

Installation & Operations Manual

Clarity™ System

Clarity™ Site Server – SPS1

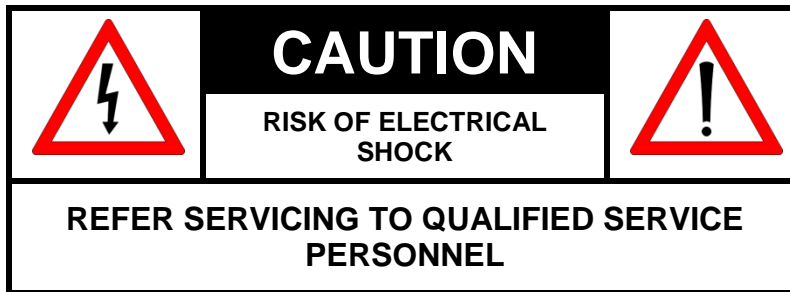
Clarity™ Gateway – SPG1; SPD1

Clarity™ Nodes:

- SPM80V12A
- SPM80V12A-S
- SPM125V8A
- SPM125V8A-S
- SPO350W80V







"Bringing Clarity to Solar Power Generation"



Caution

To reduce risk of electrical shock, do not perform any servicing other than that contained in the Installation and Troubleshooting Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.










Special Symbols That Might Appear on the Equipment and in this Manual

	Danger	This symbol indicates that dangerous voltage levels are present within the system. These voltages are not insulated and may be of sufficient strength to cause fatal, or serious bodily injury when touched. The symbol may also appear on schematics.
	Warning	The exclamation point, within an equilateral triangle, is intended to alert the user to the presence of important installation, servicing, and operating instructions in the documents accompanying the equipment.
	Caution	The exclamation point, within an equilateral triangle, is intended to alert the user to the presence of important installation, servicing, and operating instructions in the documents accompanying the equipment.
	Important Information	Accompanies notes that call attention to supplementary information that you must know and use to ensure optimal operation of the system.

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS

This manual contains important instructions for the Clarity™ System, and should be followed during the installation and maintenance of the system. Please read thoroughly before attempting installation.

	Danger	To reduce risk of electrical shock, do not open a Monitor, Optimizer, Gateway, Disable Switch, or Site Server. Do not attempt repair. There are no user-serviceable parts inside.
	Danger	When unloaded, Monitors, Optimizers, and their attached PV panels still present a shock risk. Note that the Monitor or Optimizer output voltage will be as high as the PV panel's open circuit voltage (Voc), and any electrical terminal on a monitor may be as high as 1000V with respect to ground, depending on site design and wiring connections
	Warning	Do not connect or disconnect a Monitor or Optimizer while under electrical load: DC power and AC power must be disconnected from the PV system inverter before installing or servicing Monitors.
	Warning	To ensure safety, all combiner box fuses must be opened prior to altering any Monitor or Optimizer electrical connections.
	Warning	Under extreme environmental conditions, a photovoltaic panel may produce higher short-circuit currents and/or higher open-circuit voltages than specified by the panel's nameplate Standard Test Condition (STC) rating. Accordingly, these higher values of Isc and Voc should be utilized when determining compatibility with the Monitor or Optimizer maximum current and maximum voltage specifications.
	Warning	String fuses must be present elsewhere in the system. Clarity™ Monitors and Optimizers do not include string fuses, or any form of over-current protection
	Warning	The Clarity system does not provide any protection from ground faults or arc faults. Where required, protection from ground faults and arc faults must be provided elsewhere in the system.
	Caution	Monitors, Optimizers, Gateways, Disable Switches, and Site Servers are designed to be installed outdoors. However, electrical connections to these products should be made and altered only under dry weather conditions. Every effort should be made to avoid getting dirt and moisture into electrical connections before they are mated and properly sealed. Moisture in electrical connections can present a shock hazard, and can also accelerate corrosion.
	Warning	This equipment operates over the marked Voltage and Frequency range without requiring manual setting of any selector switches. Different types of line cord sets may be used for connections to the mains supply circuit and should comply with the electrical code requirements of the country of use. The line cord provided with the equipment is acceptable for use with NEMA Style 5-15R AC receptacles supplying nominal 120 Volts.

FCC Compliance

The **SPM80V12A**, **SPM80V12A-S**, **SPM125V8A**, **SPM125V8A-S**, **SPG1**, **SPD1** and **SPS1** have been tested and found to comply with the following requirements:

- FCC 47CFR Part 15.247 Operation within the bands 902-928 MHz, 2400-2483.5MHz and 5725-5850 MHz
- FCC 47 CFR 15B Class B verification
- ETSI EN 300 328 ; Issued 2007/01/09 V1.7.1 Electromagnetic compatibility and radio spectrum matters (ERM); Wideband transmission system; data transmission equipment operating in the 2.4 GHz ISM band & using wideband modulation techniques; Harmonized EN Article 3.2
- ETSI EN 301 489-1; Issued 2008/04/01 V1.8.1 Electromagnetic compatibility and radio spectrum matters (ERM); Electromagnetic compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
- ETSI EN 301 489-17; Issued 2009/05/12 Electromagnetic compatibility and radio spectrum matters (ERM); Electromagnetic compatibility (EMC) standard for radio equipment; Part 17: Specific conditions for broadband data transmission systems – V2.1.1
- These devices comply with part 15 of the FCC Rules. Operation is subject to the following two conditions:
 - These devices may not cause harmful interference.
 - These devices must accept any interference received, including interference that may cause undesired operation.

These devices have been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in any particular installation. If these devices cause harmful interference to radio or television reception, which can be determined by turning the devices off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the devices into an AC outlet different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications made to the devices not expressly approved by SPTI may void the users authority to operate the equipment. These devices do emit Radio Frequency (RF) energy when powered up. To limit exposure to this RF energy, the user should keep a distance of 20 cm from the devices.

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Section 1

1 Introduction

1.1 CLARITY™ SYSTEM

The Clarity System is a complete site performance management solution for commercial and utility scale PV solar arrays. The Clarity Monitors and Optimizers (Clarity 'nodes') provide precise insight down to the panel level, while the innovative proprietary wireless mesh network allows the system to scale to the largest utility scale arrays. Data collected from the PV array is sent to the cloud hosted Clarity Intelligent Array™ Management System, where real time analysis and diagnostics are performed to provide unprecedented insight and management capability for large scale PV systems..

1.2 Unpacking the Clarity Components

1.2.1 Site Server Components to Unpack

Carefully unpack and check for the following items.

- Irradiance Sensor
- Ambient Temperature Sensor
- Panel Cell Temperature Sensor
- 2 Pieces of Metal Tape
- Packet of four (4) RJ45's & four (4) Cable Glands

1.2.2 Clarity Gateway Components to Unpack

Carefully unpack and check for the following items.

- Gateway
- Conec Connector

1.2.3 Clarity Nodes: (Monitors & Optimizers)

Both Nodes ship in similar cartons. The Optimizer carton is slightly larger than the Monitor carton. However, both nodes should be handled in the same manner.

- Monitor
- Optimizer

1.2.4 Other accessories

The following accessories may have been shipped with your system:

- 2 Meter Lead
- 8" Pigtail (For matching panel connector with node connector)

1.3 FEATURES

1.3.1 Clarity™ Site Server (SPS1)

- Industrial PC for consolidating data sent from nodes via the Clarity Gateway
 - LAN Connection port
 - 4 PoE ports – 3 for Gateway's and 1 for environmental monitoring
- Environmental Monitoring Including:
 - Irradiance (Insolation)
 - Panel Cell Temperature
 - Ambient Cell Temperature

1.3.2 Clarity Gateway (SPG1 – SPD1)

- Data collection from mesh network made up by Clarity Nodes

1.3.3 Clarity Monitors (SPM80V12A, SPM80V12A-S, SPM80125V8A, SPM80125V8A-S)

- Continually measure in real time:
 - Voltage
 - Current
 - Power

1.3.4 Clarity Optimizers

- Continually measure in real time:
 - Voltage
 - Current
 - Power
- Buck Voltage when needed
- Boost Voltage when Needed

1.4 USING THIS MANUAL

This manual provides instructions to install the Clarity System:

Section 1	Introduction provides a product description, a list of related documentation, the technical help line telephone number, and the return procedure.
Section 2	Overview describes the Clarity System, an overview of its use. This section also identifies the Site Server, Gateway and Monitor components.
Section 3	Installation provides instructions on how to install the Clarity Intelligent Array.
Section 4	Commissioning the array and starting the inverter
Section 5	Troubleshooting provides information on common error conditions and their resolution.
Section 6	Specifications provide the Clarity Array Management System technical specifications.

