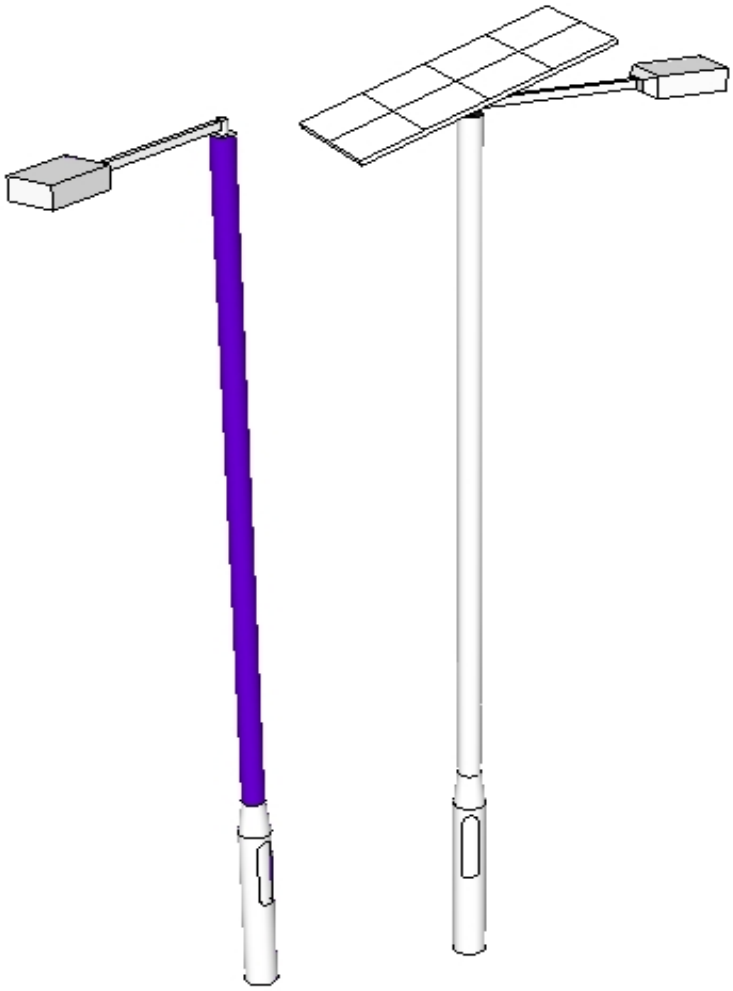
Light) Years Ahead

inovus™



Inovus Off-Grid User Manual

www.inovussolar.com

January 2013

Notice

This manual and the information contained herein are provided "as is" and are subject to change without notice. Inovus makes no warranty of any kind with regard to this manual. Inovus shall not be liable for any errors or for incidental or consequential damages in connection with the use or recommendations contained herein.

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Cautions and Warnings

- Lighting poles are heavy and require a lifting apparatus for installation. Take all normal safety precautions when working with poles & lifting equipment. Before you attempt these types of operations, be sure that you have a good understanding of the skills and risks involved. If you do not have the skills required to attempt these operations, please contact Inovus for training or a list of certified product installers in your area.

- The Inovus Off-Grid pole is NOT connected to the AC mains and thus hazardous voltages are not present. However, be aware that the solar collector can produce open circuit voltages of up to 50 volts DC. Servicing should only be undertaken by personnel with electrical service training and that have been certified to work with the Inovus Off-Grid pole operation.

- Modification of settings to Inovus equipment without approval from Inovus will result in voiding of warranty. Please consult with an Inovus engineer before attempting any setting changes.

- Batteries used in the Inovus Off-Grid pole are designed to avoid shorting, but can produce high currents if inadvertently shorted. Keep wires and terminals separated if servicing battery parts or troubleshooting the Inovus Off-Grid pole. Servicing should only be undertaken by personnel with electrical service training and that have been certified in the Inovus Off-Grid pole operation.

The following icons are placed in the left margin of this guide to indicate items having of particular importance. They are described as follows:

Caution or Warning: This icon indicates a task that directly affects safety or proper operation of the equipment. Use caution when performing this task.

Informational Note: This item is of particular importance and should be understood before proceeding.

Table of Contents

Introduction

Congratulations on your selection of the Inovus Off-Grid pole. Our mission is to significantly improve the economic and environmental impact of street and area lighting through the innovative use of proven technology. With the Inovus Off-Grid pole, you will help make a contribution towards improving the environment by reducing atmospheric emissions and reducing energy consumption, while saving money.

Although there is a long list of Inovus Off-Grid pole features, some of the most important and beneficial are listed here:

- **Integrated Solar** - The solar collector on Inovus Design poles is wrapped around the pole for a nearly invisible presence, better aesthetics, and less damage from wind/snow loading.
- **Better Lighting** - LED lighting provides better color rendition and more effective lighting when compared to standard high-pressure sodium lighting.
- **Energy Use** - The Inovus Off-Grid pole is not grid connected, zero energy use and zero CO_2 emissions.
- **Autonomy** - Up to 9 cloud covered days.
- **Light Pollution** - Dark Sky approved (IDA) luminaires are available.
- **Total Cost** - Lower total cost over life than conventional lighting.

Inovus Off-Grid Features

The following are the main parts that make up the Inovus Off-Grid pole. The location of the components is shown in Figure 1, below.

