Project Report

InSPIRE Solar Powered Outdoors Table (SPOT) Project

Funded by UIUC Student Sustainability Committee (SSC)

Executive Summary	
Created	March 2020
Last Modified	July 2022
RSO	Institute for Scientific Progress, Innovation, Research and Education (InSPIRE)
Current RSO President *	Justin Habana
Former RSO Presidents *	Jeff Snell, Didrick Manahan, Griffin Rzonca
Project Lead(s) *	Kirsten Polen
Former Lead(s) *	Keyur Patel, Justin Habana
Semester Began	Fall 2017
Semester Completed	Summer 2022
Authors	Justin Habana, Keyur Patel, Jeff Snell, John Morgan, Andy Eltzroth, Kirsten Polen
Project Summary	The SPOT project is a commercial outdoors picnic table retrofitted with solar panels on top-of-pole solar mounts and an off-grid PV system. It is used for the charging cell phones, tablets, and laptops.
* Listed leads and presidents are only from when this document was created. Leads prior to the creation date are not included.	

Timeline		
Major Milestone	**Approx. Time Completed**	**Description**
Creation of Project Design Concept	Fall 2017	Decided on a picnic table fitted with solar panels and outlets to charge laptops and cellphones
Found Sponsor and Funding	Early Spring 2018	Gained funding from Student Sustainability Committee, and sponsorship of prof Erik Benson
Found Technical Support for Electrical System	Late Spring 2018	Found technical advice and support from Philip T. Krein for the design of an off grid solar PV system
Proof of Concept	Fall 2018	- Created Functional Prototype Solar Energy System - Initial 3D model of design completed - Gained an “ok” from Craig P. Grant and Joseph Y. Youakim regarding the structural design.
Technical Knowledge Preparation	Early Spring 2019	- Gained approval and permission to start building the solar PV system (SES) from Philip T. Krein - Began learning and gaining skills related to concrete/masonry work
Electrical System	Late Spring 2019	- Purchased electrical box and electrical parts - Began assembly of the electrical system
Electrical System Construction	Summer 2019	- Completed Electrical System and began testing
Structural Design	Fall 2019	- Finalized structural design of the project - Compiled purchase list of parts for the structural system - Gained permission from Concrete Canoe RSO to share concrete workspace
Attained Approved Space for Installation	Spring 2020	- Gained Permission from the UIUC F&S Architectural Board and local Facility managers in the college of Engineering for a permanent location northeast of the Holonyak Labs
Hiatus	Spring 2020 to early Spring 2021	- Hiatus due to COVID pandemic
Preparation for construction	Spring & Summer 2021	- Completed plans and necessary permissions for construction
Began Construction & Finished Draft of Signage	Fall 2021	We finished... - Assembly of the table - Anchoring of the table - Installation of one of the poles Finished draft of signs and graphics to be placed on the project
Finish Construction	Spring & Early Summer 2022	- Installation of the second pole - Installation of off-grid PV system - Exterior Signage
Post Construction	Summer 2022	Start of Periodic inspections

Table of Contents

1.0 Project Description

1.1 Goals and Objectives

The SPOT project is a completely student designed and implemented outdoors table retrofitted with solar panels used to charge an off-grid solar energy system. It is a place that provides students in UIUC a space to sit and study outside while charging their devices (cellphones, tablets, laptops etc.) using solar energy. It will also better promote solar energy by allowing students to interact with the energy produced by solar panels they can clearly see in-front of them. Lastly, there will be a QR code on the SPOT which will direct students and RSOs to a website detailing the design and construction plans for the project. This will allow students and other RSOs to replicate the project -or parts of it- in their own endeavors. The website will also include instructions to create an off-grid solar energy system.

The current approved location for the project is on the northeast of the Holonyak Labs and is marked with an orange rectangle on Figure 1.1-1.

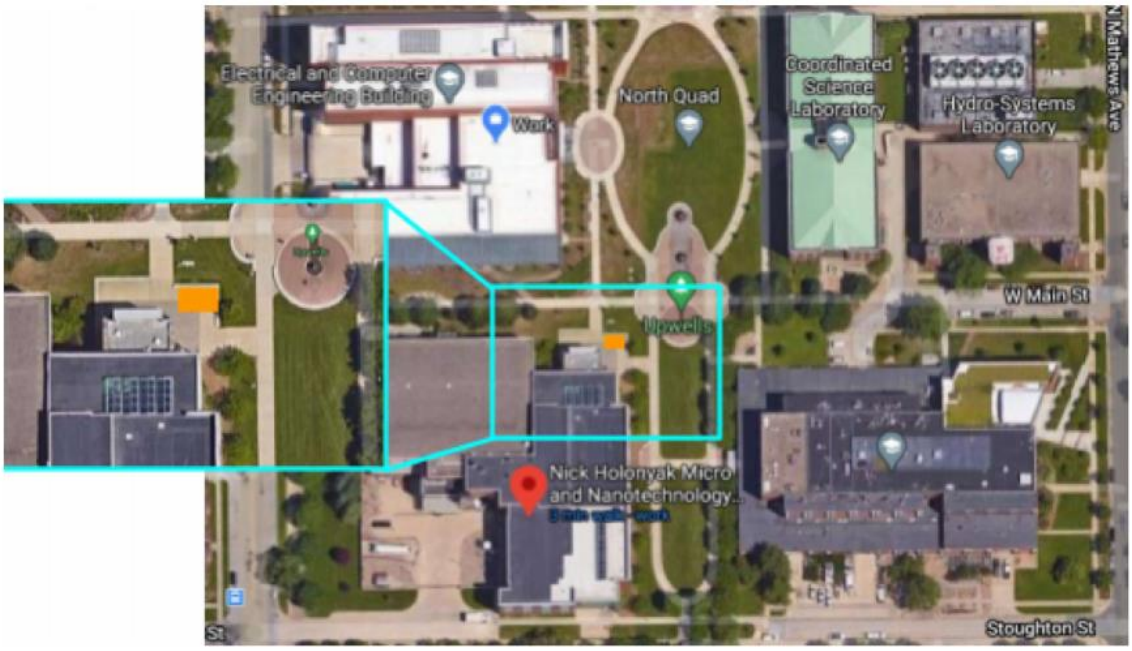


Figure 1.1-1 Location of SPOT Project

1.2 Design Summary

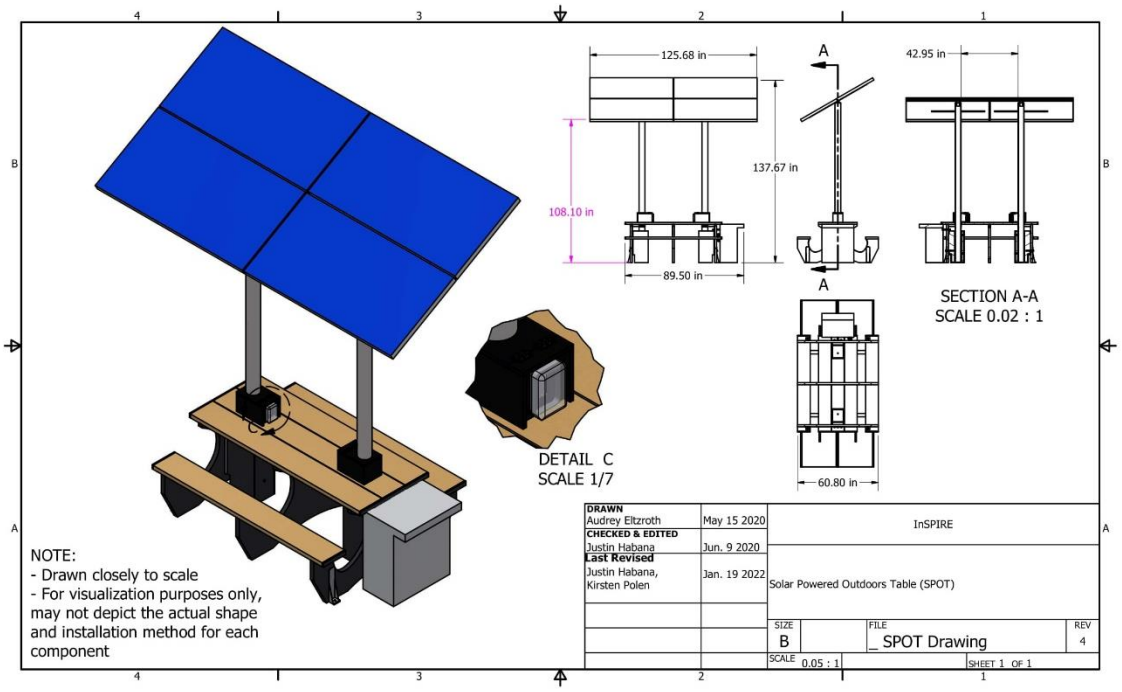


Figure 1.2-1 Overall SPOT Project Structural Design (see attachment A for larger version

The current design is to purchase a model PTEA6 recycled plastic picnic table from Belson Outdoors (see attachment B), then retrofit the table with four model BP 7185 185W solar panels and an off grid solar energy system with a 24V 50AH battery bank. The panels will sit on top of two Solaris model UNI-TP/03 solar panel mounts (see attachment C). Each of which will be installed on top of two 4” schedule 40 galvanized steel pipes which we will refer to as our poles. The poles will be fixed on to the table by means of concrete forms, grout and masonry strike anchors (see section 2.3).

An outlet base will be installed at the point in which each pole intersects the table (see Detail C in Figure 1.2-1). On each outlet base, there will be an outlet protected by a weatherproof outlet cover. Als on the outlet bases, will be logos of major contributors to the project as well as graphics that promote solar energy. Also, on the outlet bases is a QR code linked to web pages containing all design documents related to the SPOT project.

A NEMA type 3R electrical enclosure containing an off-grid solar energy system will be bolted to the side of the table. The off grid solar energy system includes a 60A charge controller, DC circuit breakers, AC circuit breakers, temp control system and pure sine wave inverter. The inverter will produce 60Hz 110V alternating current like the output of US conventional wall outlets. Temperature inside the electrical enclosure will be controlled by a fan that is programmed to activate at above 95 deg F. All non-current carrying conductors in the electrical system, electrical enclosure, poles, solar panel mounts and outlets will be grounded by means of two 8 ft long buried grounding rods.

The off grid solar energy system is designed to automatically disconnect from the outlets when battery charge is small and reconnect when battery charge is sufficient. It is also designed to be compliant with NEC regulations.

1.3 Operations and Maintenance

The system is designed to continue functioning in normal operations for 2-5 years. This is limited by the expected lifespan of a few electrical components which can be easily replaced. If the appropriate components are replaced every few years, the life of the project is expected to last for up to 2 decades, limited by the lifespan of the table. Aside from replacement of parts, the system does not require any additional maintenance.

During its operation, the InSPIRE RSO will be responsible for the following.

1. Regular Inspections
2. Repairs
3. Replacement of Parts
4. Relocation
5. Disassembly

In case of needed construction at or near the location of the SPOT which will require its removal, disassembly instructions will be available to all relevant people. These instructions will be stored inside the electrical enclosure which is locked by a combination cam lock. Contact information for requesting the combination code will be made available on the outside of the electrical enclosure. Contractors are free to remove the table with the disassembly instructions but may also request InSPIRE project team members as well.

Immediately after construction, InSPIRE members will inspect the system regularly for a span of a few weeks. Then will inspect the system more infrequently or only when needed.

1.4 Funding

The project is fully funded by the UIUC Student Sustainability Committee (SSC).

1.5 Others involved and relevant contacts

Name	Email	Role//Contribution	Occupation	Affiliation
Eric Benson	ebenson@illinois.edu	RSO Faculty Advisor	Associate Professor in Graphic Design	Collage of Arts & Design
Morgan White	mbwhite@illinois.edu	Contact in SSC, assisted in location search	Director of Sustainability	UIUC F&S
Location Search Contacts				
James Lev	jrlev@illinois.edu	Assistance in approving a location		UIUC F&S
Deon Collins	deonc69@illinois.edu	Provided permission to build on location	Holonyak Labs Facilities Manager	Holonyak Lab
Kim Qu	qkim@illinois.edu	Provided permission to build on location	Director of Facilities	Engineering Administration
Structural Design Volunteer Consultants				
Greig Gustafson	ggustafson@bernsclancy.com	Provided advice/Consultation	Civil Engineering Consultant	Bernes Clancy and Associates
Craig Grant	cpgrant@illinois.edu	Provided advice/Consultation		UIUC F&S (retired)
Electrical Design Volunteer Consultants				
Philip Krein	krein@illinois.edu	Advisor in electrical matters	ECE Professor	ECE Department
Joshua Pellum	jpellum@illinois.edu	Provided advice/consultation for outdoor wiring	Electrical Construction Superintendent	UIUC F&S
Joseph Youakim	jyouakim@illinois.edu	Provided advice/Consultation		UIUC F&S (retired)
ECEB Contacts				
Clint Harper	cdharper@illinois.edu	Gave permission to store items in ECEB. Accepted items as they arrived.	Facility Operations Specialist	ECE Department
Greg Nelson	gregn@illinois.edu	Gave permission to store items in ECEB	Facilities Operation Coordinator	ECEB Office Of Facilities
Other Contacts				
Jonathan Jakobsson	jakobssn@illinois.edu	Inspected the site after key parts of construction		UIUC F&S
Daniel Maier	dmaier@illinois.edu	Facilitated Julie survey request	Facilities Manager	Office for Facilities Management
Mike Brown	mb44@illinois.edu	Provided minor advice/Consultation		UIUC F&S
Edward Chainani	echaina2@illinois.edu	Provided advice and support related to safety and construction		
Joe Villanti	jpv023@illinois.edu		Management Architect	UIUC F&S
Brian D. Huckstep	bdhuckst@illinois.edu			UIUC F&S
Dave Lancaster	dlancast@illinois.edu		Electrical Construction Superintendent	UIUC F&S
Joshua Pellum	jpellum@illinois.edu		Electrical Construction Superintendent	UIUC F&S

