



LeadSolar Energy Microinverter LS600

Installation & Operation Guide

North American Edition

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Safety Directives and Code Compliance

This chapter contains the safety instructions and conditions of acceptability for the entire system. To maintain product warranty, these directions must be followed when installing, operating and servicing the unit. If ignored, physical injury or death may happen, or damage may occur to the unit.

Read these Instructions before working on the unit. If you are unable to understand the Dangers, Warnings, Cautions or Instructions, contact the manufacturer or authorized service agent before installing, operating and servicing the unit. The grid connected Inverter meets the requirements stipulated in:

- NEC 2014 Section 690.12 Rapid Shutdown of PV Systems on Buildings
- NEC 2014 Section 705.12 Point of Connection
- NEC 2014 Section 690.11

Other Information

All information, specifications and illustrations in this manual are those in effect at the time of printing. LeadSolar Energy reserves the right to change specifications or design at any time without notice.

For the latest information about our products, please go to www.leadsolarenergy.com

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Notes

1.1 Validity

This installation manual describes the assembly, installation, commissioning, and maintenance and failure identification of the following inverters:

LeadSolar LS600

1.2 Symbols used

The following symbols are used in this manual:



WARNING!

This indicates a safety hazard that could cause personal injury or equipment malfunction. Follow these instructions carefully to avoid or reduce the risk.



NOTE

This indicates important information that is critical to optimizing system performance.

1.3 Safety Instructions

1. **Follow local installation codes.** Make sure to adhere to all applicable national and local electrical codes during installation. Only qualified personnel should install or replace LeadSolar Microinverters.
2. **No DIY repairs.** Users must never attempt to repair or modify the LeadSolar Microinverter themselves. If the microinverter fails to operate, contact LeadSolar customer service for repair or replacement. Tampering with or opening the hardware will void the warranty.
3. **Read the instructions.** Read all instructions and cautionary notes before installing or using LeadSolar hardware.
4. **Disconnect safely.** Disconnect the AC power grid connection *first* before disconnecting the PV module from the LeadSolar Microinverter.
5. **Microinverter can get hot.** The majority of the LeadSolar Microinverter is a heat sink. Under normal operating conditions, the temperature is 59°F (15°C), but it can reach 176°F (80°C) under extreme conditions. To reduce risk of burns, use caution when working with microinverters.
6. **It's already fine-tuned for your region.** Be aware that the LS600 have different default factory settings for the applications in different regions throughout the world. The LS600 do not need field adjustment or tuning. It will start to deliver power to the electric grid automatically after installation.

1.4 Explanation of Symbols

The following symbols are shown on the microinverter:

Symbol	Explanation
	Treatment To comply with European Directive 2002/96/EC on waste Electrical and Electronic Equipment and its implementation as national law, electrical equipment that has reached the end of its life must be collected separately and returned to an approved recycling facility. Any device no longer required must be returned to an authorized dealer or approved collection and recycling facility.
	TÜV SÜD certification The LeadSolar Microinverter meets the product quality standards of TÜV SÜD.
	Caution Do not come within 8 inches (20cm) of the microinverter for any length of time while it is in operation.
	Danger of high voltages Danger to life due to high voltage in the microinverter.
	Beware of hot surface The inverter can become hot during operation. Avoid contact with metal surfaces during operation.
	CE mark The inverter complies with the requirements of the Low Voltage Directive for the European Union.
	Read manual first Please read the installation manual first before installation, operation and maintenance.
 5 minutes	Caution, risk of electric shock, Energy storage timed discharge After disconnecting both AC and DC supplies from the panel, wait 5 minutes until handling the microinverter.

Introduction

Welcome to the growing family of high performance LS600 microinverter system owners. The LeadSolar

Microinverter System is among the most advanced inverter systems for use in utility-interactive photovoltaic applications. This system is highly reliable, highly efficient, and easy to install. The three key elements of a LeadSolar Microinverter System include:

- LeadSolar Microinverter
- LeadSolar Link™ or Digi™ Communications Gateway
- LeadSolar LinkView™ web-based monitoring and analysis software

For most of the PV applications, the LeadSolar microinverter system will benefit the system owner from the initial system design throughout the entire lifetime of the system.

2.1 LeadSolar Smart Solar: More Flexibility, More Productivity

Microinverters are what make a distributed solar system possible. Conventional solar systems string numerous solar panels together and connect them all to a single, central grid-tied inverter. This works well if all panels are under uniform conditions, but efficiency is lost when some of the panels are shaded by cloud, trees, or debris. Particularly for roof-top residential and commercial PV applications, the output power from a central inverter system is usually not maximized, no matter what advanced PV modules or inverter technologies are used.