Luminaire	The luminaire or fixture is the lighting unit that contains the LEDs that provide the light output. Different lighting patterns are available through Inovus.
PV or Solar Collector	The Photo Voltaic (PV) collector or solar collector is the collector that is wrapped around the upper part of the pole or the flat panel on top of the pole. Solar collectors convert solar light into electrical energy.
Photocell	The solar collector acts as the photocell that controls the pole's luminaire on-at-dusk and off-at-dawn operations. The reliability is improved by not having a separate photocell.
Control Board	The "smarts" of the Inovus Off-Grid pole reside here. This is the main control center that manages the pole's stored energy, monitors inputs from the solar collector and motion sensors, and controls the luminaire.
Charge Controller	A key component that regulates the flow of energy in the system. A key feature is Maximum Power Point Tracking (MPPT) capability which means the charge controller will more effectively convert energy that is available from the solar collector into useable charge energy for the batteries - maximizes solar effectiveness. The charge controller is sometimes referred to as the 'MPPT'.
Motion Sensors	Three motion sensors on the pole use passive infrared technology to sense changes in the infrared background image to detect motion.
Battery Compartment	This is the internal compartment that holds the batteries necessary for the Off-Grid pole energy storage and operation.

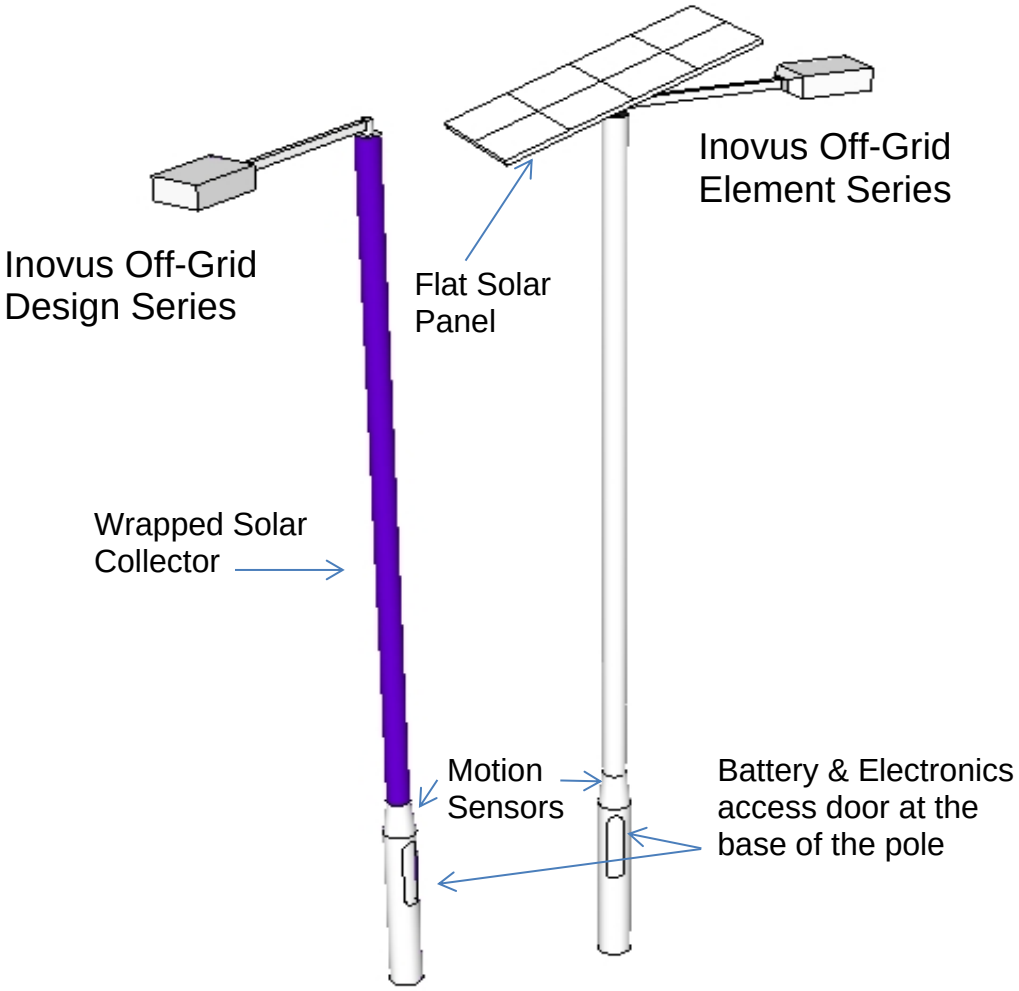

Figure 1: Inovus Off-Grid Poles are UL Listed

Secure Access

Stainless-steel security screws are used to secure the battery compartment door on the Inovus Off-Grid pole and prevent unauthorized access. The screws require a special driver bit (or key) that has a unique pattern to mate with the security screws. The bit is supplied with the Inovus Off-Grid pole installation documents and will fit into a standard 1/4" hex-bit driver tool.

Site Preparation

This section covers the basic information you will need to design the site lighting and prepare the physical layout of the Inovus Off-Grid pole. The following are the primary considerations for the physical site:

- **Pole Placement:** Because the poles have a solar collector wrapped around the upper part of the pole, the poles should be placed to maximize the solar energy collection and avoid shading.
- **Footings and Solar Alignment:** The poles have a solar collector that necessitates a directional alignment in the footing that ensures maximum solar collection. The distinction between True North and Magnetic North are discussed. Retrofits to existing footings are discussed also.
- **Lighting Pattern:** The luminaire lighting pattern will be dependent on the specific site selected and the lighting requirements for that site.
- **Lifting Techniques:** Because of the solar collector wrapped around the pole, it's extremely important to use caution when lifting and/or moving the pole.

Inovus provides an Installer's Kit to all of our new customers. In the Installer's Kit, we provide product documentation and special tools to help during the planning and installation phases of your project. Please contact your project manager leading the Inovus installation or an authorized Inovus representative to inquire about the Installer's Kit.

Shading Analysis

The main element to keep in mind when designing solar outdoor lighting is the proximity of buildings and landscape in respect to the pole placement. Shadowing can affect the pole performance, so an effective design will consider building shadows and landscape at mature sizes. In general, the poles should be located no closer to an obstruction than the height of the obstruction. It is important to consider the mature size of trees as well so that future performance is assured. This rule is mainly for obstructions on the sunny side of the pole. Figure 2 illustrates this rule of good design. Figure 3 shows the potential effects from an ineffective design with shading.