2.0 Structural Design

2.1 Structural Design Drawing

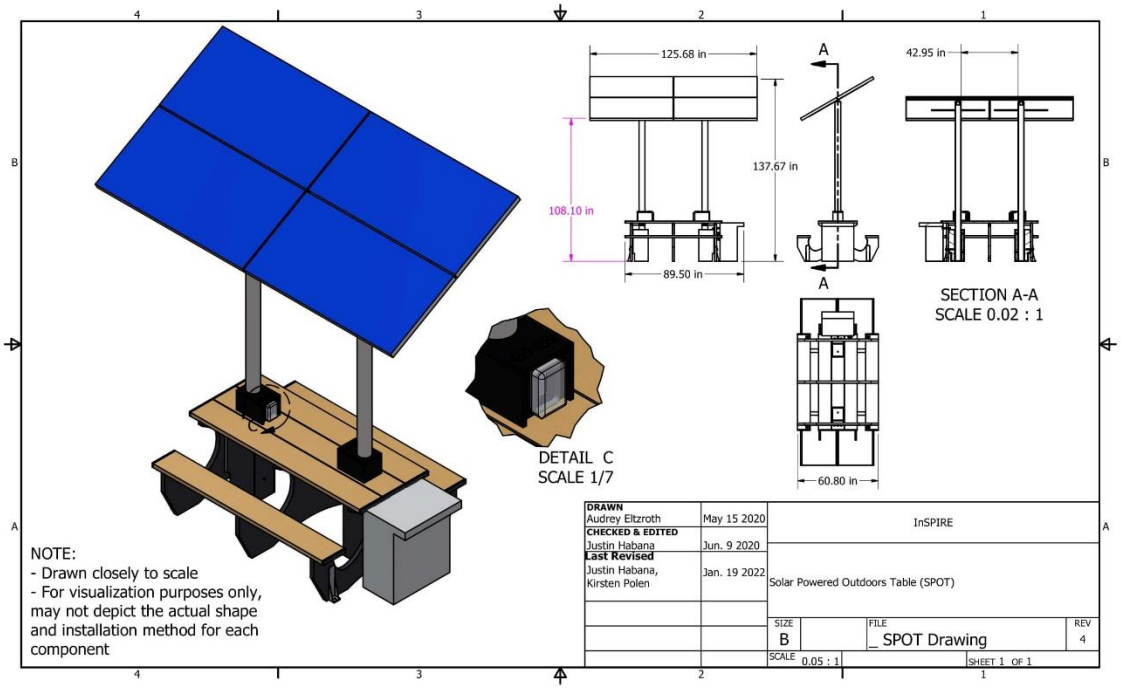


Figure 2.1-1 Overall SPOT Project Structural Design (same as Figure 1.2-1)

2.2 List of all Components

1.) Solar panels
    a.) BP 7185 185W Photovoltaic module - Saturn Tech
2.) Solar Panel Mounts
    a.) SKU: UNI-TP/03
    b.) TAMARACK SOLAR UNI-TP/03 TOP OF POLE MOUNT
    c.) From www.solaris-shop.com
3.) Metal Poles
    a.) 4" SCH 40 Galvanized Steel Pipe
    b.) Length: ~10ft
    c.) Outer Diameter: 4.5in
    d.) Material: Galvanized Steel
    e.) From www.tottentubes.com
4.) Outlet Base
    a.) Made of Recycled Plastic
    b.) See Section 4 for more details
    c.) Custom Made
5.) Table
    a.) Recycled Plastic
    b.) 6ft long

c.) From www.belson.com

6.) Concrete Pole Base
   a.) Made of Concrete with a recycled plastic outer shell
   b.) Will hold poles in place.
   c.) Connected to Table via Strike Anchors
   d.) Custom Made

7.) Electrical Enclosure
   a.) Contains Solar Energy System
      i.) Max PV voltage input 150V
      ii.) 24V 50Ah battery bank
      iii.) 2000W inverter
      iv.) Can connect up to 2 outlet modules
      v.) Wires exit the box via conduit on back face of enclosure
   b.) Model: SCE-29VR2412, 29 H x 24 W x 12"D"
   c.) From www.omega.com

2.3 Assembly of All Components

1.) Solar Panel to Mounts
   a.) As specified in the assembly/instructions manual of the mounts

2.) Solar Panel Mounts to Pole
   a.) As specified in the assembly/instructions manual of the mounts

3.) Pole to Table
   a.) Two 5in Dia. holes will be drilled on the Table. Poles will go through the holes. Silicone sealant will be used to cover gaps.
   b.) On the bottom of the table, poles will be connected to concrete bases that are in turn connected to the legs of the table.

4.) Pole to Table and Pole Base
(See section 4 for more details)
   a.) The pole will be inserted into a square hole on the pole base.
   b.) Quick Setting Grout will then be poured into the hole and left to cure
   c.) Silicone window sealant will be placed on the hole on the table intersected by the pole.

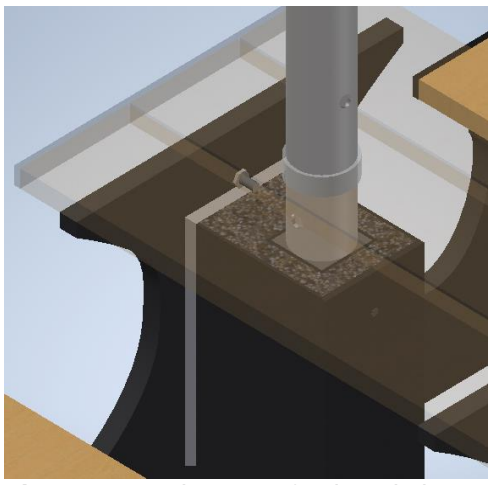


Figure 2.3-1 Close up of pole-pole base-table connection

5.) Outlet Base to Table
    a.) Bolted or screwed to the top of the table

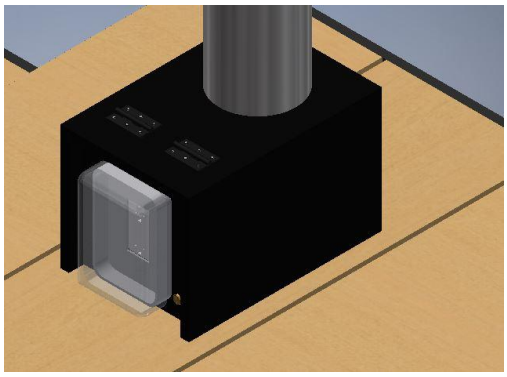


Figure 2.3-2 Close up of outlet base-table-pole connection

6.) Pole Base to Table
    a.) Secured onto the outer table legs by 3 strike anchors
    b.) Lining of the concrete base that touches the table will be caulked with construction adhesive

7.) Electrical box to table
    a.) Bolted to the legs of the table,
    b.) Will be removable.

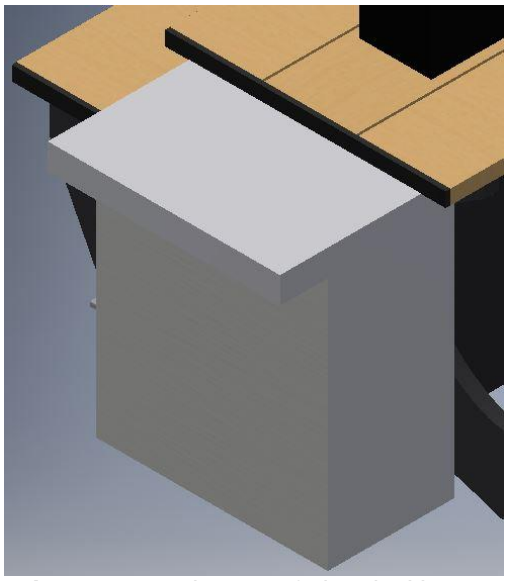


Figure 2.3-3 Closeup of electrical box to table

3.0 Electrical Design

3.1 List of Electrical Components

This section provides an overview of the off-grid solar energy system that will be integrated into the SPOT Project.

All components of the design are listed below along with a summary of their purpose and specification.

When integrated into the SPOT, all components will be kept in a weatherproof electrical enclosure except for the solar panels and outlets. The outlets will be kept in a separate enclosure on the table and protected by a weatherproof outlet cover.

In its most basic variation, the conventional off-grid PV system contains four major components, solar panels, a charge controller, a battery and an inverter. For the SPOT project, our PV system will only differ by the addition of batteries, protection components and a grounding system. See sections 3.2 for a diagram of the design.

1.) Solar Panel

Purpose:	To convert sunlight into electricity in the form of Direct Current
Main Specifications:	Model BP7185N; Manufacturer: bp solar; 36V, 5.14 amps, 5.44 max_amps, 185 watts
Purchased From:	N/A, donated by ECEB

2.) DC Circuit Breaker

Purpose:	One is located between the solar panel and the charge controller while the other is located between the battery and the inverter. When the current between the solar panel and the charge controller, -or between the charge controller and the inverter- is higher than a certain threshold, the circuit breaker will cut the current. This is to prevent damage in case of dangerously high current levels from the panels or too much current demand from the load. It also acts as a switch for manual disconnection. Lastly, to gain compliance with NEC2017 690.13 and 690.15.
Main Specifications:	30A 150VDC DIN Rail Mount Breaker; Environmental Rating - Type 1 (Indoor); Wire Size Range - 14 to 6 AWG; Width - .51 in (13mm); Number of poles - 1; 10,000 AIC
Purchased From:	Altestore.com

3.) Ground Fault Protection Device (GFPD)

Purpose:	To protect the system from ground fault currents and adhere to NEC2017 690.41(B)
Main Specifications:	63 amp 150VDC din rail mount DC ground fault protector

(NRTL listed breaker assy); Model: MNDC-GFP63

Purchased From: Altestore.com

4.) MPPT Charge Controller

Purpose: The charge controller has a multitude of necessary functions. Among which include over current protection, over charging protection, regulation of voltage & current for optimal charging, reverse current prevention etc. However, functions related to disconnecting different components of the system will mainly be handled by separate DC and AC circuit breakers external to the charge controller.

Main Specifications: 60-amp MPPT charge controller with maximum 150V PV input.

Purchased From: Altestore.com

5.) 100A DC Circuit Breaker

Purpose: This instantaneous circuit breaker will disconnect the battery from the system in case of shorts and other types of high current. It also acts as a switch for manual disconnection. This is also to gain compliance with NEC2017 690.13 and 690.15

Main Specifications: Bussmann CB185-100 100 Amp Type III switchable Circuit Breaker; Flush-Mount with manual reset; 1/4-28 threaded stud terminals with Sems nuts installed; Includes black reset lever

Purchased From: Amazon.com

6.) Battery Bank

Purpose: Energy storage

Main Specifications: 2 lead acid 50Ah AGM batteries connected in series, yielding a 24V battery bank

Purchased From: Amazon.com

7.) Inverter

Purpose: Among its multiple functions, it will mainly convert 24V DC to 110-120V 60hrz AC like those found in US outlets.

Main Specifications: Max wattage of 2000W of continuous power and 3500W surge power; Pure Sine wave; Model PST-1000-24

Purchased From: Donrowe.com

8.) AC Circuit Breaker

Purpose: Will disconnect all loads from the system when the current demand of the loads becomes too high

Main Specifications: 15A AC rpm AC breaker

Purchased From: Home Depot

9.) Outlet Modules

Purpose: To provide users access to collected and stored energy

Main Specifications: Standard 3-prong wall outlets. Includes safety reset button on the front of the outlets.

Purchased From: Amazon.com

10.) Low Voltage Disconnect

Purpose: Designed to disconnect from the batteries when the voltage across the batteries become too low, then automatically reconnect at higher voltage. To prevent disturbing our users, a low voltage disconnect will be placed between the charge controller and inverter to cut the power at a voltage higher than the alarm voltage of the inverter. Also to help extend battery life.

Main Specifications: Will disconnect at 21.8v +- .2V and reconnect at 24.8v, max current rating of 30amps

Purchased From: Amazon.com

Additional Components

- **Wires**

  Main Specifications: 12 AWG Copper Wire

  Purchased From: Home Depot

- **Outdoor, Highly Insulated Wires**

  Main Specifications: 10 AWG weather resistant copper wire; Thick Insulation

  Purchased From: Amazon.com

- **Grounding Wires**

  Main Specifications: 6 AWG bare solid copper wire

  Purchased From: Home Depot

- **Cable Connectors**

  Main Specifications: Type MC4

  Purchased From: Amazon.com

- **Grounding Rods**

  Main Specifications: ½ in Dia. 8 ft copper grounding rod

  Purchased From: Home Depot

3.2 Connection of Components

Figure 3.2-1 is a basic diagram that clearly outlines the connections between the main components.

Figure 3.2-2 provides a more detailed diagram that better represents the physical layout of the components and wiring. However, Figure 3.2-1 should not be regarded as an exact depiction of the physical layout of the components and wiring, but only as a guide.

The diagram in Figure 3.2-2 does not accurately portray the layout of the AC wiring. Research and extra care should be taken when laying out the hot, neutral and ground wires in the AC wiring set up.

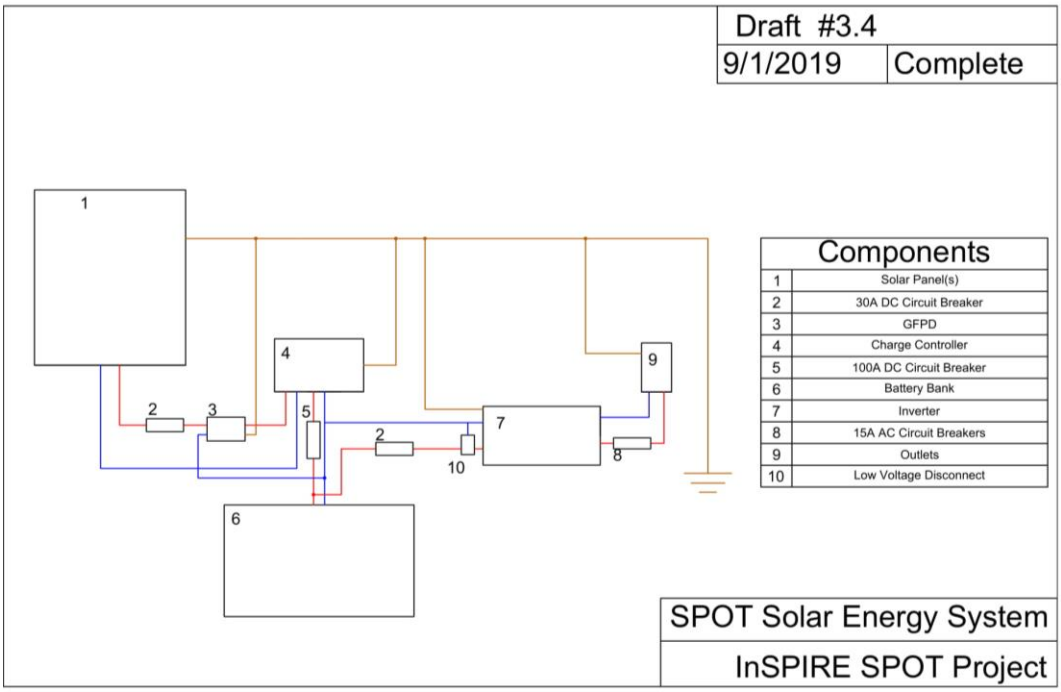


Figure 3.2-1 Simple outline of the cconnections of all Electrical Components Listed in Section 3.1. Excluding the temperature control system.