1.5 RELATED DOCUMENTATION

The following documentation may be helpful when operating the Site Server, Gateway, Monitors & Optimizers.

- Clarity™ Intelligent Array™ Software Users Guide
- User documentation for broadband connection, rBOX104, and other components

1.6 IF YOU NEED HELP

If you need assistance while working with the Clarity System, contact the SPTI Technical Support:

- Inside or Outside the U.S.: 512-782-8957
- Solar Power Technologies, Inc. website: www.spowertech.com
- SPTI Support email: support@spowertech.com

The SPTI Technical Support is open from 8:00 AM to 5:00 PM US Central Time, Monday through Friday.

1.7 RETURNS

Material may be returned to Solar Power Technologies, Inc. (SPTI) only with prior written authorization from Customer Service. Contact Customer Service at (512) 782-8957, or email: support@spowertech.com to obtain an RGA. Upon authorization, an RGA form will be issued based on the following terms and conditions:

- Product must be either (i) defective in materials or workmanship from Supplier, or (ii) new and unopened and in original carton. Any product received contrary to this provision is subject to return or no credit issued.
- All defective returns must be properly packaged. Any returned units that have been damaged in shipping due to insufficient packaging will be subject to no credit issued.
- Products must be returned within the warranty period. Out-of-date products are subject to return or no credit issued.
- Goods returned are only for those products previously authorized and written on the RGA form. Any unauthorized returned products are subject to return or no credit issued.
- A minimum of 30% restocking charge will apply to any approved new material returns.
- All freight and duties on returned goods are the responsibility of the Customer. RGA # must be referenced on all outside cartons and packing list. All returned goods are shipped to:

Solar Power Technologies, Inc.
3006 Bee Caves Road, Suite A-330
Austin, Texas 78746

Section 2

2 Overview

This section describes the hardware components of the Clarity System. There are three main components:

- Site Server
- Gateway
- Clarity Nodes:
 - Monitor
 - Optimizer



Important Information

All Clarity Nodes are installed in the same manner.

2.1 CLARITY™ SITE SERVER

Figure 2-1

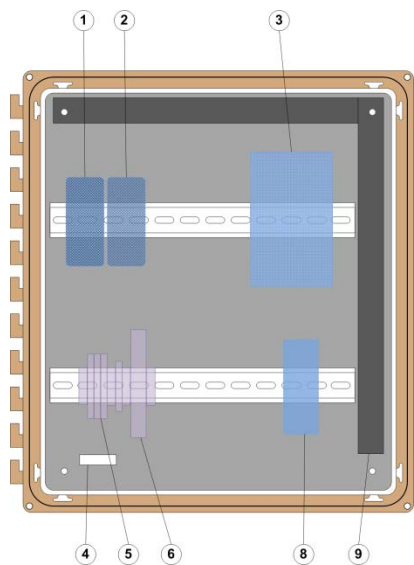


Table 2-1

Key	Function
1	12VDC Power Supply for Environmental Components
2	48VDC Power Supply for Industrial PC
3	Industrial PC (rBOX104)
4	Ground Lug
5	Terminal Blocks feeding Power Supplies
6	5Amp Breaker
8	Environment collection component
9	Cable Management



Danger

To reduce risk of electrical shock, do not perform any servicing other than that contained in the Installation and Troubleshooting Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.



Important Information

See Section 6 for Site Server Internal Wiring Schematic

2.2 CLARITY™ GATEWAY

Figure 2-2



Table 2-2

Key	Function
1	Seal Tight Location for CAT5/5e Termination

Warning

To reduce risk of electrical shock, do not open a Gateway. There are no user-serviceable parts inside.

2.3 CLARITY™ NODES

There are two types of Clarity Nodes: Monitors and Optimizers. Regardless of type, all nodes install in the same manner.

- Clarity Monitors
 - SPM80V12A
 - SPM80V12A-S
 - SPM125V8A
 - SPM125V8A-S
- Clarity Optimizer
 - SPO350W80V

2.3.1 Input & Output Connections typical for all Nodes

Figure 2-3

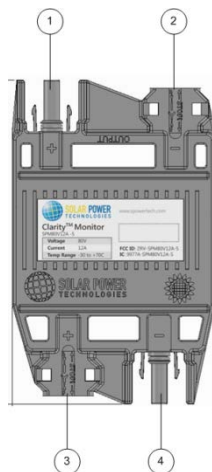


Table 2-3

Key	Function
1	Positive Output to next node or homerun to combiner/inverter.
2	Negative Output to next node or homerun to combiner/inverter.
3	Positive Input from PV Module.
4	Negative Input from PV Module.

Danger

To reduce risk of electrical shock, do not open a Monitor or Optimizer. There are no user-serviceable parts inside.

Section 3

3 Installation

This section provides instructions to install and cable the Clarity System. Covered in this section:

- Before You Begin
- Site Documentation
- Site Server Installation
 - Mounting Site Server
 - Proper Site Server Penetration Locations
 - Site Server Component Connections
 - Gateway
 - Environmental Sensors
- Gateway Installation
- Sensor Installations
 - Irradiance
 - Ambient Temperature
 - Panel Cell Temperature

3.1 BEFORE YOU BEGIN

PLANNING IS THE KEY!

- READ ALL INSTRUCTIONS COMPLETELY BEFORE BEGINNING INSTALLATION.
- INSTALLATION TO BE PERFORMED BY QUALIFIED PERSONNEL ONLY.
- INSTALL IN ACCORDANCE WITH ALL LOCAL CODES.

3.2 FIRST THINGS FIRST - SITE DOCUMENTATION MAP

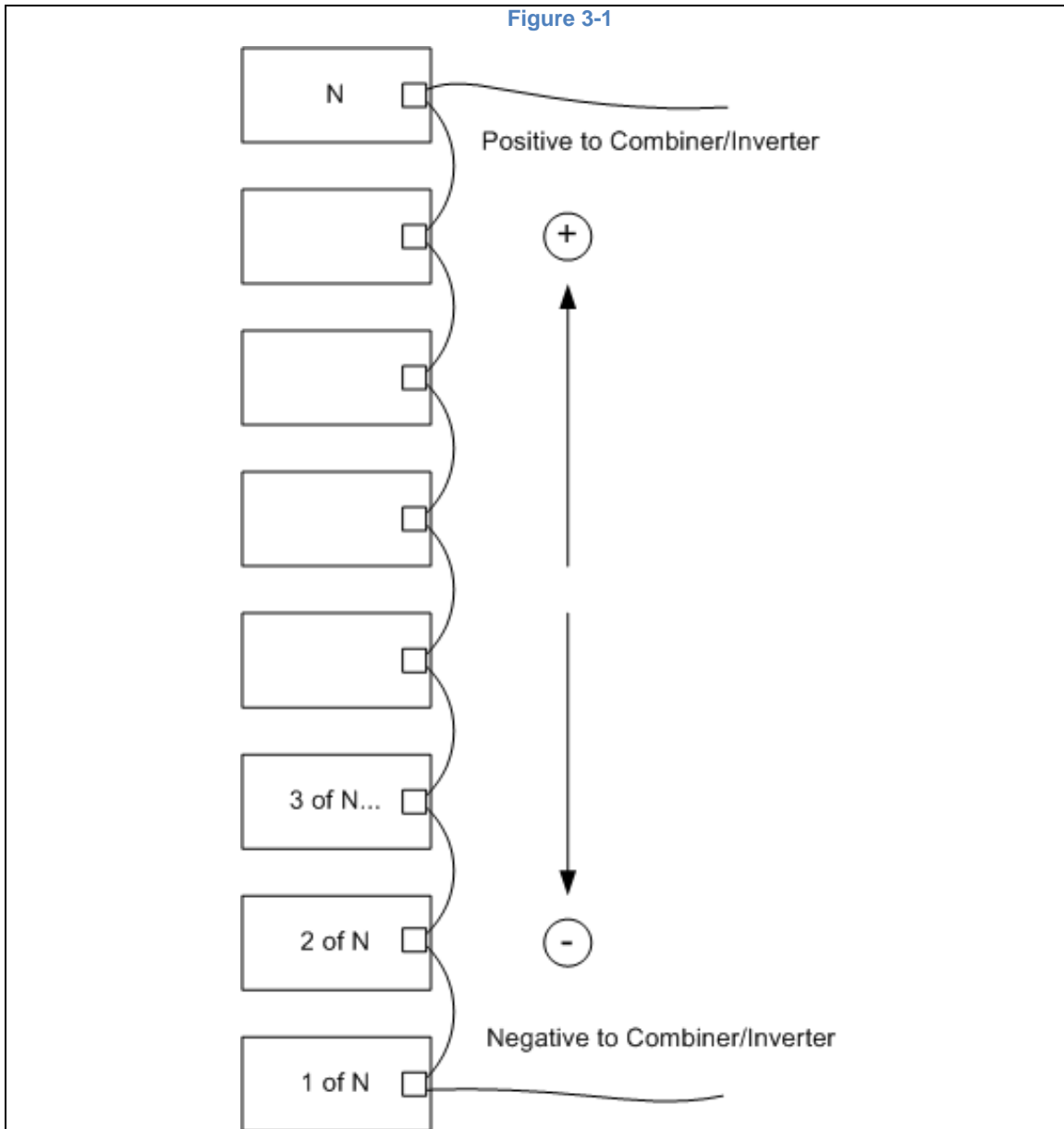
The Clarity™ Intelligent Array™ Management System utilizes a broader dataset than existing PV system optimization, monitoring and management solutions. This dataset is captured in a Site Documentation Map (SDM).

