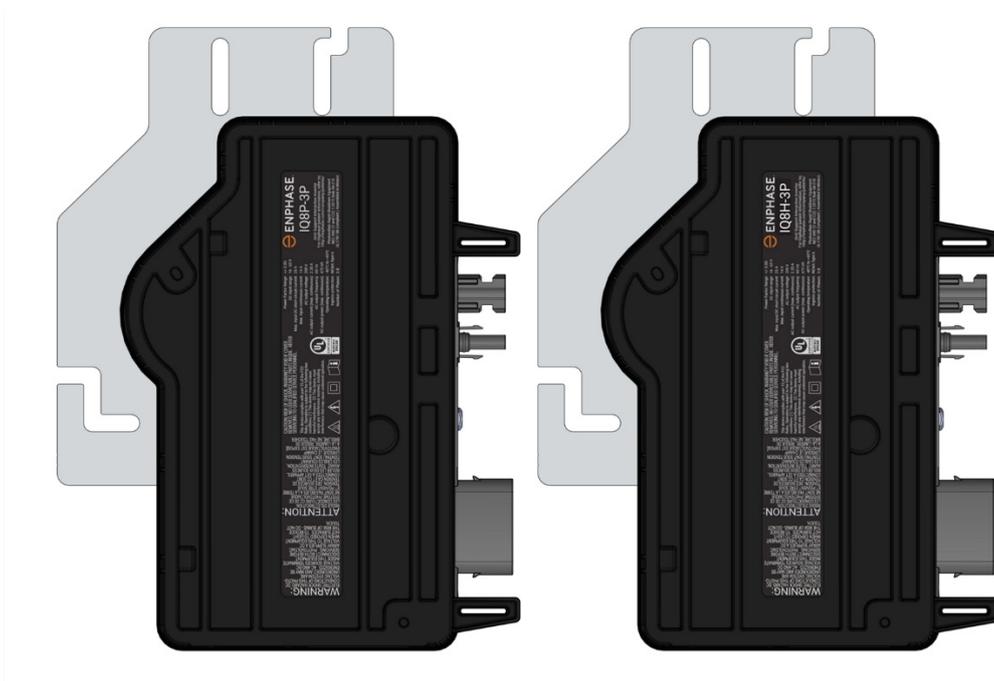


IQ8 Commercial Microinverter grid-tied PV system design guide



Corporate headquarters contact information

Enphase Energy Inc.

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<https://enphase.com/contact/support>



E341165

FCC compliance

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

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

Changes or modifications not expressly approved by the party responsible for compliance may void the user's authority to operate the equipment.

Other information

Product information is subject to change without notice. All trademarks are recognized as the property of their respective owners.

User documentation is updated frequently; check the Enphase website for the latest information: <https://enphase.com/installers/resources/documentation>.

To ensure optimal reliability and to meet warranty requirements, the Enphase microinverter must be installed according to the instructions in this manual. For warranty text, refer to enphase.com/installers/resources/warranty.

For Enphase patent information, refer to <https://enphase.com/patents>.

Audience

This manual is intended for use by professional installation and maintenance personnel.

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Important safety information

Read this first

This manual contains important instructions for use during the installation and maintenance of the IQ8 Series Microinverters.

IMPORTANT: Enphase IQ8 Commercial Microinverters require the QD Cable and are NOT compatible with previous Enphase cabling (that is, IQ Cables). A three-phase IQ Gateway Commercial 2 is required to monitor the performance of the IQ8 Commercial Microinverters. The QD accessories work only with Enphase IQ8 Commercial Microinverter-based three-phase commercial PV systems.

Product labels

The following symbols appear on the **product label** and are described here:



WARNING: Hot surface



DANGER: Refer to safety instructions



DANGER: Risk of electric shock



Refer to manual



Double insulated

Safety and advisory symbols

To reduce the risk of electric shock and to ensure the safe installation and operation of the IQ8 Series Microinverters system, the following safety symbols appear throughout this document to indicate dangerous conditions and important safety instructions.



DANGER:

This indicates a hazardous situation, which, if not avoided, will result in death or serious injury.



WARNING:

This indicates a situation where failure to follow instructions may be a safety hazard or cause equipment malfunction. Use extreme caution and follow instructions carefully.



WARNING:

This indicates a situation where failure to follow instructions may result in burn injury.



NOTE:

This indicates information that is very important for optimal system operation. Follow instructions closely.

IQ8 Commercial Microinverters safety instruction

General safety

	DANGER: Risk of electric shock. Risk of fire.	<p>Only use electrical system components approved for wet locations.</p> <p>Only competent personnel should install, troubleshoot, or replace Enphase microinverters or QD Cable and accessories.</p> <p>Ensure that all AC and DC wiring is correct and that none of the AC or DC cables are pinched, shorted, or damaged. Ensure that all AC junction boxes are properly closed.</p> <p>Do not exceed the maximum 12 (IQ8P-3P) or 15 (IQ8H-3P) microinverters in an AC branch circuit, as listed in this guide. You must protect each microinverter AC branch circuit with a 20 A maximum breaker as appropriate.</p>
	DANGER: Risk of electric shock.	<p>Do not use Enphase equipment in a manner not specified by the manufacturer. Doing so may cause death or injury to persons or damage to equipment.</p> <p>Be aware that installation of this equipment includes the risk of electric shock.</p> <p>The DC conductors of this photovoltaic system are ungrounded and may be energized.</p> <p>Always de-energize the AC branch circuit before servicing. Never disconnect the DC or AC connectors under load.</p>
	WARNINGS:	<p>Before installing or using the Enphase microinverter, read all instructions and cautionary markings in the technical description of the Enphase equipment and the photovoltaic (PV) equipment.</p> <p>Do not connect Enphase microinverters to the grid or energize the AC circuit(s) until you have completed all the installation procedures and have received approval from the electrical network operator.</p> <p>When the PV array is exposed to light, DC voltage is supplied to the power conversion equipment (PCE).</p> <p>Risk of equipment damage. Enphase male and female connectors must only be mated with the identical type and brand of male/female connector.</p>
	NOTES:	<p>To ensure optimal reliability and to meet warranty requirements, install the Enphase equipment according to the instructions in this manual.</p> <p>The AC and DC connectors on the cabling are rated as a disconnect only when used with an Enphase microinverter.</p> <p>Protection against lightning and resulting voltage surge must be in accordance with local electrical codes and standards.</p> <p>Perform all electrical installations in accordance with all applicable local electrical codes and standards.</p>

Microinverter safety

	WARNING: Risk of skin burn.	<p>The chassis of the Enphase microinverter is the heat sink. Under normal operating conditions, the temperature could be 20°C above ambient temperature, but under extreme conditions, the microinverter can reach a temperature of 90°C. To reduce the risk of burns, use caution when working with microinverters.</p>
	DANGER: Risk of fire.	<p>The DC conductors of the PV module must be labeled “PV Wire” or “PV Cable” when paired with the Enphase microinverter.</p>
	DANGER: Risk of electric shock. Risk of fire.	<p>Only competent personnel may connect the Enphase microinverter to the electricity grid.</p> <p>Do not attempt to repair the Enphase microinverter; it contains no user-serviceable parts. If it fails, contact Enphase Support to obtain a return merchandise authorization (RMA) number and start the replacement process. Tampering with or opening the Enphase microinverter will void the warranty.</p>

	WARNING: Risk of equipment damage.	Install the microinverter under the PV module to avoid direct exposure to rain, UV, and other harmful weather events. Always install the microinverter bracket side up. Do not mount the microinverter upside down. Do not expose the AC or DC connectors (on the IQ Cable, PV module, or microinverter) to rain or condensation before the connectors are mated.
		The maximum open circuit voltage of the PV module must not exceed the specified maximum input DC voltage of the Enphase microinverter. Refer to the Enphase compatibility calculator to verify PV module electrical compatibility with the microinverter. Use IQ8 Commercial Series Microinverters only with compatible PV modules as per the Enphase compatibility calculator. Using an electrically incompatible PV module voids Enphase warranty.
	WARNING: Risk of equipment damage.	You must match the DC operating voltage range of the PV module with the allowable input voltage range of the Enphase microinverter.
		The Enphase microinverter is not protected from damage due to moisture trapped in cabling systems. Never mate microinverters to cables that have been left disconnected and exposed to wet conditions. This voids the Enphase warranty.
	WARNING: Risk of warranty void	Do not attempt to open/repair the Enphase microinverter; it contains no user-serviceable parts. If the microinverter fails, contact Enphase Support to obtain a return merchandise authorization (RMA) number and start the replacement process. Tampering with or opening the Enphase microinverter will void the warranty.
	NOTES:	The Enphase microinverter has field-adjustable voltage and frequency trip points that may need to be set, depending upon local requirements. Only a competent authorized installer with the permission and following requirements of the local electrical authorities should make adjustments.
	NOTES:	Installers must check the manufacturing date of the products to ensure that the installation date is within one year of the manufactured date of the products. Contact your local distributor to validate the date code.

QD Cable safety

	DANGER: Risk of electric shock.	Do not install the QD Terminator while the power is connected.
	WARNING: Risk of electric shock. Risk of fire.	When stripping the sheath from the QD Cable, make sure the conductors are not damaged. If the exposed conductors are damaged, the system may not function properly.
		Do not leave AC connectors on the QD Cable uncovered for an extended period. You must cover any unused connector with a QD Sealing Cap.
		Make sure protective QD Sealing Caps have been installed on all unused AC connectors. Unused AC connectors are live when the system is energized.
	WARNING:	Use the QD Terminator only once. If you open the QD Terminator following installation, the latching mechanism is destroyed. If the latching mechanism is defective, do not use the QD Terminator. Do not circumvent or manipulate the latching mechanism.
		When installing the QD Cable, secure any loose cable to avoid the risk of cable insulation abrasion against the roof surface.
	NOTES:	When looping the QD Cable, do not form loops smaller than 120 mm in diameter.
		Provide support for the QD Cable every 300 mm.
		If you need to remove the QD Sealing Cap, you must use the QD Disconnect Tool.

When installing the QD Cable and accessories, adhere to the following:

- Do not expose the QD Terminator or cable connections to directed, pressurized liquid (water jets, etc.).
- Do not expose the QD Terminator or QD Cable to continuous immersion.
- Do not expose the QD Terminator or QD Cable connections to continuous tension (e.g., tension due to pulling or bending the cable near the connection).
- Use only compatible QD connectors.
- Do not allow contamination or debris in the connectors.
- Use the QD Terminator and cable connections only when all parts are present and intact.
- Do not install or use in potentially explosive environments.
- Do not allow the QD Terminator to come into contact with an open flame.
- Fit the QD Terminator using only the prescribed tools and in the prescribed manner.
- Use only the QD Terminator to seal the conductor end of the QD Cable; no other method is allowed.

DC Cable safety



NOTES:

- Ensure proper routing of PV module DC cable using the clips to prevent the leads from resting on the roof. Do not wrap excess DC cable around the microinverter.
 - Avoid direct exposure to sunlight.
 - Avoid sharp edges on racking.
 - Avoid cable contacting rough surfaces or moving parts within the racking system.
 - Avoid overly tight bending radii. The minimum bend radii for the DC cable is eight times the cable outer diameter.
 - Avoid overly tight-sized cable clips for routing.
-

1 Enphase IQ8 Commercial PV system

This design guide provides guidelines for designing three-phase commercial PV systems using Enphase IQ8 Commercial Microinverters. The high-powered, smart, grid-ready Enphase IQ8 Commercial Microinverter is the most reliable and intelligent component of the Enphase small commercial PV solution for 208/120 V WYE three-phase interconnection.

Each microinverter supports one PV module and integrates with the Enphase IQ Gateway Commercial 2 and the Enphase Installer Portal web-based monitoring and management software. The Enphase IQ8 Commercial Microinverter simplifies design, improves energy harvest with higher uptime, and offers trouble-free operation and maintenance.

This design guide introduces solar installation professionals to the IQ8 Commercial PV system components, provides guidance on component selection, and provides guidelines for IQ8 Commercial PV system design and installation scenarios.

The Enphase IQ8 Commercial PV system includes the following components:

- Enphase IQ8 Commercial Microinverters
- Enphase IQ Gateway Commercial 2
- Enphase QD Cable and accessories
- Enphase Installer Portal and Enphase Installer App

This guide describes the safe installation and operation of the IQ8 Commercial Series Microinverters.



NOTE: To ensure optimal reliability and to meet warranty requirements, Enphase microinverters must be installed according to the instructions in this guide.

1.1 IQ8 Commercial Microinverters system components

The following figure shows the system components.

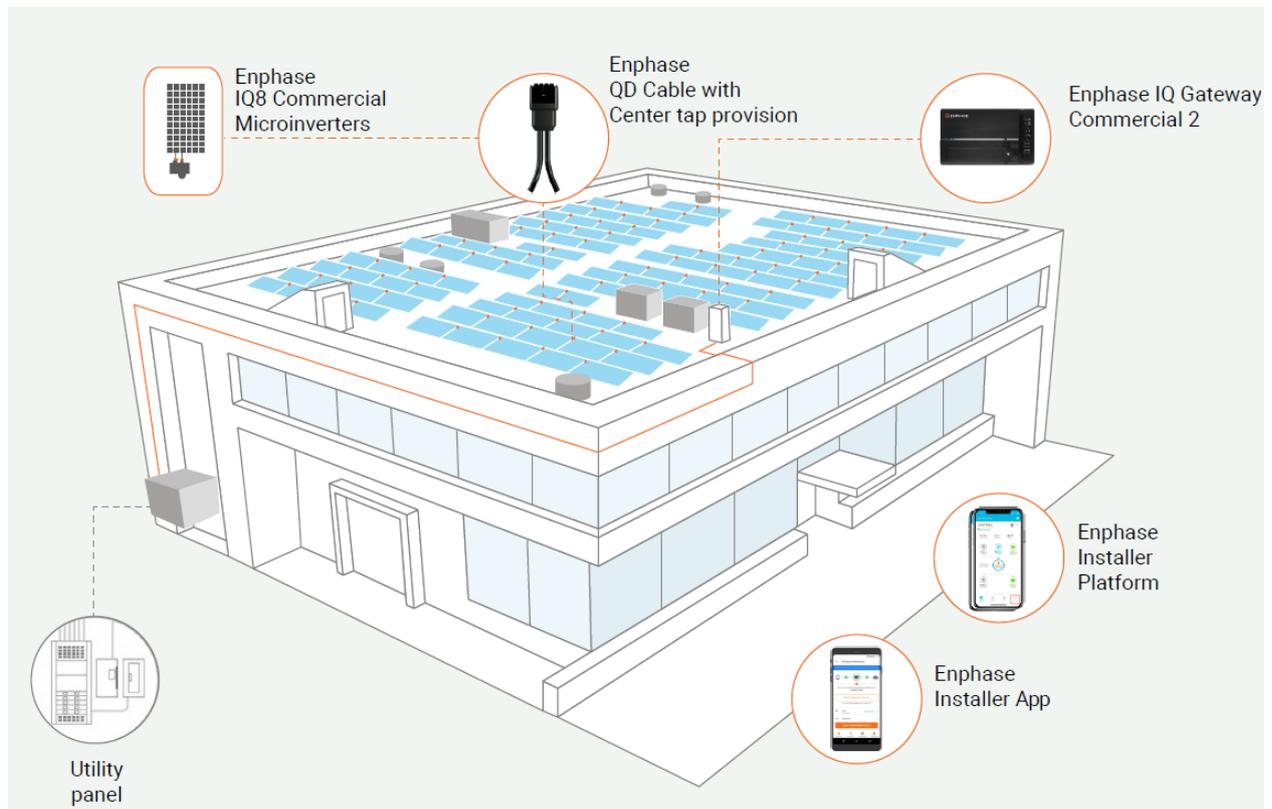


Figure 1: IQ8 Commercial Microinverter system components

The following table lists the system components.