Components	
1	Solar Panel(s)
2	30A DC Circuit Breaker
3	Ground Fault Protection Device
4	Charge Controller
5	100A DC Circuit Breaker
6	Battery Bank
7	Inverter
8	15A AC Circuit Breaker
9	Outlets
10	Low Voltage Disconnect
11	Temp. Controller
12	Temp. Sensor
13	Fan

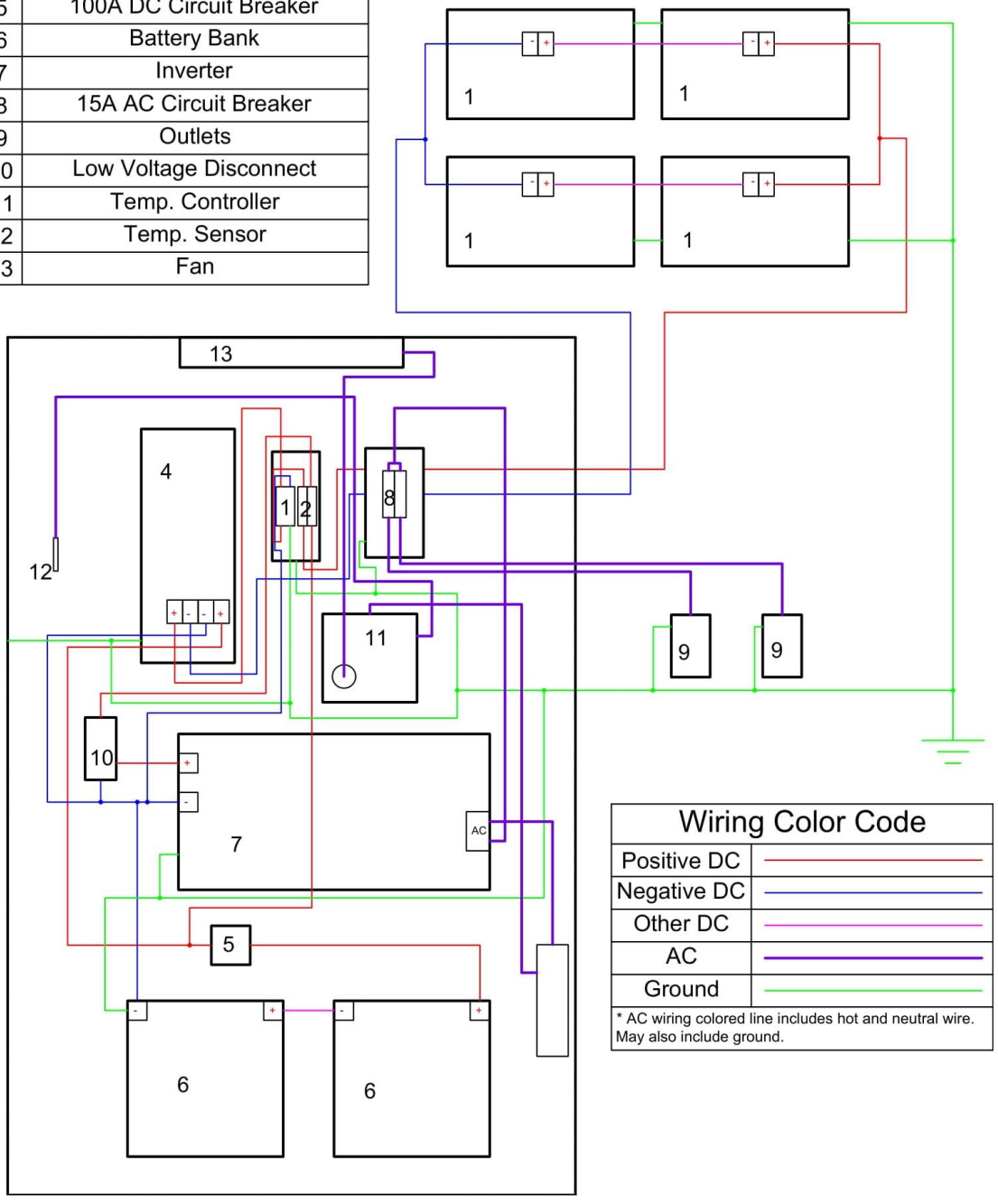


Figure 3.2-2 Model of physical layout of PV system wiring

3.3 Tests Conducted.

3.3.1 Discharge and Low-Voltage Auto Disconnection Test

From battery 100% SOC (State of Charge) and without any solar input, the system powered two laptops, a cell phone and a tablet. Before the SOC (which was estimated using a voltage meter) reached below a certain point, the “low voltage disconnect” disconnected the battery from the inverter and power to the devices stopped. Inverter automatically turned off. This was expected.

3.3.2 Recharge Test and Auto Reconnection Test

Using a 100W solar panel, the system was charged slowly. The “low voltage disconnect” automatically reconnected the system into the inverter, the inverter turned on and the system could once again power any connected loads. This was expected.

3.3.3 Temp Sensor and Fan Test

Using a heat gun aimed at the temperature sensor, the detected temperature increased past 98 deg Fahrenheit. At that point, the fan automatically turned on. The heat gun was turned off and the temperature was allowed to return to room temperature. At approximately 92 deg Fahrenheit, the fans turned off. This was expected.

3.3.4 Circuit Breaker tests

Before installation into the system, the 30A DC and 15A AC circuit breakers were tested using a DC power supply and an AC wave function generator respectively. The current output was gradually increased until it was above the rated output of the circuit breakers. The DC and AC circuit breakers disconnected as expected.

4.0 Construction Plan

4.1 Summery

The construction process will be separated into three phases, preparation, actual construction, and post-construction. The actual construction phase will be further separated into activities listed in Table 4.1-2 in roughly the order shown. A description of each phase summarized in Table 4.1-1. For additional details, see the subsequent subsections.

This document does NOT provide specific step by step details on the construction activities conducted. And should only be treated as an overview of each activity. Moreover, images are not exact replications of the actual constructed product but are drawn close to scale.

It is also important to note that we ensure nothing on site will pose a hazard to the public and the table after each construction session will always be safe for public use.

Table 4.1-1 Summery of Phases

Phase Name	Description	Summary of tasks
Preparation	A list of items to be created prior to the actual construction phase and are to be installed onto the table during said phase	• Create and test PV system. • Create outlet bases. • Create pole bases. • Drill holes on poles • Installation of grounding rods
Actual Construction	These are a set of construction sessions. In each one, members will conduct on site construction activities. This phase will likely last for multiple months. Excluding winter months.	See Table 4.1-2
Post Construction	This includes any necessary remaining tasks prior to completion.	• Placement of graphics on SPOT. • Finalize disassembly instructions. • Conduct safety checks • Make any changes based on recommendations from professional contacts

Table 4.1-2 Summery of Construction Activities

1. Assembly of table
2. Drill pole holes on table
3. Anchoring of table
4. Installation of pole bases
5. Installation of poles
6. Installation of outlet basses
7. Installation and assembly of mounts
8. Installation of electrical box
9. Installation of outlets
10. Connection of outlets
11. Connection to grounding rods
12. Installation of solar panels
13. Connection to solar panels

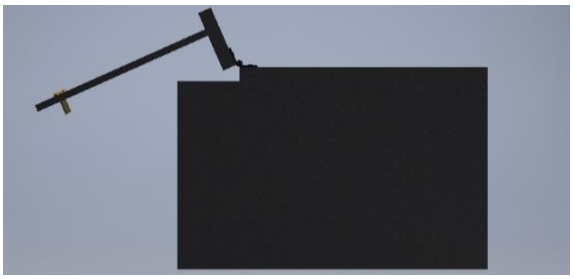
4.2 Phase 1: Preparation

4.2.1 Solar PV system

See Section 3

4.2.2 Outlet Basses

Will be made of HDPE (high density polyethylene) recycled plastic boards. The dimensions and design are shown below. Conventional wall outlets will be installed along with outlet covers. They will be installed at the front board of the base which will be designed to open and close as needed.



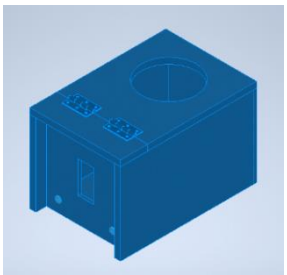


Figure 4.2.2-1 Outlet Base Side View

Figure 4.2.2-2 Highlighted Outlet Base Isometric View

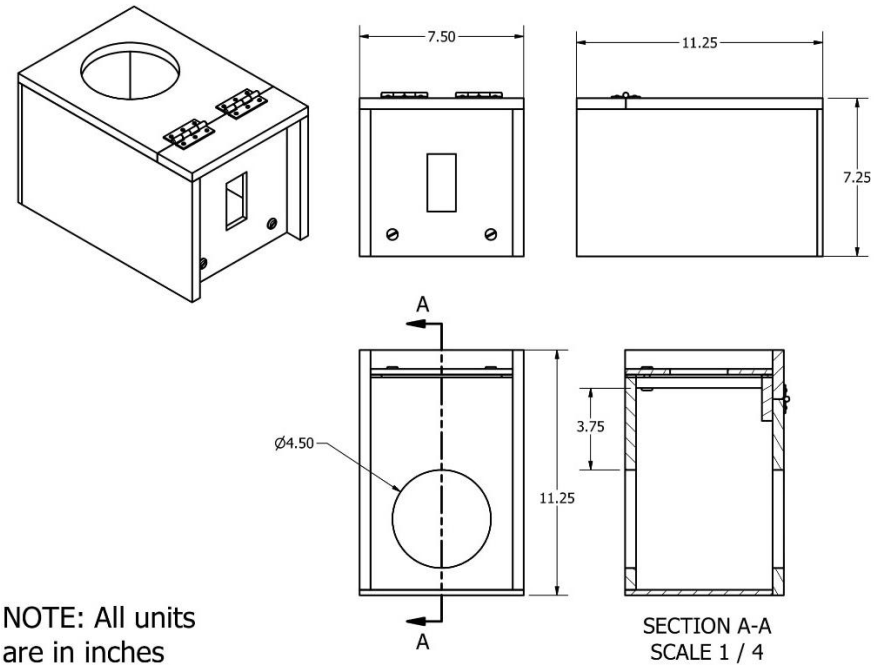


Figure 4.2.2-3 Outlet Base Dimensions

4.2.3 Concrete Pole Base

An HDPE plastic shell will be created with the dimensions shown on Figure 4.2.3-2 and Figure 4.2.3-4. A wooden board (not shown) will be placed on the front of the shell. Concrete will then be poured into the shell and left to cure for multiple weeks prior to actual installation. The wooden board is used to prevent the concrete form spilling and will be removed after curing. The final pole base is shown on the right.

NOTE: Initially, it was planned to have movable bolts installed on the back of the shell in order to secure the pole. Hence, the two holes shown in the following images. However, this was not implemented.

Figure 4.2.3-1 Pole Base

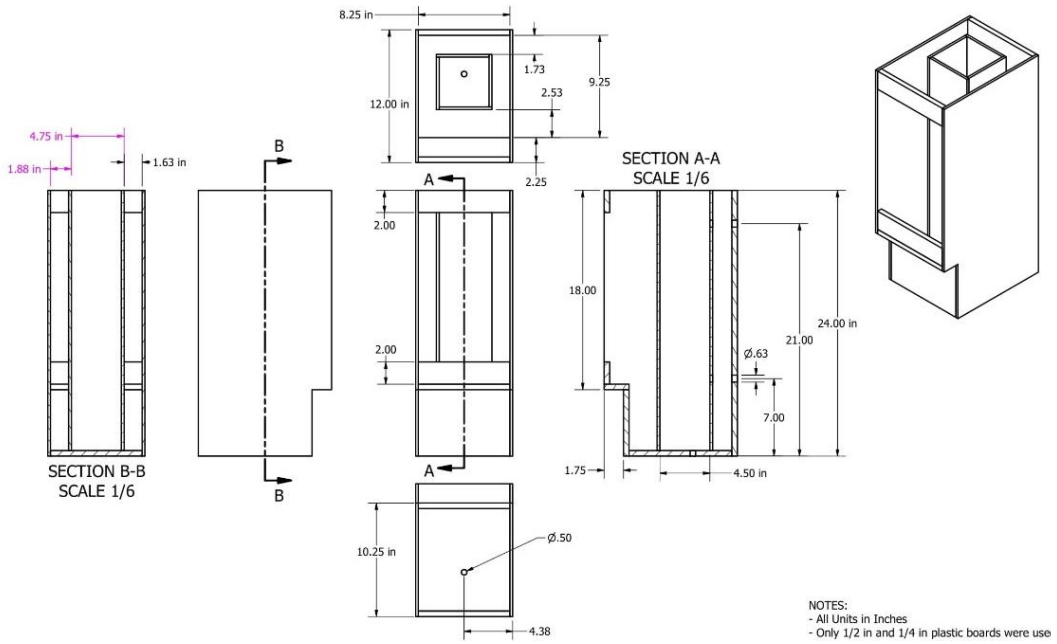


Figure 4.2.3-2 Pole Base Shell Dimensions

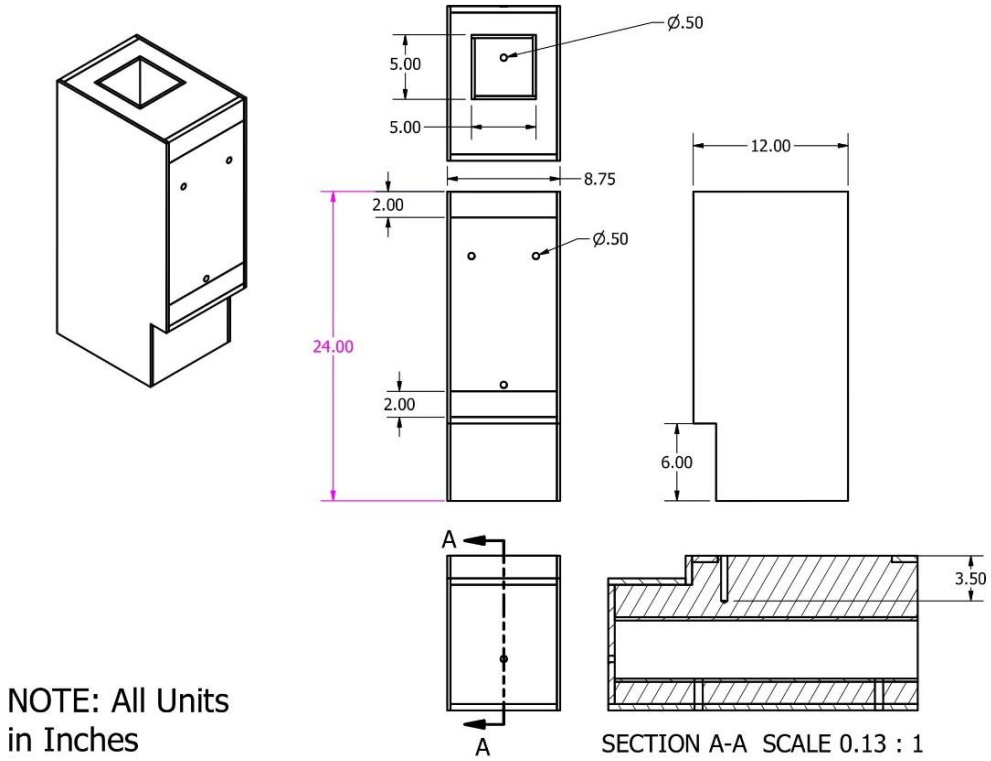


Figure 4.2.3-3 Pole Base Dimensions

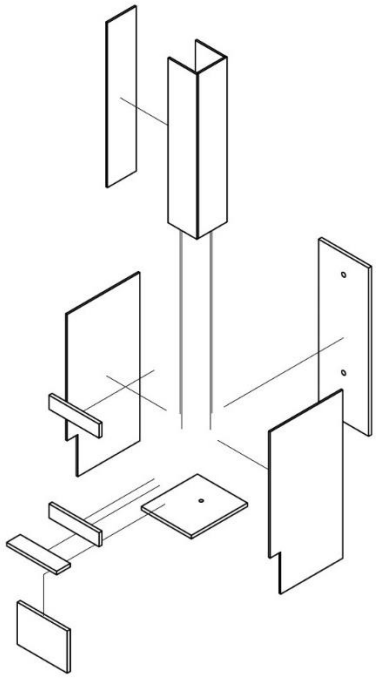


Figure 4.2.3-4 Pole Base Shell Exploded View

4.2.4 Holes Drilled into Poles

Approximately 1-1/2 in diameter holes will be drilled into the poles at the locations shown in the image below. We define the front pole as the pole closest to the electrical enclosure. The three holes on the front pole will be 90 degrees apart from each other while holes on the back pole are aligned vertically.