Perform Shading Analysis: Always perform a shading analysis before designing any solar outdoor lighting project. If you need assistance, Inovus will gladly assist and provide guidance to all Inovus customers.

Figure 2: Bad Outdoor Solar Lighting Design

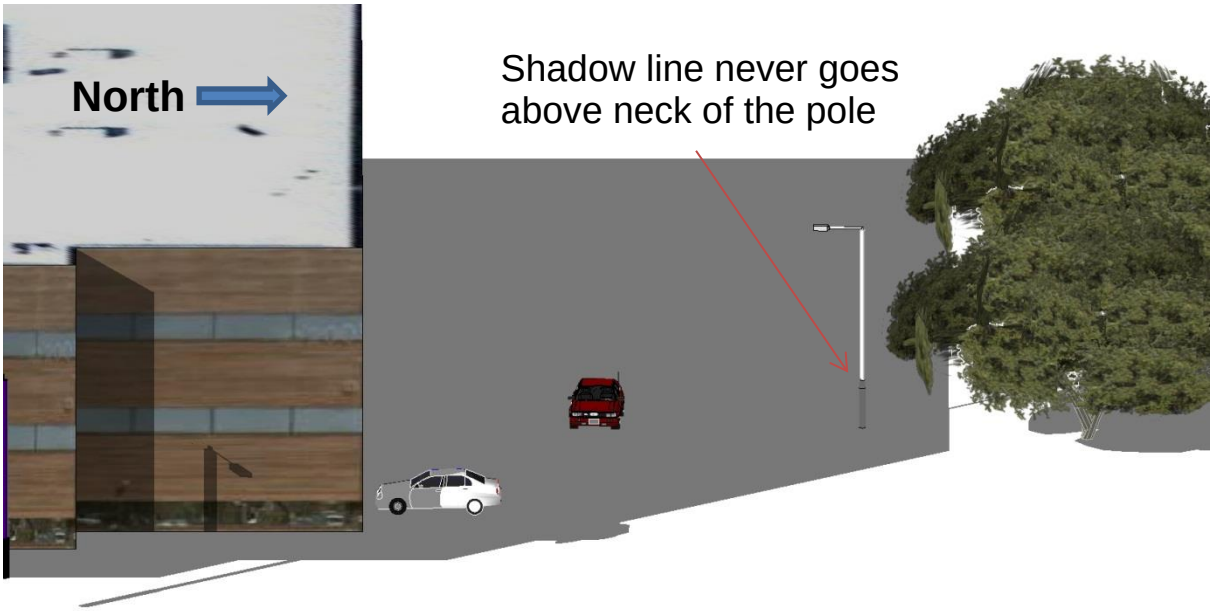

Figure 3: Good Outdoor Solar Lighting Design

Footings and Alignment

Because the Inovus Off-Grid pole is a solar device, attention must be paid to the pole directional alignment, and that is dependent on the concrete base (or footing) construction. When constructing the base and setting the anchor bolts, the anchor bolts **must** be aligned with **TRUE** North and South, +/- 10°. It is important to distinguish between Magnetic and True North. The site architect or surveyor can determine the True North direction at your site. A compass points only to Magnetic North and can give misleading directional information at your site – again consult your architect, surveyor, or engineer to get accurate directional information for the anchor bolt alignment. Figure 2-3 gives a visual example of how a compass points to Magnetic North/South, but the anchor bolts are aligned with True North/South.

The bolt pattern alignment ensures that the solar collector will be oriented to maximize solar energy collection. This occurs when the solar collector is pointed South for a Northern hemisphere location or when the solar collector is pointed North for a Southern hemisphere location. The solar collector center (pole front) is aligned with the pole access panel, so the access panel centerline can be used as a reference pointer; for example, the access panel should be aimed directly at TRUE North or South (depending on the hemisphere as explained above). The rear of the pole has a narrow strip of area that the solar collector does not cover - this area is directly behind (180° from) the front of the pole.

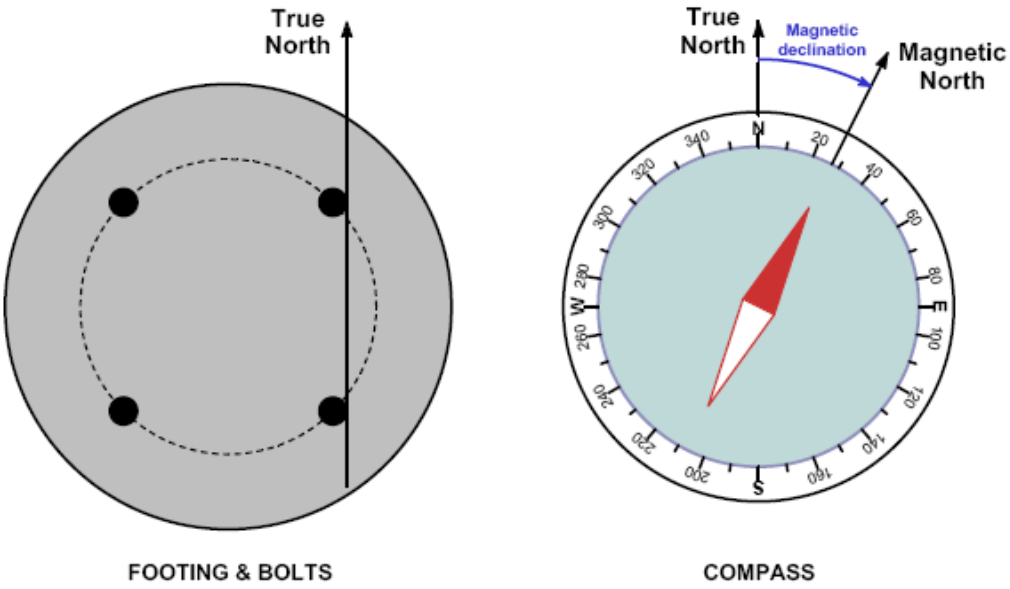

Figure 4: True North Footing Alignment

The aluminum pole uses a 4-bolt pattern on a 14-inch diameter circle and is shown in Figure 2-4. An example concrete footing is also shown in Figure 2-4. Be sure to check with your local building authorities, AHJ, or site architect to ensure that your footing conforms to local or state building codes and design standards. Different soil types, weather conditions, etc., will affect the design of the footing.

