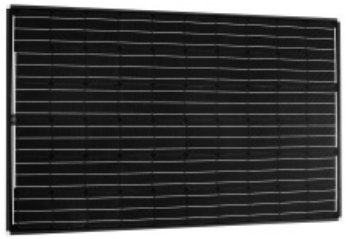
SunSource® Home Energy System

Corp. 1312-L2
March 1, 2013
Supersedes Corp. 1021-L3

APPLICATION AND DESIGN GUIDELINES

Technical Publications



Many Dave Lennox *Signature*® Collection air conditioners and heat pumps manufactured after April of 2010 are factory-equipped with components that make them SunSource® solar-ready. These units can be matched with solar modules and other optional equipment so that they can become part of a SunSource® Home Energy System.

Units can be upgraded for use with solar equipment at the time of installation or in the future.

Solar energy is first used to meet cooling/heating demands. When the outdoor unit is not operating, the system powers lighting, appliances and other electronic devices in the home. Any surplus power is sent back to the utility company for a possible credit (check with your local utility company for availability).

The SolarSync™ package consists of the following components:

- Lennox® Solar Subpanel installed in a Dave Lennox *Signature*® Collection air conditioner or heat pump unit.
- Solar modules (1 to 17 may be used to vary the amount of electricity generated).
- Envoy Communications Gateway monitors solar power performance.

All components must be ordered separately.

Wiring runs from the roof-mounted solar modules to the outdoor unit. From there, power travels to the home electrical service panel using the existing outdoor unit power wiring.

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Introduction

A solar module is made up of multiple photovoltaic cells wired together in series and/or parallel to achieve a desired power output.

Each cell produces approximately 0.5 Volt. The cells are encased in a frame to protect them from the environment. The modules are flat plat technology with mono crystalline silicon cells which produce 265 watts. The rating on each module indicates the nominal DC power output in watts of a module when it is in bright sunlight in 25 degree C conditions, and the sun's rays are perpendicular to the surface of the module Because the microinverter operates at about 95% efficiency, the AC output of the system will be approximately 5% less than the peak DC output. So, at peak conditions, a 265 watt module will produce up to about 247 watts of power.

Each module operates independently, so if one is shaded or dirty the adjacent modules will still operate to maximize their energy output. The microinverter is factory-installed on the back of the module. Because the microinverter is pre-wired, grounded and mounted, there are fewer parts that must be assembled on the roof or side of a house.

In real-world conditions, as the sun rises, moves across the sky and sets throughout the day, the output of the modules will increase from about zero at dawn to a peak of about 195-235 watts (depending on season, sun angle, mounting angle and roof orientation), and then decline again to zero.

How the SunSource® Home Energy System Works

1. Photovoltaic modules are installed in an area that has good solar exposure throughout the year, generally a south-facing roof.
2. When sunlight shines on the solar module(s), their built-in microinverter(s) produce 240 volt alternating current power synchronized to the utility's power grid. Each module has a dedicated microinverter.
3. The 240-volt alternating current (AC) from the microinverter(s) is wired through a circuit breaker into the heating, ventilating and air conditioning (HVAC) outdoor unit. This power can be used to operate the HVAC unit and/or the power can be re-directed into the home's main distribution panel to handle other power demands in the home. When the produced power is more than the home needs, the excess power can flow into the utility grid, running the electric meter in a backward direction.
4. The electric bill is reduced because the homeowner only pays for the net electricity used.

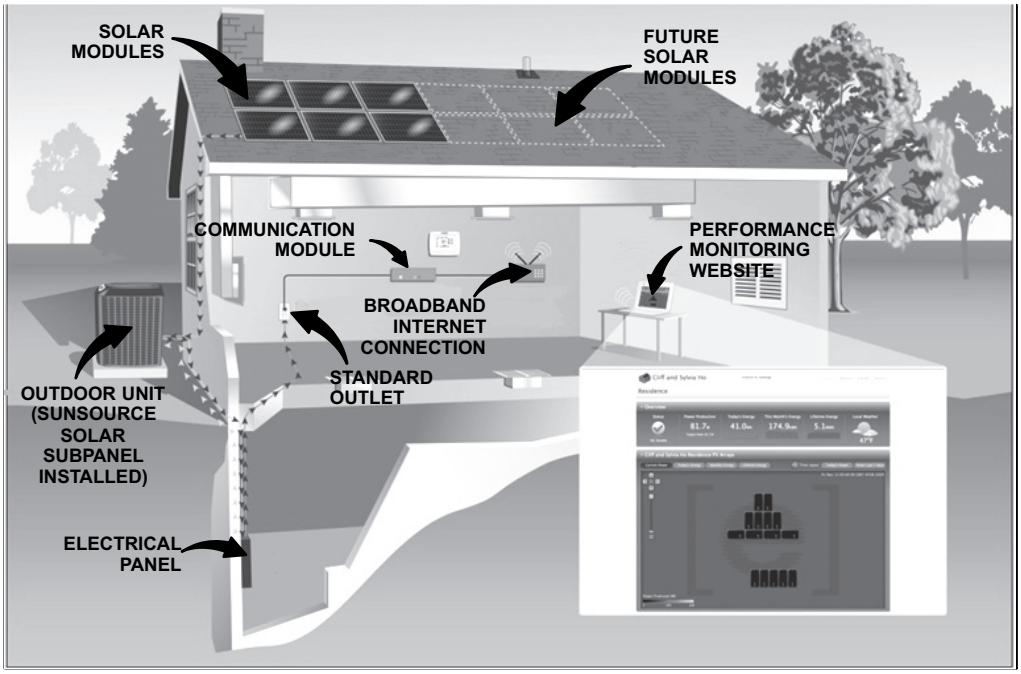


Figure 1. SunSource® Home Energy System

Utility-Interactive Microinverter

The rapidly advancing technology making this new product possible is the utility-interactive microinverter. These devices are governed by *IEEE1547 — Standard for Interconnecting Distributed Resources with Electric Power Systems*. This is a standard of the *Institute of Electrical and Electronics Engineers* meant to provide a set of criteria and requirements for the interconnection of distributed generation resources into the power grid in the United States. *UL1741 - Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources* -- addresses requirements for microinverters, converters, charge controllers and interconnection system equipment (ISE) intended for use in stand-alone (not grid-connected) or utility-interactive (grid-connected) power systems. Utility-interactive microinverters, converters and ISE are intended to be operated in parallel with an electric power system (EPS) to supply power to common loads.

⚠ IMPORTANT

The customer needs to understand that this is a utility-interactive photovoltaic (PV) system which WILL NOT generate power when the grid power is down (OFF). Due to the differences in power quality between the grid and generators, the PV module system will not produce power concurrently with a back-up generator.

ELECTRIC UTILITIES AND SOLAR PV UTILITY INTERACTIVE SYSTEMS

Does the electric utility have any special requirements?

The local utility will want to be aware of the presence of such a system on the grid. Usually, there will be an interconnection application that needs to be submitted to the local utility. Some utilities will have a particular type of electrical disconnect (indicating, lockable disconnect switch) which they want to be used in an interactive system.

Is there an incentive program?

If there is a rebate involved, the utility may require that a separate meter, which is usually referred to as a Renewable Energy Credit {REC} meter, be installed in a location where it measures the power generated by the solar PV system.

Is there a minimum kilowatt (KW) threshold?

Some utilities require a 1KW or 2KW threshold for this rebate/incentive programs.

Does the electric utility have a net-metering program?

The larger and publicly owned utilities tend to have net-metering programs. Net-metering rules specify how credit for *net generation of energy* is returned to the homeowner. The total is the amount of electricity consumed, less the amount of electricity produced.

NOTE — Additional liability insurance may be required when a utility-interactive system is installed in a home.

SunSource®-Ready Heat Pumps and Air Conditioners

The outdoor portion of the SunSource® HVAC system has a standard power connection to the dedicated HVAC branch circuit. It also has a second 240-volt AC power source connection for the utility-interactive solar power input. Solar photovoltaic (PV) alternating current modules (incorporating grid tie microinverters) are the source of the solar power.

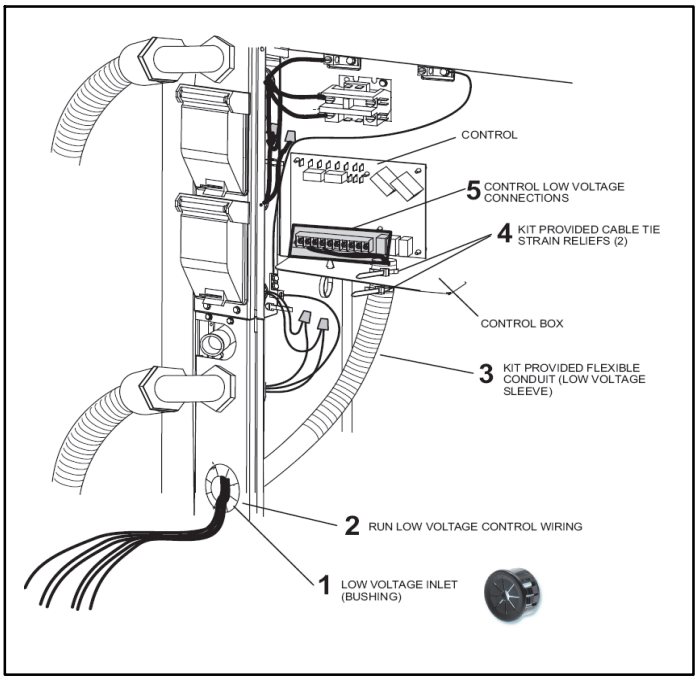
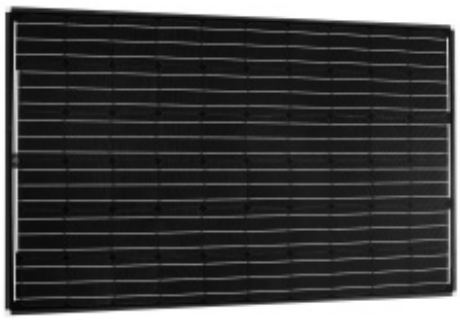


Figure 2. SunSource® Solar Subpanel

The heat pumps and air conditioners have been Electrical Testing Laboratories (ETL) listed to accept the Lennox® Solar Subpanel (an ETL-listed accessory). Units not designated as solar-ready are NOT safety agency approved for solar applications.

Over-Current Protection

Each solar PV AC module will supply a small increment of 240 VAC electrical current (up to 0.9 amps). The number of modules is limited to 17, so that no more than 15 amps is supplied to the HVAC outdoor unit. Each microinverter automatically limits its output current to its 0.9 amp nameplate value. This upper limit on the number of modules that can be used is compatible with the branch circuit ampacity of the smallest (1.5-ton) Dave Lennox *Signature*® Collection (DLSC) outdoor units. The Lennox® subpanel for the SunSource® outdoor unit has a 20 amp circuit breaker for dedicated over-current protection of the solar power system and branch conductors from the modules to the outdoor HVAC unit.



Photovoltaic Module

Microinverter

Lennox® Solar Subpanel Kit

Figure 3. Components

Codes and Permits

U.S. AND CANADA CODES

In almost all United States jurisdictions, the NFPA 70 National Electrical Code® (NEC) will be cited as the authority for electrical inspections.

In Canada, the Canadian Electrical Code (CE Code). Article 690 of the NEC covers requirements for solar photovoltaic systems. There are a number of important requirements regarding solar PV systems. A licensed electrician who is knowledgeable about NEC Article 690 should supervise the electrical installation. Because the system does not involve high-voltage DC wiring, most of the wiring details will be familiar: wire sizing, working space (110.26) around electrical equipment, etc.

A few details will be new because the system is utility-interactive:

- The current flow on the HVAC branch circuit is bi-directional. Check to ensure that the HVAC breaker in the distribution panel is suitable for back feed. If it is not marked with LINE and LOAD, then it is okay.
- HVAC breaker cannot be GCFI or arc-fault-type breaker.
- Route from the roof mounted solar power junction box to vicinity of outdoor HVAC unit.
- Install service disconnect labels (provided).
- Connect HVAC branch circuit and solar circuit conduits to solar subpanel.

Main breaker plus feedback breaker less than or equal to 1.2 times bus rating.

- Feedback breaker = 20 amp
- Assume main breaker = bus rating (most conservative case)
- Solving equation for minimum main breaker rating yields: 100 amp

Therefore, this system can be installed on a distribution panel rated for 100 amp or more as long as the HVAC breaker is positioned at the opposite end from the main breaker.

For a residence with multiple outdoor units, multiply the minimum main breaker size by the number of units. For example: two outdoor units using solar power would need a 200 amp distribution panel.

LOCAL JURISDICTION AND CODE REQUIREMENTS

⚠ IMPORTANT

It is advisable to meet with the local inspection department to find out what requirements exist for solar PV installations. Local jurisdictions may require electrical, mechanical and structural inspections to be done.