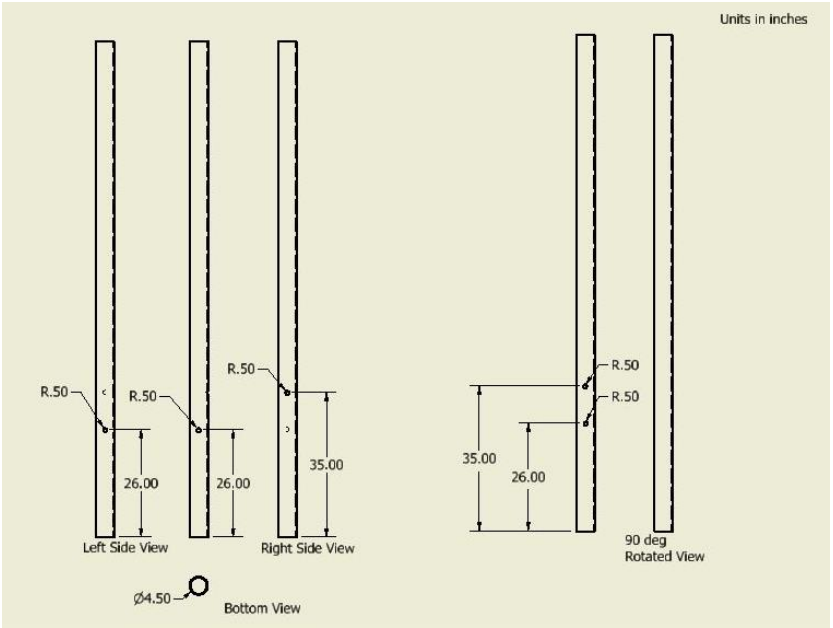


Figure 4.2.4-1 Location of Holes on 10ft long front pole (left) and back pole (right).

4.2.5 Grounding Rods

Two 1/2in Dia. 8ft long copper grounding rods will be installed, at least 6 feet apart, on a grassy field near the site.

4.3 Phase 2: Actual Construction, Major Structural Components

4.3.1 Assembly of Table and Pole Holes

Will be assembled as intended using the instructions from the seller. Assembly instructions for the table will be found in attachment B. Two 4.5 in diameter holes will be drilled on the tabletop for the poles. A 1 in hole will be drilled on the top of the center leg (not shown) for the electrical conduits.

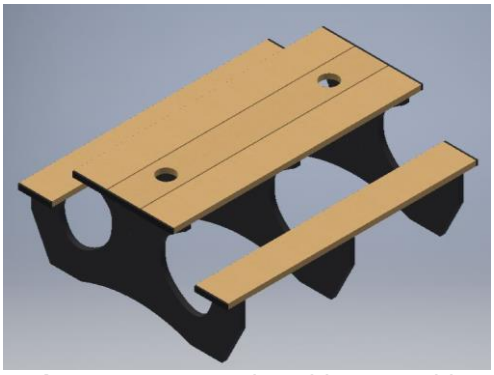


Figure 4.3.1-1 Basic Table Assembly

4.3.2 Anchoring of Table

The table will be anchored on the concrete floor. It will be anchored using four HTT holdowns and lag shield anchors for each holdown. A holdown on all four legs will assure the rigidity needed without bothering the users. 5/8 in lag shield anchors are used in this scenario because they provide strong gripping on the concrete and allow for easy removal of the table in case it is needed. The picture of the setup is shown in Figure 4.3.2-3. Four holdowns will be attached to the outer legs of the table at the four locations shown in the same figure.

Figure 4.3.2-1 HTT Holdown

Figure 4.3.2-2 Lag shield (left) and lag screw (right)

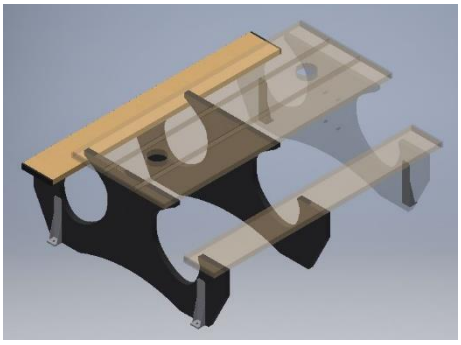


Figure 4.3.2-3 Table with attached anchors

4.3.3 Installation of Pole Base

Will be installed using four expanding masonry strike anchors at the outside face of the outer legs of the table as shown in the diagram below. Gorilla heavy duty construction adhesive will then be placed in the outside interface between the table legs and concrete as shown in Figure 4.3.3-3.

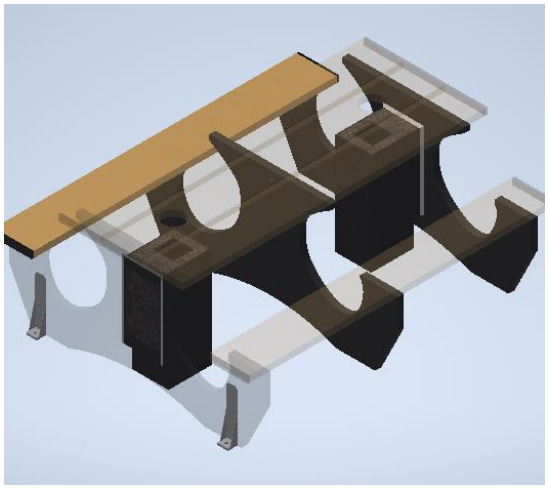


Figure 4.3.3-1 View of table with locations of Pole Bases

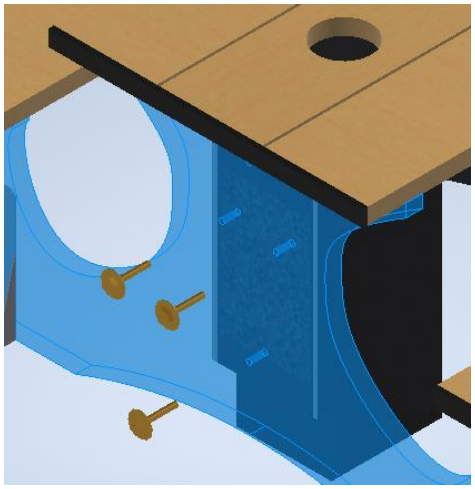


Figure 4.3.3-2 Close up view of location of strike anchors to be installed.

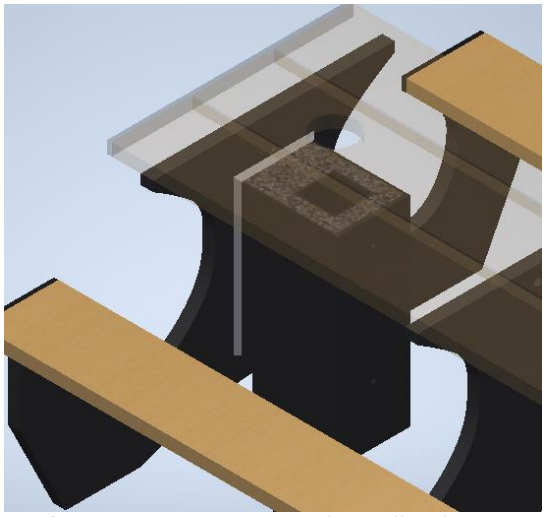


Figure 4.3.3-3 Construction adhesive on pole base

Figure 4.3.3-4 Gorilla Construction Adhesive (may not be the exact product used)

4.3.4 Installation of poles

The poles will be installed using the following steps. Members will practice this process beforehand.

1.) Carry the pole and insert it into the circular hole on the table by means of rope and the Timber Hitch knot as well as the pipe clamps used as handles.
2.) Hold pole in place to keep it vertically aligned.
3.) Two other members will then mix non-shrink construction grout with superplasticizer/water-reducer.
4.) Pour grout into pole base square hole until it is filled. Shown in Figure 4.3.4-2.
4.) Silicone window sealant will be placed in the space between the table hole and pole as shown in Figure 4.3.4-3.

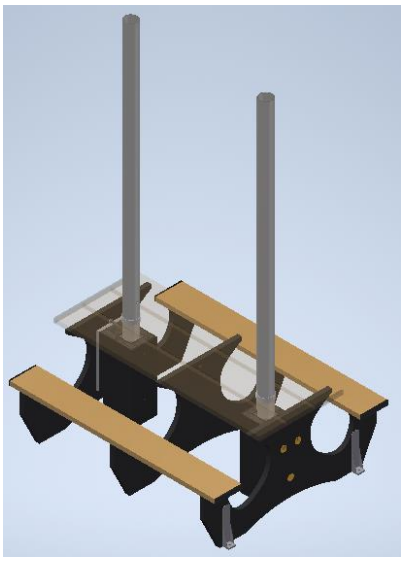


Figure 4.3.4-1 Overall structure after installation of poles

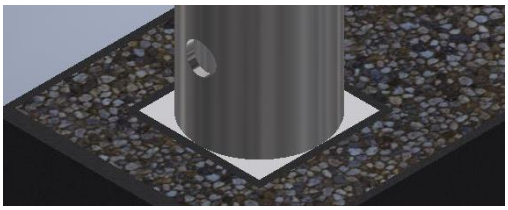


Figure 4.3.4-2 Location of Grout Application

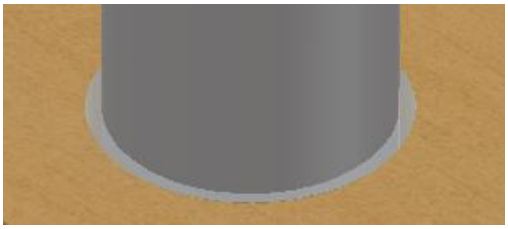


Figure 4.3.4-3 Location of silicone door & window sealant application

Figure 4.3.4-4 Pole mounting clamps Only 4.5” Dia will be used.

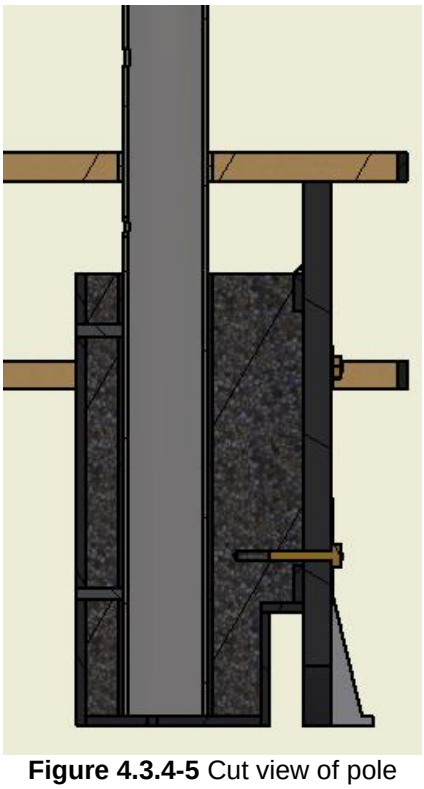


Figure 4.3.4-5 Cut view of pole installation

4.3.5 Installation of pole Cap

A rubber cap will be placed on each pole as shown in Figures 4.3.5-1 and 4.3.5-2. On the front pole, a ¾ inch hole will be drilled to allow for the conduit to come through. Silicone sealant will also be placed around the conduit and along the edges of the pole cap to keep them in place as well as prevent the infiltration of liquids and dust.

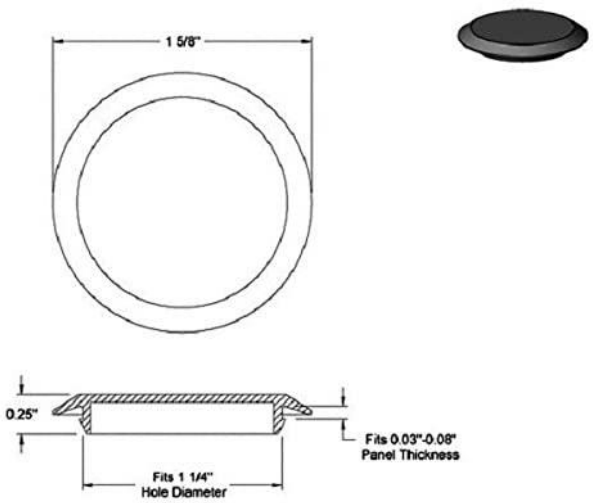


Figure 4.3.5-1 Pole cap shape and color

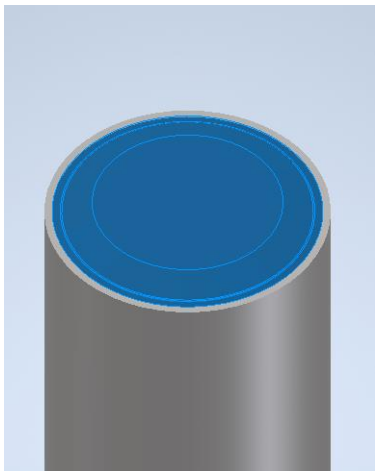


Figure 4. 3.5-2 Installed pole cap (highlighted in blue)

4.4 Phase 2: Actual Construction, Off-Grid PV System

4.4.1 Placement of the Electrical Box

The electrical box will be attached to the side of the table using one bolt and multiple nut-washers including a waterproof rubber washer. The box will sit on the floor and will have an approximate weight of 150lb (including electrical components). The bolt will be removable.