The SDM describes the array's DC electrical hierarchy plus the physical location of individual panels, strings, combiners and inverters.

3.2.1 Building Site Documentation Map

3.2.1.1 *Panel to String Hierarchy - Negative to Positive (Bottom up Approach)*

- **Rule 1:** (See Figure 3-1) Regardless of the number (N) of panels per string, to ensure consistent documentation, position 1-of-N is ALWAYS defined as the most negative voltage string position. It is the negative lead from panel 1-of-N that is the homerun wired to the combiner or inverter. 2-of-N is the next panel wired in series and so on until total N is achieved. It is the positive lead from panel N (Total number of panels in string.) that is the positive homerun wired to the combiner or inverter.

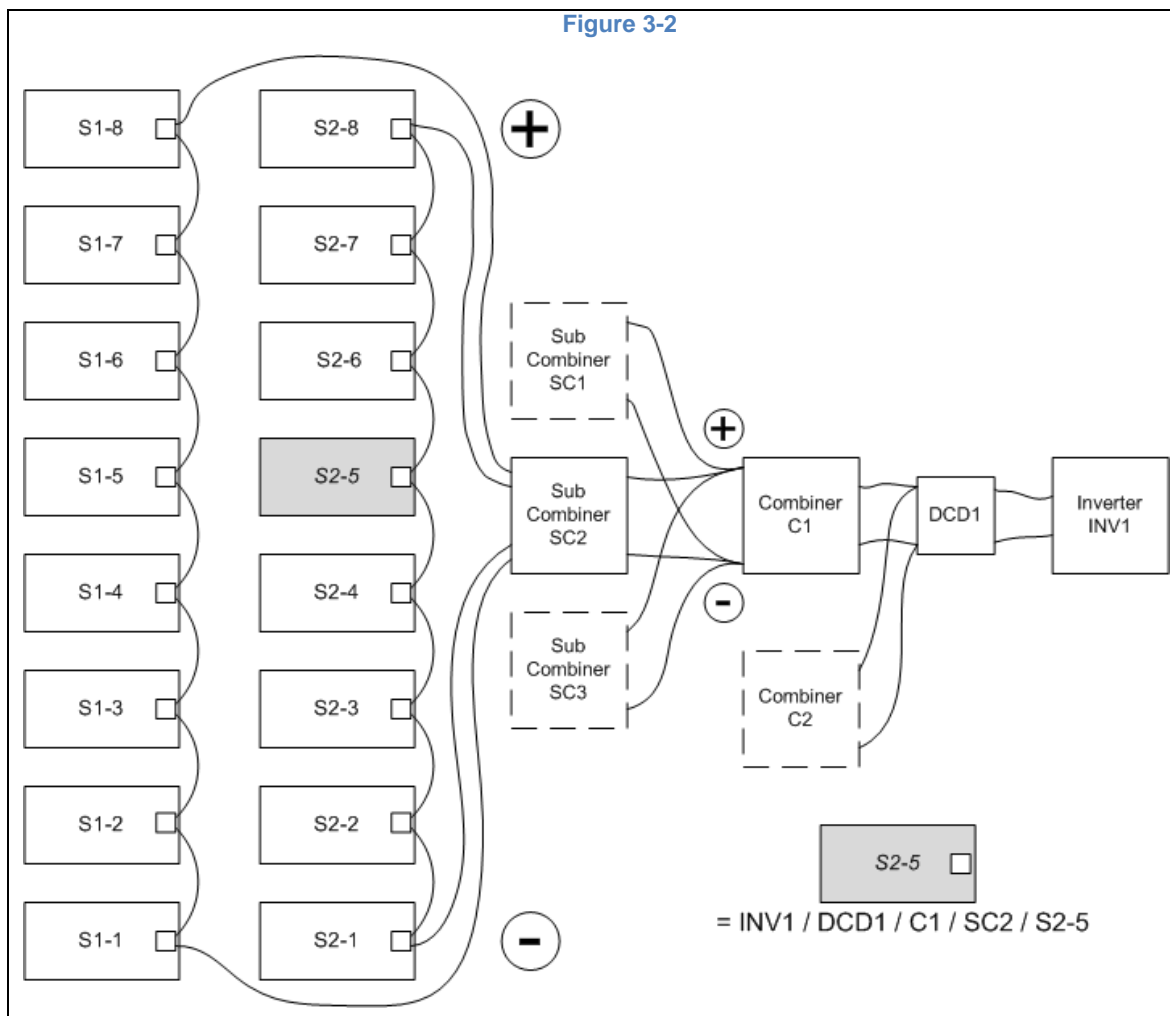


3.2.1.2 String to Combiner to Inverter Hierarchy

String to combiner hierarchy is site specific. In isolated cases the Inverter may also act as combiner. If this is the case proceed to section 3.2.1.3.

Emphasis here to be consistent using the following rule:

- **Rule 2:** (See Figure 3-2) When building String to Combiner Hierarchy always begin with the Inverter and move outward.
 - Step 1 - Label Inverter
 - Step 2 – Label Combiner
 - Step 3 – Label Strings
 - Step 4 – Label Panels in strings starting with bottom of string (Most Negative / 1 of N)

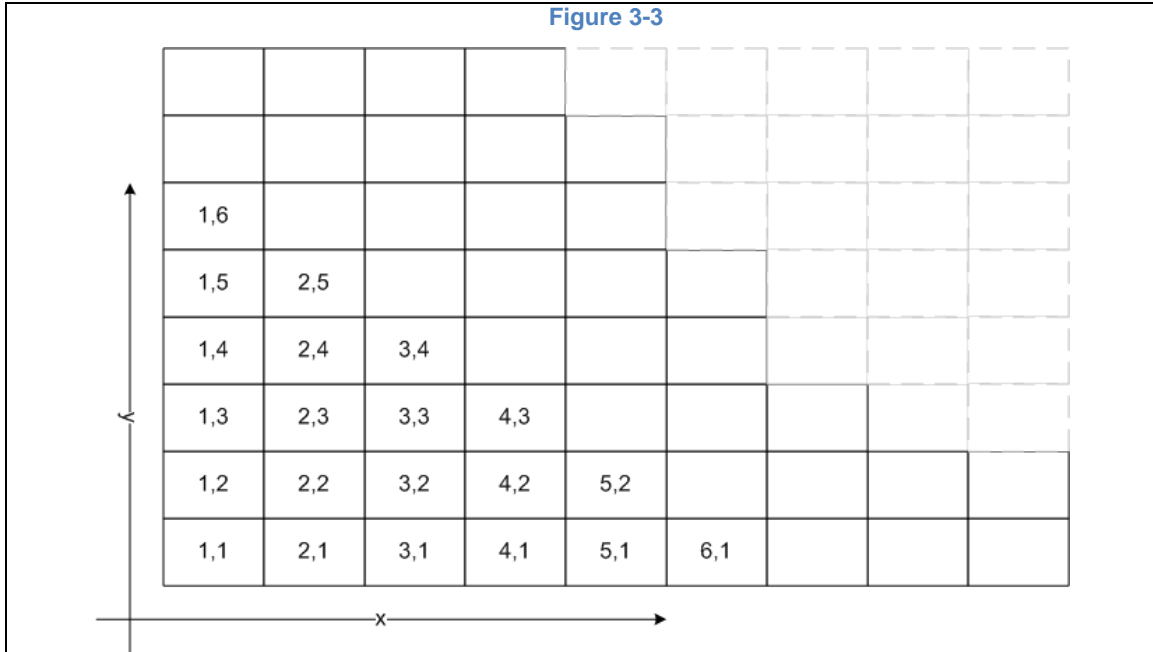


3.2.1.3 Expressing Your Array in an X Y Grid format

The panels are designated. Strings to combiners to inverters are labeled. Next is the X Y Grid documentation. The only way to associate a node with a panel is to express both in an X Y Grid

- **Rule 3:** Building the xy axis.
 - Step 1 – Build an X Y Chart (See Figure 3-3)
 - Step 2 – Associate a panel with an X Y position (See Figure 3-4 & 3-5)

Figure 3-3



Note: Layout below illustrates panel gaps that may be due to roof top obstructions. In all cases of this nature, if the panel does not exist, than the xy location will not be recorded.