Grounding of the PV array is important because it is subject to being struck by lightning. The grounding requirements for PV AC solar arrays are more flexible than DC solar arrays; however, check with the authority having jurisdiction over local area requirements.

- The AC output of the microinverters is grounded along with the utility power to HVAC unit.
- Solar PV array must be grounded according to NEC Article 690 Section V and all applicable local codes.

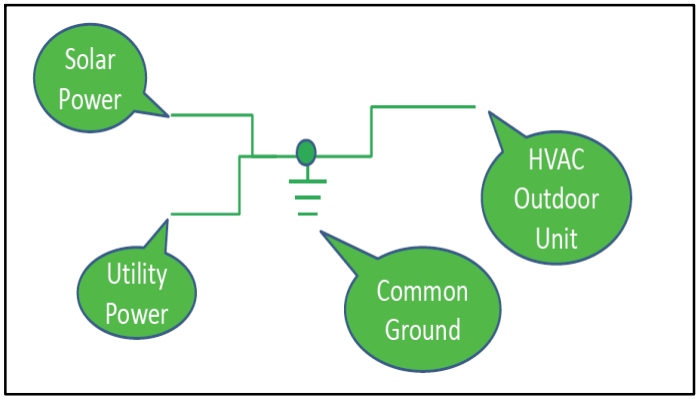


Figure 4. Grounding

PV MODULE ROOF MOUNTING AND STRUCTURE REQUIREMENTS

The authority having jurisdiction may want some information about how the solar modules will be attached to the roof. To satisfy minimal structural requirements there are two design rules that usually dictate the minimum requirements:

1. The maximum span of the modules between roof attachments should be no greater than 48”. These roof attachments are located on both the top and bottom of the single row array.
2. The second rule requires that modules which overhang the last roof attachment in a row may overhang NO MORE than a maximum of 16” from that roof attachment.

⚠ IMPORTANT

Before finalizing your roof drawing, check with your local building department to identify any unique wind and snow load requirements that pertain to your jurisdiction. A combination of shortening the maximum span between roof attachments and increasing the length of your lag bolts will enhance the wind load rating.

⚠ WARNING

The AC Solar Module System must be installed on a fire-resistant roof covering rated for the application. The minimum mechanical means (attachment points) are offered in the diagrams provided in this guide. Note that the specific number of attachment points should be appropriate to the roof type, local building code, and wind, snow and seismic loading conditions as defined by the permitting jurisdiction.

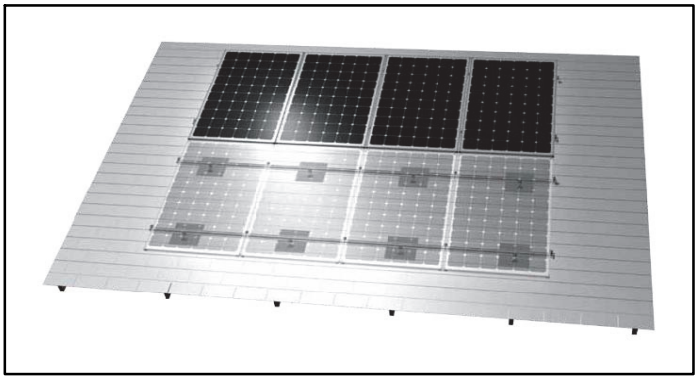


Figure 5. Roof Illustration

WIND LOADING

The system designer must determine the appropriate number of roof attachment points to ensure the solar modules remain attached to the roof under (locally specified) severe wind conditions. There is an excellent article about PV roof mounting considerations, including wind loading and structural mounting details in the February / March 2010 issue of SolarPro magazine. Regarding calculating wind load, the article states:

> *“This calculation is unnecessary for a typical residential PV system mounted on a sloped roof with standard racking materials. In these situations, the racking system and building structure can easily handle the wind loads imposed. For particularly windy regions, tall buildings, or non-standard roof framing, however, the system designer should perform these calculations to ensure the structural integrity of the system.”*

The article goes on to say that there is a wind load calculation procedure in development by the Solar America Board for Codes and Standards (Solar ABCs). Until this procedure has been finalized, the article recommends using the procedure outlined in Chapter 6 of ASCE/SEI 7-05. It is a wind load calculation procedure for components and cladding. The article provides an explanation of the steps involved. Once the wind loads are estimated, standard civil engineering procedures are used to design construction. A useful

reference is the American Wood Council's National Design Specification for Wood Construction (NDS). This reference provides a method for determining the “pull-out” capacity of lag bolts in different species and grades of wood.

Near the end of the SolarPro magazine article, it says:

> *“Modern structures are built with factors of safety large enough to account for the relatively small loads imposed by a PV array. For older buildings or those built with nonstandard construction practices, however the structural members should be evaluated to ensure structural integrity.*
>
> *…If a roof structure on an existing residential building is deficient, most* authorities having jurisdiction *require that the roof structure below the array be brought up to current building code.”*

Rebates and Incentives (Programs)

It is important to research the requirements for qualifying and applying for rebates and incentives. Many utilities have programs but certain requirements must be met to qualify. The website at **www.dsireusa.org** is a useful resource for researching federal and state incentives and getting information on programs offered by electric utilities.

Examples of types of rebates and incentives are listed below:

1. System output (either in DC or AC watts).
2. Performance-based -- Rebate levels are awarded based on the predicted output of the system, given the characteristics of the actual installation.
3. Tax credits for a percentage of the installed cost of the system are widely available through both the federal and state governments. The federal tax credit for solar renewable energy applies to the solar components of the SunSource® Home Energy System. This includes the AC solar modules, solar subpanel kit, roof mounting kits and all other labor and components needed to install the solar portion. The credit is in effect through 2016 and allows for a credit of 30% of the installed cost of the solar system. The credit is uncapped. For more information go to the Department of Energy tax credit website at:

   http://www.energy.gov/taxbreaks.htm

   or the Energy Star website at:

   www.energystar.gov/index.cfm?c=tax_credits.tx_index
4. Some states and local governments have enacted laws that will NOT allow the tax assessment of a property to be increased because of the addition of a renewable energy system. Property Assessed Clean Energy (PACE) programs are available from some governments to provide financing for the installation of a renewable energy system that is paid back, with interest, in the homeowner’s property tax.

Site Evaluation

GENERAL

On earth, the energy available from the sun is about 1000 watts per square meter. A solar module converts about 14% of that energy to electricity. For a fixed-orientation module, the peak available energy occurs in a clear sky with the module directly facing the sun. Throughout the day, the angle that sunlight hits the module changes as the sun moves across the sky. Because of this, the available energy rises to a peak daily value and then declines. There is also a seasonal variation: The sun is lower in the sky in winter and higher in the sky in summer. The more closely that the tilt angle of a solar module matches the local latitude; the more optimized the annual energy output will be.

Compromises are frequently involved in locating and installing solar PV modules. Homeowners may wish to have the module located in a sub-optimal location/orientation for esthetic reasons. This system is designed to be installed parallel with the roof pitch (see Appendix A). The pitch of the roof will determine the tilt of the solar modules The orientation of the home itself may dictate the direction the solar modules face.