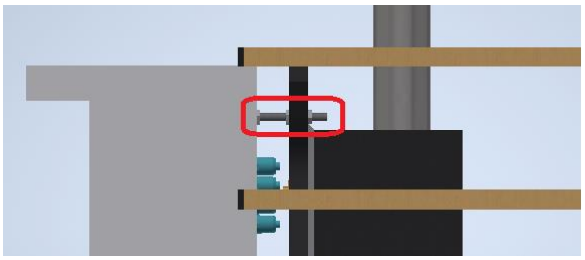


Figure 4.4.1-1 Removable mounting of Electrical Box shown in red square. Side face of the electrical box is removed to show the head of the bolt inside.

4.4.2 Installation of each outlet bases

On each pole, the outlet base will be inserted from the top of the pole and slide down along the pole until it sits on the table. Then it will be screwed in place.

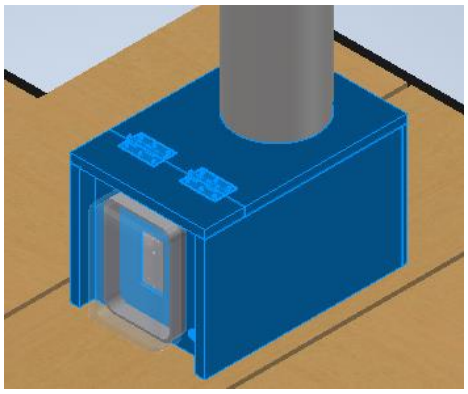


Figure 4.4.2-1 Installed Outlet Base. Highlighted to show components

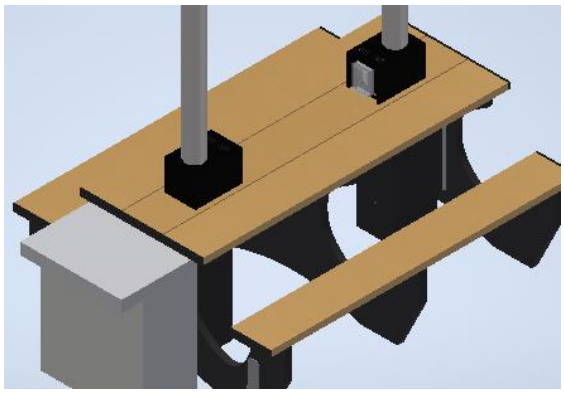


Figure 4.4.2-2 Current over all structure with both outlet basses installed

4.4.3 Installation of solar mounts and panels

See Attachment C: Solar Mounts Installation Instructions. However, we deviated from the instructions by first installing the channel rails onto the mounts, then installing each of the four panels one at a time

After both mounts have been installed, we will add two of the beams shown in figure 4.4.3-1 to connect the mounts. Not shown in model and not shown in Attachment C

Figure 4.4.3-1 Perforated Square Metal Tube

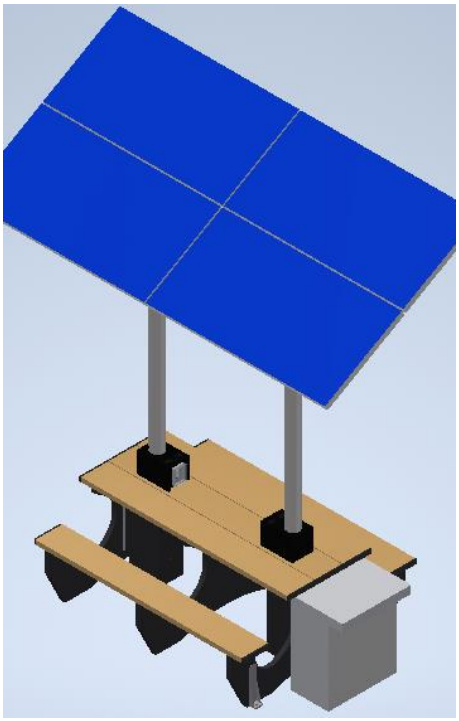


Figure 4.4.3-2 Assembly with Solar Panels Installed

4.4.4 Connection to Electrical Box

All wiring exiting the electrical box will be in conduit. There will be four lines of wiring exiting the box, ground, DC and two AC. Each conduit will connect to the electrical box by means of a liquid tight conduit adapter installed to the back of the box.

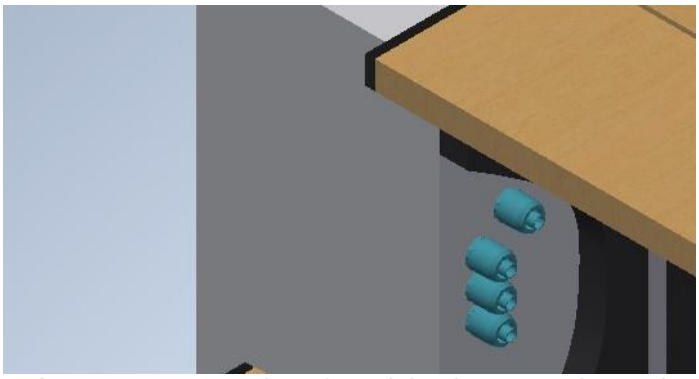


Figure 4.4.4-2 Location of conduit adapters underneath electrical box

Figure 4.4.4-1 Liquid tight conduit adapter

4.4.5 Electrical Connections

4.4.5.1 Ground

A solid copper wire will come out from the electrical box and connect to one of the grounding rods by means of the clamp shown in Figure 4.4.5.1-1. From the first grounding rod, the wire will then connect to the second grounding rod by means of the same clamp.

We will use schedule 80 1/4in Dia. PVC as conduit from the electrical box to the first grounding rod. The wire between the first and second grounding rod will be completely buried about 1ft deep and will not be in conduit.

Figure 4.4.5.1-1 Grounding Rod Clamp

4.4.5.2 Solar Panels (DC)

From the electrical box, the wires will run through the inside of the pole and through the pole cap. We will cover the wiring with the conduit similar to the one shown in Figure 4.4.5.2-2. From the top of the pole, the wires will be connected to the panels via MC4 connectors.

Figure 4.4.5.2-1 MC4 connectors, unconnected

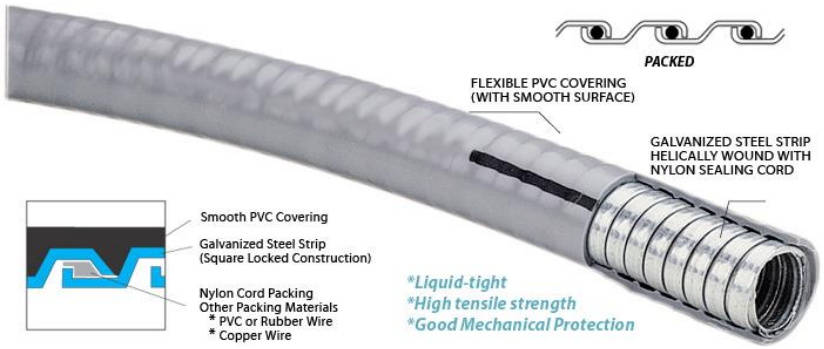


Figure 4.4.5.2-2 Liquid tight flexible metallic conduit with PVC covering

4.4.5.3 Outlets (AC)

All wiring be covered in conduit like the one shown in Figure 4.4.5.2-2.

A pair of wires will emerge from conduit adapters on the electrical box, into a hole on the front pole. Then emerge out of another hole on the pole that is inside the outlet base. They will then connect to the outlets. The relevant holes are shown in Figure 4.4.5.3.

Another pair of wires will emerge from another conduit adapter on the electrical box. The wires will run along the bottom of the tabletop and into a hole on the back pole (not shown). The wires will then emerge out of another hole on the back pole and into the second set of outlets. The portion of the conduit underneath the table will be held up by U shaped pipe straps.

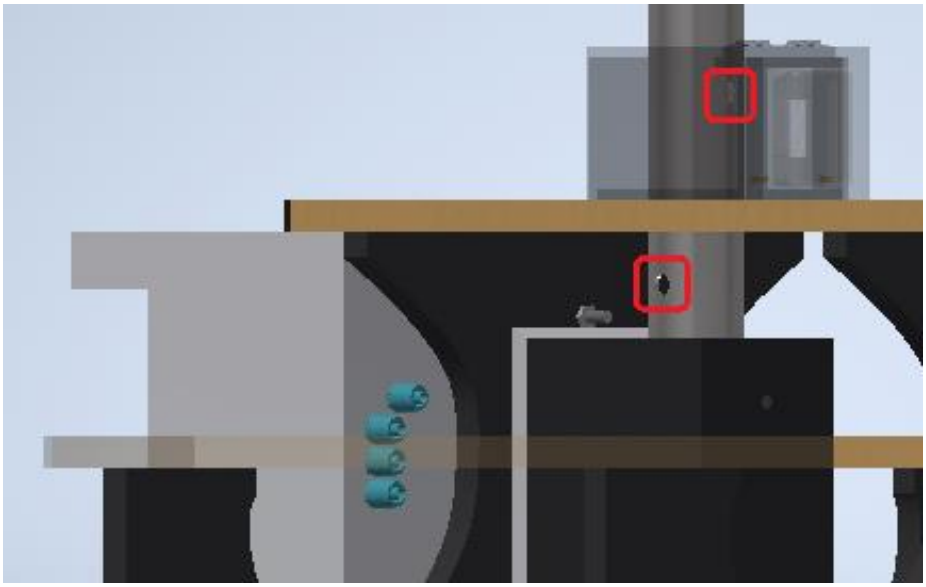


Figure 4.4.5.3-1 Close up view of underneath the table, location of holes on pole are indicated in red

4.5 Changes from Original Design and Construction Plans

One change made during construction, which is not mentioned nor shown in the model, is that the exposed concrete at the top of the pole basses were covered in a ¼" thick recycled plastic board along with sealant.

It is important to keep in mind that this document and the SPOT model was created prior to construction. And even though both were edited slightly after construction, they still may not include all changes to the design and construction activities that were made during construction.

4.6 Phase 3: Finishing Touches

4.5.1 Placement of Graphics

6. InSPIRE and SSC Logo as well as any other relevant organizations.
7. Names of all InSPIRE project team members.
8. QR code to website with design documents and tutorials

4.5.2 Finalized disassembly instructions placed inside the electrical box.

Finalized disassembly instructions will be created after construction is complete.

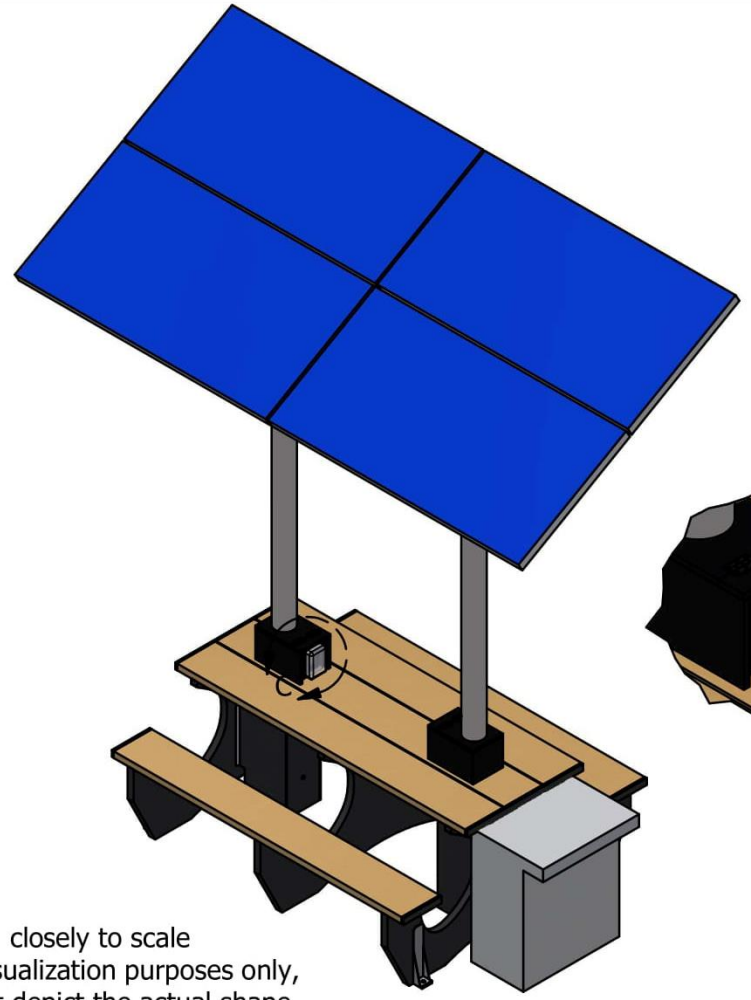
5.0 Disassembly Instructions

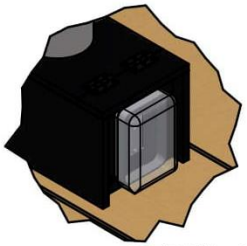
A disassembly plan will be made available inside the electrical box in case there is a need to move/dismantle the structure. The plan will be finished after construction to account for any unexpected changes during construction.