Inovus recommends that you connect all Off-Grid poles to earth ground as specified by your local and/or state codes. There are typically two different methods for grounding light poles, first one is the Ufer Grounding method and the second is the Driven Rod Grounding method.

Please make sure to follow your local and/or state codes when grounding the Inovus Off-Grid poles.

Make sure to leave at least 60 inches (5 feet) of free ground wire from the footing to reach the ground lug inside the pole.

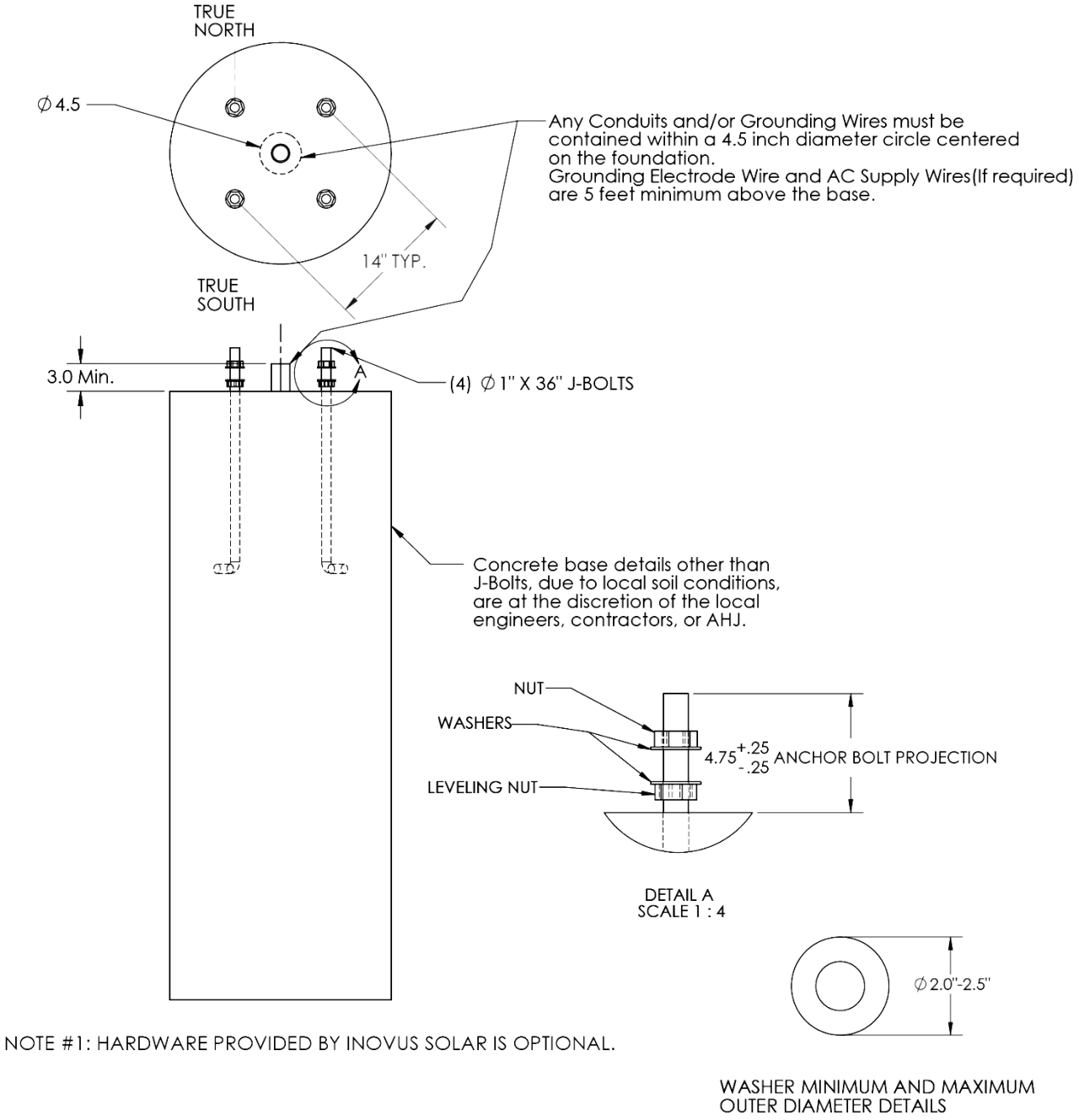

Figure 5: Bolt Pattern and Footing Example

Pole Handling

Inovus provides an Installer's Kit to all of our new customers. In the Installer's Kit, we provide product documentation, Inovus Installer's Certification information, and special tools to help during the planning and installation phases of your project. Please contact your project manager leading the Inovus installation or an authorized Inovus representative to inquire about the Installer's Kit.

Receiving and Lifting the Poles

Because the pole is wrapped with a solar collector, certain care in unpacking, handling, storage, and installation must be taken to avoid damage to the solar collector. Because a large area of the pole is covered with the solar collector, lifting the pole where the solar collector is located is usually necessary. Follow these precautions when handling the poles during unpacking, unloading, and installation. Be sure to follow these rules:

The most important item is to always protect the solar collector as it is subject to damage by mishandling; use wide nylon web slings.