Table 1: IQ8 Commercial Microinverters system components

System component	Enphase model	SKU details			
Microinverter	IQ8 Commercial Microinverter	IQ8P-3P-72-E-US		IQ8H-3P-72-E-US	
DC adapter cable	EN4 Bulkhead adapter cable	ECA-EN4-S22: EN4 (TE PV4-S SOLARLOK) 150 mm/5.9" to Stäubli MC4 (Default Supply)			
		ECA-EN4-FW-10-12: EN4 (TE PV4-S SOLARLOK) to 1000 mm/39.4" non-terminated cable (Pack of 12 pairs - Optional)			
		ECA-EN4-S22-12: EN4 (TE PV4-S SOLARLOK) 150 mm/5.9" to Stäubli MC4 (Pack of 12 pairs - Optional)			
		ECA-EN4-S22-10-12: EN4 (TE PV4-S SOLARLOK) 1000 mm/39.4" to Stäubli MC4 (Pack of 12 pairs - Optional)			
Frame mount (optional)	Enphase Frame Mount bracket	EFM-35 MM (35 mm PV module frame depth)		EFM-40 MM (40 mm PV module frame depth)	
AC cables and accessories	QD Cables and QD accessories	Cable model SKU	Connector spacing	Max. spacing between microinverters	Connectors per box/pack
		QD-12-13-120	1.7 m (5.6 ft)	1.3 m (4.3 ft)	120
		QD-12-20-120	2.4 m (7.9 ft)	2.0 m (6.6 ft)	120
		QD-12-25-108	2.9 m (9.5 ft)	2.5 m (8.2 ft)	108
		QD-12-RAW-300 (12 AWG)	-	-	300 m (984.2 ft)
		QD-10-RAW-300 (10 AWG)	-	-	300 m (984.2 ft)
		QD-12-RAW-60 (12 AWG)	-	-	60 m (196.85 ft)
		Field Wireable QD Connectors	QD-CONN-10F	-	Pack of 10
			QD-CONN-10M	-	Pack of 10
		QD Disconnect Tool	QD-DISC-10	-	Pack of 10
		QD Sealing Cap	QD-SEAL-10	-	Pack of 10
		QD Terminator	QD-TERM-10	-	Pack of 100
		Cable Clips	ET-CLIP-100	-	
Communication gateway	IQ Gateway Commercial 2	ENV2-IQC2-AM3-3P			
		Production CT	CT-400-SOLID	-	400 A – 3 CTs default supply

		Consumption CT	CT-600-SPLIT	-	600 A - 3 CTs Optional
		Cell Modem	CELLMODEM-M1-06-SP-05 or CELLMODEM-M1-06-AT-05	-	-
Power Line Filters	Astrodyne filters	-	QD-LCF-400-3P (400 A)		
Surge suppression system	Surge protectors	Example: Citel DS73RS-120 surge protector			

2 IQ8 Commercial PV system design considerations

2.1 IQ8 Commercial Microinverters

The high-powered, smart-grid-ready IQ8 Commercial Microinverter is an advanced microinverter. Each IQ8 Commercial Microinverter supports one PV module and has greater than 97% CEC efficiency for three-phase 208 V applications with peak output power ratings of 384 and 480 watts.

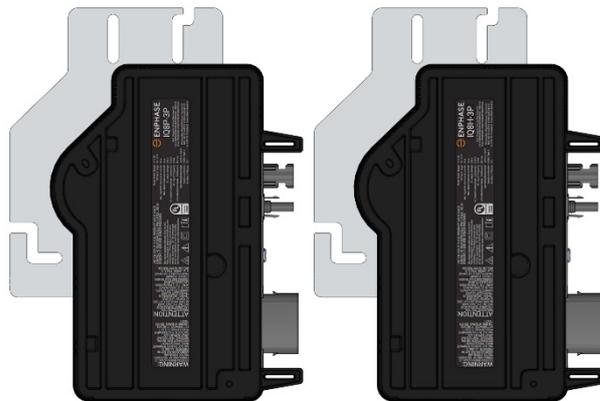


Figure 2: IQ8 Commercial Microinverters

IQ8 Commercial Microinverters have an output configuration of a 4-pin (L1, L2, L3, and N) AC connector with power on two pins and phase sensing on the other two pins. Three-phase configuration and phase balancing are achieved using the three-phase QD Cable. The following topics describe the design considerations for IQ8 Commercial Microinverters.

2.1.1 Module compatibility

The Enphase IQ8 Commercial Microinverters are electrically and mechanically compatible with PV modules, as listed in [Table 2](#). To verify PV module electrical compatibility with IQ8 Commercial Microinverter, refer to the [Enphase compatibility calculator](#).

Module compatibility calculator estimates compatibility based on information provided by the installer on the following parameters. The installer should confirm the following details with the PV module manufacturer.

- Voc (voltage at open circuit).
- Vmp (voltage at maximum power).
- Imp (current at maximum power)
- Temperature coefficient of Voc, Isc.
- Isc (short-circuit current).
- Expected daytime operating temperature range.

Table 2: IQ8 Commercial Microinverter PV module compatibility

Microinverter	Bulkhead connector	Adapter cables	PV module	PV module cell count
IQ8P-3P-72-E-US IQ8H-3P-72-E-US	Enphase EN4 (TE PV4S SOLARLOK) bulkhead	ECA-EN4-S22 EN4 (TE PV4S SOLARLOK) to Stäubli MC4 adapter	Monofacial or bifacial	54-cell/108-half-cell, 60-cell/120-half-cell, 66-cell/132-half-cell and 72-cell/144-half-cell

To ensure mechanical compatibility, order the correct connector type for both the microinverter and PV module from your distributor.

2.1.2 Enphase Frame Mount bracket

The Enphase Frame Mount bracket allows you to attach an IQ8 Commercial Microinverter easily and rapidly to the PV module frame. Use the Frame Mount bracket in rail-less or ballasted solar installations. The Enphase Frame Mount bracket comes in two sizes, 35 mm (EFM-35MM) and 40 mm (EFM-40MM), depending upon the thickness (depth) of the PV module frame.

2.1.3 DC connector intermatability

IQ8 Commercial Microinverter has an Enphase EN4 bulkhead for DC connection and bulkhead adapter cable for EN4 to Stäubli MC4 connection. If your PV modules have TE PV4S SOLARLOK connectors, you may plug them directly into the IQ8 Commercial Microinverter with EN4 bulkhead.

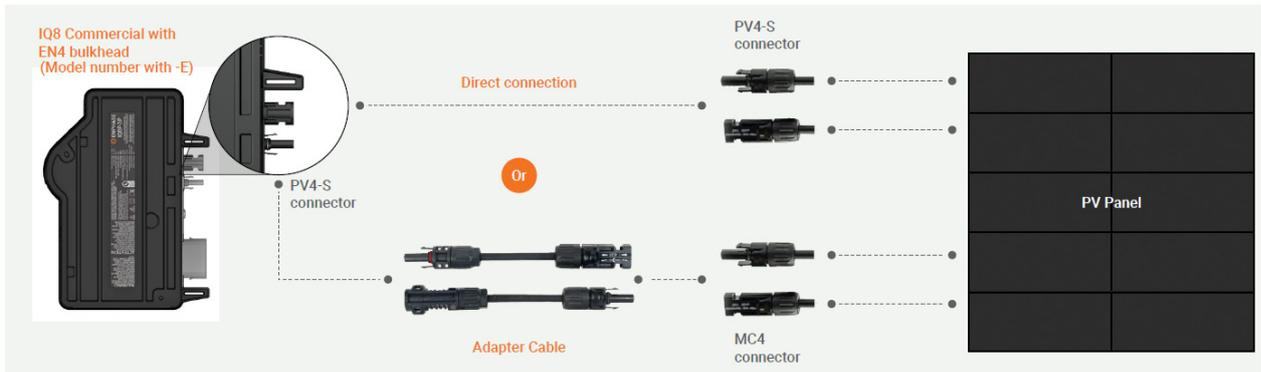


Figure 3: Commercial DC connector intermatability

For the EN4 to Stäubli MC4 connection, DC adapter cables (Part number: ECA-EN4-S22) of length 150 mm (5.91 in) are provided by default with IQ8 Commercial Microinverter. For installations where DC cables from the PV modules are unable to reach the IQ8 Commercial Microinverter, installers can order longer EN4 to Stäubli MC4 adapter cables.

Table 3: DC adapter cables

DC adapter cables	Model SKU
EN4 (TE PV4-S SOLARLOK) 150 mm/5.9" to Stäubli MC4 (Default Supply)	ECA-EN4-S22
EN4 (TE PV4-S SOLARLOK) to 150 mm/5.9" non-terminated cable (Pack of 12 pairs - Optional) ¹	ECA-EN4-FW-12
EN4 (TE PV4-S SOLARLOK) 1000 mm/39.4" to Stäubli MC4 (Pack of 12 pairs - Optional)	ECA-EN4-FW-10-12
EN4 (TE PV4-S SOLARLOK) to 1000 mm/39.4" non-terminated cable (Pack of 12 pairs - Optional)	ECA-EN4-S22-18-12

¹Qualified per UL subject 9703; 2. For field wiring of UL-certified DC connectors

2.1.4 Number of microinverters per branch circuit

Plan your AC branch circuits with the maximum recommended microinverters per branch (12 IQ8P-3P or 15 IQ8H-3P), with each branch protected by a 3-pole 20 A overcurrent protection device (OCPD). In case you are skipping a connector, ensure each branch circuit has an equal number of microinverters per phase (L-L connection), that is, L1-L2, L2-L3, and L3-L1. You can check the marking on connectors C1(L1-L2), C2(L2-L3), and C3(L3-L1) to count the number of microinverters per phase in a branch circuit. For connector marking details, see [Figure 4](#).

Table 4: Maximum microinverters per 20 A branch circuit*

Grid Interconnection	Maximum number of IQ8 Commercial Microinverters per branch circuit (IQ8P-3P-72-E-US/IQ8H-3P-72-E-US)
208/120 V WYE three-phase	12/15

*Limits may vary. Refer to local requirements to define the number of microinverters per branch in your area.

2.1.5 Grounding considerations

The Enphase IQ8 Commercial Microinverters do not require grounding electrode conductors (GEC) or equipment grounding conductors (EGC). Your Authority Having Jurisdiction (AHJ) may require you to bond the mounting bracket to the racking. If so, use UL2703 hardware or star washers.

The microinverter has a Class II double-insulated rating, which includes ground fault protection (GFP). To support GFP, use only PV modules equipped with DC cables labeled PV Wire or PV Cable.

2.2 AC cable and accessories

QD Cable is a 12 AWG cable with four conductors for L1, L2, L3, and neutral sense. QD Cable has power on two phases, sensing on the remaining phase and neutral for phase loss detection. This arrangement alternates between connectors for each drop to achieve self-phase balancing. The QD Cable 4-pin male connectors plug directly into the IQ8 Commercial Microinverters, whose double insulated rating requires no grounding conductors.

Each connector on the QD Cable is marked with phase ID C1, C2, and C3, with each connector type connected to C1(L1-L2), C2(L2-L3), and C3(L3-L1) as shown in [Figure 4](#). A similar phase rotation arrangement continues throughout the cable. For a detailed understanding of phase rotation and phase balancing the IQ8 Commercial Microinverter system, see [Appendix B: Phase balancing in IQ8 Commercial installations using the three-phase QD Cable phase rotation](#).

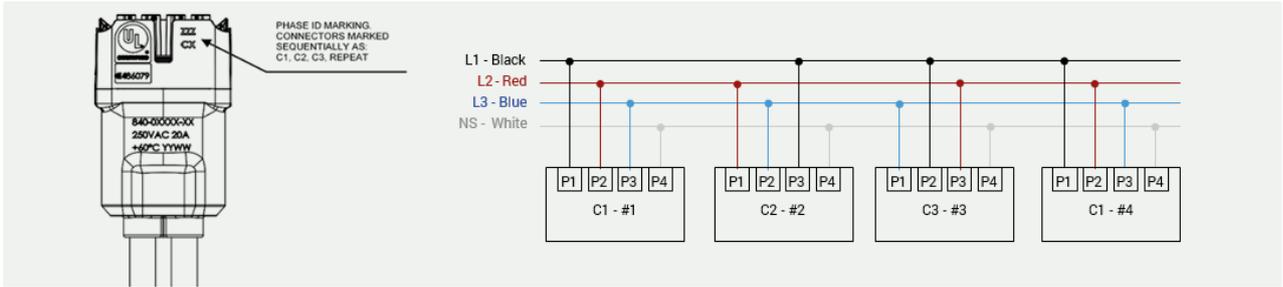


Figure 4: QD Cable connector phase rotation

2.2.1 Three-phase QD Cable specifications, cable types, and ordering options

The QD Cable and Raw QD Cable are manufactured with DG cable to the specifications in the following table.

Table 5: QD Cable specifications

QD Cable specifications	
QD Cable	Four Conductors 12 AWG.
Outer diameter	11.5 mm.
Voltage rating	600 V (Connector rating up to 277 VAC).
Max AC conductor resistance (20°C) (Ω/km)	12 AWG 5.43 Ω/km.
Certification	UL3003 (raw cable), UL 9703 (cable assemblies), DG cable.
Flame test rating	FT4.
Compliance	RoHS, OIL RES I, CE, UV resistant, combined UL for the United States.
Conductor type	THHN/THWN-2 dry/wet.
Disconnecting means	Risk of electric shock. Always de-energize the AC branch circuit before servicing. Never disconnect the DC or AC connectors under load.
Color code	L1: Black; L2 Red; L3 Blue; Neutral Sense White.

The following are three-phase QD Cable types and ordering options based on the PV module orientation specific to the site.

Table 6: QD Cable types/ordering options

QD Cable types/ordering options					
Model number	Max voltage	Size	Connector spacing	PV module orientation	Connector count per box
QD-12-13-120	277 VAC	12 AWG	1.7 m (5.6 ft)	Portrait	120
QD-12-20-120	277 VAC	12 AWG	2.4 m (7.9 ft)	Landscape	120
QD-12-25-108	277 VAC	12 AWG	2.9 m (9.5 ft)	Landscape	108

QD-12-RAW-300	300 m (984.2 ft) of 12 AWG cable with no connectors
---------------	-----------------------------------------------------

QD Cable is available in three connector-spacing options to accommodate portrait and landscape ballast applications. Raw QD Cable without integrated AC connectors can be used for runs between separated arrays or to a junction box/field wireable located some distance away from an array.

You must install supports (such as clips) for the QD Cable and Raw QD Cable at 1.8 m (6 feet) intervals or less. Installation requirements for wet-rated cable allow QD Cable and Raw QD Cable to be installed in conduits, cable trays, and other raceways.

Field Wireable QD Connectors are pre-installed at the ends of the QD Cables to increase the cable length beyond the connector limit mentioned in Table 6. The pre-installed field wireable connectors at the ends are protected with sealing caps (refer to Figure 6). The sealing caps must be removed only when you are increasing cable length using the field wireables at the cable end.



WARNING: Do not remove sealing caps from the pre-installed field-wireable connector at the ends of the QD Cable if they are not used to increase cable length.

2.2.2 Design considerations for QD Cable selection

Each IQ8 Commercial Microinverter supports one compatible PV module. IQ8 Commercial Microinverter system supports multiple positioning and orientation options for PV modules through multiple QD Cable SKUs. Cable pitch/SKU selection and microinverter mounting point need to be decided according to module positioning and orientation on the roof.

All three QD Cable SKUs include center-tapping connectors after every 6 AC male QD connectors in the QD Cable spool. The center-tap connectors are sealed with a sealing cap, and the sealing cap should be removed only when the connector is used for feeding the AC supply to the branch.

The center-tapping connector is a three-phase male field-wireable connector. Use the center-tap connector only for feeding in the AC Supply connection from the PV subpanel.

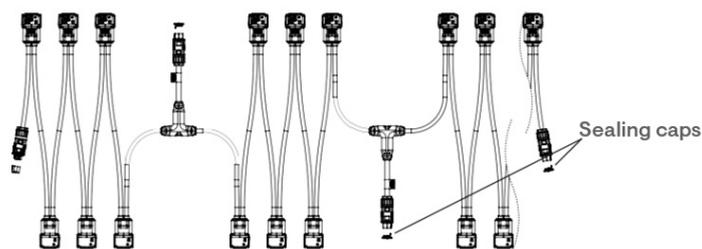


Figure 5: Center feeding of AC branch circuit

2.2.3 Design considerations for QD accessories

Table 7: QD Cable accessories

Accessories	SKU number	Description
Three-phase Field Wireable QD Connectors	QD-CONN-10M (Male) QD-CONN-10F (Female)	Use Field Wireable QD Connectors for making connections from Raw QD Cable
IQ Cable Clip	ET-CLIP-100	Used to fasten cabling to the racking or to secure looped cabling
QD Disconnect Tool	QD-DISC-10	Disconnect tool for QD Cable connectors, DC connectors, and AC module mount
QD Sealing Caps	QD-SEAL-10	Female sealing cap for the unused connector in QD Cable
QD Terminator	QD-TERM-10	Terminator for unused cable ends

Three-phase Field Wireable QD Connectors

When the microinverters are located some distance from the roof top junction box, it may be most economical to use Raw QD Cable (without connectors) to run across an array or to run through a raceway, conduit, or a chase to another array and use three-phase Field Wireable QD Connectors to connect. The three-phase Field Wireable QD Connectors should be used for cables with a cable gauge of 12 AWG/10 AWG and with a maximum outer diameter of 21 mm.