	Traditional String Inverter	LeadSolar Microinverter
Warranty (yrs)	5 - 10	10 - 25
System Risks	The whole system	Local
Maintenance	Professionally trained technician on site repair	Remote support and problem fixing
DC High Voltage	Yes	No
DC Arc Fire Risk	Yes	No
Electric Generation Control	Cannot turn off in daylight	Automatic turn off
System Design	High voltage DC wiring	Flexible
Accessories	DC conduit, junction boxes, etc.	AC connection
Installation	Additional location required	Inverter integrated with solar panel

In the LeadSolar microinverter system, PV modules will not be connected to a central inverter. Instead, each PV module has its own inverter to feed the harvested energy from PV module to electric grid. The maximum power point tracking (MPPT) controller embedded in the microinverter will monitor the operation of the PV module in real time and maintain a maximum power point. If one or several PV modules in the system are shaded, the output power of these modules will drop but the other modules will not be affected and continue to output at their maximum power level. LeadSolar's smart solar power system can typically harvest 15% - 25% more electric energy than a traditional system with one central inverter.

2.2 Reliability

The LeadSolar microinverter provides highly reliable solar installations by removing failure-prone central inverters. With no single point of system failure, LeadSolar Microinverters are designed to operate at full power with ambient temperatures as high as 65°C. The microinverter housing is designed for outdoor installation and complies with the IP65 environmental enclosure rating standard. LeadSolar Energy uses the harshest possible testing conditions; each unit is both tested at the factory and tracked in the field.

2.3 System Monitoring & Easy Maintenance

The LeadSolar Link™ Communications Gateway provides a unique and convenient way to monitor your system's operation and performance.

To install a LeadSolar Link Gateway, just plug it into any wall socket in your house and use the provided Ethernet cable or WiFi option to connect it to your broadband router or modem. Then the Gateway will automatically start to work and communicate with the microinverters in your system. The collected system operation data will be reported to the LeadSolar Management web server. The Management software presents current and historical system performance trends, and it informs you of PV system status.

2.4 Simple Design & Easy Installation

LeadSolar Microinverters have a simple design for easy installation. Traditional design procedures (string calculations, panel orientation, etc.) are not necessary for LeadSolar microinverter systems. Simply attach the microinverter to a compatible PV module and connect the DC and AC cables to the panel and AC grid. The installation is finished and the system is ready to work.

The system is open and can accommodate new panels at any time. This allows users to adopt solar power at their own pace, and as their budget allows. One panel's failure does not impede others at all. Maintenance, repair, and replacement do not require the whole system to be shut down — only the panel that needs repair. Distributed systems eliminate the risk of personnel exposure to hazardous voltages (up to 1000V), which is common in a string or central inverter system.

Installation

Follow the instructions in this section to install LeadSolar LS600 Microinverters.



Only qualified personnel should connect the LeadSolar Microinverter to the utility grid. Installation includes risk of electric shock. PV modules connected to LeadSolar Microinverters must be grounded before installation.



LeadSolar recommends installing a surge suppressor on all systems to prevent damage to the microinverters against voltage spikes. LeadSolar is not responsible for microinverter damage due to voltage spikes if the system is unprotected.



Prior to the site visit, the installer should first set up an installer account by registering at www.lead solar.net. A customer account is next created which can then be linked to the installer account

3.1 Compatibility & Capacity

The LS600 model is compatible with both 60-cell and 72-cell PV modules subject to the microinverter input specification listed on the data sheet. Lead Solar sets the maximum inverter output current at the factory. Different regions or design limitations may require a different output current. Maximum branch circuit size is a function of the PV breaker size, and the inverter output current per the table below:

Electrical Compatibility

Model Number	AC Wire Gauge	Compatible PV Module Type	PV Module Connector Type
LS600-240-P	12 AWG	60-cell or 72-cell PV Module	MC-4 Type 2 Locking or Amphenol H4 Locking
LS600-XXX-Z	10 AWG	60-cell or 72-cell PV Module	MC-4 Type 2 Locking or Amphenol H4 Locking

Maximum # LS600-240-P Microinverters per 20A AC Branch Circuit

Grid Voltage/Type	Maximum # per Branch Circuit
Single Phase 240V, Inv. Output=2.0A	8
Single Phase 240V, Inv. Output=2.5A	6
Single Phase 240V, Inv. Output=2.92A	5