Figure 3-4

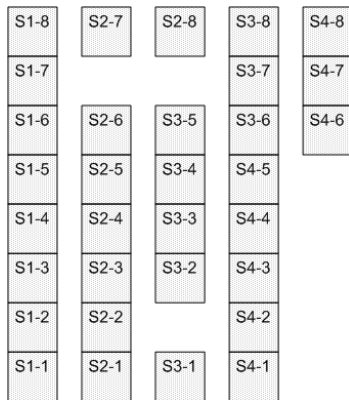
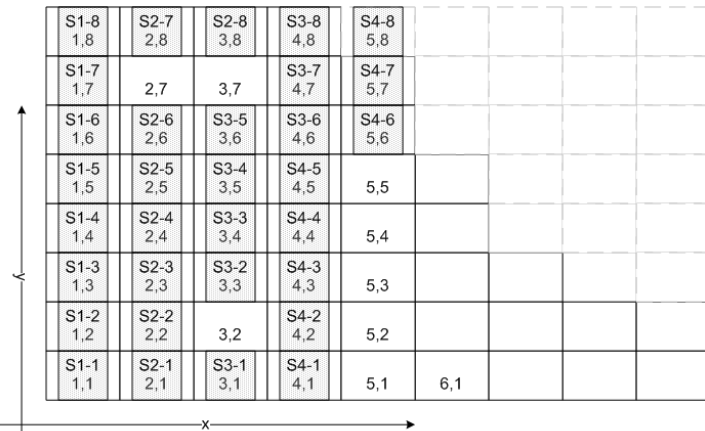


Figure 3-5



Best Practice

When associating an xy axis to an array, think about how the array will be displayed on a computer screen.

- **Rule 4:** Record node MAC address and Panel Information, then create site hierarchy..
 - Step 1: Document the MAC address of the Node.
 - Step 2: Document the Brand, Model, & serial number of the Panel.

Use the following table as a guide:

Table 3-1

Rule 1: Bottom up Approach	Most Neg Panel in String	5
Rule 2: Inverter moving out.	Inverter	INV1
	DC Disconnect	DCD1
	Combiner	C1
	Sub-Combiner	SC2
	String	S2
Rule 3: xy axis position of panel	Location	2,5
Rule 4: MAC address & Brand	MAC	F4-e6-d7-00-01-00-xx-xx
	Brand	Brand X – P240W
	SN of Panel	xxxxxxxx-xxxxxxxx

Following is an example of the data above in spreadsheet form.

Note: The spreadsheet below starts with Locations. However, consistency is the most important thing to remember.

	A	B	C	D	E	F	G	H	I	J	K
1	X,Y Location	MAC Address	Serial No.	String	Panel	Brand	Model	Sub-Combiner	Combiner	DC Disconnect	Inverter
2	2,5	F4-e6-d7-00-01-00-xx-xx	1234-5678	S2	5	Brand X	240	SC2	C1	DCD1	INV1
3	2,6	F4-e6-d7-00-01-00-xx-xx	1234-5679	S2	6	Brand X	240	SC2	C1	DCD1	INV1
4	2,7	F4-e6-d7-00-01-00-xx-xx	1234-5680	S2	7	Brand X	240	SC2	C1	DCD1	INV1



Important Information

Larger installations may require more layers of definition in the SDM, such as sub-combiners, sub-arrays or multiple inverters. The Intelligent Array data model supports this additional hierarchy. For specific requirements not covered within the SDM examples provided, please contact support@spowertech.com.



Important Information

An accurate SDM ensures that the Intelligent Array Software Suite will deliver the best and most precise fault identification and analytics at initial commissioning.



Important Information

An incomplete or inaccurate SDM does not prevent Monitor or Optimizer operation; however, the SDM should be updated as necessary to accurately reflect the actual status and configuration of the array.

3.3 CLARITY™ SITE SERVER INSTALLATION

The Site Server utilizes a 16" x 14" x 8" NEMA-4R composite (non-metallic) enclosure with a lockable front door, and is shipped with the following contents packed inside:

- Mounting brackets for the Site Server (wall or uni-strut installation)
- Irradiance sensor with a 20-meter, shielded, low-voltage, UV-resistant interconnect cable and mounting hardware.
- "One Wire" ambient-temperature sensor with a 50-foot shielded, low-voltage, UV-resistant interconnect cable and mounting hardware
- "One Wire" panel cell-temperature sensor with a 50-foot shielded low-voltage, UV-resistant interconnect cable and mounting hardware

Upon receipt, carefully unpack and verify that the Site Server arrived undamaged with all components noted above. Contact your supplier or support@spowertech.com immediately regarding any shipping damage or missing components.

3.3.1 Clarity Site Server Mounting:

The site server is design for surface mount and uni-strut mount only. Flush mount is not supported at this time.

Surface Mount

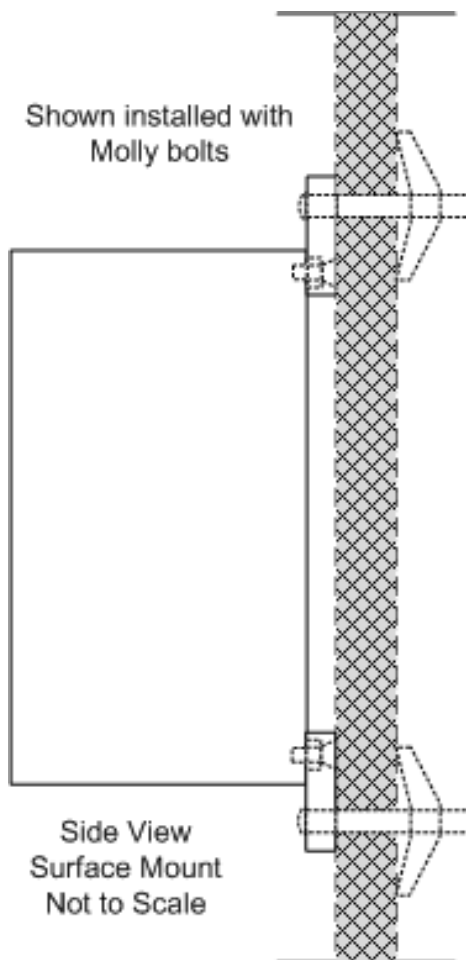
Prior to installation:

- Wall finishes should be complete.
- The wall cavity must have sufficient backing or support to ensure a firm mounting of the enclosure to the wall surface (see specifications for weight).

To install:

- Secure the surface mount flanges to the back of the enclosure with the screws provided.
- Use appropriate screws to attach the enclosure by the flanges to the wall surface.
- Level the enclosure then tighten all screws.

Figure 3-6



Strut Channel Mount

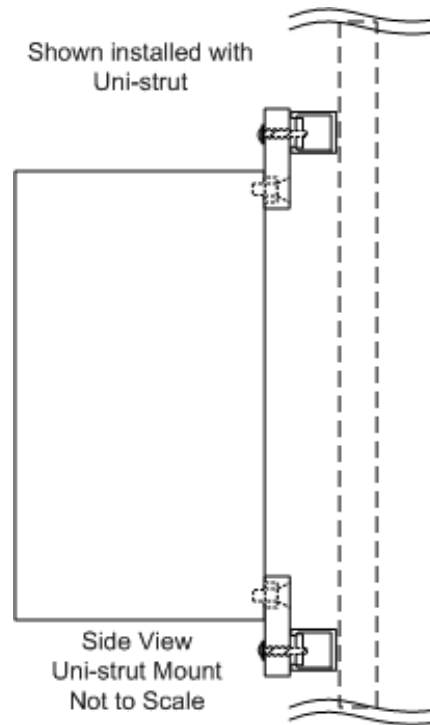
Prior to installation:

- Strut channel bracketing should be complete.
- Bracket should have sufficient support to ensure a firm mounting of the enclosure (see specifications for weight).

To install:

- Secure the surface mount flanges to the back of the enclosure with the screws provided.
- Use appropriate screws to attach the enclosure by the flanges to Strut channel.
- Level the enclosure then tighten all screws.