For more information, see the *Three-phase Field Wireable QD Connector Quick install Guide*.



NOTE: The five-pin, three-phase Field Wireable QD Connectors include connections for L1, L2, L3, N, and PE. Do not use PE pin when using four-core QD Cable.



Figure 6: Three-phase Field Wireable QD Connector

QD Cable Clip

The Enphase QD Cable Clip (ET-CLIP-100) can support one or two QD Cables or Raw QD Cables to a solar mounting rail. This clip has been evaluated with a large selection of racking systems and works with most available rail-based racking systems.

These clips support the cable along the rail and may be adequate for supporting the cabling during row-to-row transitions (depending on cable length), but additional support may be provided from module frame clips.



Figure 7: QD Cable Clip

QD Sealing Caps

Cover any unused QD Cable connector with Enphase watertight QD Sealing Caps (QD-SEAL-10). Listen for a click as the connectors engage.

Install QD Sealing Caps on all unused AC connectors because these connectors become live when the system is energized.

QD Sealing Caps are required for protection against moisture ingress. Use the QD Disconnect Tool to remove the QD Sealing Cap.

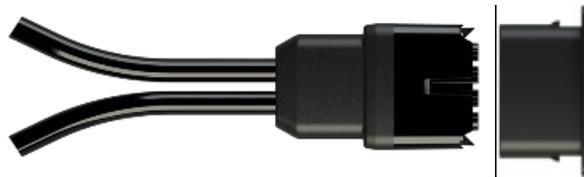


Figure 8: QD Sealing Cap

QD Terminator

Install the QD Terminator (QD-TERM-10) on any cut end of the QD Cable that is not connected to a three-phase AC grid through a junction box or a three-phase field wireable connector.



Figure 9: QD Terminator

AC wire management at the junction box

The AC junction box can be used for feeding the AC connection to the microinverter branch circuit or to splice two sections of QD Cable/Raw QD Cable together in case of complex installations with multiple arrays across the rooftop. Follow these recommendations to prevent moisture from accumulating in the AC junction box. This helps to improve system reliability while ensuring that the wiring connections last for the life of the system.

- Ensure cables enter the junction box from the side or from the bottom, never from the top, where water can enter the enclosure.
- Install cables with a drip loop. Secure the cable so that water drains away from the cable entry.
- Use properly sized strain reliefs and cord grips. Note that the QD Cable is circular with an outer diameter of 11.5 mm (0.45 inches). The cable gland securing the QD Cable must contain an inner gland sized for the QD Cable.
- Properly tighten the strain reliefs to prevent cable movement and to prevent water ingress.
- Install the junction box to meet the manufacturer's mounting and orientation requirements.
- Use NEMA 4 enclosures. (NEMA 3 enclosures have a limited mounting orientation range and may not accommodate typical rooftop installations.)
- Consider drilling a small drain hole in the bottom, lowermost corners of the junction box so that moisture or condensate can drain out of the junction box.

2.3 Design considerations for voltage rise

This section describes the voltage rise guidelines for dedicated PV branch circuits and methods for calculating the AC line voltage rise when using the Enphase IQ8 Commercial Microinverters and the Enphase QD Cable. Applying proper voltage rise calculations during your system design helps prevent nuisance voltage out-of-range trip issues due to high line voltage conditions.

Less resistance in conductors also results in less power loss, less heat at the terminals, and improved performance of the PV system.

When designing circuits for electrical loads, these calculations are commonly called voltage drop (VDrop). Since PV systems with inverters generate electricity instead of consuming it, the voltage rises at the AC terminals of each inverter. Therefore, this brief refers to these calculations as voltage rise (VRise).

2.3.1 Recommendations

- Although the National Electric Code recommends that branch circuit conductors be sized for a maximum of 3% VRise (Article 210.19, FPN 4.), this value, in practice, is generally not low enough for a utility-interactive inverter. Additional losses exist at the terminals, connectors, and circuit breakers; however, if you design for a 2% total voltage rise, these other factors may be ignored. A 2% VRise limit in the IQ8 Commercial Microinverter system design shall ensure high-quality installations with lower energy losses and higher system reliability.
- Enphase recommends that the total percentage of voltage rise in the AC wiring be a maximum of 2%, which includes a voltage rise of less than 1% in the QD Cable. Although the QD Cable is optimized for minimal VRise, it is still important to calculate the total VRise for the entire system for the farthest microinverter in the branch circuits from the point of common coupling.
- It is recommended to center-feed the branch circuit to minimize voltage rise in a fully populated branch circuit. Since the VRise is nonlinear, reducing the number of microinverters on a QD Cable from the field wireables or junction box to the farthest microinverter by center-feeding and creating sub-branch circuits reduces the voltage measured at the farthest microinverter in each sub-branch. To center-feed a branch, divide the circuit into two sub-branch circuits protected by a single overcurrent protection device (OCPD)
- Use the correct wire size for the AC extension cables and home-run cables during the system design. Using undersized conductors can result in nuisance tripping of the microinverter when an AC voltage out-of-range condition occurs.
- When installing the IQ8 Commercial Microinverter system using QD Cable, you may have

multiple center tap connectors in the branch circuit. Select the center tap connector such that a maximum of 9 IQ8 Commercial Microinverters are installed on either side of the center tap connector to limit voltage rise <1% in the QD Cable.

- Use a female three-phase field wireable connector (QD-CONN-10F) to connect the extension cable to the 3-pole 20 A over-current protection device (OCPD) in the PV subpanel.

2.3.2 IQ8 Commercial VRise for 208 VAC in QD Cable

Refer to the following tables to find the VRise in QD Cable for your project based on the number of IQ8 Commercial Microinverters in an AC Branch Circuit.

Table 8 through Table 15 provide VRise values for the IQ8 Commercial Microinverters in an AC branch circuit (with a maximum of 9 microinverters per branch circuit) for multiple QD Cable options. Use these values to help calculate the total VRise for your project based on the number of microinverters in the branch circuit. As the number of microinverters in a branch circuit increases, the voltage at each microinverter rises in an exponential manner.

Portrait PV module orientation – 1.7 m (5.6 ft) pitch

Table 8: Internal QD Cable VRise (IQ8P-3P – 208 V/Portrait cable, QD-12-13-120)

IQ8P-3P-72-E-US	IQ8P-3P Microinverters per branch (208 VAC three-phase system)											
	1	2	3	4	5	6	7	8	9	10	11	12
VRise (V)	0.051	0.117	0.193	0.32	0.461	0.614	0.817	1.035	1.264	1.544	1.838	2.144
VRise (%)	0.02	0.03	0.09	0.15	0.22	0.29	0.39	0.50	0.61	0.74	0.88	1.03

Portrait PV module landscape – 2.4 m (7.9 ft) pitch

Table 9: Internal QD Cable VRise (IQ8P-3P – 208 V/Portrait cable, QD-12-20-120)

IQ8P-3P-72-E-US	IQ8P-3P Microinverters per branch (208 VAC three-phase system)											
	1	2	3	4	5	6	7	8	9	10	11	12
VRise (V)	0.072	0.165	0.272	0.451	0.651	0.866	1.154	1.461	1.784	2.18	2.595	3.027
VRise (%)	0.03	0.08	0.13	0.22	0.31	0.42	0.55	0.70	0.86	1.05	1.25	1.46

Portrait PV module landscape – 2.9 m (9.5 ft) pitch

Table 10: Internal QD Cable VRise (IQ8P-3P – 208 V/Portrait cable, QD-12-25-108)

IQ8P-3P-72-E-US	IQ8P-3P Microinverters per branch (208 VAC three-phase system)											
	1	2	3	4	5	6	7	8	9	10	11	12
VRise (V)	0.087	0.199	0.328	0.545	0.787	1.047	1.394	1.765	2.156	2.634	3.136	3.657
VRise (%)	0.04	0.10	0.16	0.26	0.38	0.50	0.67	0.85	1.04	1.27	1.51	1.76

Portrait PV module orientation – 1.7 m (5.6 ft) pitch

Table 11: Internal QD Cable VRise (IQ8H-3P – 208 V / Portrait cable, QD-12-13-120)

IQ8H-3P-72-E-US	IQ8P-3P Microinverters per branch (208 VAC three-phase system)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VRise (V)	0.041	0.093	0.154	0.256	0.369	0.491	0.654	0.828	1.011	1.235	1.47	1.715	2	2.297	2.602
VRise (%)	0.02	0.04	0.07	0.12	0.18	0.24	0.31	0.40	0.49	0.59	0.71	0.82	0.96	1.10	1.25

Portrait PV module landscape – 2.4 m (7.9 ft) pitch

Table 12: Internal QD Cable VRise (IQ8H-3P – 208 V / Portrait cable, QD-12-20-120)

IQ8H-3P-72-E-US	IQ8P-3P Microinverters per branch (208 VAC three-phase system)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VRise (V)	0.058	0.132	0.217	0.361	0.521	0.693	0.923	1.169	1.428	1.744	2.076	2.421	2.824	3.242	3.674
VRise (%)	0.03	0.06	0.10	0.17	0.25	0.33	0.44	0.56	0.69	0.84	1.00	1.16	1.36	1.56	1.77

Portrait PV module landscape – 2.9 m (9.5 ft) pitch

Table 13: Internal QD Cable VRise (IQ8H-3P – 208 V/Portrait cable, QD-12-25-108)

IQ8H-3P-72-E-US	IQ8P-3P Microinverters per branch (208 VAC three-phase system)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
VRise (V)	0.07	0.159	0.263	0.436	0.629	0.837	1.115	1.412	1.725	2.107	2.508	2.926	3.413	3.918	4.44
VRise (%)	0.03	0.08	0.13	0.21	0.30	0.40	0.54	0.68	0.83	1.01	1.21	1.41	1.64	1.88	2.13

As the voltage rise is non-linear, reducing the number of microinverters in the branch circuit greatly reduces the voltage measured at the farthest microinverter in the branch. One way to minimize this voltage rise is to center-feed the branch, that is, divide the circuit into two sub-branch circuits protected by a single OCPD.

2.3.3 Center tap connection scenarios

All the QD Cable variants come with a center-tapping connector provision positioned after every six QD connectors for microinverter connection. Select the center tap connector such that a maximum of nine IQ8 Commercial Microinverters are installed on either side of the center tap connector to limit voltage rise <1% in the QD Cable. In case the circuit length itself is less than nine microinverters, the circuit shall be end-terminated, leaving the QD Center Tap connectors unused.



NOTE: Do not connect microinverters to the QD Center Tap connector provision.

In sites, there could be scenarios where the starting point for a circuit is not the first connector in a circuit.

The following table lists the different scenarios based on the starting point of the circuit using QD Cables and the possible number of microinverters, which could be on either side of the center tap.

Table 14: QD Cable variants

IQ8P-3P			IQ8H-3P		
Start from connector	Circuit size	Center tap	Start from connector	Circuit size	Center tap
1	12	6,6	1	15	6,9
2	12	5,7	2	15	5,10
3	12	4,8	3	15	10,5
4	12	3,9	4	15	9,6
5	12	8,4	5	15	8,7
6	12	7,5	6	15	7,8
1	9	NA	1	12	6,6
2	9	NA	2	12	5,7
3	9	NA	3	12	4,8
4	9	NA	4	12	3,9
5	9	NA	5	12	8,4
6	9	NA	6	12	7,5
			1	9	NA
			2	9	NA
			3	9	NA
			4	9	NA
			5	9	NA
			6	9	NA

Though we recommend a maximum of nine connectors on either side of the center tap, there are two instances with IQ8H-3P where the QD Center Taps have ten on either side, especially when the installer starts from connectors 2 and 3. This is acceptable as per the VRise table (refer to [Table 13](#)).

2.3.4 Advantages of center-feeding QD Cable AC branch circuit

Enphase recommends that the total percentage of voltage rise in the AC wiring be a maximum of 2%, with (an inclusive) less than 1% voltage rise in the QD Cable. A fully populated IQ8 Commercial branch circuit has 12 microinverters with IQ8P-3P and 15 microinverters with IQ8H-3P on the AC branch circuit. As voltage rise is exponential, reducing the number of microinverters in the branch circuit greatly reduces the voltage measured at the farthest microinverter in the branch. One way to minimize this voltage rise is to center-feed the branch, that is, divide the circuit into two sub-branch circuits protected by a single OCPD. Therefore, for all installations with IQ8 Commercial Microinverters, center-feeding of three-phase AC supply is recommended.

All three QD Cable SKUs include center-tapping connectors after every 6 AC male QD connectors in the QD Cable spool. The center tap connectors are sealed with a sealing cap, and the sealing cap should be removed only when the connector is used for feeding the AC supply to the branch.

When installing the IQ8 Commercial Microinverter system using QD Cable, you may have multiple center tap connectors in the branch circuit. Select the center tap connector such that a maximum of 9 IQ8 Commercial Microinverters are installed on either side of the center tap connector to limit voltage rise <1% in the QD Cable. Do not exceed the branch circuit sizing mentioned in the “[Number of microinverters per branch circuit](#)” section.



WARNING: Use a female three-phase Field Wireable QD Connector (QD-CONN-10F) to connect the extension cable to the 3-pole 20 A over-current protection device (OCPD) in the PV subpanel.



WARNING: The center-tapping AC male connector is marked “Center tap” and “Do Not Connect to Microinverter.” Do not use the center-tap connectors for connecting to the microinverter.

The center-tapping connector in the QD Cable is covered with a sealing cap. Do not remove pre-installed sealing caps if the center-tap connector is not used for center-feeding using the QD Center Tap Adapter Cable.

2.4 IQ Gateway Commercial 2

When designing a three-phase, commercial-scale system, it is critical to install an IQ Gateway Commercial 2 (model ENV2-IQC2-AM3-3P). IQ Gateway Commercial 2 will communicate with up to 276 IQ Commercial Microinverters for monitoring and maintenance when connected in the same gateway communication domain.



Figure 10: IQ Gateway Commercial 2

The IQ Gateway Commercial 2 should be used solely for 208/120 V WYE three-phase applications and provides integrated, revenue grade PV production metering ($\pm 0.5\%$) with included three 400 A continuous rated production CTs and optional 600 A continuous rated consumption monitoring ($\pm 2.5\%$).

The IQ Gateway Commercial 2 supports only CT-400-SOLID for production monitoring, CT-600-SPLIT (pack of three, to be ordered separately) for consumption monitoring and should not be used with any other type of CTs. The 400 A Production CTs support cables with a maximum gauge of 1000 KCMil, whereas the 600 A Consumption CTs support cables with a maximum gauge of 300 KCMil. You can use up to two parallel-connected Consumption CTs to monitor up to a maximum of two conductors. Check that there is enough space in the load center to install CTs. Do not install CTs where they exceed 75% of the wiring space of any cross-sectional area within the load center.

Table 15: IQ Gateway Commercial 2

Voltage configuration	Gateway type	SKU	Three-phase metering
208 V	IQ Gateway Commercial 2	ENV2-IQC2-AM3-3P	Available
Current Transformers	Three revenue grade 400 A Production CTs (+/-0.5%) - default supply with gateway Three or six optional 600 A Consumption CTs (+/-2.5%)		

2.4.1 Wiring IQ Gateway Commercial 2 ENV2-IQC2-AM3-3P for three-phase applications

When installing the three-phase IQ Gateway Commercial 2 (model ENV2-IQC2-AM3-3P), make sure the voltage configuration is 208/120 V WYE three-phase at the solar subpanel.

The Production CTs and optional Consumption CTs may be installed if the following criteria can be met.

- Production CTs are limited to 400 A of continuous current. The internal aperture of the solid core production CTs measures 43 mm and can support cables up to a maximum size of 1000 KCMil conductors.
- Consumption CTs are limited for electrical services up to 600 A. The internal aperture of the split-core CTs measures 50mm x 50mm and can support cables up to a maximum size of 300 KCMil conductors. CT wire insulation has a 600 V rating and maybe run alongside other current-carrying conductors. Two 600 A Consumption CTs can be connected in parallel if needed with a maximum of two CT wires per IQ Gateway Commercial 2 terminal block.

The following figure shows how to correctly wire an IQ Gateway Commercial 2 (model ENV2-IQC2-AM3-3P) into a 208/120 V WYE three-phase system.