Receiving and Storing the Poles

- If the poles are stored for extended periods, the original packaging should remain in place. Choose a flat area so that the wooden bunks support the pole evenly along the pole.
- Choose storage/queue areas carefully to prevent damage from vehicles or other stored materials in the area. Inovus recommends you do NOT store the poles outside without some kind of protection from potential rain. The ends of the pole must be wrapped to avoid water intrusion and to prevent voiding of warranty.
- When off-loading the poles from a truck, it is best to lift off one at a time with a sling. If a forklift is used, the center two wood bunks are designed for lifting the pole by a forklift – look for the markings indicating the lift points.
- To move the pole in a horizontal position, it is best to keep the original packing material in place. Lift with a wide nylon web sling - 2" wide recommended - and place at the center of gravity on the pole. Use additional padding if necessary - a heavy-duty wear pad made for slings is a good choice. Or, lift with a forklift at the center two bunks marked for a forklift.

See Figures 6 for visual diagrams of good and bad pole storage and handling practices. (Note - the luminaire is not shown.)

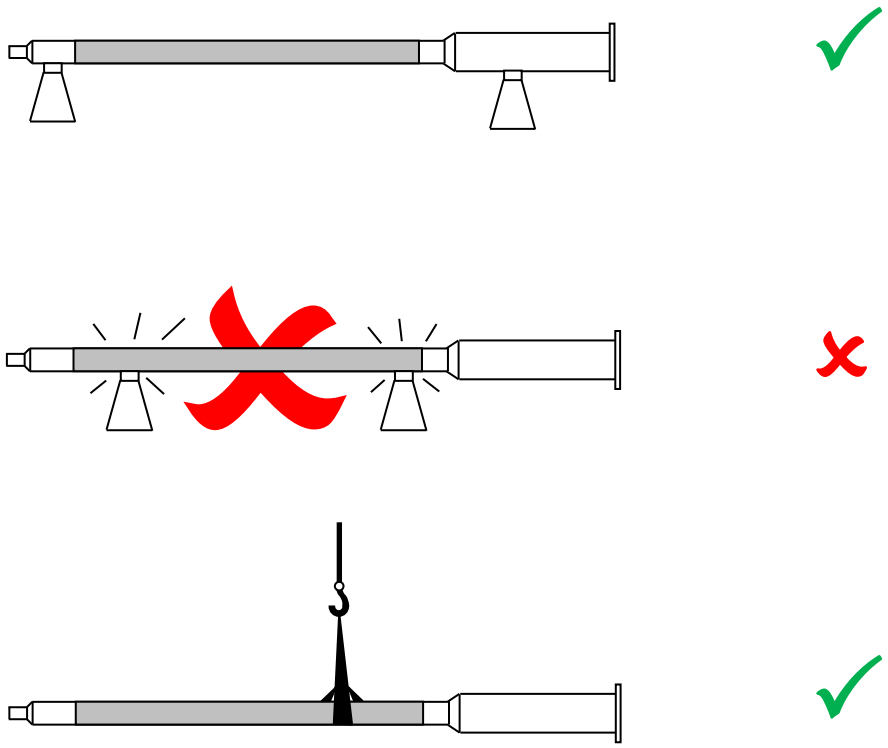

Figure 6: Pole Storage and Horizontal Lifting

Vertical Lifting of the Poles during Installation (see Figure 6)

Before you lift the pole, make sure you've checked that the luminaire turns on and that you have tightened the luminaire and arm to the pole just enough to secure it during lifting, but not too tight so you can make adjustments later. Also, ensure you've put back the Rubber Plugs that go on top of Luminaire which protect the arm screws.

- Connect the certified lifting hook to the 2" wide nylon strap. Open the door on the pole and connect the hook to the top of the door's opening. Make sure the hook does not interfere with the internal equipment/wiring. Use some of the packing foam to keep the hook from scratching the pole during lifting.

- Take the wide nylon strap and wrap it around the top of the pole approximately 3' to 5' feet from the top. Make sure the hook is still in place at the other end of the wide nylon strap.

- Make sure the wide nylon strap at the top is longer than the length of the luminaire, so when you lift the pole, the wide nylon strap doesn't hit the luminaire

- The wide nylon strap will support most of the pole weight and allow for retrieving the web for disconnection once the pole is set. Be sure the wide nylon strap used has a 5000-lb working load rating, so it can support the dynamic pole load and static weight.

- Never use chains, cables, ropes, etc., wrapped around the solar collector to lift the pole - they concentrate stress in small areas and can damage to the solar collector.

- When lifting the pole, provide some protection at the door's edge so that powder coating is not abraded or scraped.
- Prevent the weight-ball on the crane hook from striking the solar collector or pole during lifting. The best way is to use a long sling so that the ball is above the top of the pole during lifting.