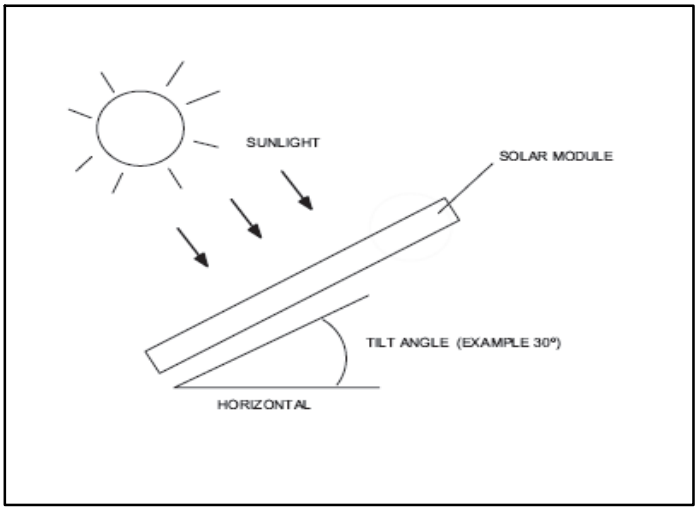


Figure 6. Orientation

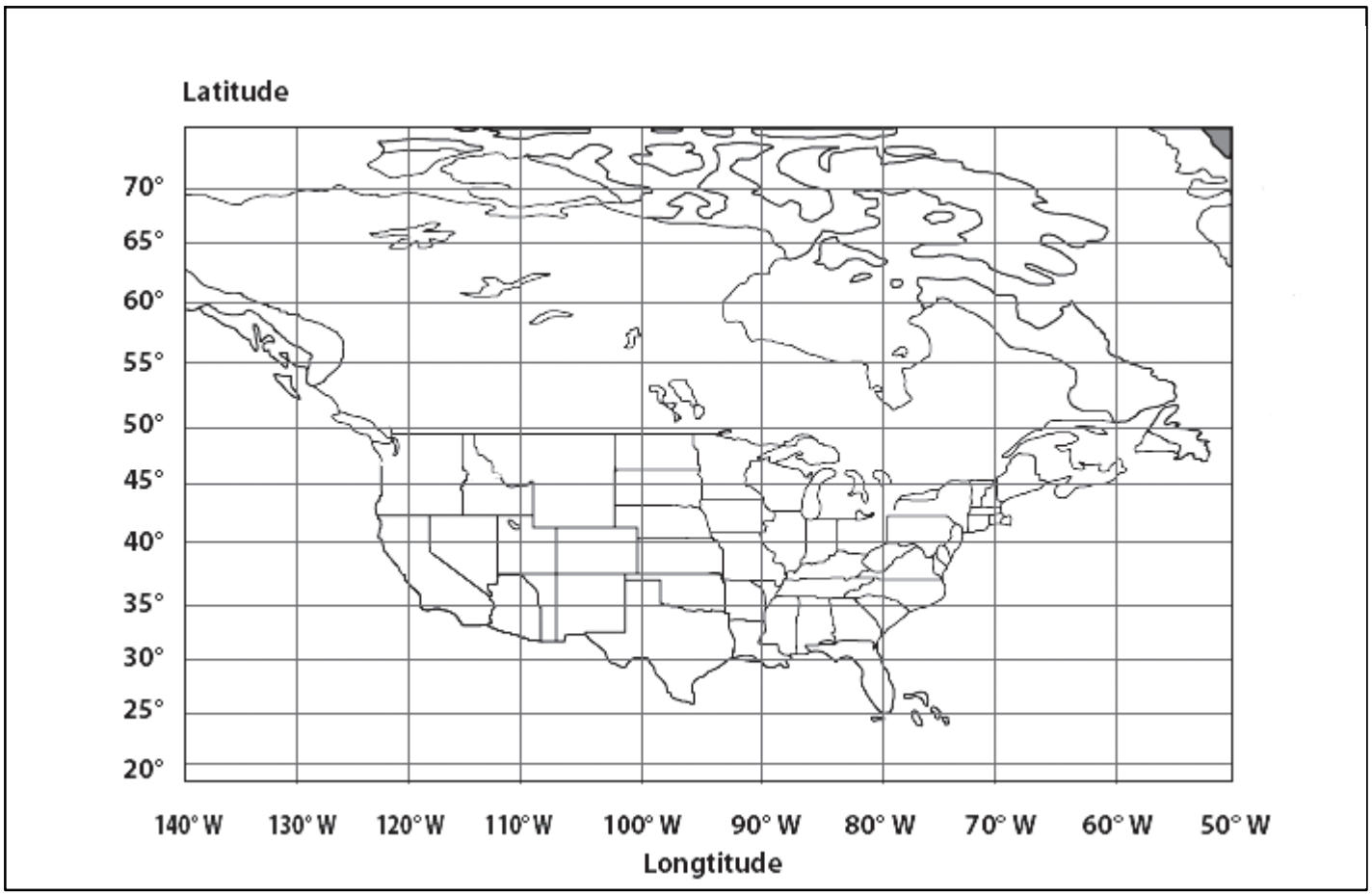


Figure 7. U.S. and Canada Longitudes

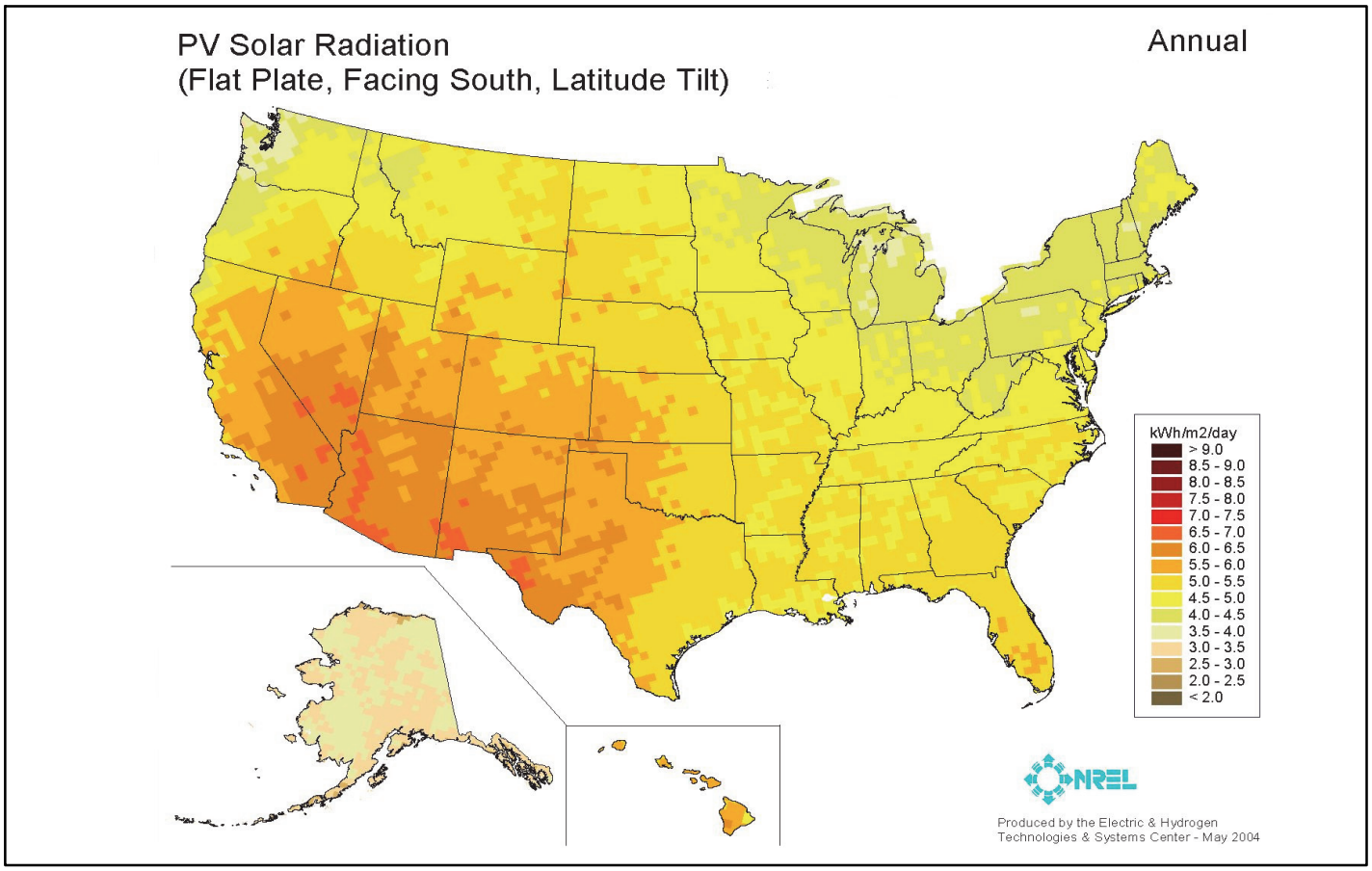


Figure 8. Annual Direct Normal Solar Radiation - U.S.

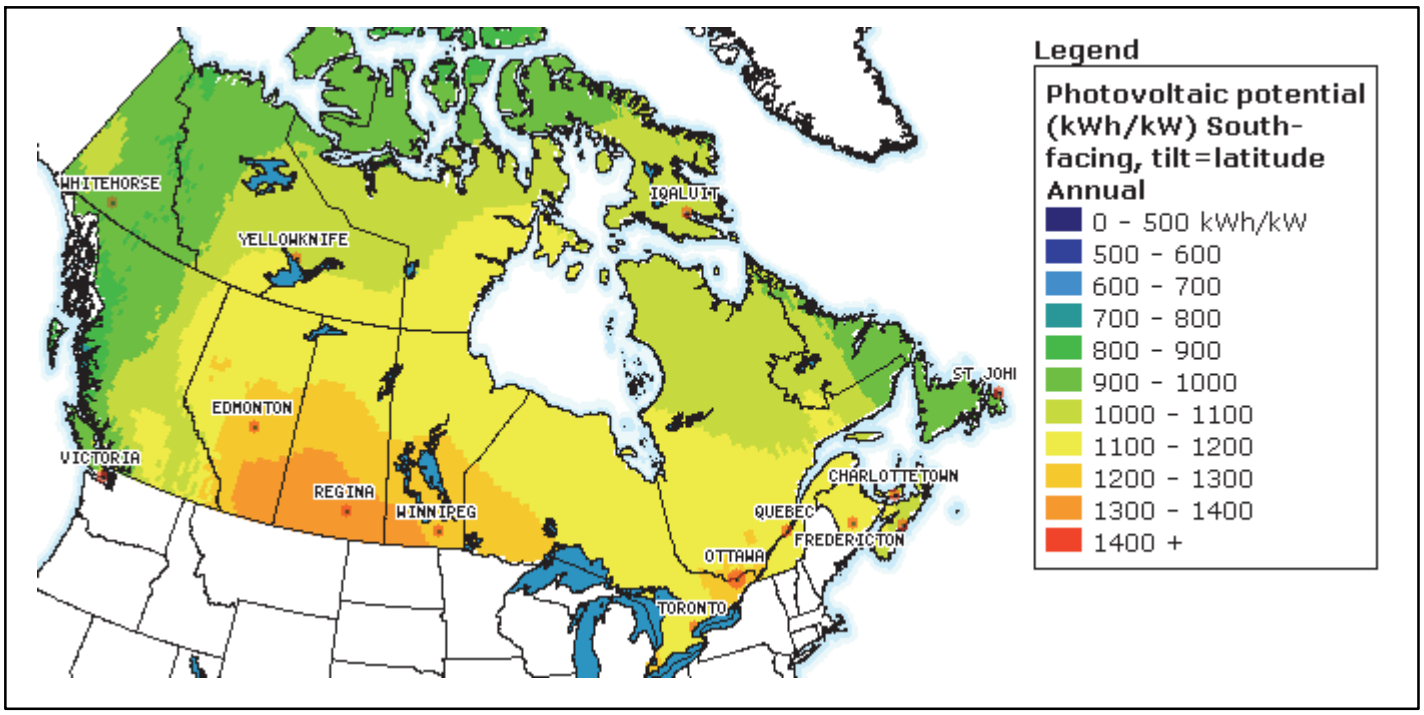


Figure 9. Photovoltaic Potential - Canada

SPECIFICS

Good Southern Exposure

Does the site have good southern exposure? Perform a solar survey using either Solar Pathfinder™ or Solmetric SunEye™. Any other survey tool may be used to assess the solar resource available (see web link page).

Figure 10. Solar Pathfinder Kit

Figure 11. Solmetric SunEye

Shading

There are several things to consider in evaluating candidate solar array locations.

- Consider direction and tilt.
- It is also important to consider whether there is any significant shading of the location during the year. Shading reduces the amount of energy that will be gathered over the year.

The University of Oregon has a web-based software program that can be used to plot *sun path charts* for any given location. This is useful if there is a question about shading.

Example: For instance, a neighbor's roof might cast a shadow during the middle of the day if the sun is below 30° elevation. You can plot a sun path chart and get an idea how many months of the year the sun is below this elevation during the middle of the day. In Portland, Oregon, this would occur in December, January and part of February.

The program can be accessed at:

solardat.uoregon.edu/SunChartProgram.html

PV Watts — Web Base Program

The web based program, PV Watts Ver. 1, from the National Renewable Energy Laboratory (NREL), can be used to estimate the monthly and annual solar energy generation potential. (See web links) This handy tool uses the following input data to predict output performance:

- Location
- Orientation
- Tilt Angle
- DC Nameplate Rating
- De-rating factors for the particular equipment and installation

The location will be set by selecting the state and nearest city to the installation site. To determine the orientation stand on the side of the house (facing away from the house) where the solar modules will be installed and find out the direction (N, S, E, W etc.) that you are facing. It is expressed in degrees with 180 equal to south. The tilt angle will be determined by the pitch of the roof (see table 1). The DC nameplate rating is the total DC output power of the solar modules (0.265 kW multiplied by the number of modules to be installed.) The de-rating factors are based on several different installation specific factors including shading, microinverter efficiency, voltage drop, etc. The value that should be used here for the SunSource® Home Energy System is 0.832. For more information on how this number was derived see the Enphase application note entitled *PV Watts Calculation Values for an Enphase Microinverter System* available on their website (see web links). If there is significant shading use the option in PVWATTS to construct a different de-rate factor by adjusting the component de-rate factor for shading.

Figure 12 is a sample output from the PV Watts program. It is a 3.18 kW DC nameplate system 12 solar modules in Fort Worth, TX. The insolation (sunshine) used is from historical data collected at the local weather station. Note that you can also input a local electrical cost and the program calculates the dollar value of the generated solar energy. (If you do not input a local electrical rate, the program uses a default value for the average rate for the state.)

PVWatts AC Energy & Cost Savings

Cautions for Interpreting the Results

12 Panel PV System: Solar World 265W Panels.

Station Identification	
City:	Fort Worth
State:	Texas
Latitude:	32.83° N
Longitude:	97.05° W
Elevation:	164 m
PV System Specifications	
DC Rating:	3.2 kW
DC to AC Derate Factor:	0.832
AC Rating:	2.6 kW
Array Type:	Fixed Tilt
Array Tilt:	32.8°
Array Azimuth:	185.0°
Energy Specifications	
Cost of Electricity:	12.0 ¢/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	4.31	345	41.40
2	4.76	342	41.04
3	5.50	426	51.12
4	6.00	441	52.92
5	6.02	449	53.88
6	6.28	440	52.80
7	6.39	453	54.36
8	6.31	447	53.64
9	5.82	407	48.84
10	5.56	416	49.92
11	4.42	336	40.32
12	4.10	326	39.12
Year	5.46	4828	579.36

Figure 12. Sample Output

The program can be used to judge the impact of the variations from optimal roof orientation and pitch by first running the case for south and tilt angle equal to latitude. Note the annual output. Next, rerun for the actual orientation and roof pitch to see how the output changes.

Table 1. PV Array Tilt Angle by Roof Pitch

Roof Pitch	Tilt Angle (°)
4 IN 12	18.4
5 IN 12	22.6
6 IN 12	26.6
7 IN 12	30.3
8 IN 12	33.7
9 IN 12	36.9
10 IN 12	39.8
11 IN 12	42.5
12 IN 12	45.0

Homeowners Associations (HOA)

HOAs may have rules regarding the placement of solar PV modules. It is important to find out what limitations may be imposed by HOA by-laws. Typically, it is the responsibility of the homeowner to identify any HOA restrictions, if any.

System Component Locations

The locations of the electric service entrance, the solar modules and the HVAC outdoor unit should be mapped out. In most cases, the electrical distribution panel will be near the service entrance. Determine what the local utility company's requirements are for routing wires from the solar modules.

Example: Some utilities require a solar PV disconnect within sight of the service entrance. There must also be a solar disconnect within sight of the HVAC outdoor unit. Typically, two disconnects will need to be installed if the *two* requirements cannot be met with a single disconnect. The Enphase DC and AC connectors have been listed as suitable for load disconnecting means. Remember, it is acceptable to wire the output of the solar system back to the distribution panel, if it makes more sense. An example of this would be the case in which the HVAC outdoor unit is on the north side of the home, but the solar modules, service entrance and distribution panel are on the south side.

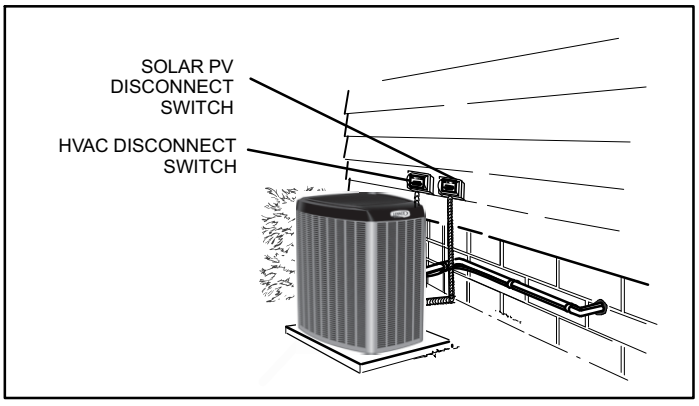


Figure 13. Solar PV Disconnect

Internet Access

An internet connection, with broadband router is required for the Envoy Communication Gateway to connect to the monitoring service.