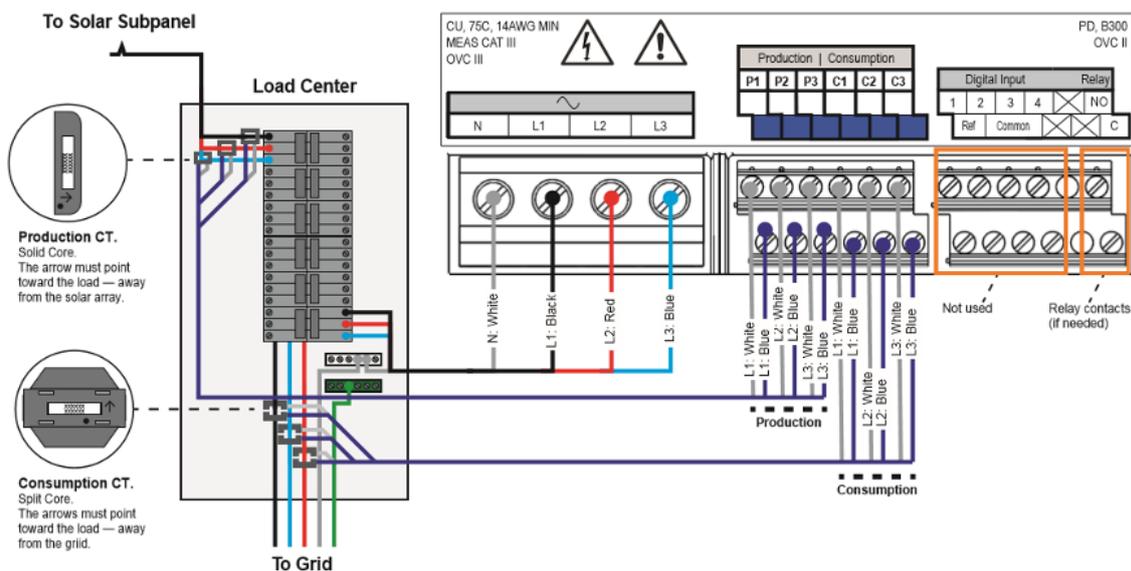


Figure 11: IQ Gateway Commercial 2 - Terminal block

2.4.2 Design considerations for reliable PLC communications

Enphase IQ Microinverter systems use power line communications (PLC) to communicate module-level data between the microinverters and the gateway. The PLC signal is at 110 kHz in an IQ8 Commercial System. In a commercial-scale system, the IQ Gateway Commercial 2 is continuously

polling the microinverters for their recent power production, temperature, voltage, amperage, and frequency data.

Therefore, it is critical to maintain good communication between devices with minimal interference on the PLC signal. Enphase recommends the following design considerations for maintaining reliable PLC communication between microinverters and IQ Gateway Commercial 2.

Designs for reliable PLC require the following:

- Do not exceed 276 IQ8 Commercial Microinverters per gateway.
- Install the gateway as close as possible to the microinverters. Consult Enphase if you need to exceed 75 meters (246 feet) conductor length between the gateway and the last IQ8 Commercial Microinverter in the circuit.
- Install a line communication filter to isolate gateway communications domains. Filtering is mandatory when multiple gateways are installed to separate communication domains.
- For sites with multiple gateways, the conductors and conduits of each gateway communication domain must be kept physically separated from the conductors and wiring of other communications domains by at least 12 inches using properly grounded metal conduits. Coupling of the signals can occur between the conductors and conduits when run together, especially on long conduit and wire runs.

2.4.3 Design considerations for sites with Power Export Limit requirements

The Enphase Power Export Limit (PEL) function can be configured to operate at different Power Export Limits to meet the site requirements, as is required by the local utility service. The value for the Power Export Limit is defined within a specific Enphase grid profile. The installer needs to use different grid profiles for different PEL values.

Primary Protection

An Enphase IQ8 Commercial PV system can support the Power Export Limit by using a PEL Grid profile and an IQ Gateway Commercial 2 with Production CTs installed at solar PV subpanels and Consumption CTs installed at/near the utility service location. When configured for the Power Export Limit, the Enphase system still automatically limits the PV generation so that energy exported to the grid is zero or the Power Export Limit set within the grid profile. This functionality is set through the grid profile and called Soft Export Limit.

Secondary protection

The IQ Gateway Commercial 2 also has a secondary level of protection called a hard PEL. The hard PEL operates a voltage-free contact in the gateway that can be wired to an external contactor to physically disconnect the IQ8 Commercial Microinverters from the grid if the Power Export Limit target is not reached in the configurable time frame. Refer to [Figure 16](#) to check for relay contacts on the IQ Gateway Commercial 2.

Export limiting for an IQ Gateway Commercial 2 requires the following system components:

- IQ8 Commercial Series Microinverters (Maximum 276 microinverters per IQ Gateway Commercial 2).
- The site must have only a single IQ Gateway Commercial 2 installed to be PEL capable. Sites with multiple gateways cannot perform Power Export Limit collectively.
- Production current transformer (400 A) and Consumption current transformers (600 A) are fitted and enabled via the Installer Enphase Installer App.
- Adequate power line communication between gateway and microinverters—showing three bars or more in the Installer Enphase Installer App for all installed microinverters. The installer should also troubleshoot and identify if power line communication is degraded or

disrupted by noise using the FFT analysis in the Enphase Installer App.

- A grid profile for the site, which includes the Power Export Limit value set to the export limit required. If there is no pre-existing grid profile for the export limit required, contact [Enphase Support](#) to request a new custom grid profile.
- Line communication filter usage shall depend on PLC strength and noise levels onsite based on FFT analysis.

2.4.4 Multiple gateway systems

Multiple gateways are often used where there are multiple array locations and multiple PV array subpanels installed across array locations on a site. Using multiple gateways in this installation scenario enables more flexibility in wiring and simplifies the design. Power Export Limiting (PEL) only works in systems with a single IQ Gateway Commercial 2 and where the Consumption CTs can fit around the total service load conductors. Therefore, any site with multiple gateways shall not be able to support system-level Power Export Limit requirements, if any.

Enphase microinverter system design can allow multiple gateways to be installed at a single site. Data from multiple gateways can be aggregated as a single installation for system monitoring in The Enphase Installer Portal.

Design consideration for multiple gateways

- The minimum number of microinverters that can report to an IQ Gateway Commercial 2 is three.
- The maximum number of microinverters that can report to an IQ Gateway Commercial 2 metered is 276.
- A PV load center must have one IQ Gateway Commercial 2 per load center.
- Power Line filters must be used for multiple gateway installations to reduce crosstalk between gateways. Enphase offers a 400 A power line filter for IQ8 Commercial PV system installation.
- CT metering with multiple gateways is not feasible as gateways do not communicate with other gateways. Consumption data from one gateway is not calculated correctly if it does not measure all the solar production across the entire site. If consumption data is required, each gateway on site can measure ONLY the consumption load at the distribution board point that the solar PV generation supplies.
- If main service conductors are inaccessible, multiple circuit conductors can be bundled for a single CT. All Line 1 conductors are bundled to go through Line 1 CT, and all line 2 conductors are bundled to go through Line 2 CT for proper bundling. Two 600 A Consumption CTs can be connected in parallel if needed with a maximum of two CT wires per IQ Gateway Commercial 2 terminal block.
- For all gateways at a site to communicate well, you must protect the communications domain for each gateway from inter-gateway crosstalk. Enphase Installer Portal highlights the microinverters in the array view that are communicating with multiple gateways. Refer to the section Troubleshooting during commissioning for more details.
- Achieve protection (PLC attenuation) using line filters. The Enphase Installer App provides a way to do the Power line communication analysis. This enables the user to troubleshoot and identify conditions where the Power Line Communications (PLC) is degraded or disrupted by noise in the frequency band that the PLC uses for communication. The installer can export/share the report generated. Refer to the section Troubleshooting during commissioning for more details.
- For sites with multiple gateways, the conductors and conduits of each communication domain must be kept physically separated from the conductors and wiring of other communications domains by at least 12 inches using properly grounded metal conduits. Coupling of the signals can occur between the conductors and conduits when run together, especially on long conduit and wire runs.



NOTE: Do not use the PLC scan function on IQ Gateway Commercial 2 to detect IQ8 Commercial Microinverters for a multiple gateway installation.

2.5 Internet connection options

The IQ Gateway Commercial 2 requires a connection to the internet for reporting to the Enphase Installer Portal. You can provide this connection through an existing broadband router, other Wi-Fi access point at the installation site, or by using the Enphase Mobile Connect cellular modem CELLMODEM-M1-06-SP-05 or CELLMODEM-M1-06-AT-05.

- Method A: Integrated Wi-Fi.
- Method B: Enphase Mobile Connect [order Enphase CELLMODEM-M1-06-SP-05 or CELLMODEM-M1-06-AT-05 separately].
- Method C: Ethernet cable (not included; installer must provide). This method requires that you use the ferrite bead included with the gateway.
- Method D: Power Line Communication Bridges (order EPLC-01 separately). This method requires that you use the ferrite bead with the IQ Gateway Commercial 2.
- Method E: Commercial Grade Wi-Fi Bridge.

Contact the Enphase sales team for more information on Internet connectivity and options.

2.6 Installing IQ Gateway Commercial 2 in an outdoor enclosure

The IQ Gateway Commercial 2 must be installed inside an electrical enclosure, keeping the operating temperature of the gateway in mind. This enclosure must be large enough to house the gateway. If you use a power line bridge or other networking component, make sure the enclosure can accommodate a receptacle. The enclosure can be metal or non-metallic but should be non-metallic if Wi-Fi or cellular networks are used for the gateway internet connection. The enclosure must meet the following requirements:

- Use a NEMA type 3R, 4, or better-rated outdoor enclosure with a hinged cover or screw cover of suitable dimensions. Typical enclosure dimensions are in the range of 10" x 10" x 4" to 12" x 12" x 6".
- Connect the gateway to phases and the neutral. A neutral is required for powering the Commercial Gateway and for metering. It does not ship with a plug-in style power cord, so a receptacle is not required in the enclosure for powering the IQ Gateway Commercial 2.
- Install a receptacle inside the enclosure if an Ethernet over power line communication (PLC) bridge is desired.
- Install the enclosure in a location that is shaded from direct sunlight. The Commercial Gateway is rated for ambient temperatures of -40°F to 115°F when installed in an enclosure.
- Do not drill holes on the top of the enclosure or anywhere that allows moisture ingress if the enclosure is outdoors. If top entry is needed, a water-tight conduit hub, like a Myers Hub™ or other suitable hub product, must be used.
- Do not leave energized terminals or components easily accessible; keep them in a location that can be accessed only by service personnel.
- Consider drilling a small drain hole in the bottom, lowermost corners of the enclosure box so that moisture or condensate can drain out of the enclosure.

2.7 Power line filters

Enphase offers a 400 A power line filter for IQ8 Commercial System installation. QD-LCF-400-3P is specific for the IQ System power line communication (PLC) frequency. You can use it to filter electrical

noise or signals between multiple IQ Gateway Commercial 2s and their respective communication domains and/or noise sources from loads or other devices in commercial and industrial settings. Do not cross-filtered Load and Line connected conductors or run them in the same conduit. This would defeat the purpose of line filtering. Also, do not run filtered Load conductors from more than one IQ Gateway Commercial 2 communication domain in the same conduit or cable tray.

2.7.1 400 A filter (SKU: QD-LCF-400-3P)

The filter must be protected by a 400 A or smaller OCPD. When installing a power line filter in an IQ8 Commercial System, the IQ8 Commercial Microinverters and the IQ Gateway Commercial 2 must ALL be located on the load side of the filter. A 400 A limit of the filter limits the communication domain to 144 kW AC at 208/120 V WYE.

2.7.2 Installation Instructions

- The filter can be wall or flat-surface mounted using 6 x M10 or M12 screws.
- The 400 A LC Filter has open terminal connections, and for safety, the filter must be installed inside a lockable electrical panel or an enclosed housing, taking proper electrical codes and clearance spaces into consideration. We recommend using insulation sleeves or heat shrink tubes to fully cover the open connections or terminals.
- For the electrical connections, the terminals have holes to accommodate an M10 bolt. The wires must be terminated with a #10 lug and fastened to the terminals using an M10 bolt and nut. The bolt and nut must be tightened to 160 in-lb (18 N m). It must be ensured that there is good contact (surface) between the lug and the terminals.

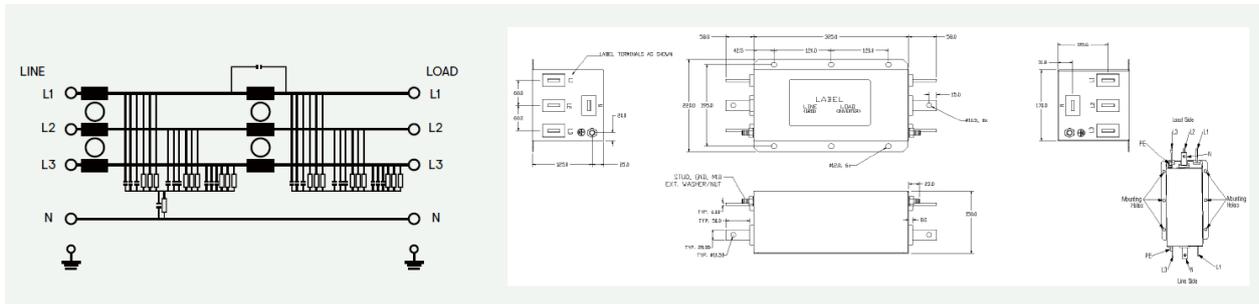


Figure 12: 400 A Line Communication Filter

2.8 Surge suppression in commercial systems

Surges can occur anywhere on the electrical grid. The guidelines in this section help to minimize any surge-related issues in your commercial installation. Enphase recommends that you protect your building or site with surge suppression devices. Enphase microinverters have integral surge protection. However, if the surge has enough energy, the protection built into the microinverter can be exceeded, and the equipment may be damaged.

Surge suppression devices protect site loads from electrical surges and can be installed in the main load center. This provides the greatest level of protection but is often more expensive than a surge protective device that is placed in parallel to the microinverter panel board and will likely filter the power line communications in a system.

If using an inline surge protective device, then the IQ Gateway Commercial 2 and microinverters must be located together on the load side of this device.

A panel-level surge suppressor interrupts the circuit and isolates equipment from the source of the surge. There is a wide range of devices available from equipment manufacturers with a range of warranties. Enphase does not warrant or guarantee the performance of any of these products. In addition to having some level of surge suppression, it is important to have insurance that protects

against electrical surges. Install protective devices per vendor instructions. For more information, see the *Citel DS73RS-120 surge protector data sheet*.

3 IQ8 Commercial System layout design

This section focuses on the IQ8 Commercial System structural layout design after the system component selection and single-line diagram finalization.

3.1 PV array layout design

Array design is the physical layout of the Solar PV modules and associate cabling for modules. Array design with Enphase IQ8 Commercial Microinverter offers flexibility.

Each IQ8 Commercial Microinverter variant can be connected with one electrically compatible high-power PV module.

You can consider any array configuration, module orientation, azimuth, and tilt angle for the PV modules.

3.1.1 Information required for array design

- Solar module specifications (mechanical and electrical).
- Allowed microinverter mounting location.
- DC connector type and cable lengths.
- Type of PV module: Monofacial or bifacial, 54-cell/108 half-cell, 60-cell/120 half-cell, 66-cell/132 half-cell, and 72-cell/144 half-cell.
- Available installation area of the proposed location (including shading, pitch, orientation, roof material/type, and access).

3.1.2 Design considerations for PV array layout

- Site electrical configuration and layout.
- Structural mounting integrity.
- Site shade paths.
- Load bearing capacity of the terrace, rooftop, or the structure on which the PV system is mounted.
- Typical and maximum wind loads at that location, also factoring in the height of the installation.
- Site access (access to arrays for maintenance, and so on).

3.2 AC cabling layout

1. Plan each cable segment to allow drop connectors on the Enphase QD Cable to align with the IQ8 Commercial Microinverter. Allow extra length for slack, cable turns, and any obstructions.
2. Mark the approximate location of the microinverter on each PV module or the PV racking.
3. Field wireable connectors are pre-installed at the ends of the QD Cables to increase the cable length beyond the connector limit mentioned in [Table 6](#). The field wireable connectors are protected with sealing caps. The sealing caps must be removed only when you are increasing cable length using the field wireables at the cable end.



WARNING: Do not remove sealing caps from the cable end field wireable connectors if they are not used to increase cable length.