Maximum # LS600-XXX-Z Microinverters per 30A AC Branch Circuit

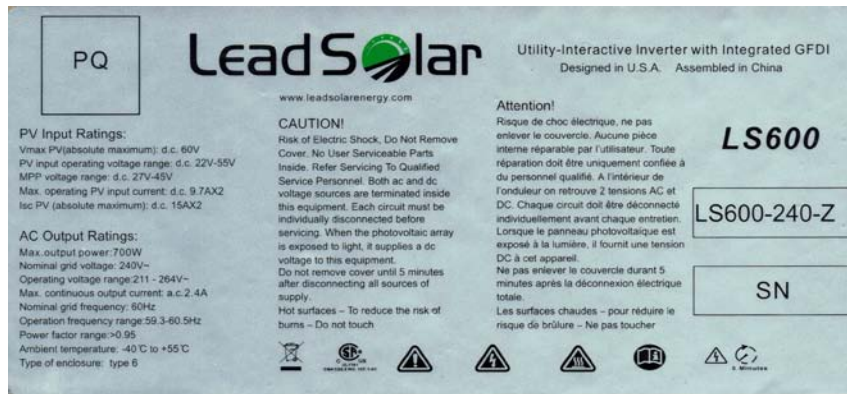
Grid Voltage/Type	Maximum # per Branch Circuit
Single Phase 208V, Inv. Output=2.88A	8
Single Phase 240V, Inv. Output=2.92A	8
Single Phase 240V, Inv. Output=2.4A	10
Single Phase 240V, Inv. Output=2.0A	12
Single Phase 277V, Inv. Output=2.53A	9
Single Phase 277V, Inv. Output=2.4A	10
Single Phase 277V, Inv. Output=2.0A	12

3.2 Packaging

Included in a LeadSolar Microinverter System package are:

Object description	Quantity
1. Microinverter	1
2. Grounding terminal	1 set

3.3 Microinverter Identification



Note: S/N attached to marking plate identifies the manufacturing location and the batch or production date. Please record the serial number and ID before installation. LeadSolar recommends making an installation map showing inverter location as laid out on the roof. Please refer to the LeadSolar Gateway Commissioning Guide for instructions on how to register microinverters for monitoring.

3.4 Required Parts & Tools

The LeadSolar microinverter systems are designed for easy installation. During installation, the following parts and tools are required:

LeadSolar Parts:

- LeadSolar LS600 Microinverters – one for every two panels
- Jumper cable- one for each active end of AC branch
(Alternatively a cable can be constructed from a connector and length of three wire TC-ER cable)
- End Caps – one for each end of a branch circuit.

Other Items:

- AC junction boxes
- Gland or strain relief fitting (one per AC junction box)
- Continuous grounding conductor, 5/16" stainless steel star washers, hex nuts and bolts
- Cable clips
- Number 2 and 3 Phillips screwdrivers
- Torque wrench, sockets, wrenches for mounting hardware
- Adjustable wrench or open-ended wrench (for terminators)
- Handheld mirror (to view indicator lights on the undersides of the microinverters)

3.5 Lightning & Surge Suppression

PV systems are usually installed in open fields or on rooftops - places where lightning can strike. Lightning causes drastic voltage spikes in solar panels, which may damage equipment. While LeadSolar Energy Microinverters have built-in surge protection, this may not always protect all equipment from the energy spike caused by lightning. Additional surge protection devices are strongly recommended.



Additional surge protection devices are strongly recommended to fully protect your system.

Installation Procedure

4.1 Preparation

Installation tools: multimeter, allen wrench, impact drill, screwdriver, torque and adjustable wrench



Make sure AC & DC plugs are drained of electrical charge before installation and maintenance! If the DC side has recently been disconnected, capacitors will still contain a residual charge. Wait for at least 5 minutes to ensure the capacitors are no longer electrified

4.2 Installation



Read entire installation procedure before installing. The following procedure must be strictly followed for a proper installation.

- Step 1: Measure AC Voltage at the Point of Common Coupling (PCC) for the electrical utility
- Step 2: Attach microinverters to PV Racking
- Step 3: Connect microinverter's AC cable
- Step 4: Terminate unused end of AC cable for each branch.
- Step 5: Install AC branch circuit junction box.
- Step 6: Ground system & microinverters
- Step 7: Complete the installation map
- Step 8: Install the Link nearby the ac main
- Step 9: Connect microinverters to PV modules
- Step 10: Register microinverters with communication option at www.lead solarenergy.com/register
(Note: The registration process may take at least 20 minutes, depending on system size)



LeadSolar recommends taking photos of the PV system during installation, including the panel label, microinverter attachment to the racking, the junction box connection, gateway connection and the system grounding.