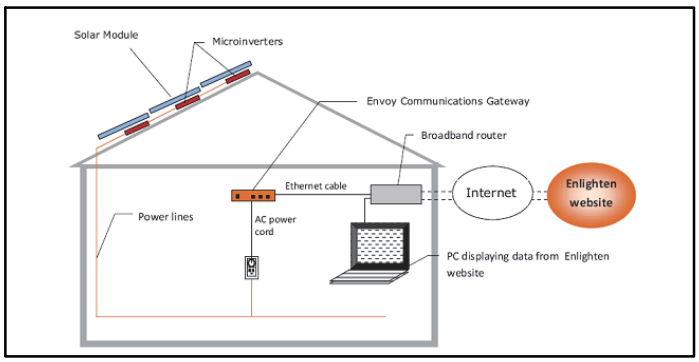


Figure 14. Broadband Router

The Envoy Communication Gateway is an integral component of the SunSource® Home Energy System. It operates between the microinverters on the solar modules and the Enphase Enlighten™ performance monitoring website and analysis system. The Envoy functions as a gateway and monitors the microinverters that are connected to the modules. NOTE — For more detailed information refer to Enphase manual.

Figure 15. Envoy Communication Gateway

Distribution Panel

The utility-interactive SunSource® Home Energy System is for split-phase power (typical residential service) and will only interconnect and supply power if the grid power meets the following specification:

- L1–L2 voltage measures between 211 volts and\ 264 volts.
- Line to neutral/ground voltage measures between 106 and 132 volts.
- Frequency measures between 59.3 Hz and 60.5 Hz

Roof Site Survey (Module Mounting, Penetration and Fire Safety

The roof itself should be evaluated.

- Fall protection for workers is addressed in OSHA Directive STD 03-00-0-0. See:
  www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES &p_id=2288
- All necessary re-roofing should be performed before installing solar modules.
- There must be enough area for the solar modules (one module requires about 20 square feet).
- Note the style of the roof — Composition (asphalt) shingles, flat (cement) tile, S or barrel tile and standing-seam.
- Mark the location of skylights and plumbing vents. Solar modules cannot block these openings in the roof.
- Fire departments request that solar modules not be placed within three feet of the roof's apex. Modules should be set back from the eaves by a few feet and a pathway, three feet wide, should always be left from the eaves to ridge. The California Department of Forestry and Fire protection has published a document with guidelines. Go to:
  www.osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf

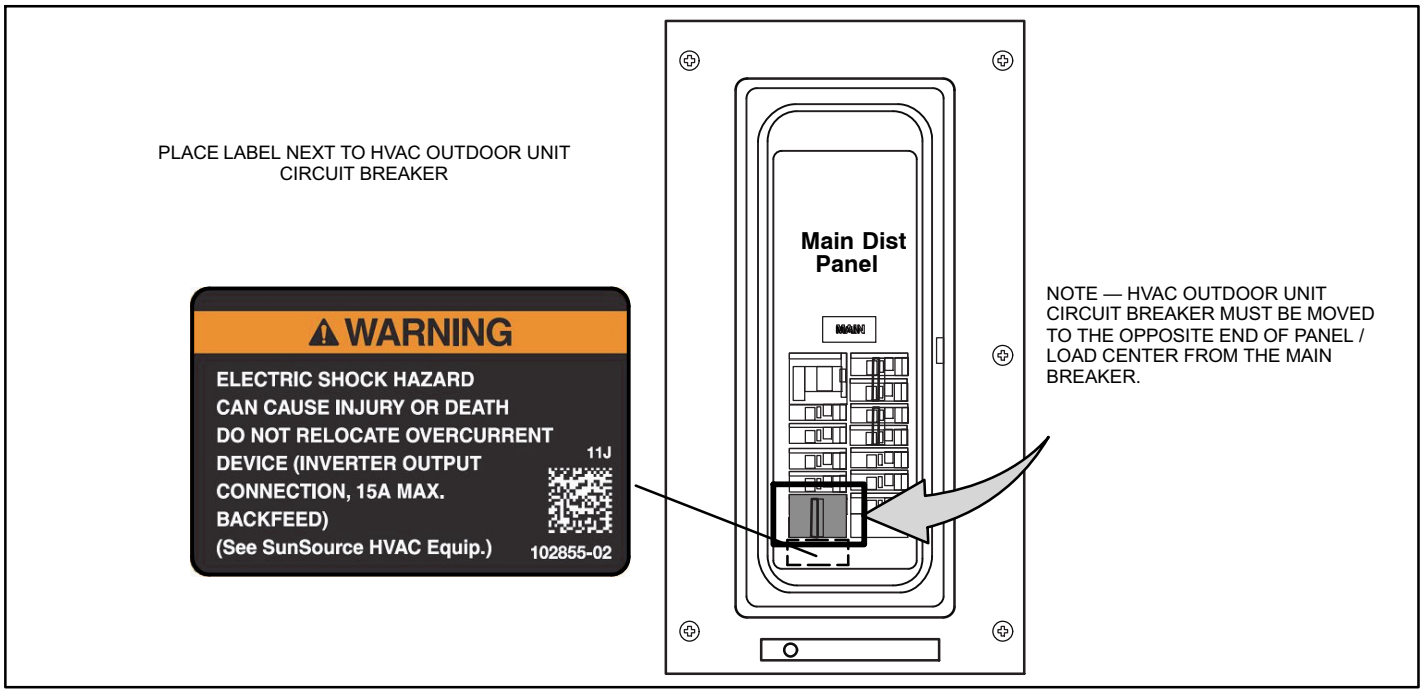


Figure 16. Breaker Installation Location

SunSource® Home Energy System — Components

FEATURED SYSTEM COMPONENTS

Dave Lennox *Signature*® Collection XC21 Two-Stage Air Conditioner

- Energy Star®-qualified.
- Up to 21.00 SEER efficiency.
- icomfort™ control.
- SilentComfort™ technology.
- Quiet operation, as low as 69 dB.
- R-410A refrigerant.
- Dependable and efficient two-stage scroll compressor.
- SmartHinge™ louvered coil protection.
- Optimized for use with the Humiditrol® whole-home dehumidification system.

Dave Lennox *Signature*® Collection XP21 Two-Stage Heat Pumps

- Energy Star® qualified.
- Up to 21.00 SEER efficiency.
- icomfort™ control.
- SilentComfort™ technology.
- Quiet operation, as low as 69 dB.
- R-410A refrigerant.
- Dependable and efficient two-stage scroll compressor.
- SmartHinge™ louvered coil protection.
- Optimized for use with the Humiditrol® whole-home dehumidification system.

Also available - XC17 Single-Stage Air Conditioner and XP17 Single-Stage Heat Pump

See separate product specification bulletins for complete information.

BASIC SYSTEM REQUIREMENTS

- Sufficient open roof space.
- Broadband internet connection.
- Homeowner association approval (where applicable).
- 240 VAC, single phase electrical service.
- Grid interconnection agreement.

LENNOX® SOLAR SUBPANEL

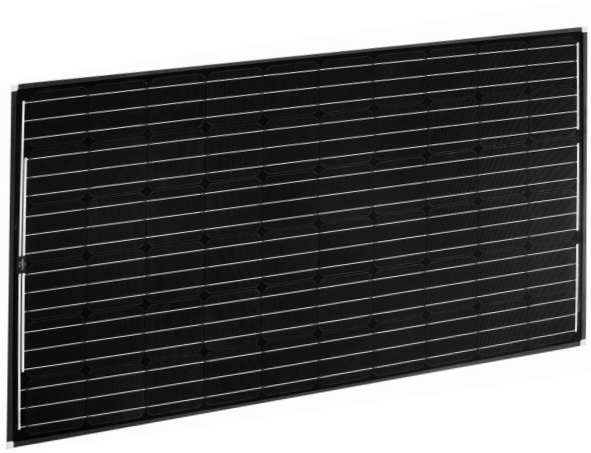
The Lennox® Solar Subpanel replaces the factory piping panel on the outdoor unit and provides circuit breaker protection and power entry for both HVAC (line) and solar power wiring.

- Subpanel is equipped with separate circuit breakers for both HVAC (line) voltage and solar power.
- Equipped with pigtail connections for easy field wiring.
- Subpanel is an ETL-listed accessory.
- Split design (upper/lower panel) allows installation on differently sized outdoor units. Subpanel is furnished with three separate lower panels. See Outdoor unit usage table for correct lower panel size.

Note - Subpanel is not backward compatible with older Dave Lennox Signature® Collection outdoor units.

- Disconnects for HVAC (line) and solar power wiring are not furnished and must be field-provided.

SOLAR MODULES



- Converts solar energy into electricity.
- Microinverters produce AC power synchronized to the utility grid.
- Modules operate independently from each other allowing modules that are not shaded or dirty to operate with optimum performance.
- Solar modules are CSA listed for the US and Canada to UL Standard 1703 and meet National and Canadian Electrical Code requirements.

SYSTEM MONITORING

Envoy Communications Gateway (Communications Booster Furnished)

The Envoy Communications Gateway monitors microinverter (on solar modules) performance and can be connected to a broadband internet connection to send data to the Enphase Enlighten™ web site for online monitoring by the homeowner. The Envoy Communications Gateway is not required, but must be used if system performance monitoring is desired. Limited system monitoring is also available locally with the Envoy Communications Gateway and a personal computer if no internet connection is available.

Various Event Messages are also available when monitoring the system via a personal computer locally.

Contents - (1) Envoy Communications Gateway, (1) Communications Booster, (1) 6 ft. power cord, (1) 10 ft. Ethernet cable, communications booster.

CSA (US/C) listed.

The Envoy Communications Gateway includes a Communications Booster which may or may not be needed depending upon how far the Envoy is away from the solar modules

Communications Booster

Ethernet bridge signal booster for the Envoy Communications Gateway. Booster is only needed if the communications gateway is installed and signal is not strong enough in the installed location. Allows the unit to be plugged into an outlet closer to the distribution panel, yet still plug into the broadband router.

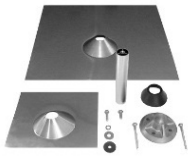
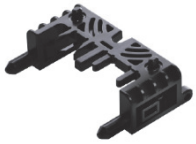
Enphase Enlighten™ Performance Monitoring Website

Powered by the Envoy Communications Gateway, the Enphase Enlighten™ Performance Monitoring website allows the homeowner to keep track of home energy usage and see environmental benefits in real time.

See demos, view reference installations and other additional information at: http://enlighten.enphaseenergy.com/

SOLARSYNC™ PACKAGE ACCESSORIES

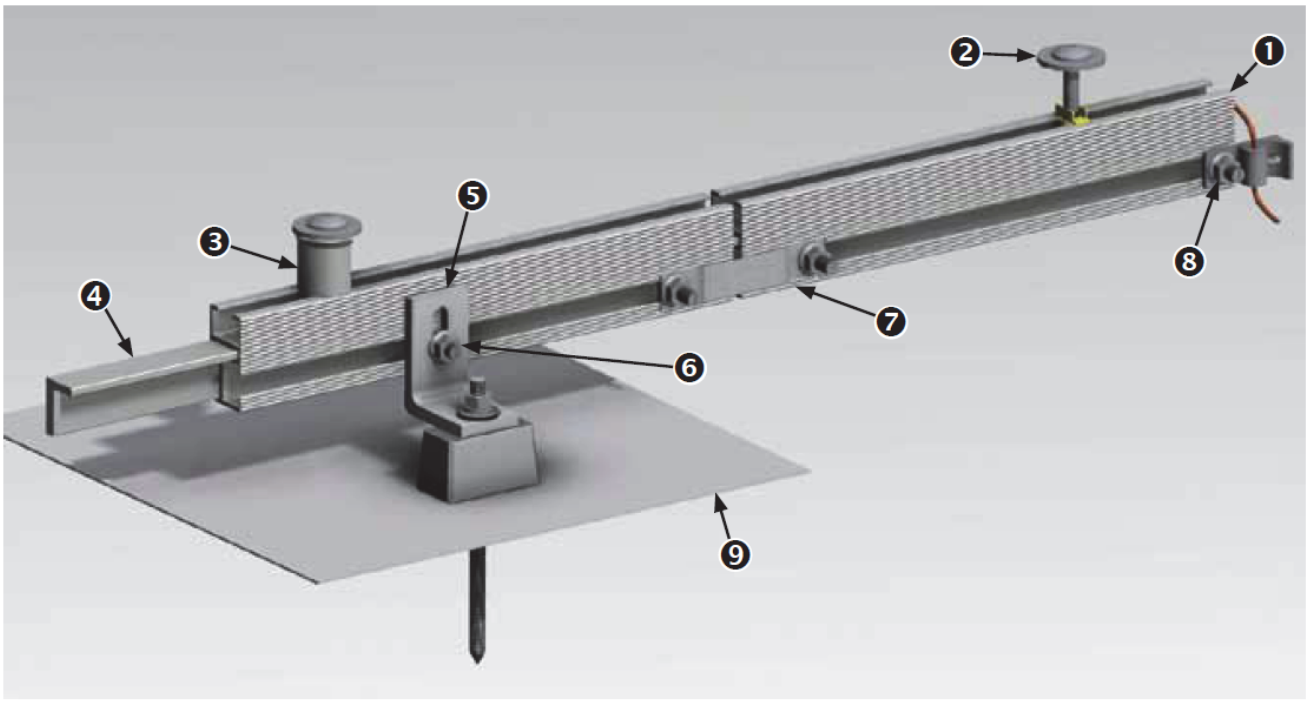
Please refer to the Product Specification bulletin for ordering information.