4. When transitioning between rows for the same AC branch circuit, go across rows with the use of three-phase Field Wireable QD Connector (QD-CONN-10F and QD-CONN-10M) connectors along with Raw QD Cable to extend the cable drop length. Try to minimize unused/skipping QD connectors in the branch circuit to maintain phase balance across each phase.
 - Each connector on the QD Cable is marked with Phase ID C1, C2, and C3, which shows the phase rotation across the connectors in the QD Cable as shown in [Figure 4](#), and the similar phase rotation arrangement continues across the cable.
 - Plan your AC branch circuits with a maximum recommended IQ8 Commercial Microinverters per branch circuit. In case you are skipping a connector, ensure that each branch circuit has IQ8 Commercial Microinverters as multiples of 3 per phase, that is, L1-L2, L2-L3, L3-L1 and within the maximum recommended number of microinverters per 3-pole 20 A circuit. You can check the marking on connectors C1 (L1- L2), C2(L2-L3), and C3(L3-L1) to count the number of microinverters per phase in a branch circuit when protected with a 3-pole 20 A overcurrent protection device (OCPD).
 - If one exceeds the limit of IQ8 Commercial Microinverters per phase (L-L) in a branch circuit (IQ8P-3P: 4 microinverters, IQ8H-3P: 5 microinverters), then the current will be more than QD Cable capacity. For more details, refer to Appendix A: Ampacity calculations for IQ8 Commercial Microinverter system.
 - In case you are skipping a connector, ensure you have an equal number of C1, C2, and C3 in the system to maintain the power balance across phases achieved using the phase rotation in QD Cable.
5. Enphase recommends that the total percentage of voltage rise in the AC wiring be a maximum of 2%, with (an inclusive) less than 1% voltage rise in the QD Cable.
6. It is recommended to use Center feeding of the AC branch circuit to reduce voltage rise when QD Cable voltage rise is >1%.
7. QD Cable is a UL3003 DG (Distributed Generation) listed cabling system. The DG cable standard UL3003 is based upon the construction specifications (wet-rated) of TC-ER cable, which may be installed in the raceway as per NEC 336.10(3).
8. You must install supports (such as clips) for the QD Cable and Raw QD Cable at 1.8 m (6 ft) intervals or less. Installation requirements for wet-rated cable allow QD Cable and Raw QD Cable to be installed in conduits, cable trays, and other raceways.

3.3 PV load center configuration and location

A PV load center enables dedicated isolation of the microinverter branch circuits and provides a simple installation platform for the IQ Gateway Commercial 2.

The PV load center should be installed considering both the cable route and distance to the microinverters. You can install the PV load center indoors or outdoors, depending on the electrical layout across the site.

3.3.1 Key components of PV load Center

- PV load center enclosure: The PV load center enclosure may be indoor or outdoor rated, depending on the installation location of the load center onsite.
- IQ Gateway Commercial 2.
- Dedicated IQ Gateway Commercial 2 circuit.
- Production CTs (Current Transformers).
- Three-phase circuit breakers.

3.3.2 Location of PV load center

Install the PV load center between the solar PV array and the existing distribution panel on site. The PV load center location can be anywhere across the site. However, consider the following when planning the location:

- Distance from the existing distribution panel to which the PV load center is connected. (Note VRise and PLC considerations).
- Distance from PV arrays to the location of the PV load center.
- Conductor sizing of the installed home run cabling system to the PV load center.
- Route length distance on the same circuit between the first microinverter and the IQ Gateway Commercial 2: Not more than 75 meters (246 feet) between the farthest microinverter on the branch circuit and the gateway.
- Accessibility for installers and for servicing.
- Available space for installation.

3.4 Consumption CTs

- Consumption monitoring is optional, and installers can order three Consumption CTs capable of measuring up to 600 A continuous current with 2.5% accuracy.
- The internal aperture of the split core Consumption CTs measures 50mm x 50mm to support a maximum size of 300 KCMil THWN conductor.
- Two 600 A Consumption CTs can be connected in parallel if needed with a maximum of two CT wires per IQ Gateway Commercial 2 terminal block.
- Do not install the Consumption CTs in a panel where they exceed 75% of the wiring space of any cross-sectional area within the panel. (NEC 2017 312.8).
- For net consumption metering, ensure there is sufficient room to install both CTs around lines 1, 2, and 3 from the main feeds.
- For total consumption metering, ensure there is sufficient room to install the CTs around the lines that feed the consumption circuit.
- You must use a protected route in conduit for the CT wires from the AC mains to the IQ Gateway Commercial 2.
- Consumption CTs lead extension: If needed, an electrician may extend the leads of the Consumption CTs using the following guidance:
 - To extend the CT leads, the electrician must use appropriately rated, 18-14 AWG, twisted pair wire and install it in accordance with all applicable local electrical codes and the National Electrical Code (NEC; NFPA 70).
 - The electrician may add as much as three ohms round trip resistance to the Consumption CT or up to 1.5 ohms per wire.
 - Select a wire that is Code type, NRTL certified, and rated for voltage and temperature for the specific application. Mechanically protect the wires in a Code type, NRTL-certified conduit or raceway. Use NRTL-certified connectors for splices and insulated splices from one another and from the raceway, conduit, or junction box if metallic.
 - If you need to extend the leads, refer to the Enphase IQ Gateway Commercial 2 Installation and Operation Guide at enphase.com/support. Do not extend the leads of the Production CT.

4 IQ8 Commercial Microinverter installation

4.1 Parts and tools required

In addition to the IQ8 Commercial Microinverters, PV modules, and racking, you will need the following.

Enphase BOM

Table 16: QD Cable types/ordering options

Enphase IQ Gateway Commercial 2	Required to monitor production. IQ Gateway Commercial 2 (model ENV2-IQC2-AM3-3P) communications gateway
Enphase Installer App	Download the Enphase Installer App mobile app, open it, and log in to your Enphase Installer Portal account. Use it later to scan microinverter serial numbers and connect to the IQ Gateway Commercial 2 to track system installation progress. To download, go to enphase.com/toolkit
Tie wraps or QD Cable Clips	(ET-CLIP-100)
QD Sealing Caps	(QD-SEAL-10) for any unused drops on the Enphase Q Cable
QD Terminator	(QD-TERM-10) typically, 1 Terminator (End feeding branch circuit) or 2 Terminator (Center feeding branch circuit) required per branch circuit
QD Disconnect Tool	(QD-DISC-10)
Field Wireable QD Connectors	Male QD-CONN-10M and female QD-CONN-10F

QD Cable types/ordering options					
Model number	Max voltage	Size	Connector spacing	PV module orientation	Connector count per box
QD-12-13-120	277 VAC	12 AWG	1.3 m (4.3 ft)	Portrait	120
QD-12-20-120	277 VAC	12 AWG	2.0 m (6.6 ft)	Landscape	120
QD-12-25-108	277 VAC	12 AWG	2.5 m (8.2 ft)	Landscape	108

Other items

- AC junction box
- Number 2 and 3 screwdrivers
- Screwdriver blade width 4 mm to 3.2 mm (1/8") (recommended tool to torque the screw on contact carrier and to disconnect field wireable connector)
- Wire cutters, voltmeter
- Torque wrench, sockets, wrenches for mounting hardware, 30 mm wrench
- DC disconnect tool for the DC connector type used

4.2 IQ8 Commercial Microinverter installation

Installing the Enphase IQ8 Commercial Microinverters involves several key steps.

1. Position the Enphase QD Cable.
2. Manage the cabling.
3. Mount the microinverters.
4. Connect the microinverters.
5. Provide an AC connection to the branch circuit.
6. Terminate the unused end of the cable.
7. Create an installation map.
8. Connect the PV modules.
9. Energize the system.

Step 1: Position the Enphase QD Cable

- A. Plan each cable segment to allow connectors on the QD Cable to align with each IQ8 Commercial Microinverter connected to the PV module. Allow extra length for slack, cable turns, and any obstructions.
- B. Mark the approximate location of the microinverter on each PV module or the PV racking.
- C. Lay out the cabling along the installed racking for the AC branch circuit.
- D. Cut each segment of cable to meet your planned needs.



When transitioning between rows, secure the cable to the rail or PV module frame to prevent cable damage or connector damage. Do not count on the connector to withstand tension.

Step 2: Manage the cabling

- A. You must install supports (clips, etc.) for the QD Cable and Raw QD Cable at 1.8 m (6 ft) intervals or less.
- B. Installation requirements for wet-rated cable allow QD Cable and Raw QD Cable to be installed in conduits, cable trays, and other raceways.
- C. Dress any excess cabling in loops so that it does not touch the roof. Do not form loops smaller than 12 cm (4.7") in diameter.

Step 3: Mount the microinverters

- A. Mount the microinverter horizontally, bracket side up, or vertically. Always place it under the PV module, protected from direct exposure to rain, sun, and other harmful weather events.

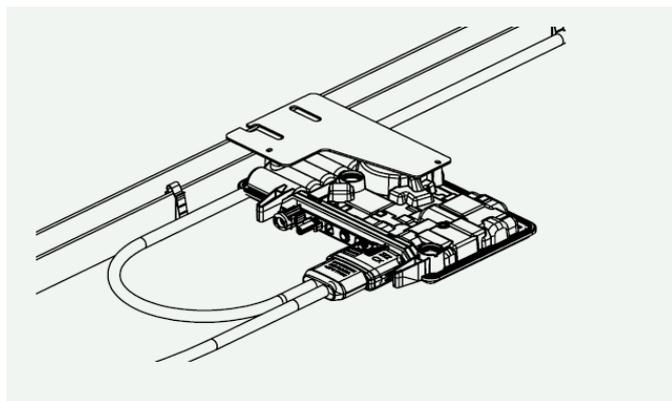


Figure 13: Horizontal mount of IQ8 Commercial Microinverter

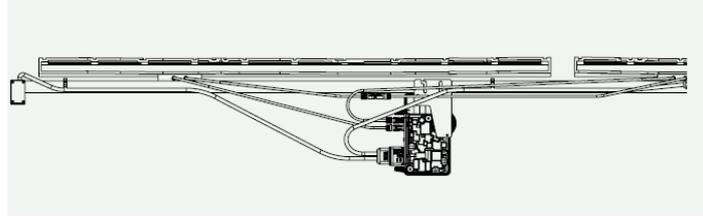


Figure 14: Vertical mount of IQ8 Commercial Microinverter

- B. Allow a minimum of 1.9 cm (3/4") between the roof and the microinverter. Also, allow 1.3 cm (1/2") between the back of the PV module and the top of the microinverter.
- C. For the vertical mount with bifacial PV modules, maintain > 30 cm (12") clearance from the edges of the PV module to protect the microinverter from direct exposure to rain, UV, and other harmful weather events.

Install the microinverter under the PV module to avoid direct exposure to rain, UV, and other harmful weather events. Do not mount the microinverter upside down.

- D. Torque the mounting fasteners (1/4-inch or 5/16-inch) as follows. Do not over-torque.
 - 6 mm (1/4") mounting hardware: 5 N m (45 to 50 in-lbs.)
 - 8 mm (5/16") mounting hardware: 9 N m (80 to 85 in-lbs.)
 - When using UL 2703 mounting hardware, use the manufacturer's recommended torque value.
- E. Ensure microinverters are oriented in the correct direction with the correct side facing the solar PV module (bracket side up).
- F. The Enphase Frame Mount bracket allows you to attach an IQ8 Commercial Microinverter easily and rapidly to the PV module frame. Use the Frame Mount bracket in rail-less or ballasted solar installations.



Figure 15: Frame Mount bracket

The Enphase Frame Mount bracket comes in two sizes, 35 mm (EFM- 35 MM) and 40 mm (EFM-40MM), depending upon the thickness (depth) of the PV module frame.

- Place the bracket clamp over the edge of the module frame, as shown in the following figure, on the deeper frame side of the PV module.

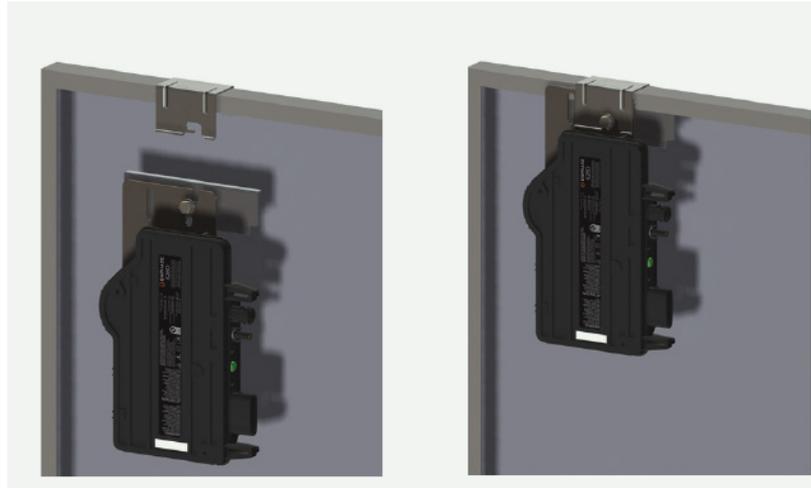


Figure 16: Frame Mount bracket placement

- Thread the cap bolt into the threaded insert on the bracket, then slide the IQ8 Commercial Microinverter slot onto the bolt.
- Slide the microinverter unit onto the bracket clamp. The bolt now holds the frame mount to the bracket clamp. The microinverter mounting flange should be on the outside of the module frame, as shown in [Figure 16](#).
- With a 13 mm or 1/2-inch socket wrench, tighten the cap screw until you reach a torque of 18 N m (13 ft-lbs.).
- When using any racking manufacturer's frame mount bracket, follow the manufacturer's recommended torque value and installation guidelines for frame mounting the IQ8 Commercial Microinverter.

Step 4: Connect the microinverters

- Connect the IQ8 Commercial Microinverter to the QD Cable connector. Listen for a click as the connectors engage.
- Ensure the QD connector is fully seated and locked on the microinverter AC Connector. You can verify the connection using the green and red indicators on the QD Cable connector, as shown in the image below.



Figure 17: QD Cable connection

- Cover any unused connectors on the AC cable with the QD Sealing Caps (QD-SEAL-10). Listen for a click as the sealing caps engage.



WARNING: Risk of electric shock. Risk of fire. Install sealing caps on all unused AC connectors, as these connectors become live when the system is energized. Sealing caps are required for protection against moisture ingress.



NOTE: To remove a sealing cap or AC connector, you must use the QD Disconnect Tool.

Step 5: Provide an AC connection to the branch circuit

Method A: Center-feeding the branch circuit

Enphase recommends that the total percentage of voltage rise in the AC wiring be a maximum of 2%, with (an inclusive) less than 1% voltage rise in the QD Cable.

Although the QD Cable is optimized for minimal VRise, it is still important to calculate the total VRise for the entire system for the farthest microinverter in the branch circuits from the point of common coupling.

Because voltage rise is exponential, reducing the number of microinverters in the branch circuit greatly reduces the voltage measured at the farthest microinverter in the branch. One way to minimize this voltage rise is to center-feed the branch, that is, divide the circuit into two sub-branch circuits protected by a single OCPD. Therefore, for all installations with IQ8 Commercial Microinverters, center-feeding of a three-phase AC supply is recommended.

Follow these installation steps for center-feeding the microinverter branch circuits:

- A. All three QD Cable SKUs include center-tapping connectors after every 6 AC male QD connectors in the QD Cable spool. The center-tap connectors are sealed with sealing caps, and the sealing cap should be removed only when the connector is used for feeding the AC supply to the branch.



NOTE: The center-tap connector is a three-phase male field-wireable connector. Use the center-tap connector only for feeding in the AC Supply connection from the PV subpanel.

- B. When installing the IQ8 Commercial Microinverter system using QD Cable, you may have multiple center-tap connectors in the branch circuit. Select the center-tap connector such that a maximum of nine IQ8 Commercial Microinverters are installed on either side of the center-tap connector to limit voltage rise <1% in the QD Cable. Do not exceed the branch circuit sizing mentioned in this guide.
- C. Use a female three-phase Field Wireable QD Connector (QD-CONN-10F) to connect the extension cable to the 3-pole 20 A over-current protection device (OCPD) in the PV subpanel.



NOTE: Do not remove pre-installed sealing caps on the center-tap connector if the connector is not used for center-feeding AC supply.

- D. Complete the AC connection. Verify that the AC voltage at the site is within range.