DO NOT connect LeadSolar Microinverters to the utility grid to energize the AC circuit(s) until you have completed all of the installation procedures.

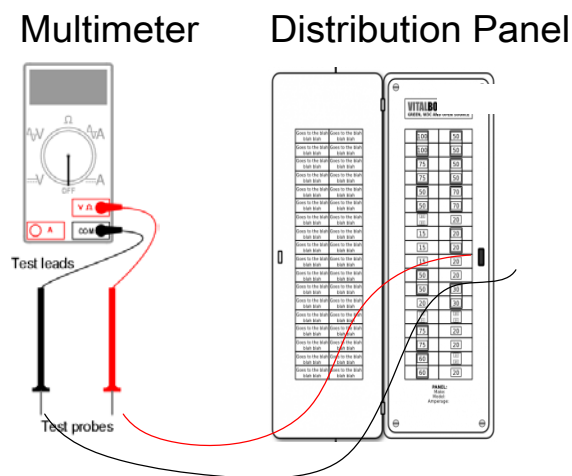
Step 1: Measure Grid AC Voltage at Electrical Utility Connection

Measure AC line voltage at the point of common utility connection coupling to ensure it is within the proper range for the microinverter's operation. Acceptable ranges are shown as below:

Single phase 240V AC: 211V – 264V

Single phase 120/208V AC: 183V – 229V

Single phase 277/480V AC: 244V – 305V



Check cable voltage rating before installation. For LeadSolar jumper cables, voltage rating is marked on the cable's label. Never use cables with insufficient voltage rating

Step 2: Attach Microinverter to PV Racking

The position for the microinverter on the PV racking is flexible and is usually determined before installation.

Put the microinverter under the PV module, out of direct sunlight with the rib side facing down. Also, leave at least 0.6in (1.5cm) clearance between the roof and the bottom of the microinverter; and at least 0.6 in (1.5cm) clearance between the back of the PV module and the top of the microinverter.



Ensure the microinverter is properly grounded per the instructions in Step 6.

Step 3: Connect Microinverter's AC Cable

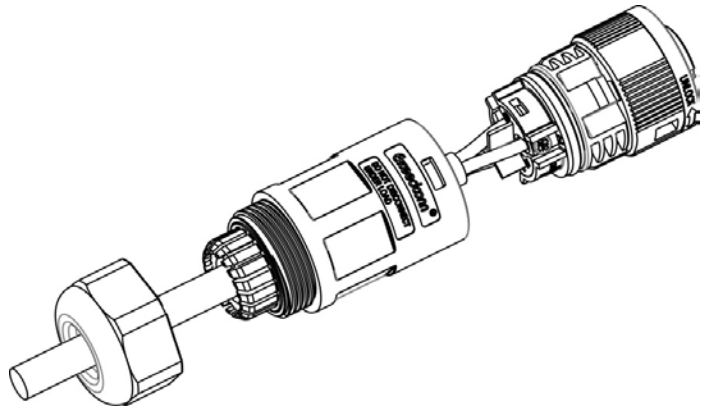


Do NOT exceed the maximum number of microinverters in an AC branch circuit as specified in this manual.

Series Connection

Before connecting the AC cables of the microinverter, check the number of the microinverters in each AC branch circuit. Beginning with the end of the branch, connect one of the AC cable of the last microinverter in the branch to the adjacent microinverter. Then, sequentially repeat this step for each microinverter in the branch. Next, connect the second AC cable of the first microinverter to the AC cable running from the junction box. This cable may be constructed by either building a jumper by adding the appropriate connector to a length of three wire TC-ER cable (as pictured below) or cutting off the non needed connector from the prefabricated LeadSolar three meter jumper cable.

- User constructed AC jumper cable
- Connects first microinverter to J box
- Do not leave this cable exposed if disconnected from microinverter
- If disconnected, terminate with protective cap.



Alternative Center Tap Connection

For systems where a fully populated branch circuit exceeds voltage rise limits (>75') or where dictated by roof topology, LeadSolar recommends center tapping the branch circuit. This is accomplished by placing the junction box midway between the first and last inverter in the branch. The microinverters then connect to the junction box by either constructing two jumpers, one with a male connector and the other with a female connector attached to a three wire TC-ER cable (or two female pigtails for the 10AWG cables), or by cutting the prefabricated LeadSolar three meter jumper approximately in half and terminating each wire end into the junction box.

