all wiring for corrosion, insulation integrity, and damage.
   2. Replace as necessary.

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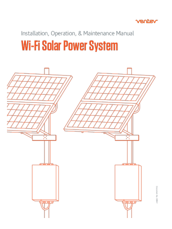
Documents / Resources

	**Ventev 072222 Solar Powered System for PoE+ Wi-Fi Access Points** [pdf] Owner's Manual 072222 Solar Powered System for PoE Wi-Fi Access Points, 072222, Solar Powered System for PoE Wi-Fi Access Points, PoE Wi-Fi Access Points, Wi-Fi Access Points, Access Points

References

- **NOAA National Centers for Environmental Information (NCEI)**
- **Wi-Fi Networking Solutions Provider | Ventev**

- Magnetic Declination
- NOAA National Centers for Environmental Information (NCEI)
- Magnetic Declination
- Historical Declination Viewer