Service type and voltage: L1-L2, L2-L3 and L3-L1	
208 VAC three-phase	183 to 229 VAC
220 VAC three-phase	198 to 242 VAC

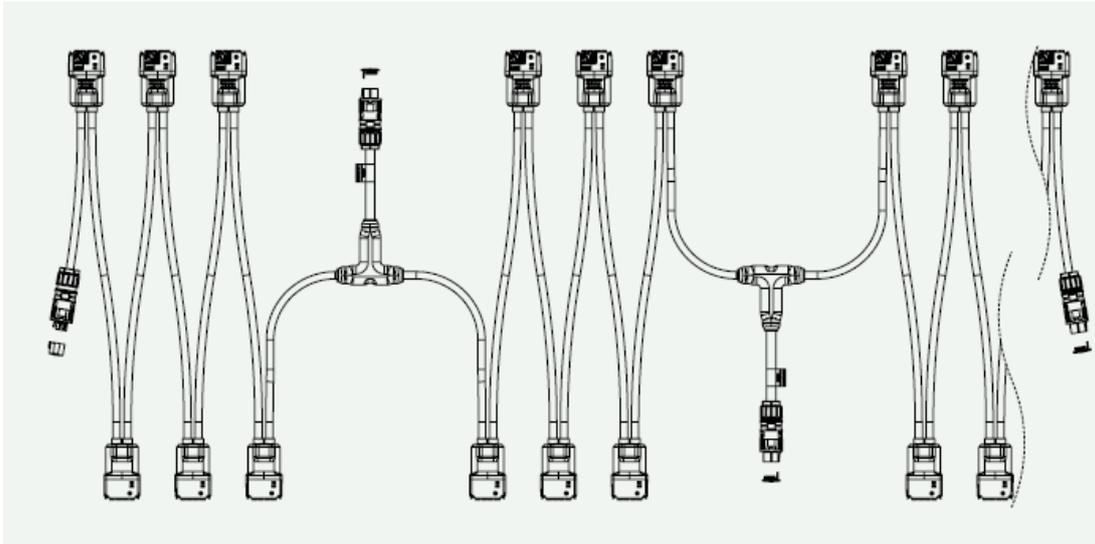


Figure 18: Center-feeding of AC branch circuit

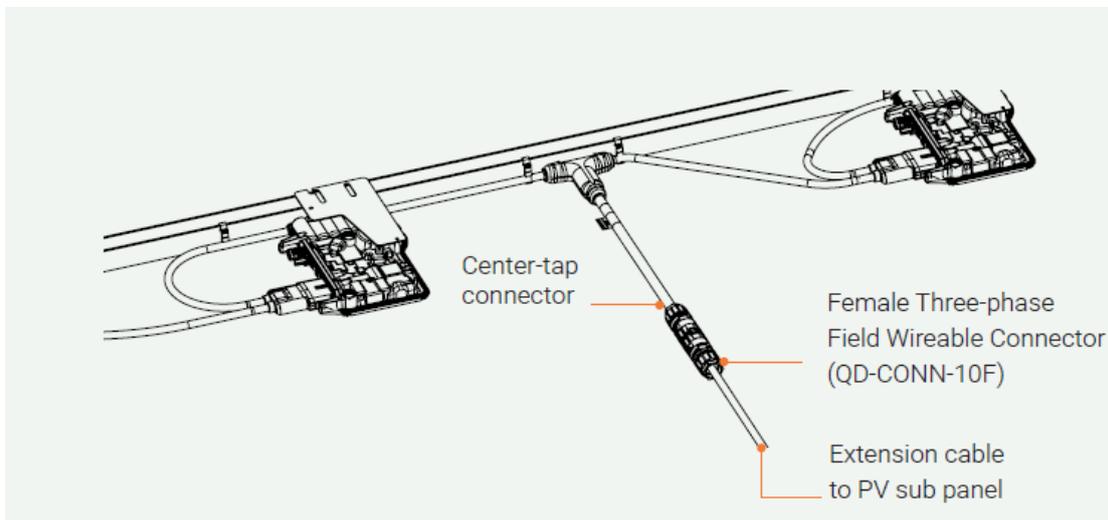


Figure 19: Center-feeding of AC branch circuit with link FW connector

Method B: End-feeding the branch circuit

For QD Cable SKUs QD-12-10-150 and QD-12-20-135, the voltage rise in the QD Cable is <1%. Therefore, end-feeding or center-feeding methodology can be used for the three-phase AC supply.

Use the Enphase three-phase Field Wireable QD Connectors (QD-CONN-10M and QD-CONN-10F) for end feeding the AC supply to IQ8 Commercial Microinverter branch circuits. OR installers can use off-the-shelf junction boxes for end feeding or center-feeding the three-phase AC supply to the IQ8 Commercial Microinverter branch circuit.



NOTE: QD Cable SKUS QD-12-10-150 and QD-12-10-135 does not include separate center-tapping connector within the cable. Therefore, it is recommended to use an off-the-shelf junction box for center-feeding the three-phase AC supply.

Service type and voltage: L1-L2, L2-L3 and L3-L1	
208 VAC three-phase	183 to 229 VAC
220 VAC three-phase	198 to 242 VAC

Step 6: Terminate the unused end of the cable

- A. Remove 20 mm (0.8 inches) of the cable sheath from the conductors.
- B. Slide the hex nut onto the cable.
- C. Insert the cable into the terminator body so that each of the four wires lands on opposite sides of the internal separators. There is a grommet inside of the hex nut that should remain in place.
- D. To attach the cap:
 1. Bend the wires down into the recesses of the terminator body and trim as needed. Place the cap over the terminator body.
 2. Insert a screwdriver into the slot on the terminator cap to hold it in place.
 3. Rotate the hex nut with your hand or a wrench until the latching mechanism meets the base. Do not over-torque.
- E. Attach the terminated cable end to the PV racking with a cable clip or tie wrap so that the cable and terminator do not touch the roof.

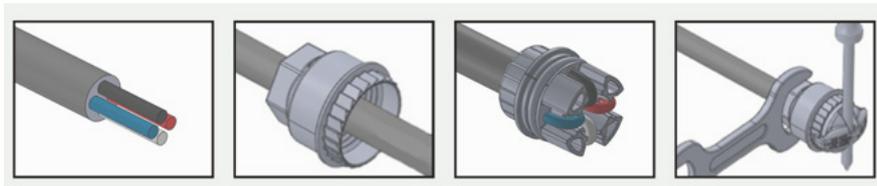


Figure 20: QD Terminator



NOTE: Turn only the hex nut to prevent conductors from twisting out of the separator.



NOTE: The terminator cannot be reused. If you unscrew the nut, you must discard the terminator.

Step 7: Create an installation map

Create a paper installation map to record microinverter serial numbers and position in the array.

- A. Peel the removable serial number label from each microinverter and affix it to the respective location on the paper installation map.
- B. Peel the label from the IQ Gateway Commercial 2 and affix it to the installation map.
- C. Always keep a copy of the installation map for your records.

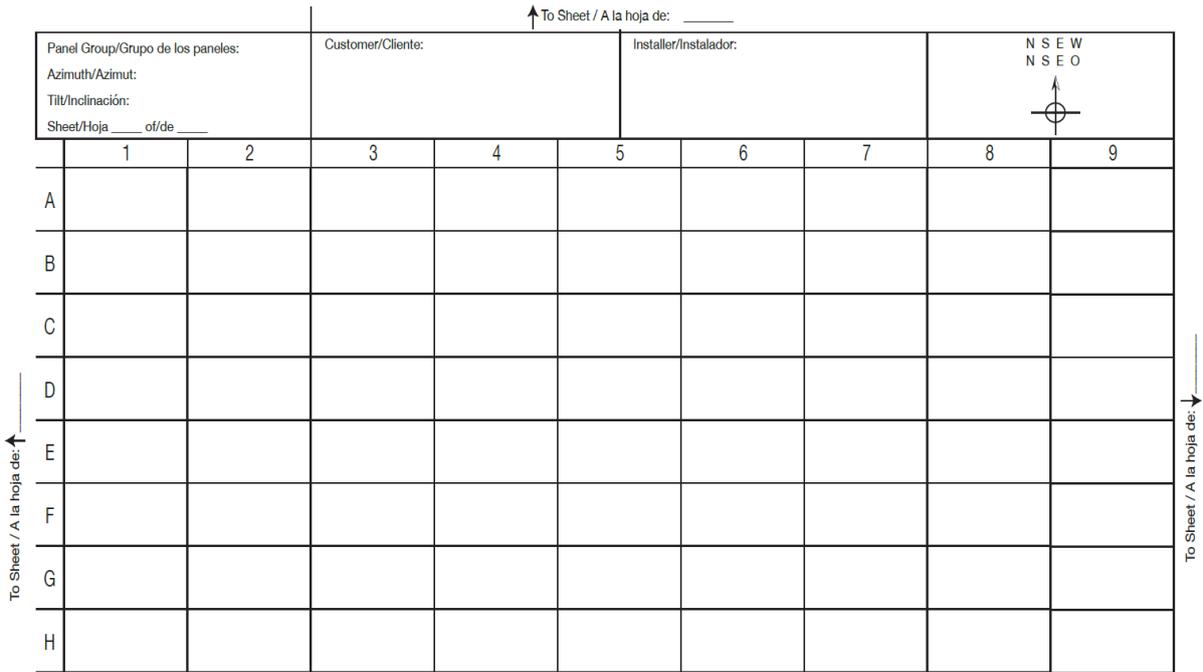


Figure 21: Installation map

Step 8: Connect PV modules to IQ8 Commercial Microinverter

- A. IQ8 Commercial Microinverter has an Enphase EN4 bulkhead for DC connection and bulkhead adapter cable for EN4 to MC4 connection. If your PV modules have TE PV4S SOLARLOK connectors, you may plug them directly into the IQ8 Commercial Microinverter with EN4 bulkhead. Or use the adapter cable for PV modules with MC4 connectors. If your PV module has any other connector, use the EN4 to non-terminated adapter cable for connection with the PV module connector installed in the field.
- B. When using adapters, make sure they are fully seated. Do not reverse the adapter connections. When using an adapter cable, ensure that EN4 (TE PV4S SOLARLOK) connectors are used for connection with the microinverter. Refer to the label on the adapter cables. IQ8 Commercial Series Microinverter bulkhead and adapter male and female DC connectors must only be mated with the identical type and manufacturer brand of male/female connector.
- C. Microinverter mounting needs to be decided according to PV module placement (landscape, portrait, ballast E/W), racking hardware used for mounting the module, and microinverter mounting hardware.

In installations where DC cables from the PV modules are unable to reach the IQ8 Commercial Microinverter, installers can use optional 1-meter EN4 to MC4 extension cable SKUs, which are available in both terminated and non-terminated options.

- PV Module DC cable length and location of junction box for the module (split cell vs full cell).
- Type of racking hardware used and PV module mounting on racking.
- Microinverter mounting location.
- Type of DC connector on the PV module (MC4 or any other manufacturer).

The installer needs to evaluate the DC cable connectors and length requirement based on the above factors and choose the correct extension cable required to connect PV modules to IQ8 Commercial Microinverter, ensuring proper wire management for DC cable, which includes:

- Proper routing of the PV module DC cable as well as the EN4 to MC4 extension cable using the clips to prevent the leads from resting on the roof.

- Avoid direct exposure to sunlight.
- Avoid sharp edges on racking.
- Avoid cable touching rough surfaces or moving parts within the racking system.
- Avoid overly tight bending radii. The minimum bend radii for the DC cable are 8×OD or R55 mm for the Enphase DC cable.
- Avoid overly tight-sized cable clips for routing.
- Half-cut or split-cell PV modules require more careful consideration of microinverter placement and DC cable length due to the split junction box at the center of the PV module.
- Enphase male and female connectors must only be mated with the identical type and manufacturer brand of male/female connector. IQ8 Commercial Microinverter has an Enphase EN4 bulkhead for DC connection and bulkhead adapter cable for EN4 to MC4 connection.
- In the case of non-MC4 connector with PV modules, installers can use ECA-EN4-FW-12 non-terminated cable, which can be used for field wiring with identical type and manufacturer brand of male/female connector as per PV modules for connection.
- Check the LED on the connector side of the microinverter. The LED flashes six times when DC power is applied.

D. Mount the PV modules above the microinverters.



WARNING: Electrical shock hazard. The DC conductors of this photovoltaic system are ungrounded and may be energized.



WARNING: If adapters are used, ensure that they are installed in the correct orientation.

Enphase IQ8 Commercial Microinverter bulkhead male and female DC connectors must only be mated with the identical type and manufacturer brand of male/female connector. IQ8 Commercial Microinverter has an Enphase EN4 bulkhead for DC connection and bulkhead adapter cable for EN4 to Stäubli MC4 connection.

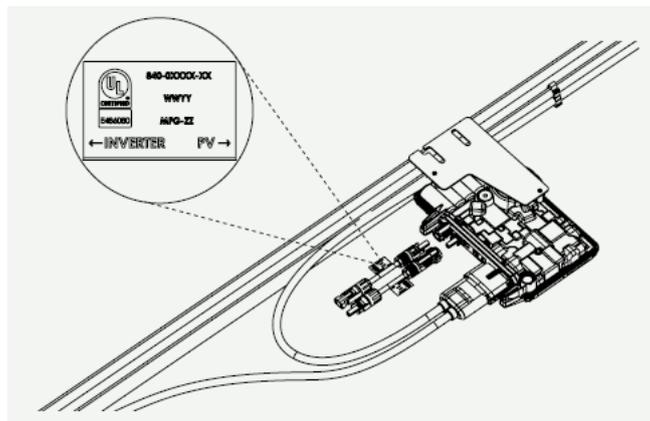


Figure 22: DC connection of microinverter

Step 9: Energize the system

- Turn ON the AC disconnect or circuit breaker for the branch circuit.
- Turn ON the main utility-grid AC circuit breaker. Your system will start producing power after a five-minute wait time.

C. Check the LED on the connector side of the microinverter.



NOTE: Installers may see numerous ACVOOR (AC voltage out of range) events during the commissioning of IQ8 Commercial Systems if the grid has higher impedance or is operating in a region with wide voltage or frequency regulation.

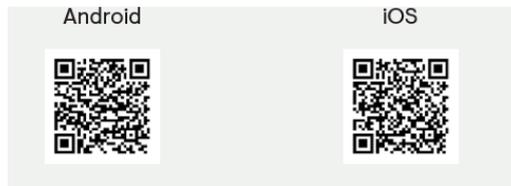
Table 17: LED indication for IQ8 Commercial Microinverter

	<p>FLASHING GREEN Normal operation. AC grid function is normal and there is communication with the IQ Gateway Commercial 2.</p>
	<p>FLASHING ORANGE The AC grid is normal but there is no communication with the IQ Gateway Commercial 2.</p>
	<p>FLASHING RED The AC grid is either not present or not within specification.</p>
	<p>SOLID RED There is an active “DC Resistance Low, Power Off condition”. To reset, refer to the <i>Commercial PV design guide using the Enphase IQ Microinverter System tech brief</i>.</p>
	<p>RAPID RED/FLASHING ORANGE IQ8 Commercial Microinverter has detected a PV panel that operates outside the arc-safe region.</p>

5 IQ8 Commercial System startup and commissioning

5.1 Preparing for commissioning

Commercial Enphase Energy Systems should be commissioned using the Enphase Installer App with software version 3.29 or later. You can install the app on your mobile device at Google Play for Android and the App Store for iOS, or scan one of the QR codes below.

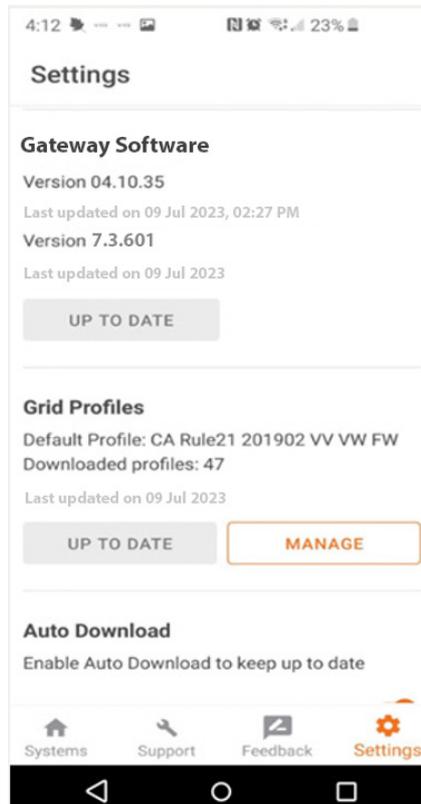


The site's Enphase IQ Gateway must have software version 7.3.601 or later for commissioning and operation. If necessary, the gateway's software can be updated using the Enphase Installer App.

A system activation must be created to complete commissioning. This can be accomplished beforehand using the Enphase Installer Portal, or onsite using the Enphase Installer App.

Downloading the latest IQ Gateway software to your mobile device and creating an activation beforehand can help save time in the field. To complete an activation onsite, the Enphase Installer App must have internet access through cellular data or Wi-Fi.

The **Settings** tab in the Enphase Installer App has a **Gateway Software** section with an **UPDATE SOFTWARE** button for downloading the gateway software. When your gateway software is updated, this button will appear as **UP TO DATE**.



The Enphase Installer App automatically selects the right version for commercial sites.