Step 4: Terminate Unused End of AC Cable for Each Branch

Install the appropriate end cap (male or female) on the end or ends of the branch not connected to the junction box



Never leave unused AC cables open/floating in the system. Terminate the unused end of an AC cable with provided protective caps. Terminate the unused end of the AC cable for each branch.

Step 5: Ground the System & Microinverter

For safety considerations, all non-current carrying elements in a photovoltaic system (including PV module, PV racking and microinverter case) must be securely grounded before operation. Choose one of the two methods below for system grounding:

1. LS600 series of microinverters include an Integrated Ground feature. Therefore, it is not necessary to connect a Grounding Electrode Conductor (GEC) between each microinverter.
2. The requirement for an EGC is met by the ground conductor internal to the LS600 cable. It may be possible to eliminate the need for an EGC to the rest of the PV system (racking and modules) if a suitable ground connection is made between the microinverter and the rest of the system. The Grounding Electrode Conductor (GEC), which is used between the grounding electrode and the point where a normally current carrying conductor should be bonded to ground
3. Optional Connection: Should the local jurisdiction insist on an additional equipment ground, LeadSolar provides an optional grounding clamp and attachment point.



Never start system operation before finishing system grounding. The ground fault detection device (GFDD) inside the microinverter may be tripped if the system is not securely grounded.

Step 6: Complete the Installation Map

The serial numbers or QR codes of the microinverters are necessary for registration in the LeadSolar monitoring software.

The Installation Map is a representation of the physical location of each microinverter in your PV installation. The virtual array in the LeadSolar web APP is created from the map you created. You can first create a blank version according to a previous system design before placing the microinverters to the array.

Each microinverter has a removable serial number label located on the top. When installing the microinverters, remove the serial number labels located and place in the correct order on your drawing of the system. Remember to keep a copy of the installation for your records.



You are not done yet! Complete the Operation Guide section to begin use properly. It is important to record the series number of the microinverters and communication gateways for adding these devices in our database.

Step 7: Install the Communication Link

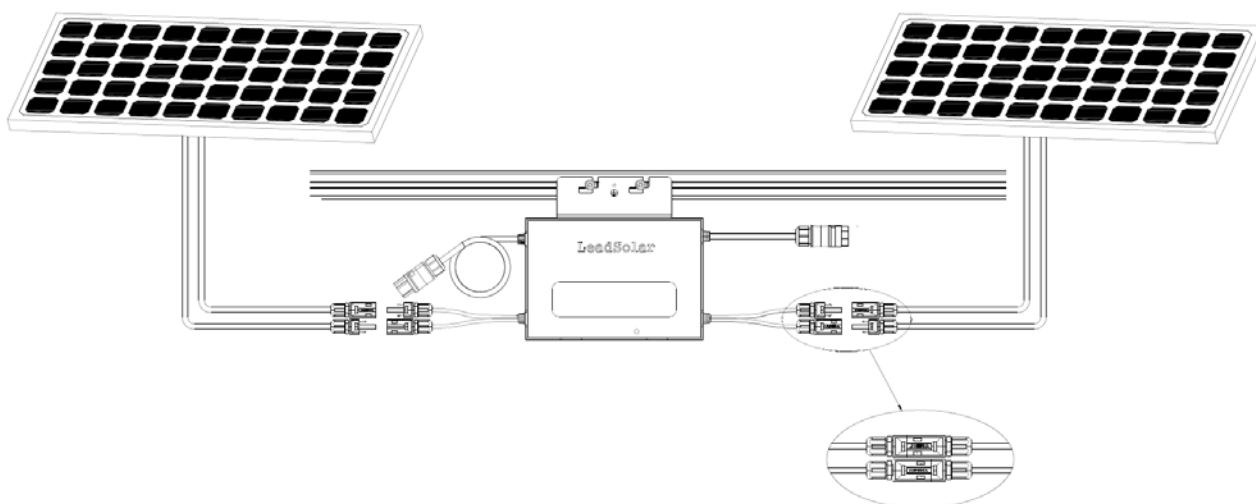
The Link™ or Digi™ Gateway is an integral component of the LeadSolar Energy Microinverter system. It functions as a communication gateway and monitors the microinverters that are connected to the PV modules.