Figure 3-7



3.3.2 Connecting Environmental Sensors:



Important Information

Take care when drilling through or mounting the enclosure to avoid damaging internal electronic components.

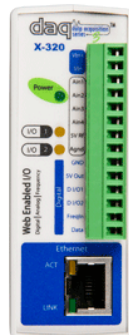


Caution

Make sure there is NO POWER feeding the site server before wiring environmental sensors.

SPTI utilizes a daq X-320 to gather environmental data. The Irradiance, Ambient Temperature, and Panel Cell Temperature sensors are all wired to the X-320.

Figure 3-8

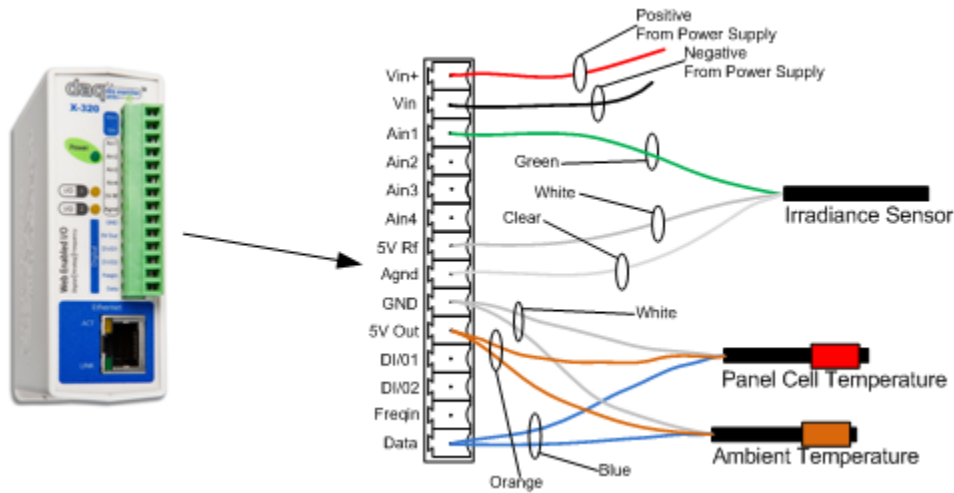


A removable terminal connector is provided for simple wiring.

- Step 1: Make sure there is no power to the site server.
- Step 2: Remove the terminal connector from the X-320™ and make wiring connections to the terminals as shown in Figures 3-4 and 3-5.
- Step 3: Reconnect the terminal connector.

Connect Sensors as Shown:

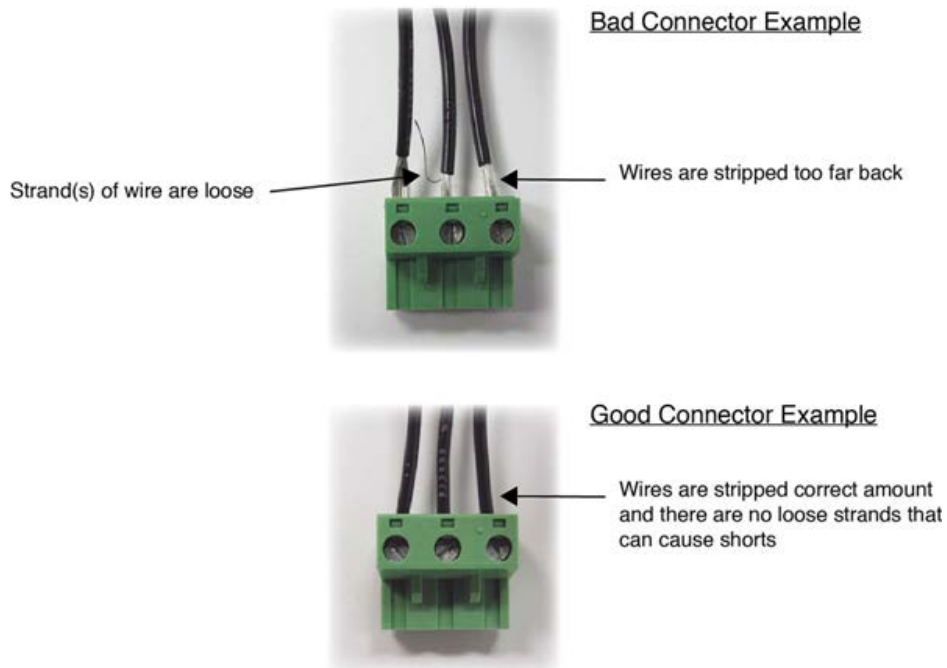
Figure 3-9



**Important
Information**

**MAKE SURE WIRES ARE PROPERLY ATTACHED TO THE
TERMINALS. SEE FIGURE 3-5 FOR EXAMPLES.**

Figure 3-10



3.3.3 Connecting Gateway

Gateway connections are made to one of the four (4) PoE ports on the Site Server PC.

- Step 1: Locate the Site Server PC (See Figure 2-1)

Figure 3-11



- Step 2: Terminate CAT5/5e wiring with RJ45 using Standard T568A or T568B Wiring
- Step 3: Insert RJ45 into PoE Port.

3.3.4 Connecting to LAN

The LAN is connected to the LAN1 Port on the Site Server PC.

- Step 1: Locate the Site Server PC (See Figure 2-1)

Figure 3-12



- Step 2: Determine the LAN Connection Type
- Step 3: Terminate the CAT5/5e RJ45 as determined for the LAN.
- Step 4: Insert RJ45 into the LAN1 Port on the Site Server PC.

3.4 ENVIRONMENTAL SENSORS EXTERNAL MOUNTING



Caution

All environmental sensors are supplied with 50 feet of UV protected jacketed outdoor rated wiring. Sensor wiring can also be run inside conduit. In either case National and Local electrical codes **MUST** be adhered too.

3.4.1 Irradiance Sensor Mounting

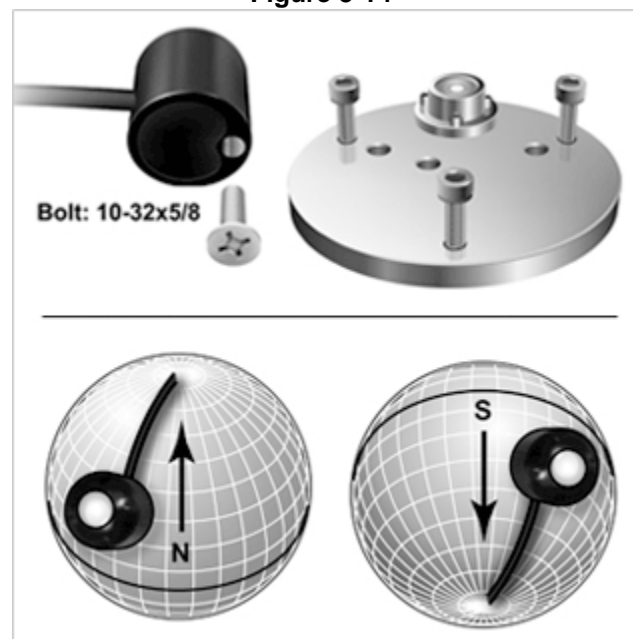
SPTI utilizes the Apogee Instrument's Model SP-215 Amplified Pyranometer as the Irradiance sensor for the system.

Figure 3-13



Mount the pyranometer sensor to a solid surface with the nylon mounting bolt (Provided). The sensor should be mounted level for the most accurate measurements.

Figure 3-14



The pyranometer sensor should be mounted with the cable pointing toward true north in the northern hemisphere or true south in the southern hemisphere to minimize azimuth error. The azimuth error is typically less than 1%.

3.4.2 Ambient Temperature Sensor Mounting

The Ambient Temperature Sensor is identified by the orange shrink wrap collar.

Once the temperature sensor with an orange shrink wrap collar is identified, record the 16 digit serial number located on the white shrink wrap.



Important Information

Record the 16 digit serial number found on the white shrink wrap of temperature sensor.

Figure 3-15



Mounting is site specific using the following rules:

- Rule 1: Locate an exterior area close to the array.
- Rule 2: Mount in a perpetually shaded area.
- Rule 3: Mount in an unenclosed area.
- Rule 4: The sensor should be mounted in a suspended manner to prevent it contacting any surfaces.

3.4.3 Panel Cell Temperature Sensor Mounting

The Panel Cell Temperature Sensor is identified by the red shrink wrap collar.

Once the temperature sensor with a red shrink wrap collar is identified, record the 16 digit serial number located on the white shrink wrap.



Important Information

Record the 16 digit serial number found on the white shrink wrap of temperature sensor.