A stable Wi-Fi connection is required to successfully download the IQ Gateway software from the Enphase Installer App to the gateway. Do not move the phone around or step out of the Wi-Fi range

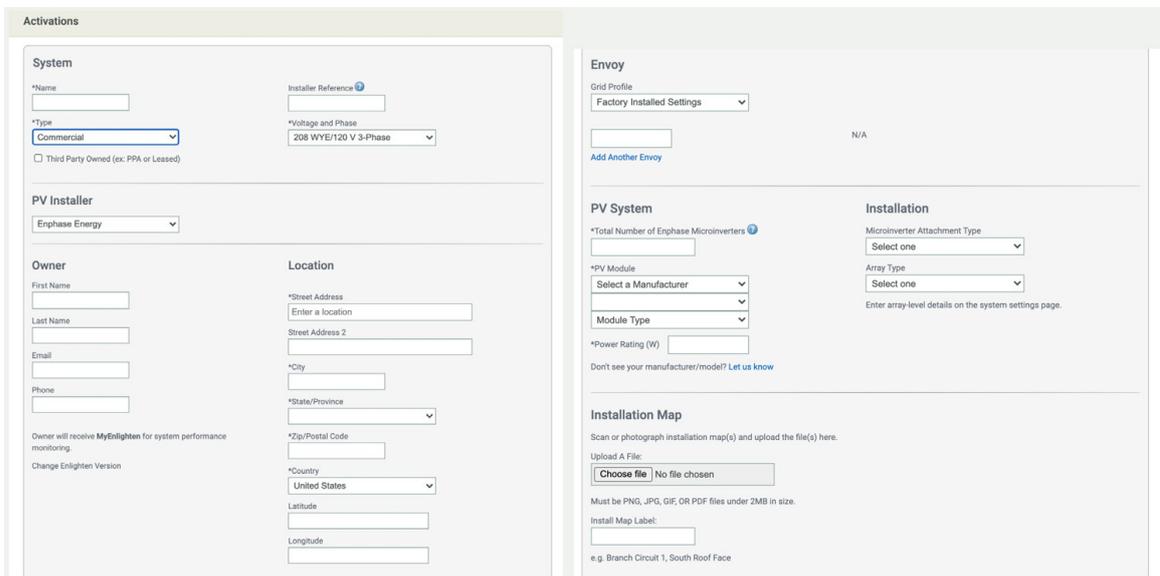
(30 ft, line of sight) while downloading the software. This can also be done by using Cradlepoint or cellular modem through AP mode.

5.1.1 System activation using the Enphase Installer Portal

A system activation must be created to complete commissioning. This can be accomplished beforehand using the Enphase Installer Portal, or onsite using the Enphase Installer App.

Follow these steps to create a system activation:

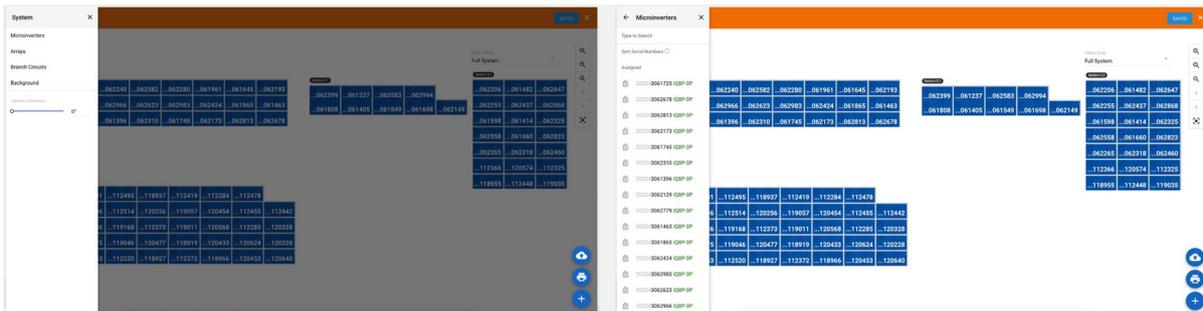
- A. Go to <http://enlighten.enphaseenergy.com> and log in with your username (email) and password.
 Confirm that you are logged into the correct branch office. If your branch office is not yet set up in the Enphase Installer Portal, contact your administrator.
- B. In your Enphase Installer Portal Dashboard, on the **Activations** tab, click **Add New System**.



- C. In the **System** section under the **Activations** tab, select **Commercial** in the **Type** drop-down.
- D. For all commercial sites, select the **Voltage and Phase** information.
- E. For all commercial sites, you must also select the **PV Module** manufacturer, model, type, and power rating.

5.1.2 Array building using the Enphase Installer Portal

Use the Enphase Array Builder to build your virtual array. You can find a link to the Array Builder on the **System Activation** form or the **Settings** page. The Array Builder allows importing PNG and JPG files for background details.

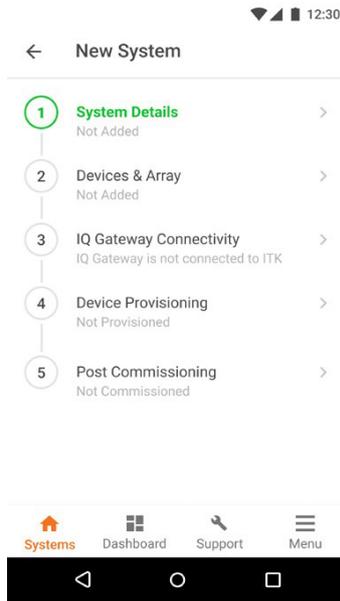


5.2 Commercial Enphase Energy System commissioning using the Enphase Installer App

Commissioning a Commercial Enphase Energy System using the Enphase Installer App requires the following steps.

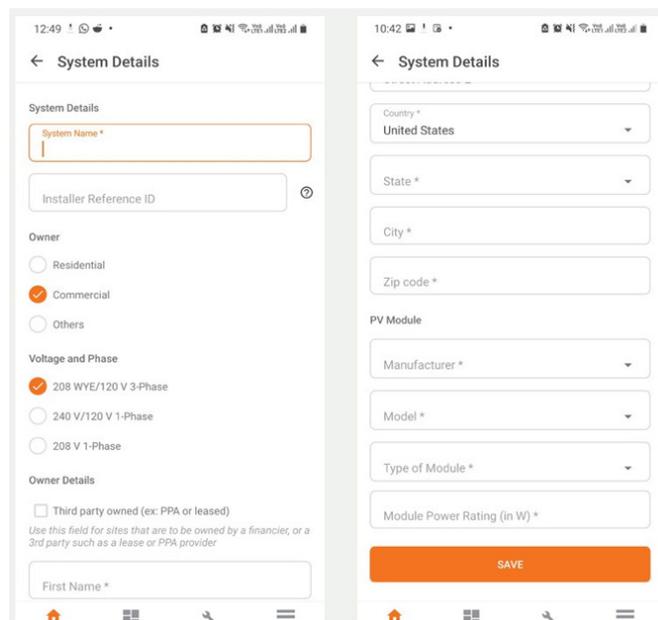
5.2.1 System Details

- A. Open the Enphase Installer App. Tap the **Systems** tab on the lower left side of the screen.



- B. If an activation has not previously been completed using the [Enphase Installer Portal](#), complete Step 1 in the Enphase Installer App (input system details including address, grid profile, phase/voltage details, and so on.)

A grid profile is not selected by default for an activation created in the Enphase Installer Portal. When prompted, select the default profile for your area.





NOTE: If you select a grid profile incorrectly (with the wrong nominal voltage) at a site, change the profile to the correct one and reboot the IQ Gateway (Envoy). If that doesn't work, contact [Enphase Support](#).

- C. In the Enphase Installer Portal or Enphase Installer App, under the **Activations** tab, select a **Commercial** system.
- D. For all commercial sites, select the **Voltage and Phase** information.
- E. For all commercial sites, you must also select the PV module rating, type of module, manufacturer, and model.

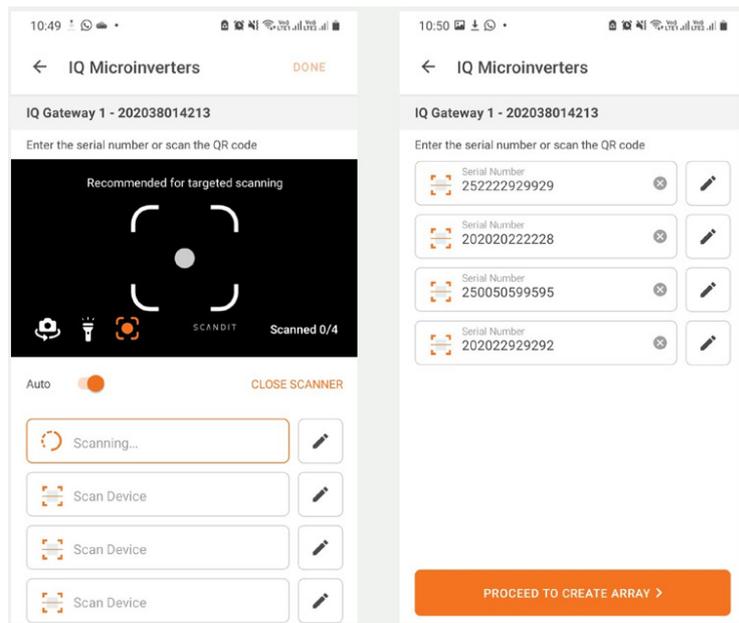
5.2.2 Devices & Array

- A. Enter the total count of each device type to be added to the system.
When retrofitting an existing site, microinverters appear in the activation.
- B. Add the IQ Gateway by using a camera scan to read the barcode.
- C. Select the correct grid profile applicable to your region that meets the PV system requirements. Contact [Enphase Support](#) to request a new custom grid profile if no pre-existing grid profile meets local Authority Having Jurisdiction (AHJ) requirements.
- D. Use the Enphase Installer App Array Builder to build your virtual array. After building the array, scan all the microinverters using the Enphase Installer App camera scan to read the barcodes and create an array from the scanned microinverters.
- E. Assign an IQ8 Commercial Microinverter to each panel in the Array Builder.

The Array Builder in the Enphase Installer App or Enphase Installer Portal supports assigning each panel to a microinverter. It allows importing PNGs and JPGs for background details, and also allows uploading a photo of the layout to scan multiple inverters.

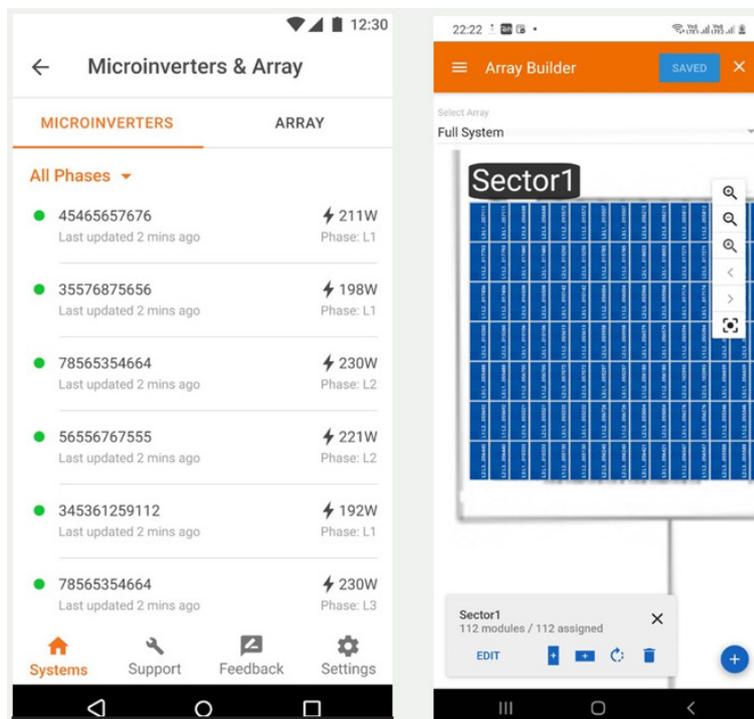


NOTE: Do not use the PLC scan function on the IQ Gateway to detect the IQ8 Commercial Microinverters. Use the barcode scanner for the best results.



You can see the line-to-line connection information in the Array Builder to confirm the microinverter phase connection. You can also filter microinverters based on line-to-line connection in the Enphase Installer App.

All inverters must have the grid profile set before moving on to phase association. Grid profile setting, provisioning, and phase association may take a few minutes based on your system configuration.

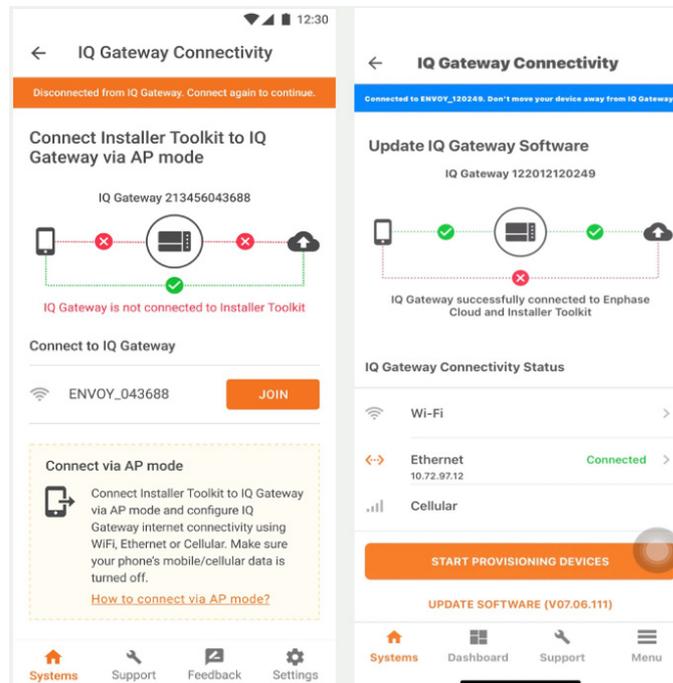


5.2.3 Set utility tariff

[Setting the utility tariff](#) is optional and can be skipped, but selecting a tariff is a meaningful enhancement to help the customer understand their ongoing utility cost savings. Contact [Enphase Support](#) for any questions.

5.2.4 IQ Gateway Connectivity

After completing the Devices & Array step, the **IQ Gateway Connectivity** screen is displayed, as shown below. It indicates your mobile device connectivity to the web and the gateway. Your mobile device should be shown as connected to the web, but not to the gateway.



- A. To provision the devices, connect to the gateway using AP mode.
- B. On the gateway, press the AP mode button (first button from the left) for about one second. The LED will turn solid green.
- C. Go to your mobile device settings and connect to the gateway's local broadcast network. The gateway will show up on the available Wi-Fi network as Gateway, with the appended digits being the final numbers of the gateway serial number. Tap this network to connect. After connection, the Enphase Installer App shows your phone connected to the gateway, but not to the web.
- D. If there are issues connecting to this network, turn AP mode off and on again by repeating Step E through Step G.
- E. Configure the IQ Gateway using Wi-Fi or Ethernet. Enter the network and password information in the Wi-Fi section. To connect to Ethernet, plug the cable into the gateway.
- F. Before device provisioning, the IQ Gateway must have software version 7.03.711 (or later) installed. Tap **UPDATE SOFTWARE** to complete this process, which takes approximately 30 minutes.
- G. Ensure the phone is close to the gateway, and do not move the phone away while upgrading the gateway. Moving the phone away from the gateway could result in problems during the gateway upgrade.

Your phone screen must stay active while this update occurs. Allowing your phone to go to sleep will interrupt the update.

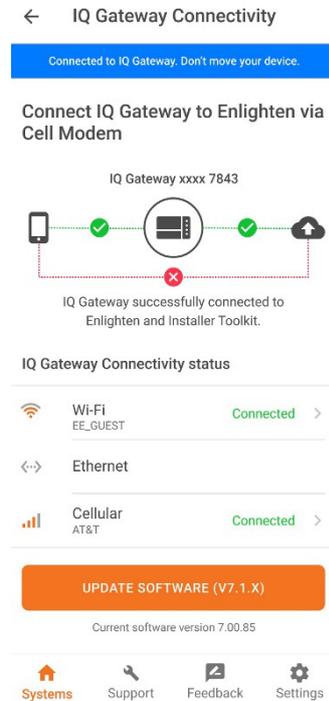
After the gateway software has been updated, the gateway will restart.

- While the gateway restarts, all four LEDs flash red together.
- After the restart is complete, the network communications LED lights solid green.

When the IQ Gateway reboots, your phone will lose AP mode connectivity. After the gateway

reboots successfully, reconnect to the gateway’s AP mode using the Wi-Fi settings menu of your mobile device.

- H. If you have issues connecting to AP mode, turn off AP mode on the gateway by pressing the AP mode button for one second, and then choose to forget the AP mode network in your mobile device Wi-Fi settings.