The Link™ collects energy and performance data from the microinverters via the AC power line (PLC), while the Digi™ via a Zigbee wireless mesh network. Both are rated at NEMA1 so they must be installed in a NEMA 3R or 4 rated enclosure, typically near the main service panel. However, for the Digi™ gateway, LeadSolar recommends installing it indoors, near the client's router using a LAN cable (it can also be connected via Wifi). The Zigbee communication can typically reliably connect up to 150' to the nearest microinverter.

For 240V single phase, the Link™ typically connects in series with the combined outputs of the PV branch circuits, supporting up to 50A thru current. In this configuration the Link can support up to 25 microinverters. For higher amperage systems an external filter is used in conjunction with the filter less Link. In this configuration, the Link can support up to 100A thru current.

Step 8: Connect the PV Modules

Connect each of the microinverter DC input terminals to the adjacent two PV modules output terminals through the MC4 terminated Quick Connect cables. Check your work to make sure all the microinverters in the system are securely connected to the PV modules. (Note the microinverter should be mounted with the label up and the heatsink fins toward the roof.)



Step 9: Register Microinverters

Go to <http://www.lead solar.net>

Click onto "LOGIN"

For more information, refer to the "LeadSolar Smart Grid Web Application".

Three Phase Systems

5.1 Three Phase Microinverter System

- Three phase systems require use of LeadSolar’s Digi Gateway which uses Zigbee communication.
- For a balanced system, each phase should use the same number of microinverters.
- Three phase SPD (Surge Protection Devices) are needed for a three phase system.
- Each phase needs breakers.



The Digi Gateway is designed to measure data on all microinverters within its mesh network. Each Digi Gateway can support up to 100 microinverters.

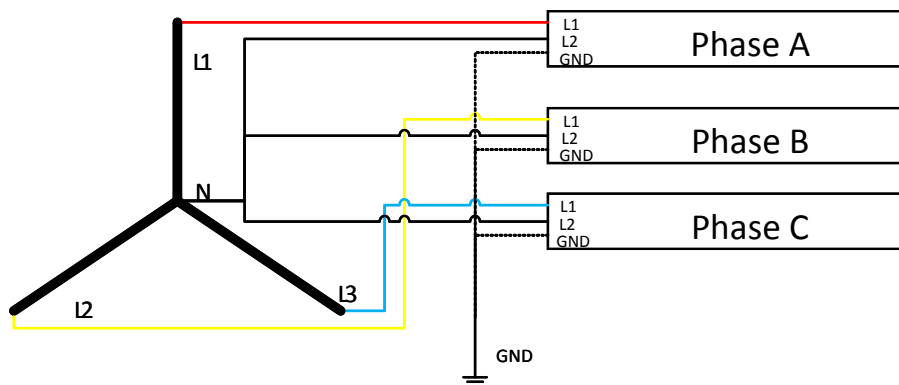


The Digi Gateway signal range is up to 200', subject to limitations from obstructions. If multiple arrays are separated by large distances, then it may be necessary to use more than one Digi Gateway.

5.2 AC Cable Connection

Wye Configuration

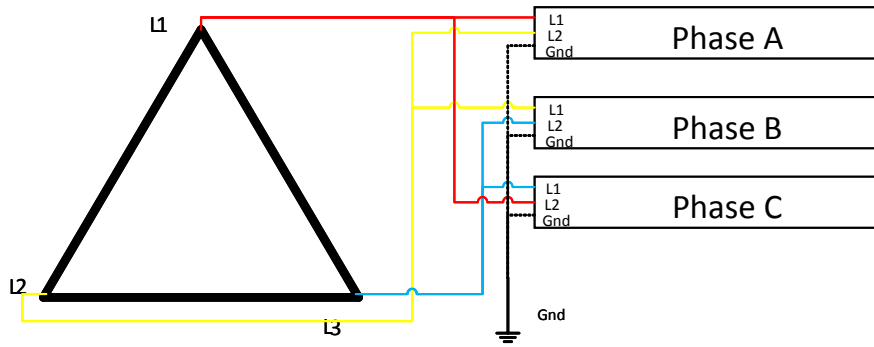
For a Wye configuration circuit, configure equally balanced branch circuits for each of the phases and then connect the L1 output (RED) of each branch to each of the high legs of the circuit. Connect each of the L2 outputs (Black) from each phase to the common system neutral.