Figure 3-16



Mounting is site specific using the following rules:

- Rule 1: Locate the easiest panel to get to.
- Rule 2: Use the metal tape provided and adhere to the back of the chosen panel.
- Rule 3: Adhere to the middle of a cell on back of panel.

3.5 GATEWAY MOUNTING (Models SPG1 & SPD1)

There are three steps in installing a Gateway (SPG1).

- **Step 1:** Terminate the Cat5/5e cable at the Gateway end with the watertight RJ45 plug provided (see 3.5.1).
- **Step 2:** Locate and install the Gateway in a correct orientation to the closest few Clarity nodes.
- **Step 3:** Connect the Cat5/5e cable from the Site Server to the Gateway

There are three steps in installing a Disable Switch (SPD1).

- **Step 1:** Terminate the Cat5/5e cable at the Disconnect Switch end with the watertight RJ45 plug provided (see 3.5.1).
- **Step 2:** Locate and install the Disable Switch in the desired location.
- **Step 3:** Connect the Cat5/5e cable from the Site Server to the Disable Switch

3.5.1 Weather Proof Connection of CAT5/5e to Gateway or Disable Switch

- **Step 1:** Insert the seal ring into the housing.
- **Step 2:** Insert cable through the sealing nut, screw nut, and housing.
- **Step 3:** Terminate CAT5/5e cable using and RJ45 connector using the T568A or T568B standard shown in Table 3-2.
- **Step 4:** Set the RJ45 connector into the housing such that the snap handle is in the notch.
- **Step 5:** Make certain that the seal ring is fully-seated into the housing.
- **Step 6:** Plug the assembly into the socket on the Gateway and secure the screw nut.
- **Step 7:** Then apply the sealing nut and securely tighten.

Table 3-2

Table 1-1: TIA/EIA T568A & T568B Conductor Pairs and Wire Colors				
Conductor Pair	Conductor Pair Definitions		Wire Color Code (Abbreviation)	
	T568A	T568B	Option 1	Option 2
Pair 1	4	4	Blue (BL)	Red (R)
	5	5	White-Blue(W-BL)	Green (G)
Pair 2	3	1	White-Orange (W-O)	Black (BK)
	6	2	Orange (O)	Yellow (Y)
Pair 3	1	3	White-Green (W-G)	Blue (BL)
	2	6	Green (G)	Orange (O)
Pair 4	7	7	White-Brown (W-BR)	Brown (BR)
	8	8	Brown (BR)	Slate (S)

3.5.2 Mounting Gateway

A Gateway or Disable Switch can be located as far as 100 meters from the Site Server. This is limited by the specification of the PoE port by which the Gateway is powered.

Gateway Installation is site specific. When installing a Gateway, adhere to all national and local codes, and use the following rules:

- Rule: Mount the Gateway with mounting plate down.
- Rule: Mount Gateway in parallel plane to the nodes.
- Rule: Gateways should be mounted within 10 feet of the nearest Clarity nodes.


Additional Gateways may be required in arrays where gaps greater than 20 feet exist between sections of the array.

In large sites, it is recommended that additional Gateways be added for fault tolerance.

3.6 POWER TO THE SITE SERVER

When installing power to the site server adhere to all National and Local Electrical Codes.

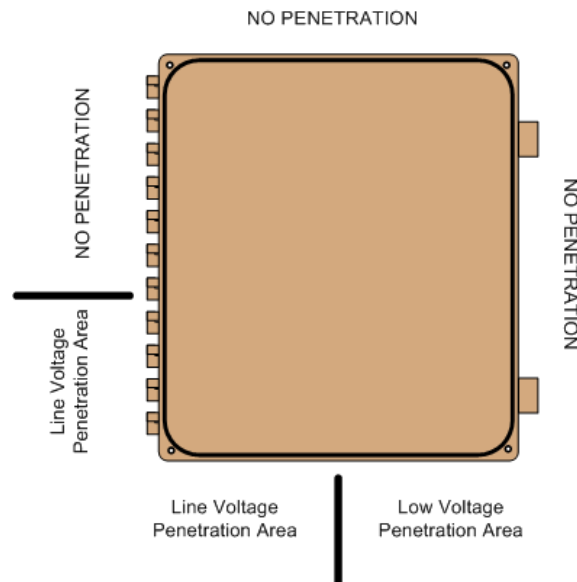
	Caution	Do not power the Site Server until all external wiring is complete including, LAN, all sensor connections, and Gateway connections.
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	Danger	There are no user-serviceable components within the Site Server. Any modification of or tampering with the internal wiring or components, other than connecting power as stated in this section can present a safety hazard, and will void the warranty.
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3.6.1 Site Server Penetration Locations


The Site Server can be penetrated in the following manner:

Figure 3-17



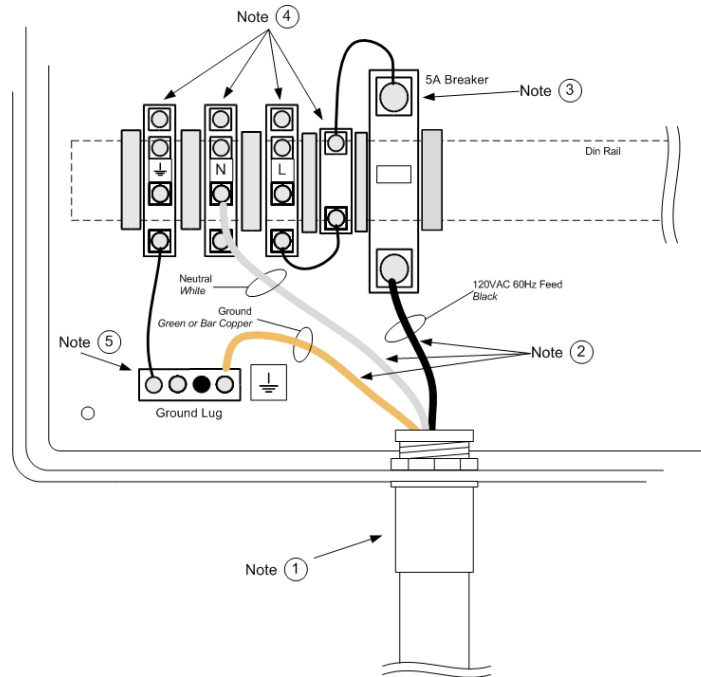
3.6.2 Connecting Power To The Site Server

	Important Information	Only supply power to the Site Server from a dedicated circuit.
---	------------------------------	--

	Danger	Before making the line connection to the Site Server make sure the circuit is open, or off.
---	---------------	---

Connect power to the Site Server in the following Manner:

Figure 3-18



- **Step 1:** Connect ground (Green Jacket or Bare Copper) to ground lug.
- **Step 2:** Connect Neutral (White) to Terminal Block marked “N”.
- **Step 3:** Connect Line Voltage (Black) to Breaker Input.



Important Information

Use of an electrical cord, plug and cable gland is acceptable as long as the configuration meets appropriate Electrical Codes.


Notes in Figure 3-18 Above


Note 1	Both Schedule 40 Gray PVC and EMT (Electrical Metal Tubing) are acceptable. Size as necessary based on all applicable Electrical Codes.			
Note 2	Breaker and Terminal Blocks accept both solid and stranded copper wire. Size as necessary based on all applicable Electrical Codes and Size Acceptability in Note 3, Note 4 & Note 5.			
	Wire Size		Torque Limits	
	Min	Max	Min	Max
Note 3 <i>Circuit Breaker</i>	12 AWG	3 AWG	13 lbs. in.	17.5 lbs. in.
Note 4 <i>Terminal Blocks</i>	22 AWG	10 AWG	7 lbs. in.	7 lbs. in.
Note 5 <i>Ground Lug</i>	14 AWG	4 AWG	20 lbs. in.	35 lbs. in.

3.7 INSTALLING CLARITY NODES

Clarity Nodes are all models of monitors (SPM's) as well as all models of Optimizers (SPO's). All nodes install in the same manner.

3.7.1 Action 1: Shutdown Inverter / Open Combiner Box Fuses

	Warning	Do not connect or disconnect SPTI Nodes while the inverter is powered up. The inverter and all DC and AC Disconnects at the inverter must be set to the 'off' state, and all combiner box fuses must be opened, prior to Monitor or Optimizer installation, removal, or servicing.
---	----------------	--

	Danger	Nodes (Monitor's and Optimizers) DO NOT REPLACE NORMAL STRING FUSING as required by Code.
---	---------------	--

3.7.2 Action 2: Connecting a Node to a Panel

- Step 1: Identify the Negative Lead from the junction box of the panel and connect to the negative input side of the node.
- Step 2: Connect the remaining positive lead to the positive input side of the node.