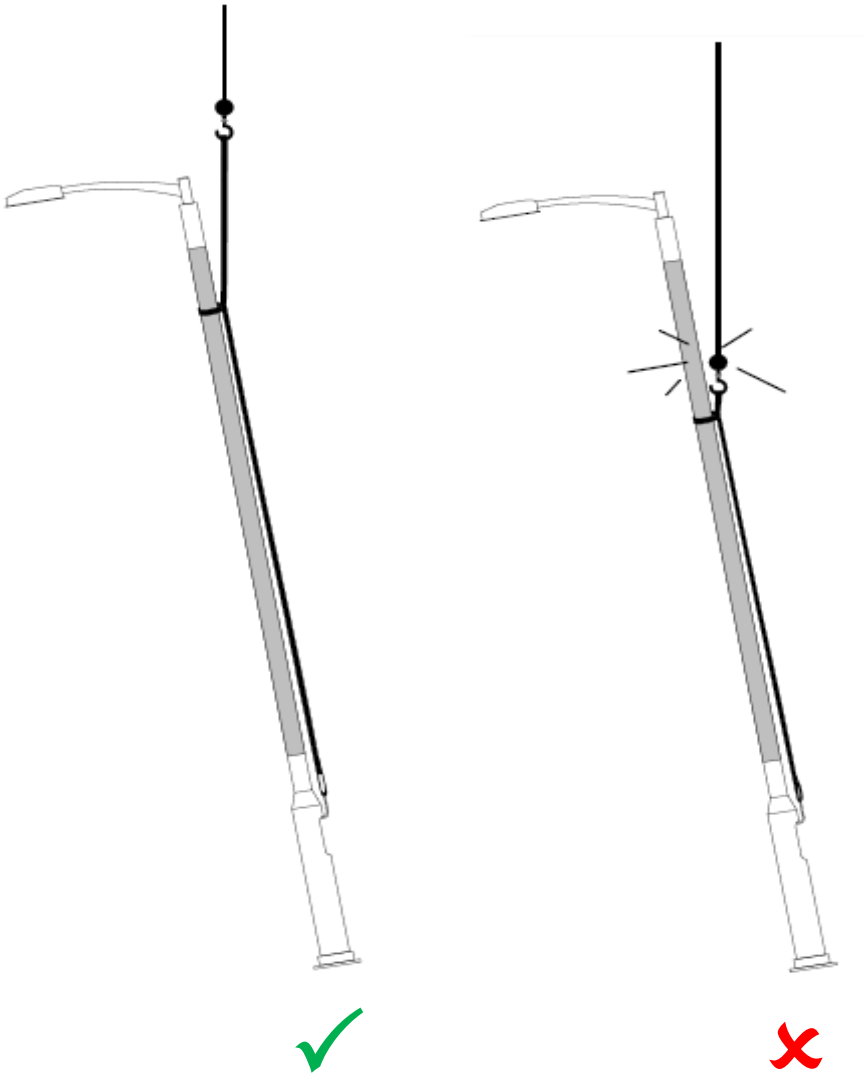

Figure 7: Pole Vertical Lifting

Unpacking the Poles

The poles will arrive packaged in SonoTube and will be wrapped with plastic to try and protect the poles from damage during shipment. When you are ready to unpack the poles, please make sure to not use sharp objects across the pole to prevent from scratching the pole or solar collector.

- Remove the metal strap first being careful as the metal strap may snap back upon cutting and could hurt someone.
- Carefully remove the plastic SonoTube.
- If you are unpacking an Inovus Design pole, make sure not to damage the solar collector as it is wrapped around most of the pole.
- If you are unpacking an Inovus Element pole, make sure not to damage the pole itself. Inovus Element pole's do not have a solar collector wrapped around the pole. The solar collector for Inovus Element is a flat panel on the top of the pole.

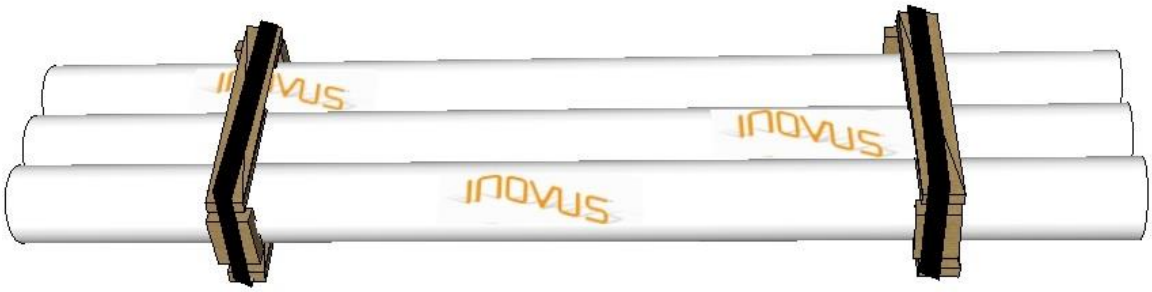

Figure 8: Inovus Poles Packaged

All Inovus Poles have electronic components inside the poles. Therefore, during storage and/or installation installers should be careful to not let water enter the pole. If poles are stored outside or installed during a rainy day make sure you protect the poles. Warranty will be void if water is allowed inside the poles.

System Operations

Standard Operation

The standard operation of the Inovus Off-Grid pole consists of controlled power settings to the luminaire. This is key in energy management and produces best in class autonomy. The Inovus Off-Grid pole has the following default lighting behavior:

- Turn on at 100% power (full brightness) at Dusk for 3 hours, then…
- After 3 hours, Dim to 25% power, then…
- If motion is detected, increase power to 100% for 1 minute, or until motion ceases, or until 15 minutes elapsed time is reached.

A graphical profile of the standard (default) operation is shown in Figure 9.

If there is an extended period of cloudy days which causes the batteries to have a lower state of charge, the Inovus Off-Grid pole enters additional energy saving modes which modify the On/Off/Dimming profile further to extend the pole operation as long as possible.

These energy profiles can be updated and designed to meet special lighting situations. Contact Inovus or an Inovus certified partner, if additional energy profiles may be required.

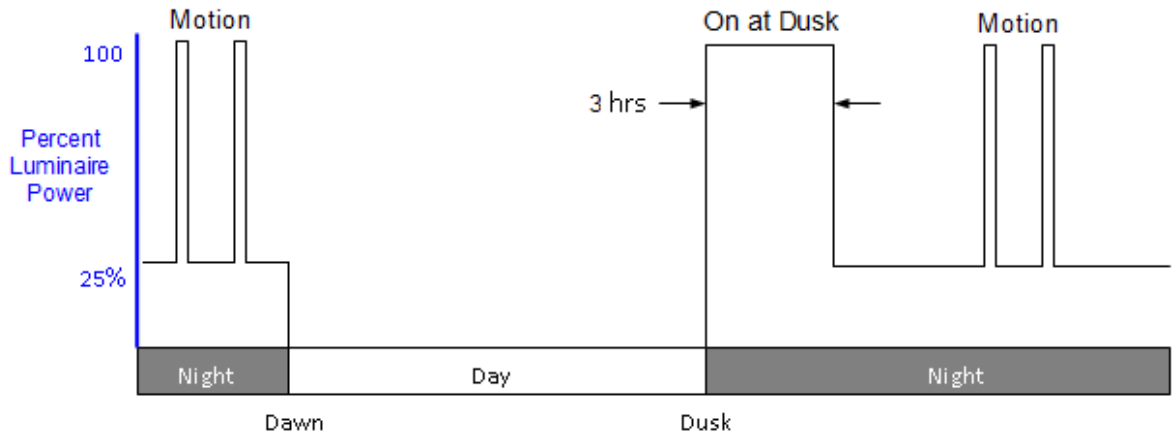

Figure 9: Default Light Profile Off-Grid Poles

Maintenance

In general, the Inovus Off-Grid pole needs no periodic maintenance or adjustments. If desired, some minimal confidence checking can be done.