Part Nomenclature	Part Image	Catalog Number	Description
OUTDOOR UNIT COMPONENTS			
Lennox Solar Sub-panel			One per outdoor unit. Replaces the outdoor unit piping panel and provides the connection between the solar modules and outdoor unit.
SOLAR COMPONENTS			
Solar Panel			Use up to 17 per outdoor unit. 265 Watt, single-phase, 240 VAC. Weight - 47.6 lbs. (each module)
ROOF MOUNTING EQUIPMENT			
Composition (Asphalt) Shingle			Standard flashing and roof penetration for composition shingle. In mild weather areas, typically 2 flashings per module is used.
Flat (Cement) Tile or S/Barrel Tile			Roof flashing and penetration designed for tile roofs. Does not attach to tiles.
ENPHASE EQUIPMENT			
M215			Enphase 215W micro-inverter. Each PV module is paired with a micro-inverter.
Engage Cable			Special cable to connect micro-inverters together. 4 and 5-wire cables are available to manage 240 VAC single phase and 208 VAC three phase respectively.
Cable Disconnect			Enphase proprietary tool to disconnect engage cable from micro-inverters.
End Cap			Engage cable cap used terminate wires. Keeps wires eclectically separated .
Envoy			Communication gateway for data transfer from micro-inverters to Elighten

Part Nomenclature	Part Image	Catalog Number	Description

RACKING EQUIPMENT

1. Sunfix plus rail 2 modules = 82", 3 modules = 122", 4 modules = 162"
2. Top-clamp assembly for 31 mm frame - M8 bolt with channel nut with bolt positioning retainer
3. End clamp aluminum spacer - 31 mm
4. Rail splice bar; joins rails together
5. L-bracket with dual adjustment slots & mating serrations
6. T-bolt M8 x 20 stainless steel with serrated flange hex nut
7. Rail splice ground jumper WEEB 8.0 pre-assembled with T-bolts
8. Rail-equipment ground WEEB-lug 8.0 with T-bolt assembly
9. Roof attachment/flashing - Quick Mount PV®



Microinverter

How the Microinverter Works

The microinverter maximizes energy production from the solar module array. Each microinverter is individually installed on one solar module in the array.

This unique configuration means that an individual Maximum Peak Power Point Tracker (MPPT) controls each solar module. This insures that the maximum power available from each solar module is exported to the utility grid regardless of the performance of the other solar modules in the array.

Even if individual solar modules in the array are affected by shading, soiling or orientation, the microinverter insures optimum performance for each associated solar module. The result is maximum energy production from the SunSource® Home Energy System system.

Microinverter Status LED Indications and Error Reporting

Startup LED Operation:

Six short green blinks when DC power is first applied to the microinverter indicates a successful microinverter startup sequence.

Six short red blinks when DC power is first applied to the microinverter indicates a failure during microinverter startup.

Post-Startup LED Operations:

- **Flashing Green** - Producing power and communicating with Envoy
- **Flashing Orange** – Producing power and not communicating with Envoy
- **Flashing Red** – Not producing power

GFDI Fault:

A solid red status LED when DC power has been cycled, indicates the microinverter has detected a ground fault (GFDI) error. The LED will remain red and the fault will continue to be reported by the Envoy until the error has been cleared. The error can only be cleared via the Envoy after the ground fault condition has been remedied.

Other Faults:

All other faults are reported to the Envoy.

M215 — MICROINVERTER TECHNICAL DATA

Input Data (DC)	M215-60-2LL-S22/S23/S24 and M215-60-2LL-S22-NA/S23-NA (Ontario)
Recommended input power (STC)	190 - 270W
Maximum input DC voltage	45V
Peak power tracking voltage	22V - 36V
Operating range	16V - 36V
Min./Max. start voltage	22V/45V
Max. DC short circuit current	15A
Max. input current	10.5A

Output Data (AC)	@208 Vac	@240 Vac
Maximum output power	215W	215W
Nominal output current	1.0A (arms at nominal duration)	0.9A (arms at nominal duration)
Nominal voltage/range	208V/183-229V	240V/211-264V
Extended voltage/range	208V/179-232V	240V/206-269V
Nominal frequency/range	60.0/59.3-60.5 Hz	60.0/59.3-60.5 Hz
Extended frequency range	60.0/59.2-60.6 Hz	60.0/59.2-60.6 Hz
Power Factor	>0.95	>0.95
Maximum units per 20A branch circuit	25 (three phase)	17 (single phase)
Maximum output fault current	1.05 Arms, over 3 cycles; 25.2 Apeak, 1.74ms duration	

Efficiency	
CEC weighted efficiency	96.0%
Peak inverter efficiency	96.3%
Static MPPT efficiency (weighted, reference EN50530)	99.6%
Dynamic MPPT efficiency (fast irradiation changes, reference EN50530)	99.3%
Night time power consumption	46mW

Mechanical Data	
Ambient temperature range	-40°C to + 65°C
Operating temperature range (internal)	-40°C to + 85°C
Dimensions (WxHxD)	17.3 cm x 16.4 cm x 2.5 cm (6.8" x 6.45" x 1.0")*
Weight	1.6 kg (3.5 lbs)
Cooling	Natural convection - No fans
Enclosure environmental rating	Outdoor - NEMA 6

* without mounting bracket

Features	
Compatibility	Pairs with most 60-cell PV modules
Communication	Power line
Warranty	25-year limited warranty
Monitoring	Free lifetime monitoring via Enlighten software
Compliance	UL1741/IEEE1547, FCC Part 15 Class B CAN/CSA-C22.2 NO. 0-M91, 0.4-04, and 107.1-01

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Petaluma, CA 94954
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142-00010, Rev 04b

SYSTEM MODULE LAYOUT (EXAMPLE)

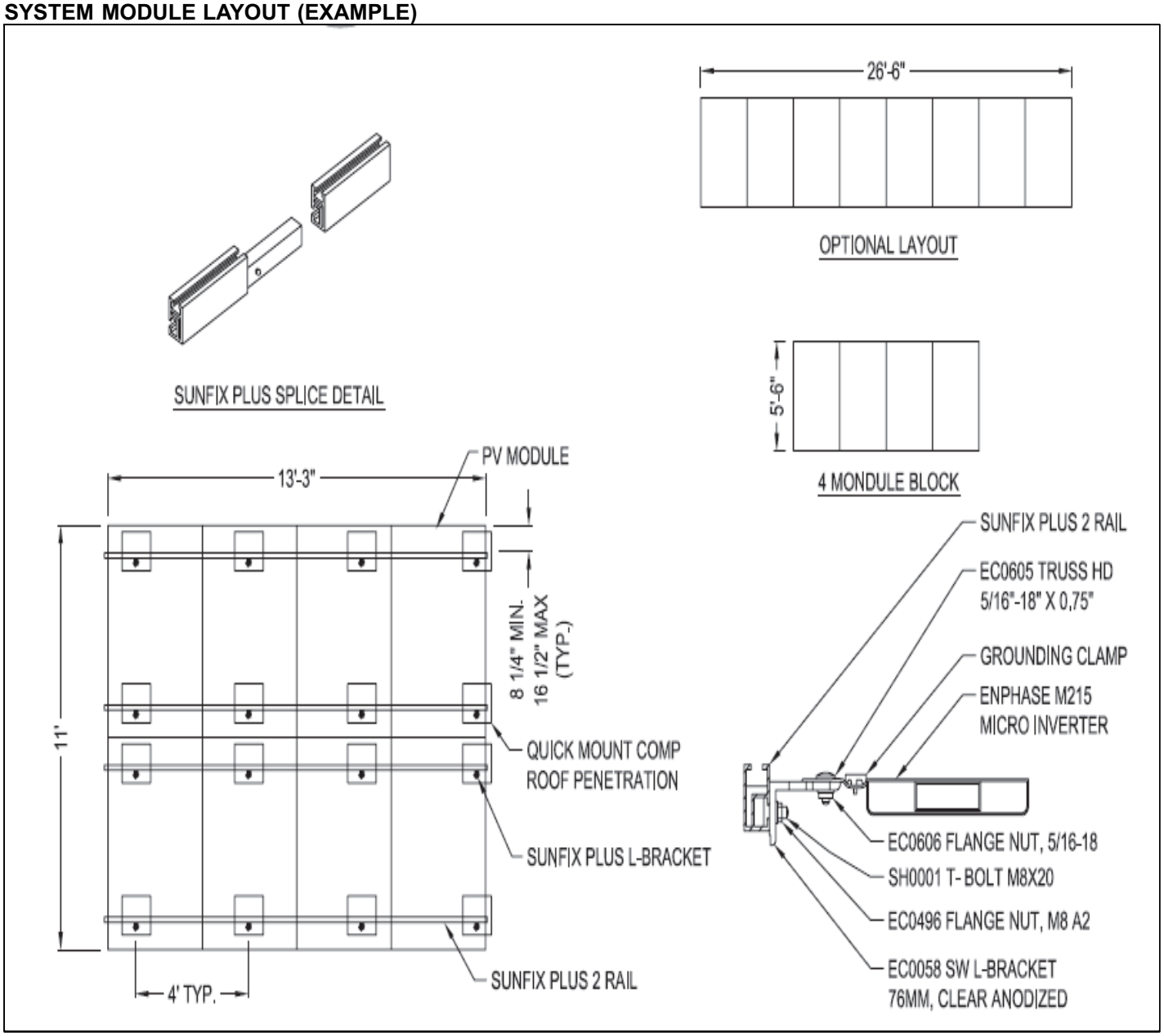


Figure 17. System Module Layout

Wiring

Table 2 reflects the recommended wire sizing for the wiring between the junction box at the beginning of the branch and the solar disconnect.

The lengths are calculated for a 1.5% maximum voltage drop. The values take into account the 6' of 14AWG wire between the individual microinverters.

NOTE - For more detailed information refer to *Enphase - Microinverter System Installation and Operation Manual.*

Table 2. Maximum Wire Length — Feet (Meters)

Wire Size (AWG)	Number of Solar Modules per Branch										
	Wire length maximum distance from solar modules to HVAC unit.										
	7	8	9	10	11	12	13	14	15	16	17
10	148 (45)	130 (40)	115 (35)	104 (32)	94 (29)	87 (27)	80 (24)	74 (23)	69 (21)	65 (20)	61 (19)
8	237 (72)	207 (63)	184 (56)	166 (51)	151 (46)	138 (42)	127 (39)	118 (36)	110 (34)	103 (31)	97 (30)
6	375 (114)	328 (100)	292 (89)	263 (80)	239 (73)	219 (67)	202 (62)	188 (57)	175 (53)	164 (50)	155 (47)