3.7.3 Action 3: Attaching a Node to a Panel

- Step 1: Based on the orientation of the panel select the best position to attach the node.
- Step 2: Firmly push the node on to the panel frame, taking care to ensure that the spring clips located on the back of the node are aligned with the panel frame. Check to ensure that the node is attached firmly to the panel frame. It should not be possible to pull the node off the frame without applying considerable force

3.7.4 Action 4: Connecting a Node to another Node

- Step 1: Starting with the "bottom of the string" or the most negative panel. Connect the Positive Output of the Node to the next nodes Negative Input.
- Step 2: Repeat Step 1 until desired string N is reached.

Once the desired string length is connected together, wire array as designed.

Section 4

4 Array Commissioning

4.1 Verify String Voltages

- Step 1: Verify that all string fusing is open.
- Step 2: With a precision DC Meter check string voltages.



Important Information

There should be no more than a 2% difference between the voltage measurements of strings.



Danger

Do not close string fuses, or attempt an inverter start if string voltage issues persist.

- Step 3: Correct any voltage differences found. See Troubleshooting Section
- Step 4: Once Strings are verified close combiner box fusing. Close DC disconnects if present. Also if present close sub-combiner box fuses.
- Step 5: Verify voltage readings at Inverter

4.2 Inverter Start



Important Information

It is recommended the Inverter Startup be performed early in morning during low irradiance. This reduces any stresses to the inverter or array that might still exist due to wiring faults that have not yet been identified. Additionally, it allows sufficient time for data collection by the Clarity system and any troubleshooting or further commissioning activity that may be required.

- Step 1: Verify string voltages are accurate.



Important Information

There should be no more than a 2% difference between the voltage measurements of strings.

- Step 2: Start the Inverter and allow the Inverter to run through its startup sequence.
- Step 3: Depending on Inverter type. Verify voltage and power readings.

Section 5

5 Troubleshooting

This section provides troubleshooting guidelines. If problems still occur contact SPTI technical support.

Problem	Possible Cause and Solution
String is not showing correct Voltage	<p>Verify that all Solar Wiring Connectors are securely connected.</p> <p>A shade event may be present on one or several panels. Check to make sure there are no shade events effecting panels in the string being measured.</p> <p>Possible underperforming panel. Check other identical strings, if voltage loss is equal to a portion of one panel, this could indicate a snapped diode on a panel. Every panel in the string should be checked if this is the case.</p>
The node is warm to the touch.	<p>Polarity may be reversed on the input or output side of the Node. Check polarity. If reversed, open string fusing on combiner, verify the open circuit voltage Voc is correct. Disconnect and correctly reconnect node. Close combiner fusing.</p> <p>Node may be connected in reverse. The output of the panel should be connected to the input of the Node. The output of the node and then connected to the next node in series. Check input/output connection. If wired backwards, open string fusing on combiner, verify the open circuit voltage Voc is correct. Disconnect and correctly reconnect node. Close combiner fusing.</p>

6 - Appendix A - Specifications

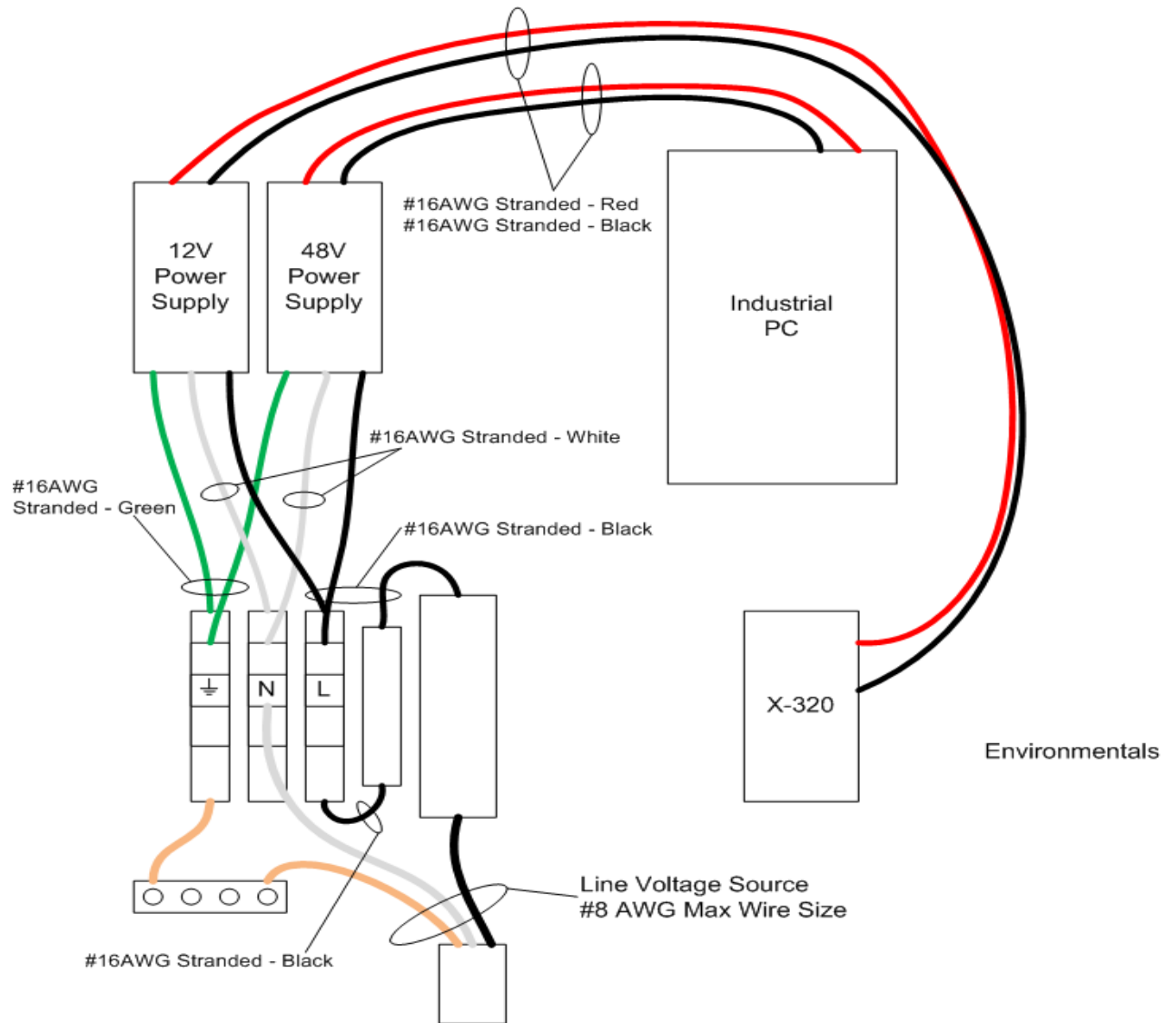
6 Appendix A

6.1 Site Server Specification



Dimensions	16"X14"X8"
Rated UL Types	3R, 4, 4X, 12
Rated NEMA Types	3R, 4, 4X, 12
IP Rating	IP66
UV Light	F1
Flammability	5VA
Voltage	100Vac to 240Vac
Frequency	50 Hz to 60Hz
Temperature	-20C to 55C
Std Configuration Weight	15 lbs. approx

6.1.1 Site Server Schematic

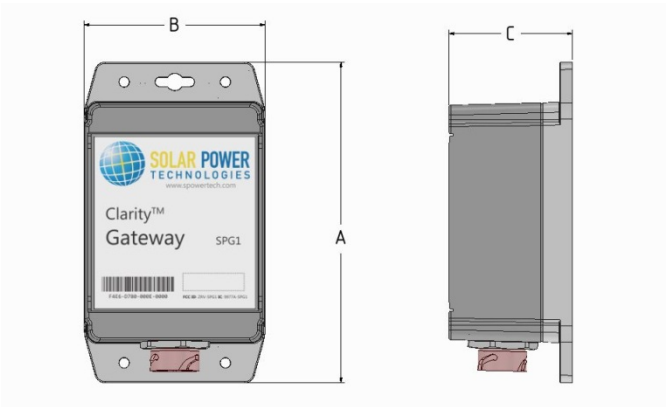


6.2 Gateway Specification

SPG1



SPD1



A	6.25"
B	3.875"
C	2.43"

Maximum Voltage	48VDC
Maximum Current	35mA
PoE	Class I
Ambient Temperature	-30C to +70C
Weight (approx.)	9 oz.