Three phase Wye configuration for 120/208V or 277/480V

Delta Configuration

For a Delta configuration circuit, configure equally balanced branch circuits for each of the phases and then connect the L1 output (RED) of Phase A and the L2 output (black) of Phase C to the L1 of the circuit. Connect the L1 output (RED) of Phase B and the L2 output (black) of Phase A to the L2 of the circuit. Connect the L1 output (RED) of Phase C and the L2 output (black) of Phase B to the L3 of the circuit.



Three phase Delta configuration for 120/208V

LeadSolar Microinverter System Operation Guide

Congratulations on finishing the PV system installation! Follow these steps to begin operation:

1. Close the AC circuit breaker for each branch circuit (usually 20A or 30A rating breakers).
2. Close the main circuit breaker for the entire system. This breaker should be chosen based on your PV system capacity. The microinverter system will begin operation in about 2 minutes.
3. Use the WiFi or Ethernet connection to connect LeadSolar Link Gateway to your router. Place the Link so that its AC cord can reach this outlet. Try unplugging any other device that may be sharing the outlet with the Link. Do not plug the Gateway into a power strip as these may contain filters.
4. The Link must be able to obtain a DHCP (Dynamic Host Configuration Protocol) IP address and have a path to the internet after power on. Following this, the Link Gateway will query the data of the microinverters that registered in our website.
5. Login to your user account at www.lead solar.net and monitor the operation of your system in real-time.

Please note that for the first time power up after installation; the system may need ~10 minutes to establish communication between each microinverter and LeadSolar Link Gateway. This portal will display the power generated by each microinverter, along with fault reports for quick trouble shooting.

The operational status of each microinverter is also displayed by the indicator LEDs on each microinverter. It is recommended to take a quick check of the LEDs after initial power up. Each microinverter will self-check its connection after being connected to DC Power. The Status LED will blink green ten times to indicate continued connection. A solid red status indicates disconnection -- make sure all connectors are fully mated.

The table below summarizes the description of the LED indicators' operation after self-checking:

LED Status	Descriptions
Solid Green	Producing power normally
Flash Green 1 time per sec	Producing power normally but detecting GFDI error.
Flash Green 2 times per sec	Standby

Microinverter System Trouble Shooting Guide



Leave troubleshooting to qualified electrical professionals.



Do not unplug the microinverter during operation. This may damage the microinverter and expose the operator to electrical hazard. First open the AC circuit breaker; then disconnect the AC grid; then unplug the inverter from the PV module. (To disconnect the entire system from the AC grid, open the main circuit breaker. To disconnect a particular AC branch circuit, open the circuit breaker connected to that branch.)

Please follow the steps below for troubleshooting system problems:

1. Make sure the AC grid voltage and frequency are both in the allowed range for proper operation. Refer to the microinverter datasheet for the accepted AC grid conditions.
2. Reset all system connections. Disconnect the AC side and then the DC input side of the microinverter.
3. Check the PV module open circuit voltage. The open-circuit voltage of PV module should stay in the range specified in the microinverter datasheet.
4. Reconnect the DC side cable and check the LED status of the microinverter. If the green LED light is flashing, the DC connection is good.
5. Check the AC grid side connection. If the entire system doesn't work, check the main AC circuit breaker. For a particular branch problem, check the AC circuit breaker connected to that branch. For a particular microinverter problem in a branch, check the AC cable connection of that microinverter. If the LED is solid green after blinking 10 times, the grid connection is good.



Do Not attempt to repair the microinverter. This will void the warranty and can bring electrical hazard to those attempting it. Contact LeadSolar customer support to initiate an inverter return process.

Replacing or Adding a Microinverter



Identify the circuit breaker for the branch in which a microinverter will be replaced or added. Open that circuit breaker before starting the replacement/adding procedure.

Follow the steps below to replace a microinverter:

1. Disconnect the branch AC circuit breaker
2. Cover the PV module connected to microinverter to be replaced
3. Disconnect the AC connection cable from adjacent microinverter
4. Disconnect the PV module from microinverter
5. Remove the failed microinverter from PV rack
6. Follow the Installation Instructions to install new microinverter
7. Remove the PV module cover and close branch circuit breaker
8. The new microinverter will begin operating in 2 minutes
9. Register the new microinverter on the LeadSolar website

New PV modules and microinverters can be added to existing distributed system at any time. Please follow the Installation Instructions section to complete the new installation of PV modules and microinverters.

Technical Data

6.1 Technical Considerations

The LeadSolar LS600 Microinverters are electrically compatible with most 60-cell or 72-cell PV modules. Be sure to verify the voltage and current specifications of your PV module match those of the microinverter. For more information, refer to our list of compatible PV modules.