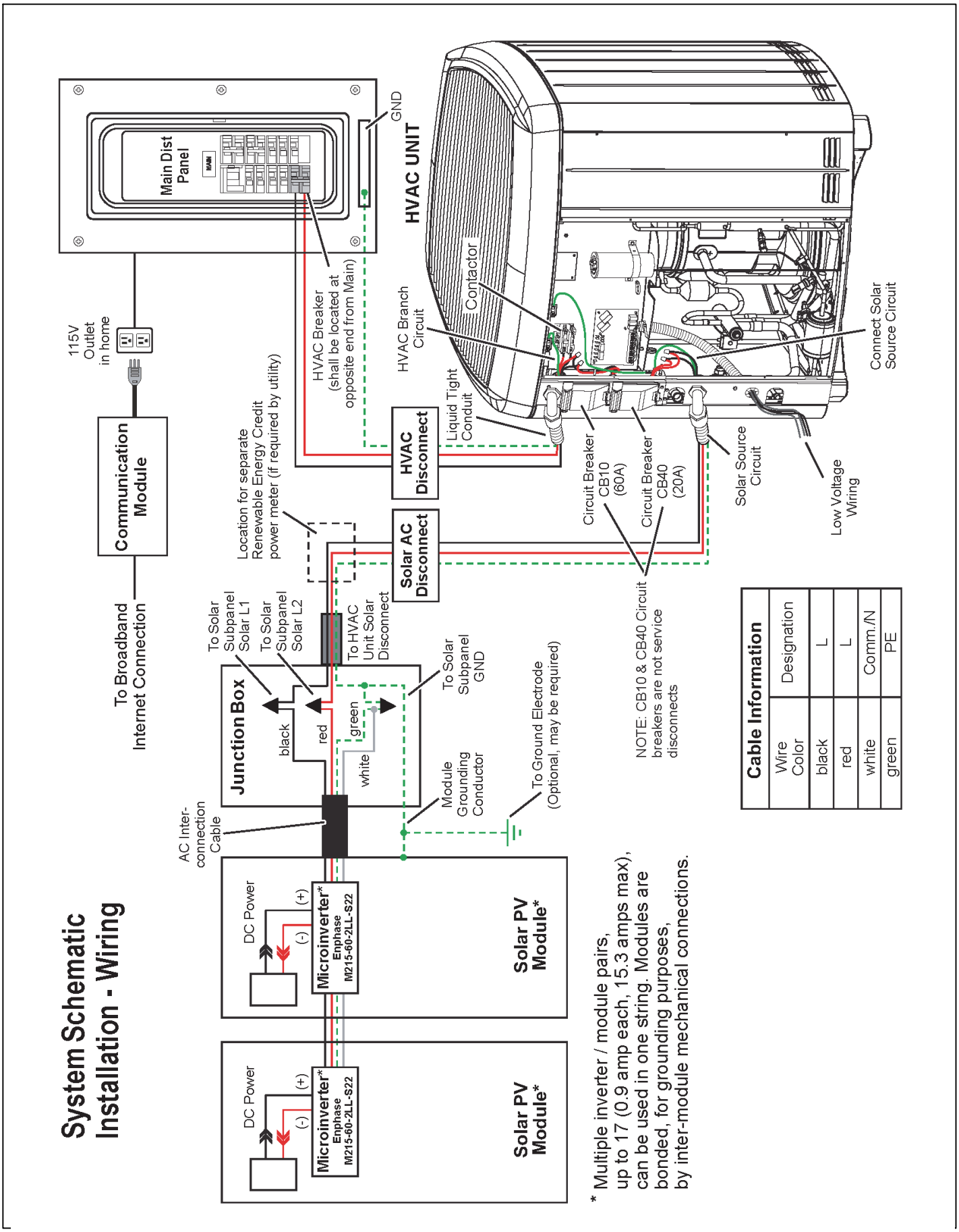


Figure 18. SunSource® Home Energy System Electrical Layout

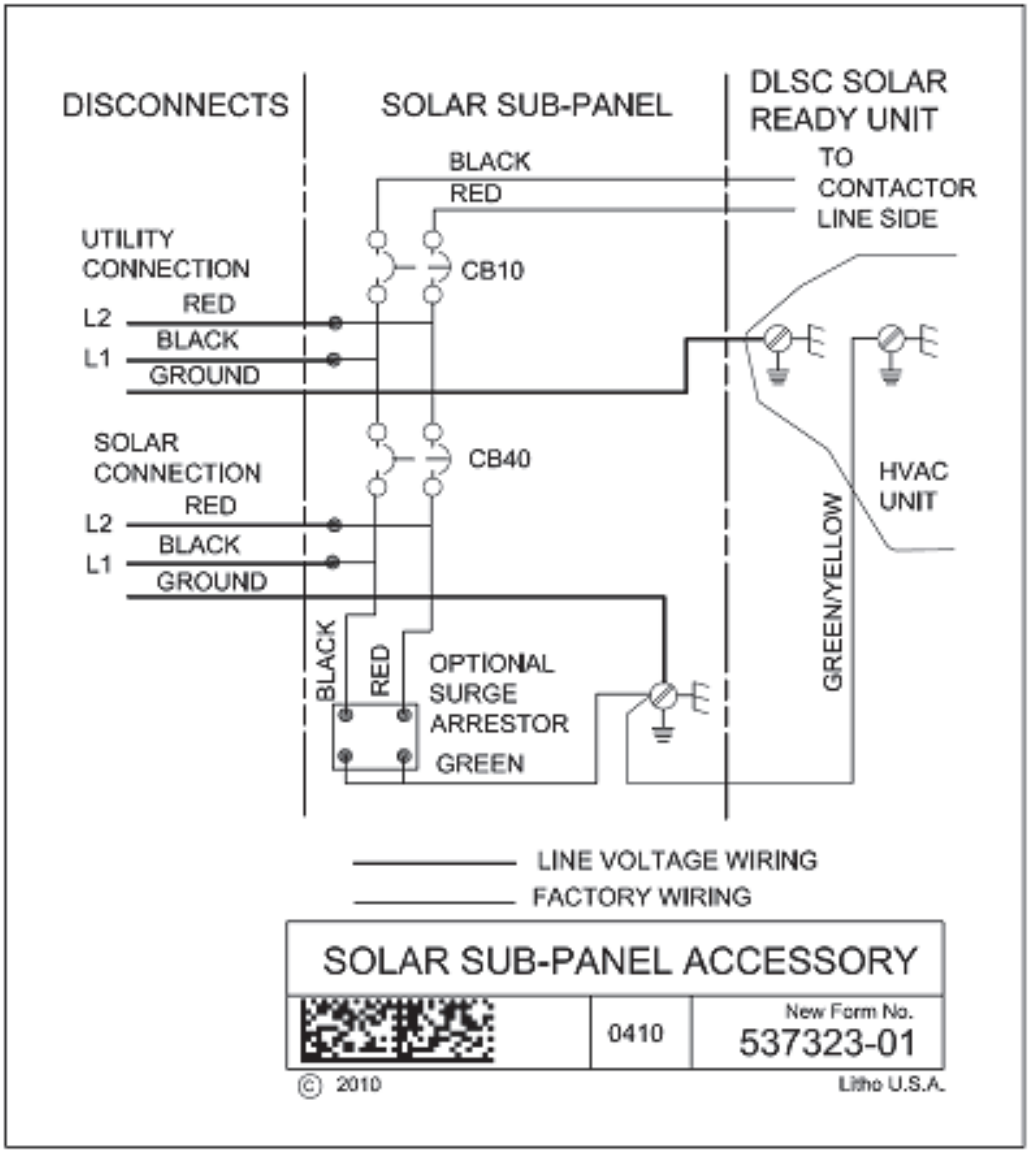


Figure 19. Lennox® Solar Subpanel Electrical Diagram

WARNING AND SAFETY

1. Before installing or using the AC module, read all instructions and cautionary markings.
2. Do NOT disconnect the PV module from the microinverter without removing AC power.
3. Perform electrical installation in accordance with all electrical codes
4. Solar modules generate electricity when exposed to light and can cause lethal shock and burn hazards.
5. Be aware that only qualified personnel should install, service and/or replace AC modules. The system involves electricity, and can be dangerous if installation personnel are not familiar with the appropriate safety procedures.
6. Do not attempt to repair the AC module. It contains no user-serviceable parts. If it fails, please contact Andalay customer service to obtain an RMA number and start the replacement process. Tampering with or opening the Andalay AC module or Enphase Microinverter will void the warranty.
7. Connect the AC module to the electrical utility grid only after receiving prior approval from the utility company.
8. To reduce electric shock possibility, do not wear metallic jewelry
9. Do not expose solar modules to sunlight concentrated with mirrors, lenses or similar means
10. Do not strike the glass surface of the module with heavy or sharp objects or walk on the solar module.
11. Do not scratch the back sheet (behind the glass) of the solar module. Use approved glass cleaning products on modules.
12. Do not block frame drain holes.

Start Up and Checkout of System

COMMISSIONING

Start up and checkout of system

Outdoor Unit

Refer to the maintenance section in the installation instructions provided with the outdoor unit.

Solar Modules

1. **Install the AC branch circuit junction box.**

   Use electrical system components approved for wet locations only. Connect the open wire end of the AC interconnection cable into the junction box using appropriate strain relief fittings. **Do not connect the connector end to the Andalay AC panels at this time, as this is to be done during during the commissioning step.**

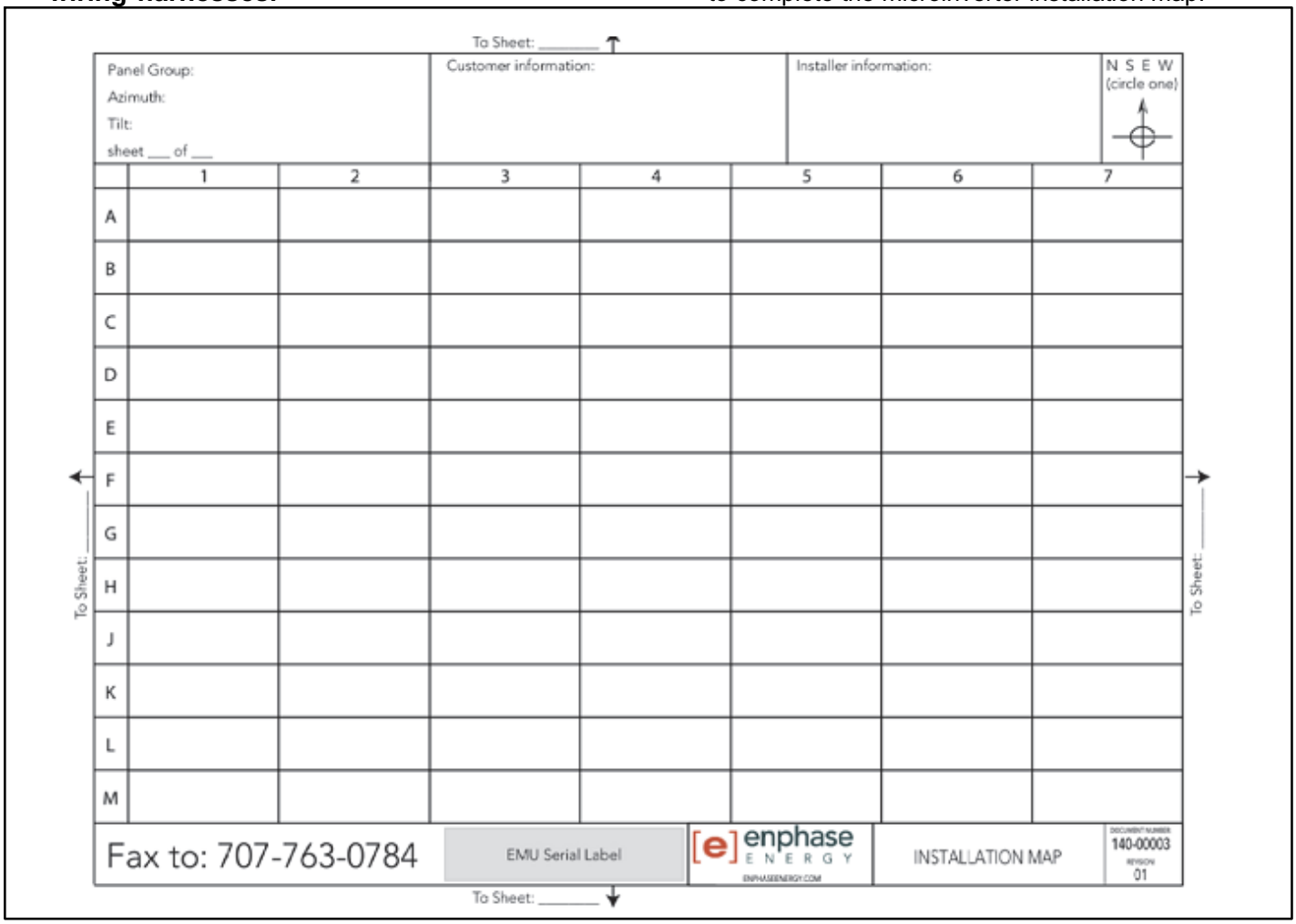
2. **Verify the connections of the microinverter wiring harnesses.**

   Each microinverter comes with one 4-pin receptacle and one 70-inch AC wire harness with multi-pin connectors. The AC connectors are oppositely sexed, so that multiple microinverters can be connected to form one continuous AC branch circuit.

   - Install a protective end cap on the open AC connector of the last microinverter in the AC branch circuit.
   - Wait to connect the first microinventer to the AC interconnection cable until step 4. All AC interconnection cables have four conductors. Do not exceed 15 microinverters in an AC branch circuit, as displayed on the unit-rating label.

3. **Complete the microinverter installation map.**

   The microinverter installation map is a diagram of the physical location of each microinverter in your system. If you have purchased an Envoy Communications Gateway, follow the included quickstart monitoring guide to complete the microinverter installation map.



4. **Commissioning**

   Ensure that all AC wiring is correct. Ensure that none of the AC and DC wires are pinched or damaged. Ensure that all junction boxes are properly closed.

To commission the Andalay AC system:

A Turn ON the AC disconnect or circuit breaker on the microinverter AC branch circuit. Check the voltages on the AC interconnection cable pins to ensure proper wiring. **Please verify proper AC cable voltage prior to connecting to live voltage or connecting the harness to the Andalay AC string (see figure 18). Failure to properly connecting the wires can result in severe damage and void the warranty.**

B Turn OFF the AC disconnect or circuit breaker and connect the AC interconnection cable to the string/branch.

C Turn ON the AC disconnect or circuit breaker. Your system will start producing power after a five-minute wait time.