Cleaning:	The pole or solar collector does not need any regular cleaning. In most locations, normal rainfall is sufficient to clean any accumulation of dust or debris from the pole. If desired, the pole and/or the luminaire can be cleaned with clear water (use softened water to avoid water spots). Use caution with high-pressure water sprays as these can drive water into otherwise sealed areas of the pole or luminaire, or possibly be injurious to the solar collector at close proximity.
Inspection:	Check for any damaged or vandalized parts.
Electrical:	Use the Remote Meter to access the battery state of charge and history for the last 30 days of operation (stored in charge controller). This gives a good daily indication of the pole operation - solar energy production and power use by the luminaire.
Graffiti on Pole:	DO NOT use anything with acetone or lacquer thinner in it. Ensure that the contact time is as short as possible and rinse the solvent cleaner thoroughly from the surface with copious amounts of fresh water. It is strongly recommended that a small test area be checked first to ensure that no damage will occur to the whole area.
Graffiti on Collector:	For water based paint you can use soap and water. For oil based paint you can use commercial or home based paint thinner. Inovus recommends only using the items mentioned above.

Troubleshooting

Only a minimal amount of troubleshooting information is included here as the operation of the Inovus Off-Grid pole involves many details that the service technician must be aware of. It is intended that involved troubleshooting and repair be carried out by personnel that have received factory training and certification. Contact Inovus for more information about training and certification.

⚠ *Batteries used in the Inovus Off-Grid pole are designed to avoid shorting. However, inadvertent shorting is possible if they are not properly installed. Use caution when accessing the pole electronics and batteries.*

Status Indicators

There are several status indicators that are part of the electronics that will give good indications that the Inovus Off-Grid pole is working normally. These are visual and required no measurement equipment or connections.

Normal Status Indicators

Control Board — If the white LED is on but the luminaire is off, it could mean that the power connections are interrupted to the LED modules

LED Color	Indication	Status
White	On solid	Light On
Green	On solid	Night
Red	Slow Flashing	Normal

Figure 10: Green Control Board LED indicators

Charge Controller — The STATUS LED shows charging and any error conditions.

LED Color	Indication	State
None	Heartbeat only (1)	Night
Green	On solid w/ heartbeat (2)	Charging
Red	Flashing or solid w/ heartbeat (2)	Error

Figure 11: MPPT STATUS LED indicators

(1) Heartbeat is a brief ON flash of the Status LED every 5 seconds.
(2) Heartbeat is a brief turn OFF of the Status LED every 5 seconds.

Charge Controller

The BATTERY LEDs show the "state of charge" of the batteries. There are 3 battery LEDs, see Figure 6-1 for the location.

LED	Indication	Battery Status	Load Status
Green	Fast Flashing(1)	Equalize Charge	Load On
Green	Med. Flashing(2)	Absorption Charge	Load On
Green	Slow Flashing(3)	Float Charge	Load On
Green	On Solid	Nearly Full	Load On
Yellow	On Solid	Half Full	Load On
Red	Flashing	Battery Low	Load On
Red	On Solid	Battery Empty	Load Disconnect

Figure 12: MPPT CHARGE LED indicators

(1) Fast flashing is 2 per second
(2) Medium is 1 per second,
(3) Slow is 1 per 2 seconds.

Basic Electrical Checks

If measurements or further testing is needed to confirm the pole operation, then the following basic electrical checks can be performed. These are listed here and are in the order they should be performed. If there is a discrepancy with these checks, more in-depth troubleshooting will be required which requires personnel with factory training.

Equipment Needed:

1. *Morningstar Remote Meter (RM)*
   a. *RM is included in the Inovus Toolkit*
   b. *The Remote Meter Map is located at www.inovusintelligence.com*

OR

2. *Volt Meter*
   a. *Not provided by Inovus*

Figure 13: Remote Meter

Basic Troubleshooting Steps

- ❑ Inspect wiring & connections, + and – wires in right place, MPPT switches correct & no charge jumper on the MPPT.

- ❑ Inspect fuses making sure they have not blown
- ❑ Check MPPT status and battery charge LEDs.
- ❑ Use RM or Volt Meter to read solar voltage: 28-35V at MPPT (sunny day).
- ❑ Use RM or Volt Meter to read the load current: Up to 1.7A with luminaire full on.
- ❑ Use RM or Volt Meter to read minimum battery voltage: 24.0-29.0V for AGM, 25.0-30.0V for LFP, depending on state of charge (SOC).
- ❑ Use RM or Volt Meter to read battery temperature: 105°F maximum for AGM, 125°F for LFP.
- ❑ Use RM to read any alarm or error codes. A:01 or no code is normal.
- ❑ Pull the PWM line connector and verify the luminaire turns ON (replace PWM line).
- ❑ Pull the solar fuse and verify the luminaire turns ON after 1 minute (replace fuse).
- ❑ Measure yellow lead of each motion sensor – should indicate a charging signal of about 5 VDC. This is only necessary if a motion-sensing problem is observed.