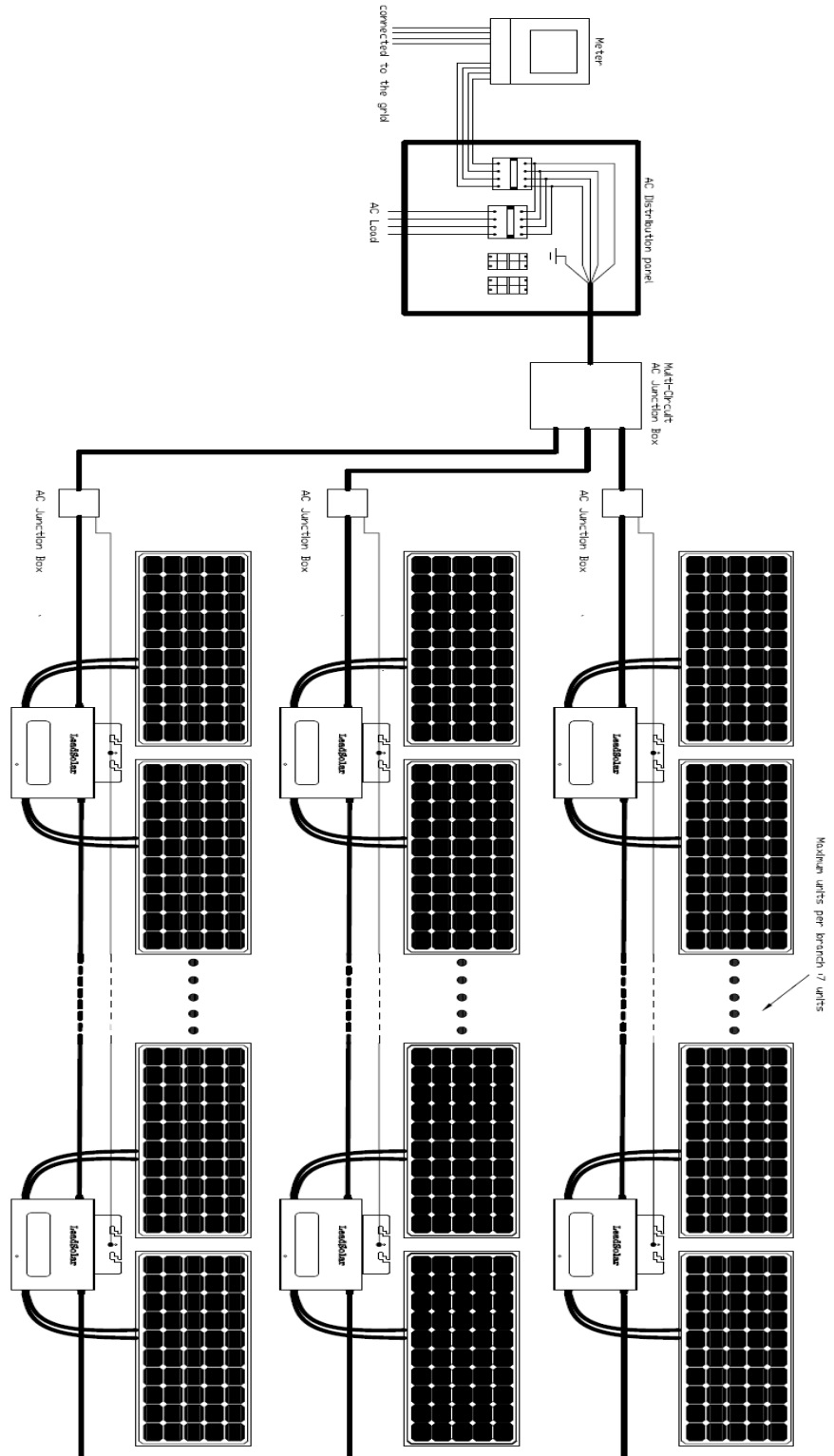


The PV module's maximum open circuit voltage must not exceed the microinverter's maximum input voltage.

The output voltage and current of the PV module depends on the quantity, size and temperature of the PV cells, as well as the isolation on each cell. The highest PV module output voltage occurs when the temperature of the cells is the lowest and the PV module is at open circuit (not operating). The maximum short circuit current rating of the PV module must be equal to or less than the maximum input DC short circuit current rating of the microinverter.

Appendix

Microinverter PV system with gateway (Note: Microinverters should be mounted with the label up)



Three phase microinverter PV system with filters and coupler



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