D The Andalay AC microinverters will start to send performance data over household wiring to the Envoy. The time required for all the microinverters in the system to report to the Envoy will vary with the number of microinverters in the system. The first units should be detected within 15 minutes; however, the entire system could take hours to detect. Please refer to the Envoy installation and operation manual for further information.

The microinverter is powered on when sufficient sunlight hits the solar panel. The status LED will flash green six times indicating proper start-up.

In the event of a PV ground-fault detector interrupter (GFDI) failure, the status LED will display continuous red after the fault occurs. This will persist until AC power is cycled to the microinverter.

System Equipment Maintenance

MATERIAL AND TOOLS LIST

- Manufacturer's literature and troubleshooting guides**.**
- Volt- ohm meter
- Gauges
- Thermometer
- Assortment of screwdrivers, nut drivers and wrenches.

⚠ WARNING

Electric Shock Hazard. Can cause injury or death. Unit must be grounded in accordance with national and local codes.

Line voltage is present at all components when unit is not in operation on units with single-pole contactors. Disconnect all remote electric power supplies before opening access panel. Unit may have multiple power supplies.

OUTDOOR UNIT

Refer to the maintenance section in the installation instructions provided with the outdoor unit.

SOLAR MODULES

- Check for any shading problems caused by new plant growth.
- If dirt build-up becomes excessive, clean the glass surface only with a soft cloth using water. Avoid solvents and strong detergents.
- Once a year, have qualified service personnel check the general condition of the wiring and check to be sure that mounting hardware is tight.

MICROINVENTER AND MONITORING DEVICES

These devices have no maintenance requirements.

Troubleshooting

COMMON SYSTEM FAILURES

- Check for blown fuses, tripped breakers or poor electrical connections.
- Check system for proper system voltage and current.

OUTDOOR UNIT

Refer to Lennox Service Manual for troubleshooting information

SOLAR MODULES AND MICROINVERTERS

1. **Troubleshooting**

   Adhere to all the safety measures described throughout this document. Qualified personnel can use the following troubleshooting steps if the solar system does not operate correctly:

⚠ WARNING

Do not attempt to repair the microinverter; it contains no user-serviceable parts. If it fails, please contact Enphase customer service to obtain an RMA number and start the replacement process.

Microinverter Status LED Indications and Error Reporting

Start-Up LED Operation:

- Six short green blinks when DC power is first applied to the microinverter indicate a successful microinverter start up sequence.
- Six short red blinks when DC power is first applied to the microinverter indicate a failure during microinverter start-up.

Post-Start-Up LED Operation:

- Flashing Green — System is producing power and communicating with Envoy.
- Flashing Orange — System is producing power and not communicating with Envoy.
- Flashing Red - System is not producing power.

GFDI Fault

A solid red status LED when DC power has been cycled indicates the microinverter has detected a GFDI error. The LED will remain red and the fault will continue to be reported by the Envoy until the error has been cleared. The error can only be cleared via the Envoy after the ground fault condition has been remedied. Contact Enphase customer support for assistance.

Other Faults

All other faults are reported to the Envoy. Refer to the Envoy installation and operation manual for a list of additional faults and troubleshooting procedures.

⚠ WARNING

Always disconnect AC power before disconnecting the solar panel wires from the microinverter. The AC connector of the first microinverter in a branch circuit is suitable as a disconnecting means once the AC branch circuit breaker in the load center has been opened.

2. **Troubleshooting an Inoperable microinverter (for experienced installers)**
   To troubleshoot an inoperable microinverter, follow the steps in the order shown:
   - **A** Check the connection to the utility grid. Verify the utility voltage and frequency is within allowable ranges shown in the technical data section of the Andalay AC System Install Tips. Verify utility power is present at the microinverter in question by removing AC, then DC power. Never disconnect the DC wires while the microinverter is producing power. Re-connect the DC panel connectors and watch for six short LED flashes.
   - **B** Check the AC branch circuit interconnection harness between all the microinverters. Verify each microinverter is energized by the utility grid as described in the previous step.
   - **C** Make sure that any AC disconnects are functioning properly and are closed.
   - **D** Verify the PV panel DC voltage is within the allowable range shown in the Technical Data page of this document.
   - **E** Check the DC connections between the microinverter and the solar panel.
   - **F** If the problem persists, please call customer support at Andalay Solar.

3. Disconnecting the microinverter from the solar panel
   To ensure the microinverter is not disconnected from the PV panels under load, adhere to the following disconnection steps in the order shown:
   - **A** Disconnect the AC by opening the branch circuit breaker, or disconnect.
   - **B** Disconnect the first AC connector in the branch circuit.
   - **C** Cover the panel with an opaque cover.
   - **D** Using a DC current probe, verify there is no current flowing in the DC wires between the Andalay panel and the microinverter.
   - **E** Care should be taken when measuring DC currents, most clamp-on meters must be zeroed first and tend to drift with time.
   - **F** Disconnect the Andalay panel DC wire connectors from the microinverter.
   - **G** Remove the microinverter from the Andalay AC frame.

MONITORING SYSTEM

The following sections describe possible problems. For information on system status and events messages see Enphase Envoy event messages on page 21.

Potential Problems and Solutions

IP Address Problem: If the IP address displayed on the Envoy's LCD window does not match the dynamic host configuration protocol (DHCP) subnet on your internal network and shows something beginning with 169.254.x.x, this means that it was unsuccessful in obtaining a DHCP lease from your router.

- Check network connectivity to the router or other DHCP server. You may also wish to contact your internet service provider or refer to your router documentation for assistance.

LCD Window Displays — Web: This means that the Envoy could not connect to the internet to find an network time protocol (NTP) server and could not connect to the Enlighten website.

- Check network connectivity to the premises router or switch. You may also wish to contact your internet service provider or refer to your router documentation for assistance.

LCD Window Displays — Envoy Failure +Web or -Web: This message displays after the Envoy has tried unsuccessfully three times to initialize. At this point, the Envoy attempts to open a virtual private network (VPN) tunnel to allow Enphase to perform remote diagnostics addressing the problem. This attempt to open a VPN tunnel occurs every hour on the hour. If successfully opened, the tunnel stays open for 50 minutes. The Envoy displays **Envoy Failure +Web** to indicate that the tunnel is open. After the 50 minute period, the tunnel is closed and the **-Web** indication may again be displayed.

NOTE — Attempts to open a tunnel continue until recovery takes place, at which point the Envoy resumes normal operation.

Microinverter count does not match number of installed units: This message may indicate that the Envoy has not finished scanning/discovering the entire array. It may indicate that the Envoy is having difficulty communicating over the power lines. It could also be a result of low light levels and the module voltage is too low for the microinverter to power-up.

- Try plugging the Envoy into a different electrical socket that is closer to your main electrical panel. Also, make sure that the Envoy is plugged directly into the wall and not into a power strip or surge protector.

ENVOY LOCAL INTERFACE

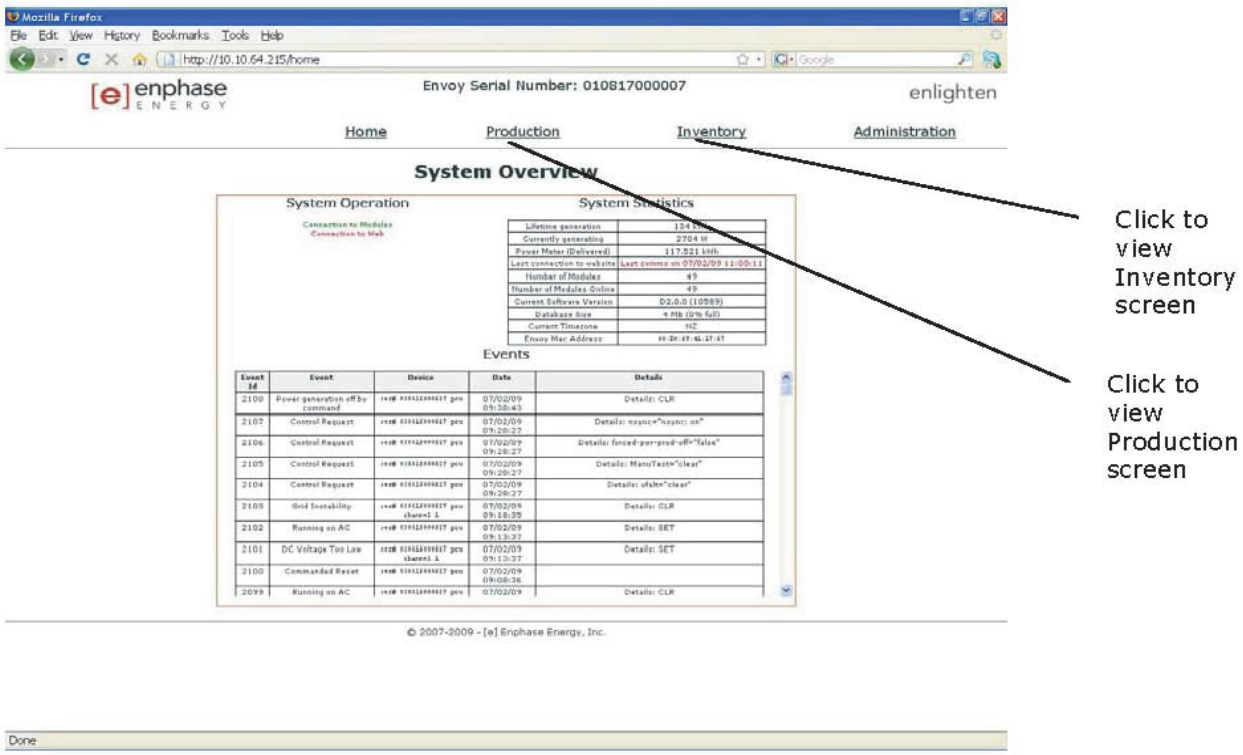
Connection to the Enphase Enlighten™ web-based monitoring and analysis website requires an Internet connection. However, if there is no Internet access at the installation site, it is still possible to communicate directly with the Envoy using the ethernet port and a personal computer with a web browser. The following steps describe how to access the Envoy and the data that is available through the local connection.

1. Connect one end of the ethernet cable supplied with the Envoy to the Envoy port labeled ethernet.
2. Connect the other end of the ethernet cable to the RJ45 network port of the computer.
3. Open the Internet browser application on the computer.
4. In the browser address window, enter the IP address displayed in the LCD window of the Envoy (for example - 192.194.2.141).
   - Subnet to 169.254.120.2
   - Subnet mask to 255.255.0.0

   If you still fail to make a connection, try to manually configure your subnet. Call Enphase customer support at 877-797-4743.

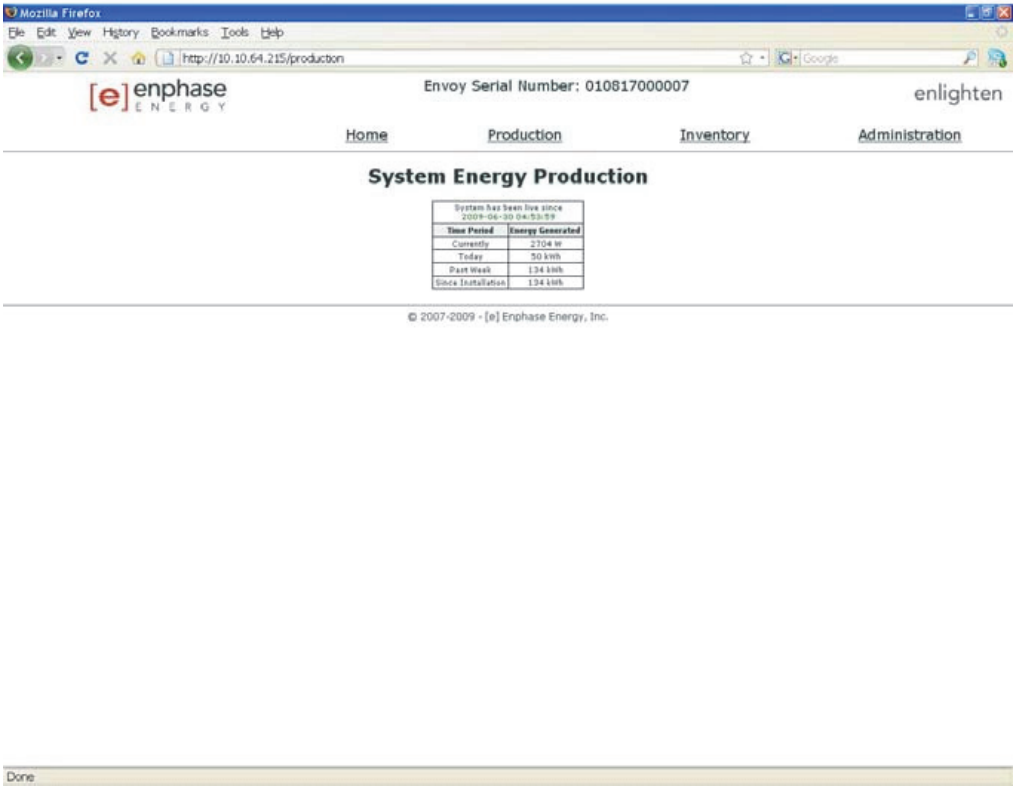
Home Screen

Once the browser has successfully connected with the Envoy, the following screen is displayed in the browser. This home screen provides a system overview and shows the current status of the microinverters that have been identified by this Envoy. From this screen, you can access other screens in the interface.