6.0 List of Attachments

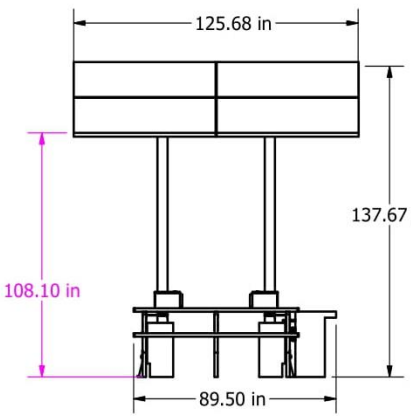
A. Over-all SPOT Model
B. Table Assembly Instructions
C. Solar Mounts Installation Instructions, Model: UNI-TP/03
D. Holdown Specifications (HTT4)

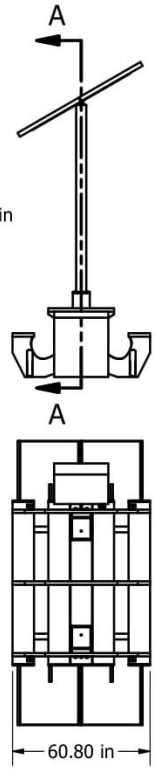
Appendix A: Over-all SPOT Model

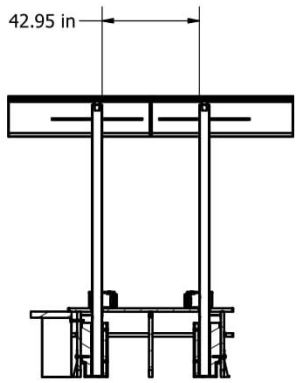




DETAIL C
SCALE 1/7







SECTION A-A
SCALE 0.02 : 1

NOTE:
- Drawn closely to scale
- For visualization purposes only, may not depict the actual shape and installation method for each component

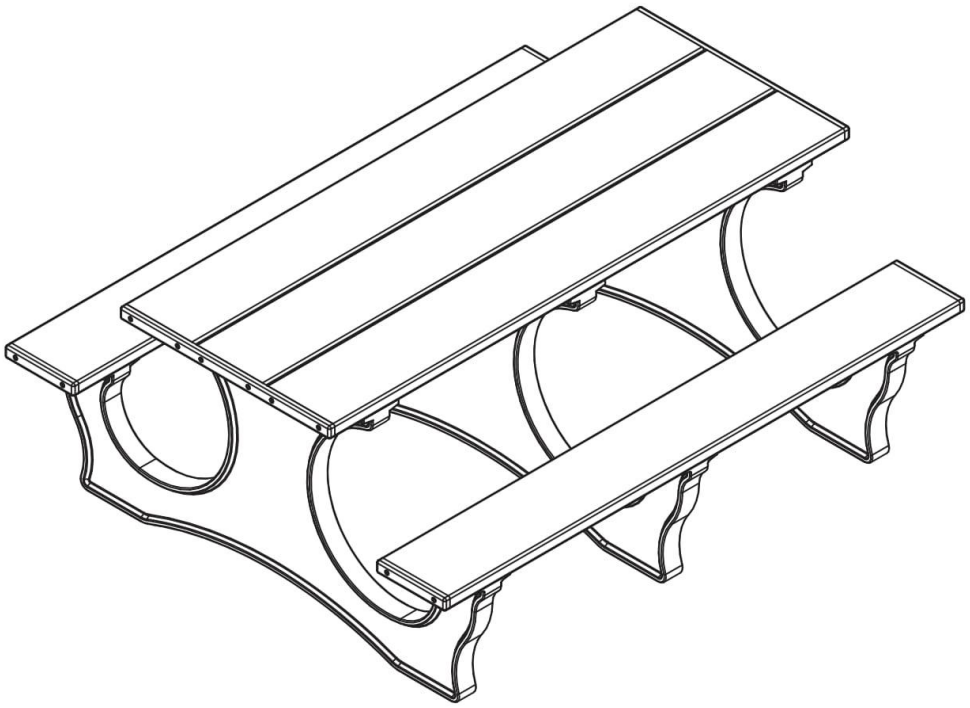
DRAWN Audrey Eltzroth	May 15 2020	InSPIRE
CHECKED & EDITED Justin Habana	Jun. 9 2020	
Last Revised Justin Habana, Kirsten Polen	Jan. 19 2022	Solar Powered Outdoors Table (SPOT)
		SIZE B / FILE _ SPOT Drawing / REV 4
		SCALE 0.05 : 1 / SHEET 1 OF 1

Appendix B: Table Assembly Instructions

111 North River Road
North Aurora, IL 60542
Phone: (800) 323-5664
Fax: (630) 897-0573
sales@belson.com

Model # PTEA6 **Instructions Sheet**

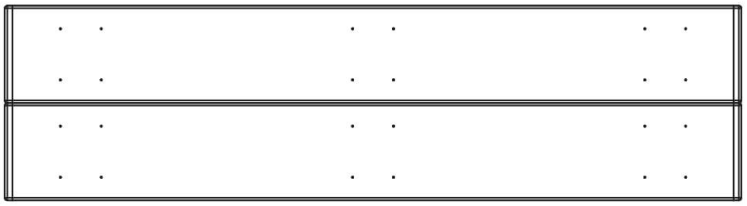
RECYCLED PLASTIC PICNIC TABLES W/ONE-PIECE MOLDED LEGS



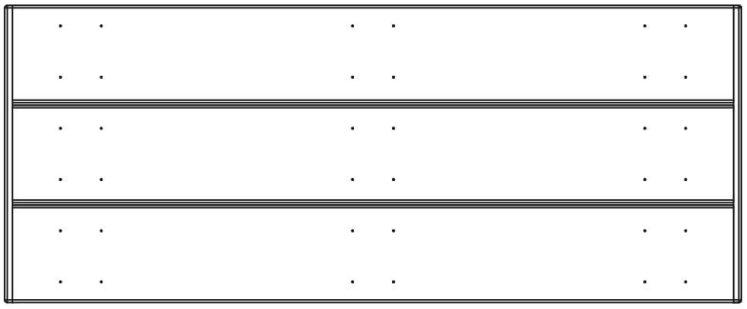
Appendix B: Table Assembly Instructions

BEFORE ASSEMBLY, PLEASE MAKE SURE ALL COMPONENTS ARE INCLUDED.

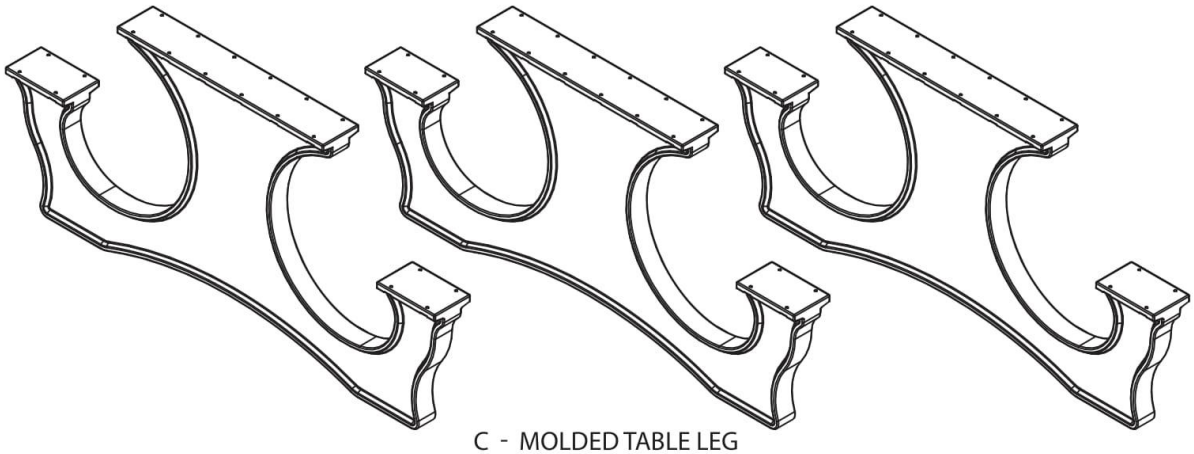
FP - FASTENER PACK
(1) - ONE FASTENER PACK



A - SEAT BOARD
(2) - TWO SEAT BOARDS



B - TABLE TOP
(1) - ONE TABLE TOP

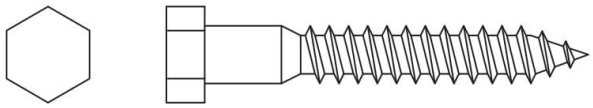


C - MOLDED TABLE LEG
(3) - THREE MOLDED TABLE LEGS

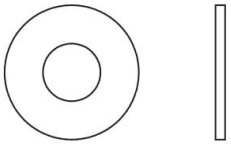
Appendix B: Table Assembly Instructions

BEFORE ASSEMBLY, PLEASE MAKE SURE ALL FASTENERS ARE INCLUDED.

60 - 1/4" X 1-3/4" HEX HEAD LAG BOLT



60 - 1/4" FLAT WASHER

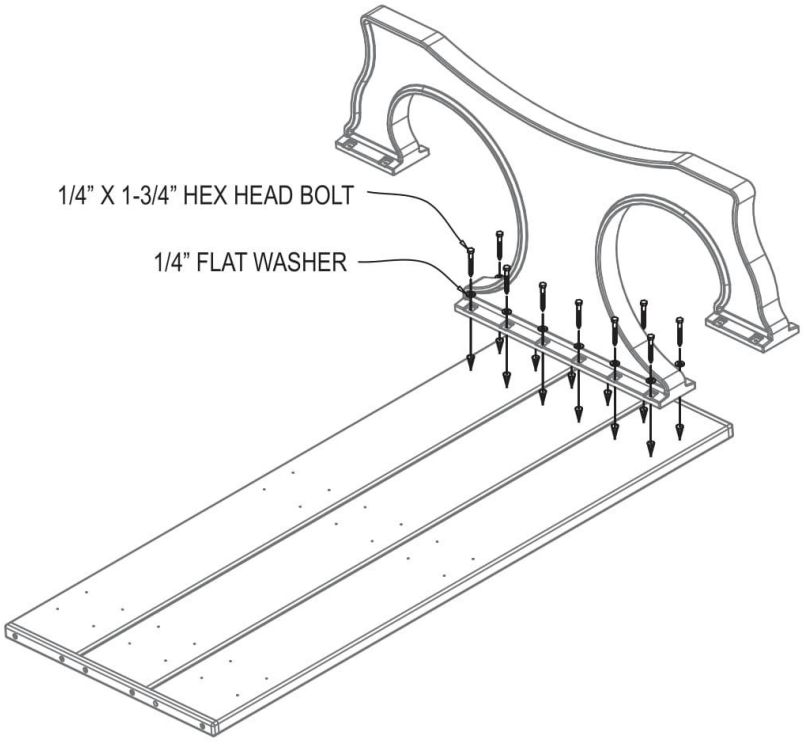


ALSO NEEDED FOR THIS ASSEMBLY WILL BE THE FOLLOWING MATERIALS:

1 - 7/16" SOCKET WRENCH OR 7/16" BOX END WRENCH

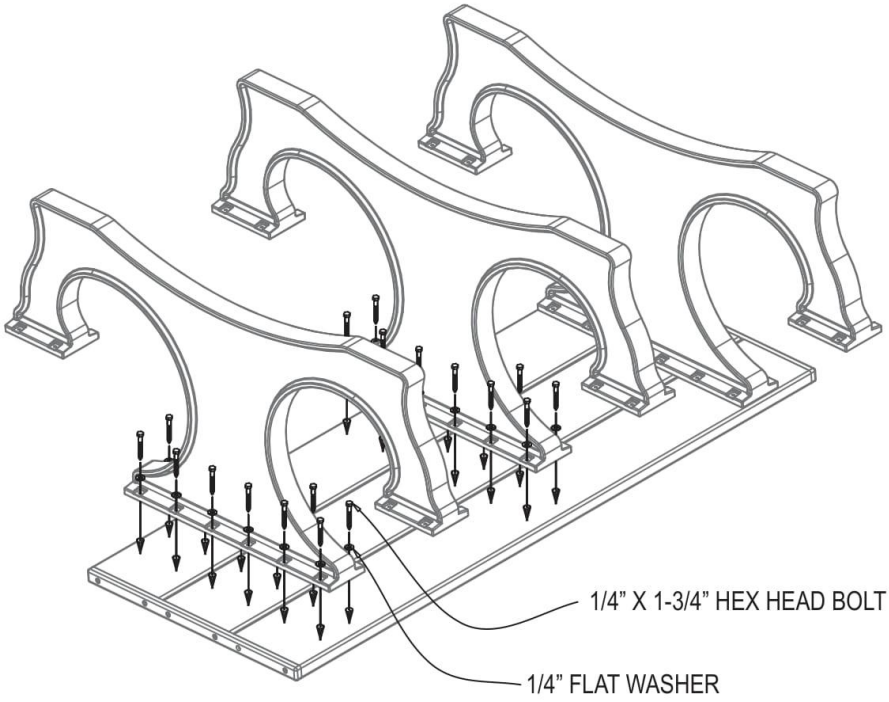
Appendix B: Table Assembly Instructions

STEP #1:
PLACE THE TABLE TOP ASSEMBLY UPSIDE DOWN ONTO A PIECE OF CARDBOARD OR ANOTHER SOFT LEVEL SURFACE, TO PROTECT IT DURING INSTALLATION. PLACE ONE MOLDED LEG ON THE TABLE TOP AS SHOWN BELOW. ALIGN THE PRE-DRILLED HOLES IN THE MOLDED LEG WITH THE PILOT HOLES IN THE TABLE TOP. USE (1) ONE 1/4" X 103/4" LAG BOLT AND (1) ONE 1/4" FLAT WASHER PER HOLE, TO SECURE.
NOTE: DO NOT TIGHTEN BOLTS COMPLETELY. THIS WILL BE DONE IN A LATER STEP.

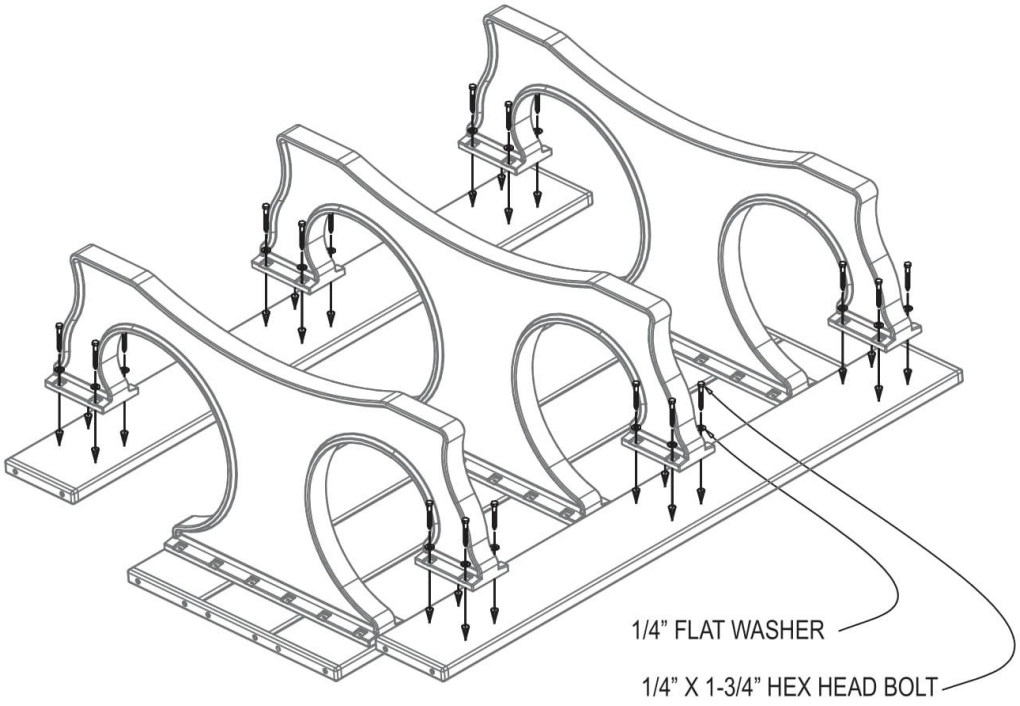


STEP #2:
PLACE THE REMAINING MOLDED TABLE LEGS IN POSITION, AS SHOWN BELOW, BEING SURE TO ALIGN THE PRE-DRILLED HOLES TO THE PILOT HOLES IN THE TABLE TOP. AFTER THE HOLES ARE PROPERLY ALIGNED, FASTEN WITH (1) ONE 1/4" X 1-3/4" LAG BOLT AND (1) ONE 1/4" FLAT WASHER PER HOLE TO SECURE.