6.3 Node Specifications

6.3.1 Clarity Monitor



Technical Specification for the Clarity Monitor				
	SPM80V12A		SPM125V8A	
	Standard	Switch Option	Standard	Switch Option
Input / Output Electrical Characteristics				
Input DC Voltage (Voc max)	80 V		125 V	
Input/String Current (Isc max)	12A		8 A	
Measurement Accuracy (% error max)	0.5%		0.5%	
Power Consumption (typ @ 50% Isc max)	288mW	504mW	144mW	288mW
Mechanical and Other				
Dimensions	140mm x 88mm x 19mm			
Weight	Approx 6 oz			
Mechanical I/O	Integrated MC4 input and output			
Temperature – Ambient	-30 °C to 70 °C			
Cooling	Natural Convection (sealed)			
Compliance	UL60950-1, CSA22.2# 60950-1, IEC 60950 FCC Part 15.247 & Class B, EN 300328/301489			
Environmental Sealing	IP65			

6.3.2 Clarity Optimizer



Technical Specification for the Clarity Optimizer

Input / Output Electrical Characteristics

Input and Output DC Voltage (Voc & Vout max)	80 V
Max Power Point Range (Vmp dc)	12V to 80V
Input and Output Current (Isc & Iout max)	10 A
Power (max)	350 W
Efficiency (Typical Operation)	98.5% -99.5%
Measurement Accuracy (% error max)	0.5%

Mechanical and Other

Dimensions	183mm x 98mm x 21mm
Weight	Approx 8 oz
Mechanical I/O	Integrated MC4 Inout and Output
Temperature – Ambient	-30 °C - +70 °C
Cooling	Natural Convection (sealed)
Compliance	UL1741, CSA22.2#107.1, IEC 62109-1 FCC Part 15.247 & Class B, EN300328/301489
Environmental Sealing	IP65

6.4 Daq X-320 Specification

6.4.1 Daq X-320 Pinout

14-pin Connector Pinout	
Pin	Description
Vin+	9-28 VDC for model X-320-I Power Supply VDC+ 5 VDC for model X-320 POE DO NOT EXCEED MAXIMUM POWER SUPPLY VOLTAGE.
Vin-	VDC- (Ground) power supply input.
Ain1	Analog Input 1+ (Single-ended mode) or Analog input 1+ (Differential mode).
Ain2	Analog Input 2+ (Single-ended mode) or Analog Input 1- (Differential mode)
Ain3	Analog Input 3+ (Single-ended mode) or Analog Input 3+ (Differential mode).
Ain4	Analog Input 4+ (Single-ended mode) or Analog Input 3- (Differential mode).
5V Rf	+5 VDC reference output.
AGnd	Analog Ground: Common ground for analog inputs when used in single-ended mode and frequency ground.
Gnd	Digital Ground: Common ground connection for 5 VDC, Outputs, Inputs, Pulse Counters, and Temperature/Humidity sensors.
5V Out	+5 VDC Output. Voltage output for inputs and for the digital temperature and humidity sensors
D I/O 1	Digital I/O 1: Configurable as logic inputs or outputs. Programmable pull-up resistors for input mode.
D I/O 2	Digital I/O 2: See above.
FreqIn	Frequency Input: AC frequency counter.
Data	Temperature/Humidity Data Input. Data connection for the digital temperature and humidity sensors.



6.4.2 Daq X-320 Specifications

- Power Requirements
- Input Voltage: 9-28 VDC

Current: See table below for typical values at 25°C.

10 Mbps Network Speed

Power Supply	Digital Outputs		Digital Inputs w/ Pull Resistors	
	All Off	All On	Pull-up	Pull-down
9 VDC	160 mA	182 mA	179 mA	160 mA
12 VDC	121 mA	136 mA	136 mA	121 mA
24 VDC	66 mA	74 mA	73 mA	66 mA

100 Mbps Network Speed

Power Supply	Digital Outputs		Digital Inputs w/ Pull Resistors	
	All Off	All On	Pull-up	Pull-down
9 VDC	269 mA	288 mA	290 mA	269 mA
12 VDC	203 mA	219 mA	219 mA	202 mA
24 VDC	107 mA	114 mA	115 mA	107 mA

6.4.2.1 I/O Connector

- 14-position, removable terminal strip, 3.81 mm spacing
- (Replacement part number, Phoenix Contact 1803691)

6.4.2.2 Digital Inputs/Outputs

- Programmable I/O (2)
- Transient over-voltage protection

6.4.2.3 Input Mode

- Discrete Inputs (connect to dry contacts)
- Configurable debounce, 0 to 65535 ms
- Pulse Counter, 32-bit (250 Hz-max)
- 5 Vmax Input
- 47 kohm Programmable 5 V pull-up/pull-down resistor
- Schmitt trigger input (> 0.7 V hysteresis)
- 2.7 Vlow-high (typical)
- 1.8 Vhigh-low (typical)

6.4.2.4 Output Mode

- Logic output to external controllers
- 5 Vhigh through 49.9 Ohm resistor
- Pulse Counters
- See Digital Input Mode
- 2 second average
- 0.5 Hz read rate

6.4.2.5 Frequency Input

- 0-130 kHz input frequency



- AC or DC input, 20 V peak to peak
- Sine or square wave (Triangle wave, add approximately 10% to Min Vin)
- 2 second average
- 0.5 Hz read rate
- Auto-zero, positive slope detection
- Accuracy and minimum input level over 24 hrs:

Input Frequency	Min Vin	Read Error
1 to 2 Hz	90 mV	+/-0.5 Hz
2 to 200 Hz	60 mV	+/-0.1 Hz
200 Hz to 1000 Hz	60 mV	+/-1 Hz
1 kHz to 10 kHz	60 mV	+/-1.5 Hz
10 kHz to 50 kHz	60 mV	+1/-2 Hz
50 kHz to 100 kHz	60 mV	+1/-6 Hz
100 kHz to 130 kHz	60 mV	+2/-16 Hz

6.4.2.6 Analog Inputs

- 4 Channels (configurable as 4 single-ended, 2 differential, or a combination)
- 0 to 5 V input, full scale
- 10 μ V resolution
- $\pm 0.02\% + 20 \mu$ V full scale single-ended mode
- 151 ms read time, sequential read of each channel

6.4.2.7 Temperature/Humidity Sensors

- 6 Sensor maximum
- 600 ft (180 m) maximum combined cable length
- Temperature Sensors
- "1-Wire" Digital Thermometer (Dallas Semiconductor DS18B20)
- +/-0.5°C from -10°C to +85°C

6.4.2.8 Humidity Sensors

- "1-Wire" Digital Sensor
- 0-100% RH +/- 1.8%

6.4.2.9 Network

- 10 Base-T or 100 Base-T Ethernet IPv4
- Static IP address assignment or DHCP
- HTTP port selectable
- Standard 8-pin RJ-45 Modular Socket
- Supports Web Browser (HTTP), XML, Modbus/TCP, SNMP protocols

6.5 12Volt Power Supply Specification

Specification	Value
Family	MDR-40
Output Connector Type	Screw Terminal Block
Product Length	40mm
Product Width	100mm
Product Height	90mm
Agency Approvals	EN NEC/LPS TUV UL
Efficiency	86%(Typ)
Minimum Isolation Voltage	3000V
Minimum Operating Temperature	-20°C
Maximum Operating Temperature	70°C
Number of Outputs	1
Specification	Value
MFR Product Family	MDR-40
Product Type	AC to DC Power Supply
Style	DIN Rail
Output Voltage	12V
Maximum Output Current	3.33A
Maximum Output Power	40W
Input Voltage	85V to 264V
Input Frequency	47Hz to 63Hz
Maximum Current Rating	1.1A(Typ)



6.6 48Volt Power Supply Specification

Specification	Value
Family	MDR-40
Output Connector Type	Screw Terminal Block
Product Length	40mm
Product Width	100mm
Product Height	90mm
Agency Approvals	EN NEC/LPS TUV UL
Efficiency	88%(Typ)
Minimum Isolation Voltage	3000V
Minimum Operating Temperature	-20°C
Maximum Operating Temperature	70°C
Number of Outputs	1
Specification	Value
MFR Product Family	MDR-40
Product Type	AC to DC Power Supply
Style	DIN Rail
Output Voltage	48V
Maximum Output Current	0.83A
Maximum Output Power	39.8W
Input Voltage	85V to 264V
Input Frequency	47Hz to 63Hz
Maximum Current Rating	1.1A(Typ)



6.7 Industrial PC Specification (rBox104)

For specification of rBox104 industrial PC, go to <http://axiomtek.com/Download/Spec/rbox104.pdf> contact sales agent, or contact SPTI at support@spowertech.com.



**3006 BEE CAVES ROAD
A-330
AUSTIN, TEXAS 78746**