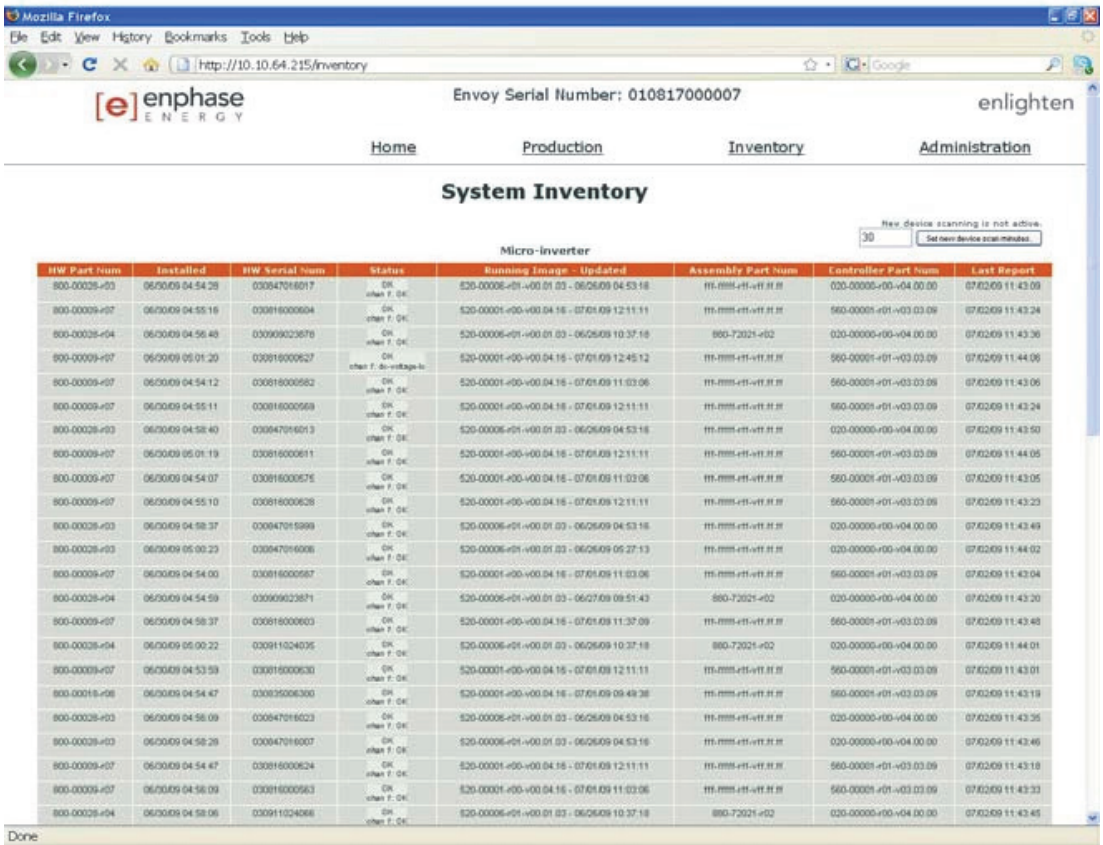
Production Screen

To view system energy production statistics for your system, click **Production** from the Envoy home screen to navigate to the production screen.



Inventory Screen

To view a listing of the microinverters in your system, click **Inventory** from any screen to navigate to the inventory screen.



Event Messages

The table below lists messages that the Envoy can produce to indicate certain conditions. These messages appear on the screen when your computer is connected to the Envoy local interface. These messages can provide Enphase customer support with valuable information, should you need to call for assistance.

Where message is displayed:		
Home Screen	**Inventory Screen**	**Description**
AC Frequency Out Of Range	ac-freq-oor	The frequency of the AC grid has exceeded the limits specified by UL 1741.
AC Voltage Out Of Range	ac-voltage-oos-p# (# = 1, 2 or 3)	The voltage of the indicated AC phase (relative to neutral) has exceeded the limits specified by UL 1741.
Audible alarm active	audible-active	The inverter's buzzer is active, either due to an internally detected error or by user command.
Bad Flash Image	bad-flash-image	The inverter is not producing power because one of its flash memory images is corrupt. Contact Enphase Energy customer support at 877-797-4743 for assistance.
Commanded Reset	commanded-reset	The inverter has reset, either following a successful image download or by user command.
Control Request		This event logs a user control request made using the Administration > Device Conditions and Controls page or via Enlighten.
Critical Temperature	critical-temp	The inverter is producing less power in an attempt to not overheat (see Over Temperature)
DC Too High	dc-voltage-hi	The DC input voltage to the inverter is too high; check that the PV module and inverter are compatible.
DC Too Low	dc-voltage-lo	The DC input voltage to the inverter is too low; this is a normal condition at night, but during the day may indicate a bad or missing DC connection to the inverter.
Download to module begun		The Envoy has begun an image download to the indicated inverter.
Download to module ended		The Envoy has successfully downloaded an image to an inverter.
Download to module failed		The Envoy was unable to successfully download an image to an inverter.

Where message is displayed:		
Home Screen	**Inventory Screen**	**Description**
GFI Tripped	gfi-tripped	An inverter has detected ground fault current greater than one amp. The error can only be cleared via the Envoy after the ground fault condition has been remedied. The GFI can be cleared using the Device Conditions and Controls page unless the failure is permanent. Contact Enphase Energy customer support at 877-797-4743 for assistance.
Grid Gone	grid-gone	The AC utility grid is no longer present.
Grid Instability	grid-instability	The inverter is not producing power due to one or more of these conditions: AC Frequency Out Of Range, AC Voltage Out Of Range, or Grid Gone. Note that Grid Instability will remain for about 5 minutes after the underlying conditions clear.
Module added		The Envoy has detected and is now associated to a new inverter.
Module failed to report		The Envoy has not received a response to the last three messages sent to an inverter.
Module Sleeping		Inverter is off for the night
Over Temperature	over-temp	The inverter is not producing power, because it is too hot.
Power generation off by command	forced-pwr-prod-off	The inverter is not producing power by user command.
Power On Reset	power-on-reset	The inverter has powered on after having both AC and DC disconnected.
Shutdown		The Envoy shut down its internal processing.
Skipped Cycles	skipped-cycles	The inverter has not produced power for more than 5% of the most recent production interval; this may be due to real problems in the grid, or a hardware failure of the inverter.
Startup		The Envoy started its internal processing.

Warranty

Dave Lennox *Signature*® Collection air conditioners and heat pumps have a 10-year limited warranty. The Lennox® Solar Subpanel accessory is also covered by a 10-year limited warranty.

The PV AC module consists of several components, each of which is covered by its own warranty. The frame on the panel and the balance of the system components (roof mounting hardware, etc.) are covered by a 10−year limited warranty. The solar module is covered by a 10−year workmanship warranty and also has a power output guarantee. The power output guarantee states that the output of the module will not degrade over time more than a set percentage of 0.7% per year for 25 years. The micro-inverter has a 25 year limited warranty. The Envoy Communication Gateway has a one (1) year warranty. Warranty for these items are handled by their respective manufactures.

Item	Warranty
DLSC SunSource® Outdoor Unit	10 years
Lennox® Solar Subpanel Accessory (circuit breakers only)	10 years
Solar module (except panel i.e., frame, hardware, etc)	10 years
Solar panel performance	.7% degradation of rated output per year for 25 years
Microinverter	25 years
Envoy communication gate-way	1 year

Glossary

Microinverter — A microinverter is a device that converts the direct current output of a single solar panel into grid-compliant alternating current power.

Module — The technical term for a solar panel.

NEC — National Electrical Code® which contains safety guidelines and required practices for all types of electrical installations. Article 690 pertains to solar photovoltaic systems.

Net Metering — Allows the exchange of any surplus energy produced by the PV system. This means that the electric meter spins backward when power is flowing from the home to the utility and spins forward when power is flowing from the utility to the home. At the end of the month, only the net consumption is billed to the homeowner.

Nominal Operating Cell Temperature (NOCT) — The reference module operating temperature presented on manufacturer's literature. Generally the NOCT is referenced at 25°C (77° F).

Open-circuit voltage (Voc) — The maximum possible voltage across a photovoltaic module; the voltage across the module in sunlight when no current is flowing.

Photovoltaic peak watt — Maximum rated output of a module, or system. Typical rating conditions are 0.645 watts per square inch (1000 watts per square meter) of sunlight, 20°C (68°F) ambient temperature and 6.2 x10 $^{-3}$ mi/s (1 m/s) wind speed.

Power Factor — The ratio of the average power and the apparent volt-amperes.

PV – Abbreviation for photovoltaic.

Short-circuit current (Isc) — The current flowing freely from a photovoltaic module through an external circuit that has no load or resistance; the maximum current possible.

Voltage at Maximum Power (Vmp) — The voltage at which maximum power is available from a module.

Watt-hour (Wh) — A quantity of electrical energy when one watt is used for one hour.

Solar Resources on the Web

ENPHASE ENERGY

Contact options for support of questions regarding product, installation, operation or warranty

www.enphaseenergy.com

DSIRE

Database of state incentives and efficiency.

www.dsireusa.org

SOLAR ENERGY INTERNATIONAL

Information on renewable energy resources.

www.solarenergy.org

NATIONAL RENEWABLE ENERGY LABORATORY (NREL)

NREL is the only federal laboratory dedicated to the research, development, commercialization and deployment of renewable energy and energy efficiency technologies.

www.nrel.gov

FLORIDA SOLAR ENERGY CENTER

Although many people think that our research is targeted only at solutions for tomorrow, much of what we do creates technologies for today.

www.fsec.ucf.edu

SOLAR TRAINING AND CONSULTATION

North American Board of Certified Energy Practitioners

www.nabcep.org

HOMEPOWER MAGAZINE

Information resource.

www.homepower.com

SOLAR PATHFINDER™ or **SOLMETRIC SUNEYE™**

Manufacturers and distributors of site shade analysis tool used to aid in site selection

www.solarpathfinder.com

www.solmetric.com

SOLARBUZZ®

Information resources for solar energy organizations.

www.solarbuzz.com./CompanyListings/UnitedStates8.htm

SOLAR AMERICA BOARD FOR CODES AND STANDARDS

The Solar America Board for Codes and Standards (Solar ABCs) is a collaborative effort among experts to formally gather and prioritize input from the broad spectrum of solar photovoltaic stakeholders including policy makers, manufacturers, installers, and consumers resulting in coordinated recommendations to codes and standards making bodies for existing and new solar technologies. The U.S. Department of Energy funds Solar ABCs as part of its commitment to facilitate wide-spread adoption of safe, reliable, and cost-effective solar technologies.

www.solarabcs.org

SOLARPRO

SolarPro is a high-quality technical publication available to qualifying solar industry professionals. Subscriptions are free. Highly recommended.

www.solarprofessional.com

ENPHASE ENERGY - ALL PUBLIC SYSTEMS

Select the following link as an example of a 15-module system SunSource® System·

https://enlighten.enphaseenergy.com/public/systems/D72j46363

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

California Department of Forestry and Fire Protection, Solar Photovoltaic Installation Guideline (dealing with fire safety issues)

www.osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf

UNIVERSITY OF OREGON SOLAR RADIATION LABORATORY

University of Oregon Solar Radiation Laboratory sun path chart program.

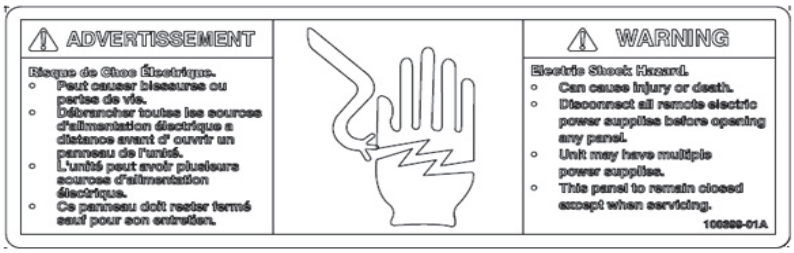
solardat.uoregon.edu/SunChartProgram.html

NOTICE

SOURCE CIRCUIT DISCONNECT FOR HVAC UNIT
(DISCONNECT BOTH POWER SOURCES BEFORE PERFORMING REPAIRS OR OPENING EQUIPMENT SERVICE PANEL)

HVAC BREAKER (CB10)
NOT A SERVICE DISCONNECT

SOLAR BREAKER (CB40)
NOT A SERVICE DISCONNECT



Appendix A — Roof Pitch