NOTE: DO NOT TIGHTEN BOLTS COMPLETELY. THIS WILL BE DONE AT A LATER STEP.



STEP #3:
PLACE THE SEAT BOARDS IN POSITION, AS SHOWN BELOW, BEING SURE TO ALIGN THE PILOT HOLES TO THE PRE-DRILLED HOLES IN THE MOLDED TABLE LEGS. AFTER THE HOLES ARE PROPERLY ALIGNED, FASTEN WITH (1) ONE 1/4" X 1-3/4" LAG BOLT AND (1) ONE 1/4" FLAT WASHER PER HOLE TO SECURE.
NOTE: BE SURE TO TIGHTEN ALL FASTENERS AFTER COMPLETING THIS STEP.
PLEASE USE CAUTION NOT TO OVER-TIGHTEN THE FASTENERS.



Attachment C: Solar Mounts Installation Instructions, Model UNI-TP03

Tamarack Solar Products

LEGACY UNI-SERIES TOP OF POLE

Top of Pole Mounts are a heavy duty mounting system ideal for single pole, multi panel arrays. Originally designed for 80W BP modules, these mounts accomodate a wide variety of smaller 12V and 24V modules with ease.

- Uses either 4" or 6" Schedule 40 poles, (not included)
- Fits multiple modules in single or dual column configurations, rails are 45" - 110"
- Manufactured using powder coated steel and heavy-duty corrosion-resistant 5000 series aluminum.
- In stock for immediate shipment using ground carriers.

To configure based on your specific pole mounting needs, please use the Tamarack Solar Pole Mount Modeling Spreadsheet available at www.tamaracksolar.com or contact our customer service team at: 1-800-819-7236, or at sales@tamaracksolar.com.

Legacy UNI Top of Pole Series	
UNI-TP/02	Pole Top (4") Single Row 45"
UNI-TP/02A	Pole Top (4") Single Row 55"
UNI-TP/03	Pole Top (4") Single Row 70"
UNI-TP/04	Pole Top (4") Single Row 90"
UNI-TP/04A	Pole Top (4") Single Row 110"
UNI-TP/06LL	Pole Top, (6") Dual Row 70"
UNI-TP/08	Pole Top, (6") Dual Row 90"
UNI-TP/08LL	Pole Top, (6") Dual Row 90"
UNI-TP/10LL	Pole Top, (6") Dual Row 115"

sales@tamaracksolar.com 800-819-7236 1435 Baechtel Road, Willits CA

Tamarack Solar Products

Top of **Pole Mount**

Installation Manual

2016 Edition v1.01

For models:

UNI-TP/06
UNI-TP/06LL
UNI-TP/08
UNI-TP/08LL
UNI-TP/10
UNI-TP/10LL
UNI-TP/12
UNI-TP/12LL

UNI-TP02-MAN

Attachment C: Solar Mounts Installation Instructions, Model UNI-TP03

Tamarack Solar Products

Table of Contents

Introduction

The Top of Pole Mount is a very sturdy and universal pole mounting solution for small area solar photovoltaic (PV) needs. With its user-adjustable angle settings, the Top of Pole Mount can support installations in a wide range of locations. Panel and pole support varies with the model.

Customer Support

Tamarack Solar makes every effort to ensure your mounting kit is easy to install. If you need assistance at any point in your installation or have suggestions on how we can improve your experience, call customer support at **1-800-819-7236** or email us at info@tamaracksolar.com.

Tamarack Solar Products

Tools Required

A wrench that supports the following size hex heads:

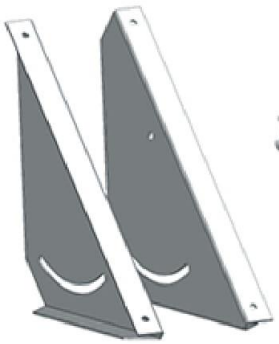
1/2″ 3/8″ 5/16″ 1/4″

Components List

The following parts are used across various models of our Top of Pole mount and ship with necessary hardware:

Brace Assembly

Tilt Plates



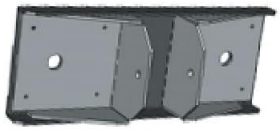
Cross Rails

Channel Rails

Connectors*

1/2-13 U-Bolt*

Lower Knee Brace*



Upper Knee Brace Bracket*

Upper Knee Brace Rail*

Inner/Outer Knee Brace Channels*

**Component only needed for models: 10, 10LL, 12, and 12LL.*

Tamarack Solar Products

Step 1. Connecting Channel Rails

Only for UNI-TP models: 10, 10LL, 12, 12LL

A. Lay two channel rails end to end.

B. Using a connector, bolt the channel rails together. Tighten the 1/4-20 x 3/4" hardware (hex bolt, flat washer, lock washer, and hex nut) to 84 in-lbs (dry).

C. Repeat with the remaining set of channel rails.

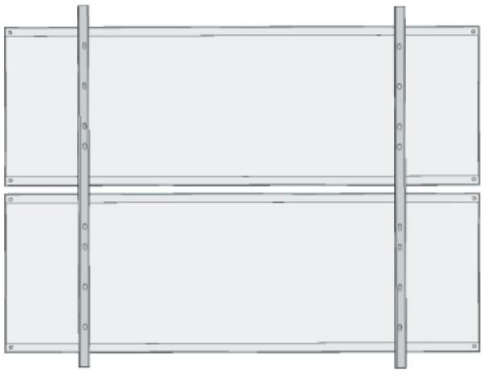
Step 2. Attach Channel Rails to Module(s)

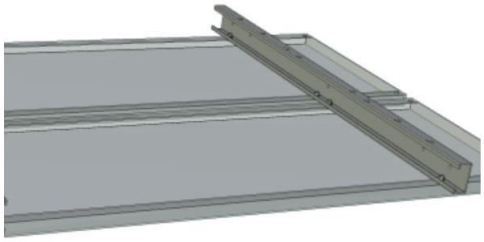
A. Lay the modules face down on a protected surface in the suitable orientation. Leave at least 1/4" between panels.

B. Lay the channel rails on the back of the modules with the evenly-spaced holes down, so the flat side of the rails are facing towards the outside edges of the panels.

C. Secure the rails with 1/4-20 x 3/4" hardware (hex bolt, flat washer, lock washer, and hex nut) in each of the PV mounting holes. Tighten the bolts to 84 in-lbs (dry).

D. Repeat steps, attaching the remaining PV modules to the remaining channel rails.





Step 3. Attach Brace Assembly to Pole

A. Place the brace assembly onto the pole so the "lip" catches the top of the pole.

B. Install the 3/8-16 x 6" hardware (hex bolt, flat washer, lock washer, and hex nut) as shown.

C. Tighten the nuts evenly, making sure that both hex bolts are tightened the same amount so the distance between braces is the same on the front and the back.

D. Tighten the 3/8" hex bolts to 240 in-lbs (dry).

Includes Large Pole Bracket Kit with 3/8-16 x 5.5" Hex Bolt

Step 4. Attach Tilt Plate

A. Place the tilt plates on the brace assembly as shown. Use a 1/2" flat washers, lock washer and hex nut on each stud, and finger-tighten.

Step 5. Attach Cross Rail

A. Place the cross rails on the tilt plates with the open sides facing each other and attach using 3/8-16 x 1" hardware (hex bolt, flat washers, lock washer, and hex nut).

B. Tighten the bolts to 240 in-lbs (dry).

Step 6. Attach PV Assembly(s)

A. Lift the PV array assembly onto the cross rails and attach using 3/8-16 x 1" hardware (hex bolt, flat washers, lock washer, and hex nut).

B. Tighten the bolts to 240 in-lbs (dry).

C. Adjust the tilt of the panel, then tighten then tighten the tilt plate. 480 in-lbs (dry) for ½" nuts.

Tamarack Solar Products

Step 7. Mounting the Knee Brace

Only for UNI-TP models: 10LL, 12, 12LL

A. Attach the lower knee brace to the pole with the U-bolt. Adjust knee braces to meet necessary tilt angle for assembly. Loosely tighten U-bolt hardware.

B. Bolt the knee brace bracket to the upper knee brace rail using 5/16 x 1" hardware (hex bolt, flat washers, alum backing washer, lock washer, and hex nut).

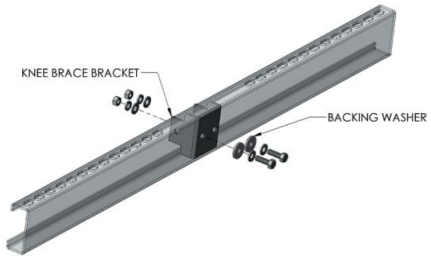
C. Attach the upper knee brace rail to the ends of the PV module channel rails using 3/8" x 1" hardware (hex bolt, flat washer, lock washer, and hex nut). Tighten to 240 in-lbs.

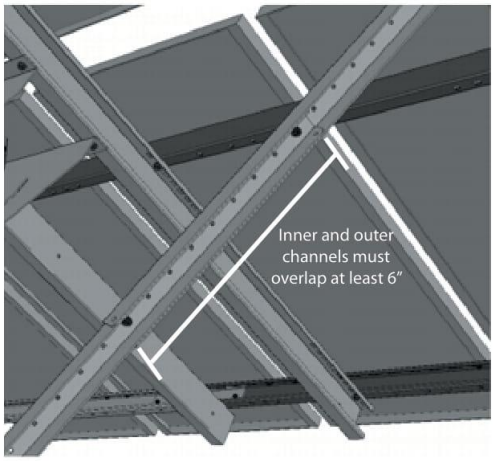
D. Bolt the inner (narrower) knee brace channel to the lower knee brace using the supplied 1/4" x 3/4" hardware.

E. Bolt the outer (wider) knee brace channel to the upper knee brace bracket, using the supplied 5/16" x 3" bolt. Tighten hardware to 144 in-lbs. Do not deform channel.

F. Bolt the inner and outer knee brace channels together by lining up the appropriate holes and using two sets of 1/4" x 3/4" hardware. Knee brace channels should overlap at least 6". Tighten to 84 in-lbs.

Move lower knee brace slightly as required to align brace holes and minimum 6" overlap, then tighten 1/2-13 U-Bolt hardware to 480 in-lbs. Do not deform lower brace assembly.





Installer Responsibility

The installer is solely responsible for:

i. Complying with all applicable local or national building codes, including any that may supersede this manual;

ii. Ensuring that Tamarack Solar and other products are appropriate for the particular installation and the installation environment;

iii. Using only Tamarack Solar parts and installer-supplied parts as specified by Tamarack Solar. Substitution parts may void the warranty;

iv. Ensuring safe installation of all electrical aspects of the PV array; and

v. Ensuring correct and appropriate design parameters are used in determining the design loading used for the specific

Warranty Information

Tamarack Solar warrants each Mounting Structure to be free from defects in materials and workmanship for ten (10) years from the date of first purchase ("Warranty Period"), when installed properly and used for the purpose for which it is designed, except for the finish, which shall be free from visible peeling, or cracking or chalking under normal atmospheric conditions for a period of three (3) years, from the earlier of 1) the date the installation of the Product is completed, or 2) 30 days after the purchase of the Product by the original Purchaser ("Finish Warranty"). The Finish Warranty does not apply to any foreign residue deposited on the finish. All installations in corrosive atmospheric conditions are excluded. The Finish Warranty is VOID if the practices specified by AAMA 609 & 610-02 – "Cleaning and Maintenance for Architecturally Finished Aluminum" (www.aamanet.org) are not followed by Purchaser for Tamarack Solar's aluminum based products.

The warranty covers the replacement cost of parts to repair the product to proper working condition. Transportation and incidental costs associated with warranty items are not reimbursable. The warranty does not cover normal wear, or damage resulting from misuse, abuse, improper installation, negligence, or accident. The warranty does not cover any defect that has not been reported in writing to Tamarack Solar within ten (10) days after discovery of such defect. Furthermore, it does not cover units that have been altered, modified or repaired without written authorization from the manufacturer or its authorized representative, or units used in a manner or for a purpose other than that specified by the manufacturer. Tamarack Solar's entire liability and Purchaser exclusive remedy, whether in contract, tort or otherwise, for any claim related to or arising out of breach of the warranty covering the Mounting Structures shall be correction of defects by repair, replacement, or credit, at Tamarack Solar's discretion. Refurbished Mounting Structures may be used to repair or replace the Mounting Structures.

Tamarack Solar shall have no liability for any injuries or damages to persons or property resulting from any cause, whatsoever, or any claims or demands brought against Tamarack Solar by Purchaser, any employee of Purchaser, client of Purchaser, end-user of the Product or other party, even if Tamarack Solar has been advised of the possibility of such claims or demands (collectively, "Third Party Claims"). This limitation applies to all materials provided by Tamarack Solar during and after the Warranty Period.

Foundation Recommendation Addendum

Note: The suggestions below are recommendations only. It is the installer's responsibility to validate foundation parameters prior to installation, as a local geotechnical report may be required to assess ground conditions. We recommend consulting with a local engineer familiar with local regulations and build site requirements, including soil conditions, terrain and load criteria (wind, snow, seismic). All of these parameters may impact foundation requirements.