Frequently Asked Questions

1. **Why is the light not on at night?**
    a. Insufficient battery charge due to cloudy weather or shading
        i. Several consecutive days of overcast weather may impair the ability of the pole to fully recharge the batteries. Likewise, if the pole was installed too near a source of shading, such as a tall building or mature tree, it may not receive adequate daily sunlight to operate.
    b. Missing or Blown battery fuse
        i. A missing or blown battery fuse will inhibit the batteries from being charged during the day.
    c. Missing or Blown solar fuse
        i. A missing or blown solar fuse will inhibit the batteries from being charged during the day, as well as cause the luminaire to operate continually under assumed night conditions (the control board receives no photovoltaic voltage from the solar panel, therefore it assumes it is night-time.)
    d. Loose connections at MPPT terminal
        i. Wiring should be checked to ensure solid connectivity with the lead terminals on the MPPT.
    e. Loose luminaire wiring
        i. The wires connected to the luminaire cabling must be checked for looseness.
    f. Damaged MPPT or Control Board
        i. Although rare, it is possible that the control board or mppt may be damaged and may need to be replaced
    g. Dead or Inoperable Batteries

i. Batteries may no longer be able to hold a charge and may need to be replaced

h. Damaged or inoperable luminaire
    i. While rare, the luminaire itself may be inoperable or damaged.

2. Why is the light on during the day?

a. Missing or blown solar fuse
    i. A missing or blown solar fuse will cause the control board to assume it is night time, as the solar panel acts as the photocell. This will force the luminaire to operate continuously under assumed nighttime conditions.

b. Loose solar panel wiring
    i. Wiring should be checked for solid connectivity.

c. Luminaire dimming (PWM) wiring loose (blue wire on control board)
    i. A loose PWM will cause continuous operation of the luminaire. Check this wiring to ensure it is not loose.

3. Why doesn't the light change brightness when I walk by the pole?

a. Number of allowed motion events exceeded
    i. Depending on the energy profile you have chosen for the light pole(s), the maximum number of motion events allowed for one night may have been reached. If this is the case the pole will remain dimmed regardless of whether there is motion or not in order to protect the batteries from excessive depletion.
    ii. Motion events may be triggered by nearby trees, bushes, etc. that have been blowing in the wind.

b. Faulty motion sensors
    i. While rare, the motion sensors may not be picking up motion. A faulty motion sensor can be replaced in the field.

c. Insufficient battery charge
    i. If the batteries haven't received sufficient battery charge the pole control system may have altered the energy profile in order to prevent damage to the batteries. This could prevent the pole from going to full brightness.

4. The batteries aren't fully charging/are constantly at low voltage. Why?

a. Pole may be configured with incorrect lighting profile for your location
    i. If the pole is configured to support, for example, 7 hours of full brightness, but your location only supports 4 hours the batteries will drain each night.

b. Inadequate solar exposure
    i. The pole may have been installed near a source of shading that is preventing it from receiving adequate sunlight.
    ii. The weather may also have been continuously overcast preventing adequate charging.

c. Damaged battery or batteries
    i. There may be a damaged or inoperable battery pack, causing the system to divert much of the solar energy collected to the damaged battery in an effort to equalize battery charge.
    ii. If the batteries have maintained a low voltage for several consecutive days they may have become sulfated. If this has occurred the batteries will no longer be able to hold a full charge and must be replaced.

5. What are some common components that should be checked when there is a problem?

a. LED Status lights
    i. The LED status lights on the MPPT and control board are good initial indicators of proper (or improper) system operation. These should be your first check in any troubleshooting scenario.
    ii. It is possible that the control board or MPPT itself has been damaged. The LED status lights can aid in determining if it is a possible problem.
b. Wiring
    i. Loose or damaged wiring may cause improper system performance. It can cause problems running from poor connectivity of components to a short in the system. The terminals at the MPPT are a good first place to check for problems. A new wiring harness may need to be installed if the wires are damaged.
c. Fuses
    i. A loose, damaged, or missing fuse will prevent battery charging, proper control board operation, and improper system operation.
d. PWM
    i. Removing the PWM should immediately turn the luminaire on. This is a good check to see if your batteries have sufficient charge to operate the luminaire. If the luminaire fails to turn on you may have an inoperable luminaire, or damaged/inoperable batteries.
e. Voltages
    i. Check battery and solar array voltages
f. History
    i. Check the solar production vs solar consumption history using the Morningstar Remote Meter (RM)

6. How long can the solar light poles run at night?

a. Inovus Off-grid poles have battery capacity, power management controls, and designed efficiencies that allow for multiple days of autonomous operation. Even with several days of overcast skies, the pole can maintain lighting by varying the amount of full-brightness operation it allows each night.

7. How can I manually download data from the pole to review its performance?

a. Included in all Inovus installer kits is a Remote Meter (RM) which can be easily used to connect to the pole and manually collect both past and current

pole performance information. You can download up to 30 days' worth of historical data.

8. **Are solar light poles weather-proof?**
    a. Inovus light poles are designed to exist in many weather and environmental conditions for many years with little to no degradation in performance. The light poles are tested for water tightness, and many models are rated to withstand winds up to 150 mph. The photovoltaic collector is damage resistant and self-cleaning.

9. **What types of batteries are used, and how long do they last?**
    a. Inovus uses the highest quality AGM and LFP battery types. AGM batteries carry a 5 year warranty, and LFP batteries carry a 10 year warranty.

10. **What type of light is used?**
    a. Inovus uses cutting-edge LED luminaires in its light poles. LED's use less electricity to provide superior area lighting and color temperatures when compared to HPS and other, older lighting technologies.

11. **How should the light poles be stored prior to installation?**
    a. It is important to prevent water incursion into the uninstalled poles, and therefore indoor storage is highly recommended. To prevent bowing of the pole ensure that the pole is supported at both ends and in the middle.

12. **How much does a pole weigh?**
    a. A typical Inovus light pole weighs between 300-500 lbs, depending on pole height and material.

13. **How do I connect the battery cables to the charge controller harness?**
    a. If you are attempting to connect the battery cables to the charge controller harness and the cables seem to be too short, try pulling gently on the cable. There is slack that can be used to ensure adequate length.