Mounting Pole Guidelines

Table 1

Part Number	Pipe required
Small Top of Pole Mounts	
UNI-TP/02	4" Nominal Pipe Size, Schedule 40
UNI-TP/02A	4" Nominal Pipe Size, Schedule 40
UNI-TP/03	4" Nominal Pipe Size, Schedule 40
UNI-TP/04	4" Nominal Pipe Size, Schedule 40
UNI-TP/04A	4" Nominal Pipe Size, Schedule 40
Large Top of Pole Mounts	
UNI-TP/06	6" Nominal Pipe Size, Schedule 40
UNI-TP/06LL	6" Nominal Pipe Size, Schedule 40
UNI-TP/08	6" Nominal Pipe Size, Schedule 40
UNI-TP/08LL	6" Nominal Pipe Size, Schedule 40
UNI-TP/10	6" Nominal Pipe Size, Schedule 40
UNI-TP/10LL	6" Nominal Pipe Size, Schedule 40
UNI-TP/12	6" Nominal Pipe Size, Schedule 40
UNI-TP/12LL	6" Nominal Pipe Size, Schedule 40

Note: All Tamarack Top of Pole Mounts are engineered for a maximum height of 6' above grade

Foundation Hole Guidelines

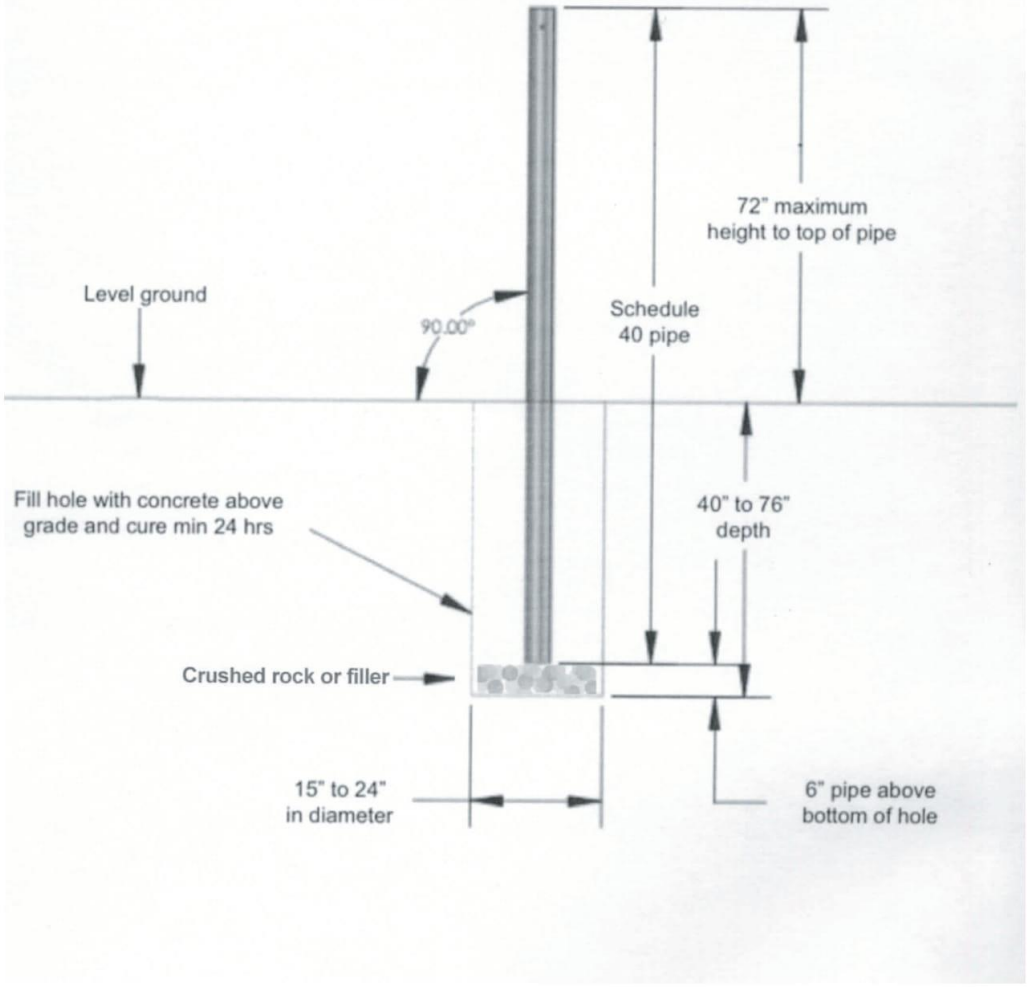
Table 2

Module Area	Max. Wind Speed	Min. Hole Diameter	Min. Hole Depth	Min. Pole Depth
20 Sq Feet	90 MPH	15"	46"	40"
30 Sq Feet	90 MPH	18"	51"	45"
40 Sq Feet	90 MPH	18"	60"	54"
50 Sq Feet	90 MPH	18"	62"	56"
60 Sq Feet	90 MPH	24"	52"	46"
70 Sq Feet	90 MPH	24"	60"	54"
80 Sq Feet	90 MPH	24"	66"	60"
90 Sq Feet	90 MPH	24"	74"	68"
105 Sq Feet	90 MPH	24"	82"	76"

Installation Recommendations

- Auger hole to minimum depth shown in Table 2.
- 6" of hole should be filled with crushed rock or a blocking. This will prevent the pipe from touching the base of the hole, insuring complete encapsulation of the pipe when concrete is poured, as well as allowing for water drainage. See Fig. 1.
- Pipe should be installed vertically no matter the slope of the install site.
- Make arrangements to prevent the pipe from twisting prior to pouring concrete.
- Pipe should be braced to remain plumb until concrete has cured (at least 24 hours).

Fig. 1: Top of Pole Foundation Guideline Diagram



Attachment D: Holdown Specifications (HTT4)

Tension Ties

Tension ties offer a solution for resisting tension loads that are fastened with nails or Strong-Drive® SD Connector screws. The new LTTP2 light tension tie, designed for wood joist attachments to concrete or masonry walls, features two separate nailing patterns: obround holes spaced 3" apart for I-joist purlins and square holes spaced to accommodate the narrow face of 2x solid-sawn purlins. LTTP2 may also be installed vertically on the wide face of a minimum 2x4 stud for holdown application. It features an extruded anchor bolt hole to accommodate ¾", ⅝" and ½" bolt diameters.

The LTTI31 is designed for wood chord open-web truss attachments to concrete or masonry walls and may also be installed vertically on a minimum 2x6 stud.

The HTT4 and HTT5 tension ties feature an optimized nailing pattern which results in better performance with less deflection. HTT5KT is sold as a kit with the holdown, bearing plate washer and Strong-Drive SD Connector screws.

The HTT5-¾ is designed to use a ¾"-diameter anchor bolt.

When using LTT or HTT tension ties with unreinforced concrete masonry, ¾" post-installed anchor bolts are commonly used.

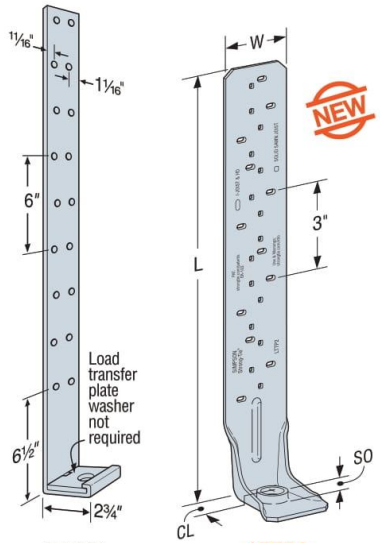
Material: See table

Finish: Galvanized. May be ordered HDG; contact Simpson Strong-Tie.

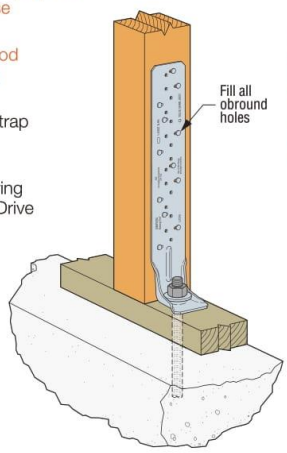
Installation:

- See Holdown and Tension Tie General Notes on pp. 49–50.
- LTTP2 — one standard cut-washer is required when using ½" and ⅝" anchor bolts; and no additional washer is required for ¾" anchor bolts.
- LTTP2 — For installations on narrow edge of solid sawn (2x, 3x) joists use (15) square holes; for all other installations use (12) obround holes.
- For tension ties installed over wood structural panel sheathing, use a 2½"-long fastener minimum.
- For information about marriage strap at panelized roof applications, see **strongtie.com**.
- HTT5-KT requires BP 5/8-2 bearing plate and #10 x 2½" SD Strong-Drive screws (included in kit).

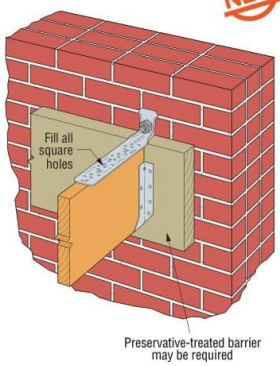
Codes: See p. 11 for Code Reference Key Chart



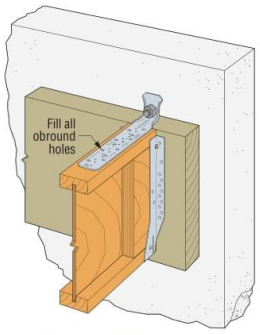
LTTI31 | **LTTP2** US Patent Pending | **HTT5** *(HTT4 similar)*



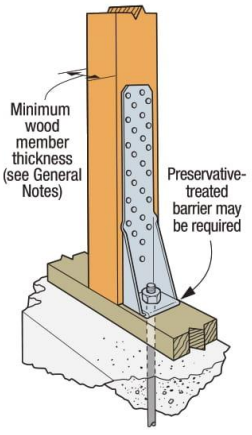
Typical LTTP2 Installation for Holdown Application



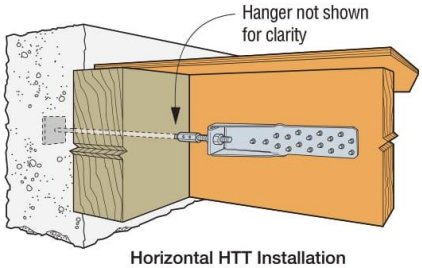
Typical LTTP2 Installation for Solid Sawn Joist



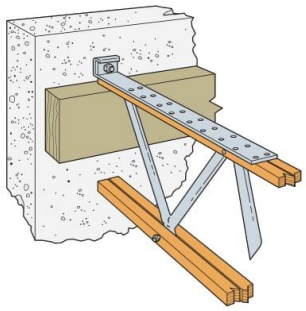
Typical LTTP2 Installation for I-joist



Vertical HTT5 Installation
(HTT4 similar)



Horizontal HTT Installation



Horizontal LTTI31 Installation

Attachment D: Holdown Specifications (HTT4)

Tension Ties (cont.)

These products are available with additional corrosion protection. For more information, see p. 14.

SD Many of these products are approved for installation with Strong-Drive® SD Connector screws. See pp. 348–352 for more information.

Model No.	Ga.	Dimensions (in.) W	L	CL	SO (in.)	Fasteners (in.) Anchor Rod Diameter	Wood Fasteners	Minimum Wood Member Size (in.)	Allowable Tension Loads (160) DF/SP	SPF/HF	Deflection at Highest Allowable Load (in.)	Code Ref.
LTTP2	10	2 9/16	14 15/16	1 1/8	7/16	1/2, 5/8, 3/4	(15) 0.148 x 2 1/2	1 1/2 x 3 1/2 (narrow edge)[4,5]	1,845	1,695	0.009	IBC, FL, LA
						1/2	(12) 0.148 x 1 1/2	1 1/2 x 3 1/2	1,680[6]	1,545[6]	0.008	
						5/8, 3/4			2,135	1,965	0.011	
						1/2	(12) #9 x 1 1/2" SD	1 1/2 x 3 1/2	2,320	1,970	0.013	
						5/8, 3/4			2,570	2,045	0.015	
						1/2, 5/8, 3/4	(12) 0.148 x 2 1/2	3 x 3 1/2	2,275	2,230	0.013	
LTTI31	18	3 3/4	31	1 3/8	1/4	5/8	(18) 0.148 x 1 1/2	3 x 3 1/2	1,350	1,160	0.193	
HTT4	11	2 1/2	12 3/8	1 5/16	7/16	5/8	(18) 0.148 x 1 1/2	1 1/2 x 3 1/2	3,000	2,580	0.090	—
							(18) 0.148 x 1 1/2	3 x 3 1/2	3,610	3,105	0.086	IBC, FL, LA
							(18) 0.162 x 2 1/2	3 x 3 1/2	4,235	3,640	0.123	
							(18) #10 x 1 1/2" SD	1 1/2 x 5 1/2	4,455	3,830	0.112	—
							(18) #10 x 1 1/2" SD	3 x 3 1/2	4,455	3,830	0.112	
HTT5	11	2 1/2	16	1 7/16	7/16	5/8	(26) 0.148 x 1 1/2	3 x 3 1/2	4,350	3,740	0.120	IBC, FL, LA
							(26) 0.148 x 3	3 x 3 1/2	4,670	4,015	0.116	
							(26) 0.162 x 2 1/2	3 x 3 1/2	5,090	4,375	0.135	
							(26) #10 x 1 1/2" SD	1 1/2 x 5 1/2	4,555	3,915	0.114	—
HTT5KT	11	2 1/2	16	1 7/16	7/16	5/8	(26) #10 x 2 1/2" SD	3 x 3 1/2	5,445	5,360	0.103	
HTT5-3/4	11	2 1/2	16	1 7/16	7/16	3/4	(26) 0.148 x 1 1/2	1 1/2 x 5 1/2	4,065	3,495	0.103	IBC, FL
							(26) 0.162 x 2 1/2	3 x 3 1/2	5,090	4,375	0.121	
							(26) #10 x 1 1/2" SD	1 1/2 x 7 1/4	4,830	4,155	0.100	

1. LTTI31 installed flush with concrete or masonry has an allowable load of 2,285 lb.
2. Allowable load for HTT5 with a BP5/8-2 bearing-plate washer installed in the seat of the holdown is 5,295 lb. for DF/SP and 4,555 lb. for SPF/HF.
3. For LTTP2, standard cut washer is required when using 1/2" and 5/8" anchor rods.
4. For (15) nail installations on narrow edge of 2x4 (minimum) joist, LTTP2 installed flush with concrete or masonry has an allowable load of 2,560 lb. for DF/SP and 2,355 lb. for SPF/HF.
5. LTTP2 installed with (15) #9 x 1 1/2" SD screws on narrow edge of 2x joist has an allowable load of 2,105 lb. for DF/SP and 1,935 lb. for SPF/HF.
6. For (12) nail installations on I-joist or wide face of 2x member, LTTP2 installed flush with concrete or masonry has an allowable load of 1,950 lb. for DF/SP and 1,795 lb. for SPF/HF.
7. **Fasteners:** Nail dimensions are listed diameter by length. SD screws are Simpson Strong-Tie® Strong-Drive SD Connector screws. See pp. 21–22 for fastener information.