- I. Repeat Step E through Step G to reconnect to the IQ Gateway. After rebooting the IQ Gateway, the Enphase Installer App takes approximately 10 minutes to correctly display system metrics, including web connectivity. The gateway requires communicating with the web to display internet connectivity. For more information, contact [Enphase Support](#).
- J. Ensure the gateway’s Wi-Fi access or Ethernet connection and cellular modem connection are configured. If, after completing the previous step, the gateway software version shown on the **UPDATE SOFTWARE** button does not match the gateway software version below the button, then the update has failed, and you must tap **UPDATE SOFTWARE** again.
- K. Tap **Start Provisioning Devices** at the bottom of the **IQ Gateway Connectivity** screen.

5.2.5 Configuring Production and Consumption CTs using the meter wizard

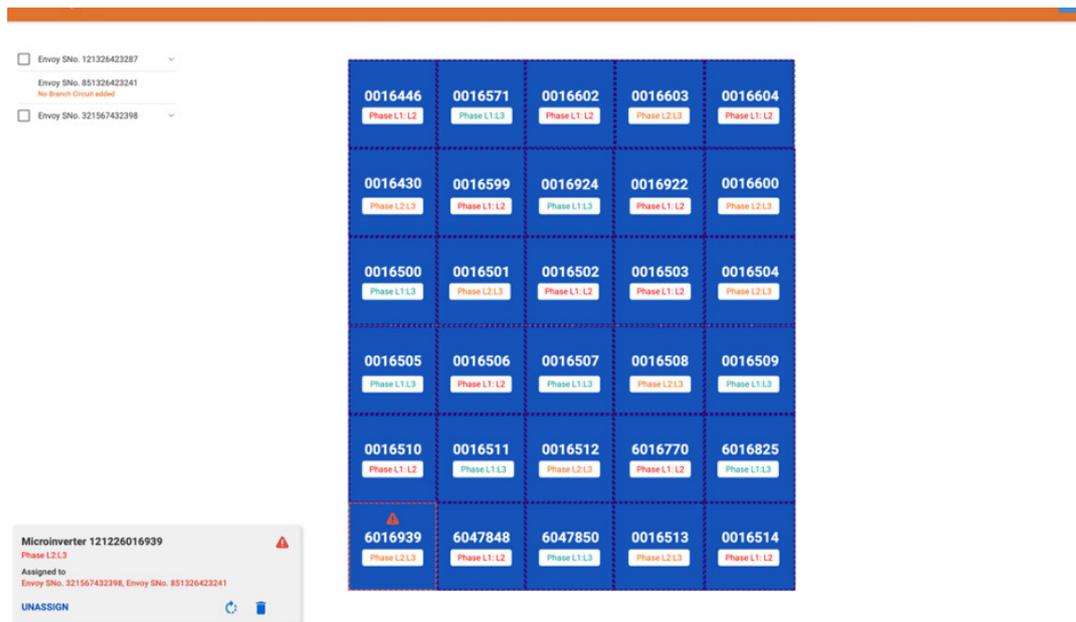
- A. Verify that the configuration matches what is installed (solar + load or load only).
- B. Enable the meters by verifying the readings in the meter wizard (required). Ensure there is a minimum of 1 kW per CT before advancing.
- C. While in the production meter wizard, wait for the minimum values to settle.
- D. Switch off the PV breakers as instructed to ensure the readings go to zero before enabling.



- E. While in the consumption meter wizard, turn on the PV and a known load in the building to confirm consumption rises as expected, and select the meter location (solar + load). See [these detailed instructions](#) for commissioning the CTs.
- F. To generate a summary report for your commissioned system, tap **Summary**. To share the document, use the **Share** button.

5.2.6 Troubleshooting during commissioning

To identify cross-talking microinverters in an array, the Enphase Installer Portal highlights the microinverters in an array view that are communicating with multiple gateways at the site that are reporting, or have reported, at least once in the previous 30 minutes of commissioning.

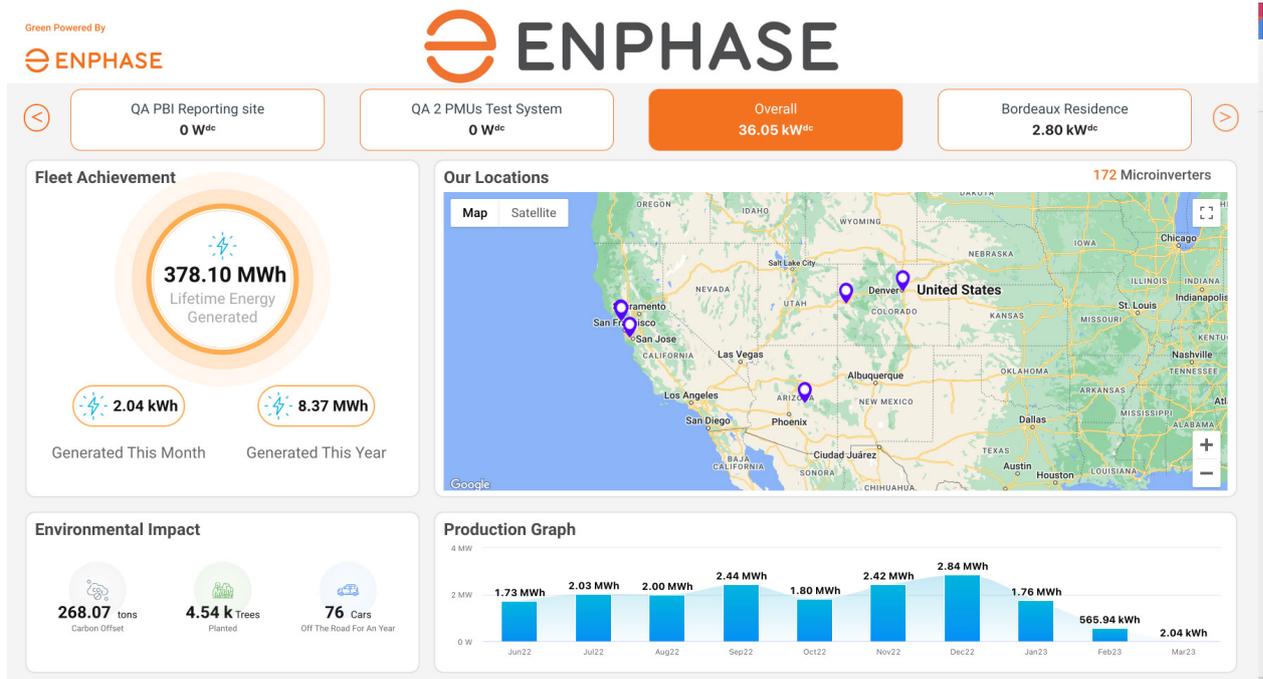


6 IQ8 Commercial System monitoring and maintenance

6.1 System details

6.1.1 Kiosk view

The system summary page contains the following information: Dollar value created; Energy generated; System name, Location, and Last Updated time; Environmental Benefits; and Map view.



6.1.2 Energy and power data

- A. The installer can monitor the energy and power data at a time for the following levels. Installers can also filter the data through multiple gateway, subarrays, and microinverters.
- System aggregate
 - Gateway level for multiple gateways (up to 5)
 - Subarray level for multiple subarrays (up to 5)
 - Micro-level for multiple microinverters (up to 5)

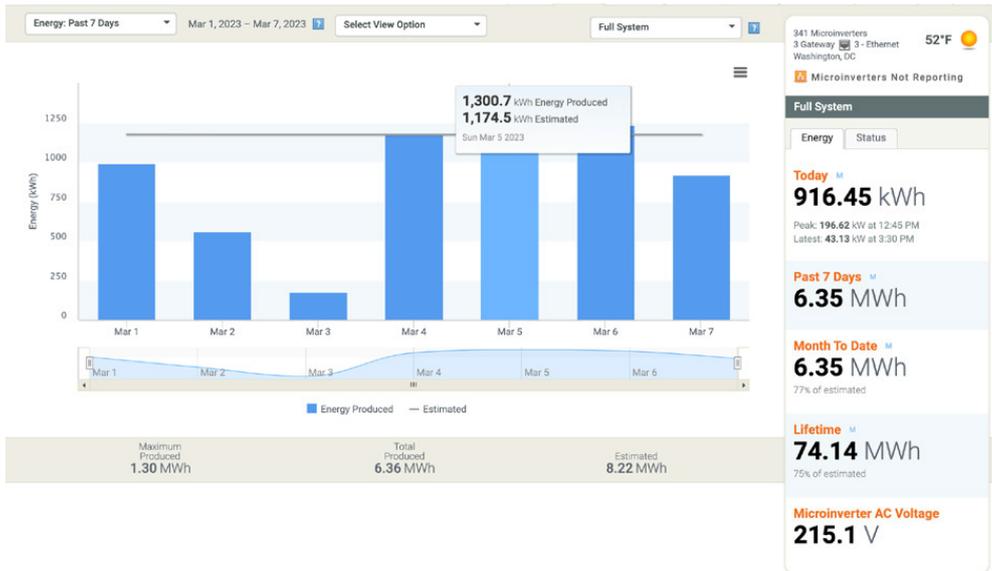


Figure 23: System energy data

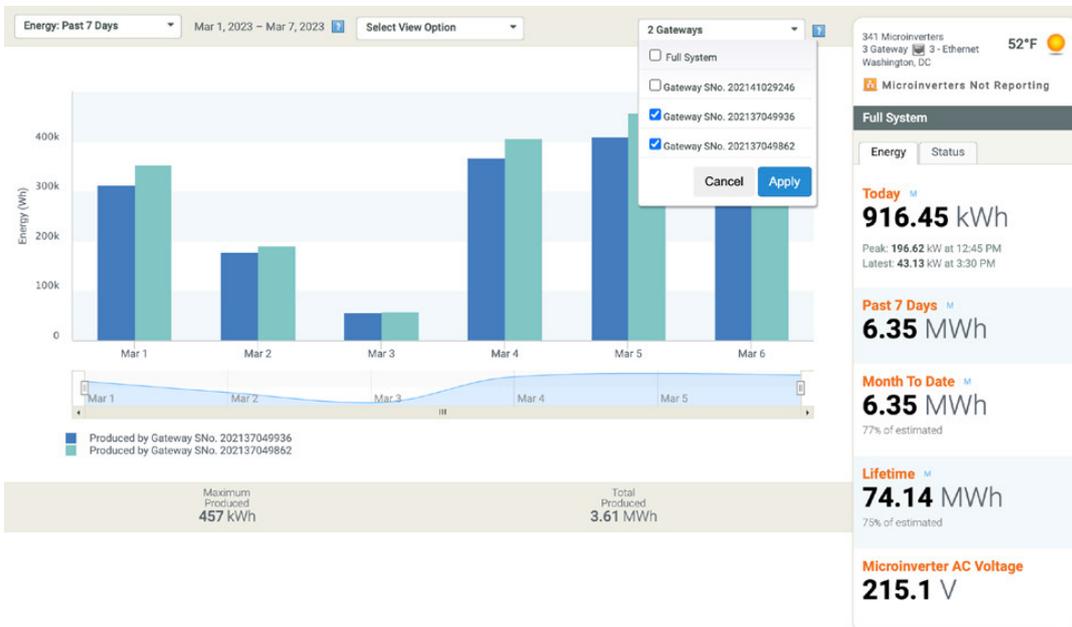


Figure 24: Array energy data

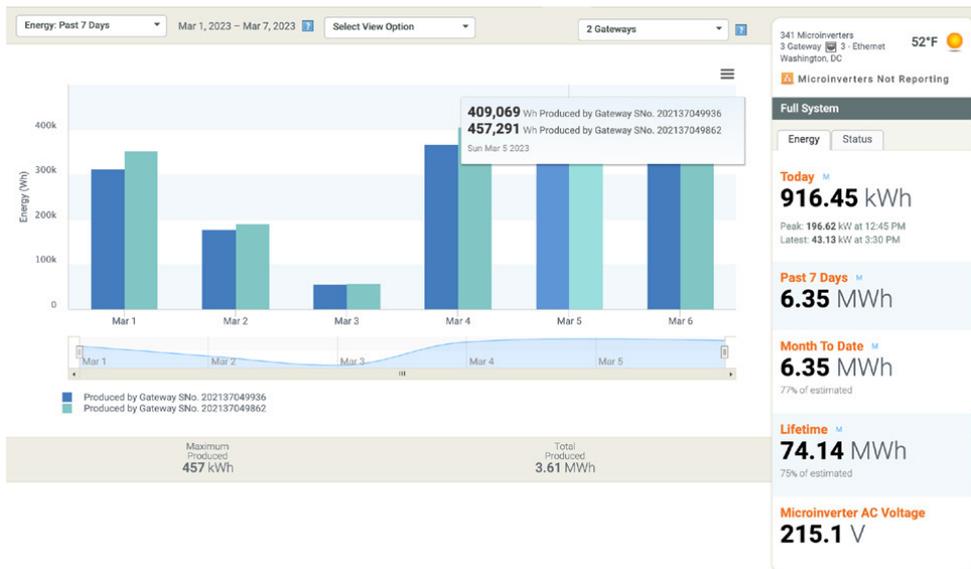


Figure 25: Microinverter energy data

B. Installers can monitor line-to-line phase (L1:L2, L2:L3, L3:L1) information for the energy and power production data at the system aggregate level and can filter per gateway, subarray, and microinverters.

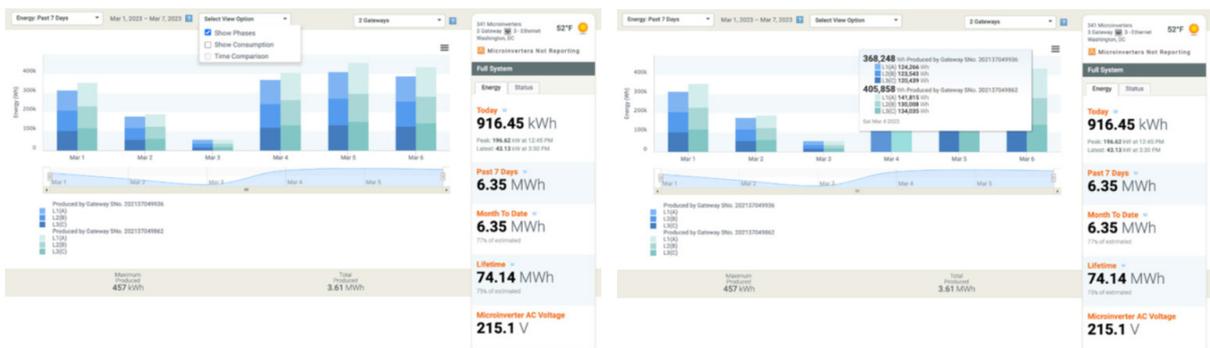


Figure 26: Phase-wise energy

C. Installers can compare the energy and power data between any two time periods based on selected time-period inputs.

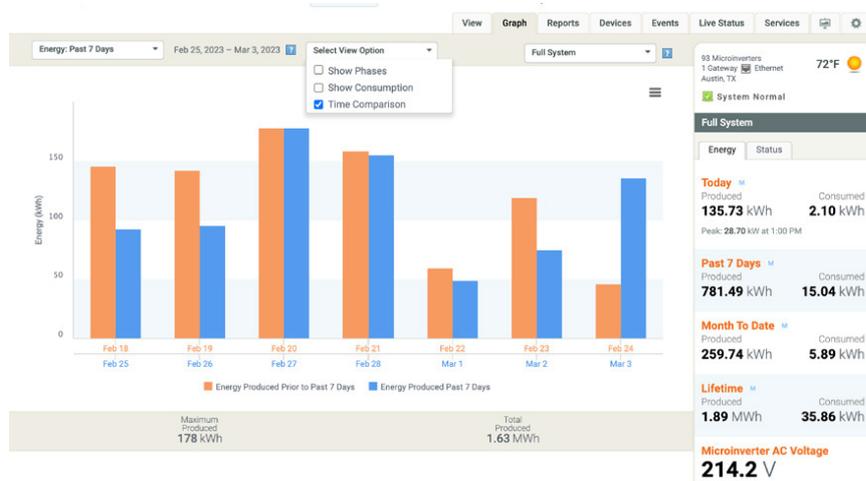


Figure 27: Energy and power data comparison

- D. The telemetry graph provides an option to see multiple parameters in a line graph, as shown in the following graph. The installer can select multiple parameters, as shown at the bottom of the graph. The Enphase Installer Portal also offers an option to include events-related details to be included in the telemetry graph.



Figure 28: Telemetry data

6.2 Array details

- A. Array builder allows the user to create/edit/delete a branch circuit component. A branch circuit is always mapped to a gateway, and the Installer shall be able to find all the microinverters that are part of the gateway and the branch circuit.



Figure 29: Array Builder

After commissioning, each microinverter shall show phase information of each microinverter in the array view.

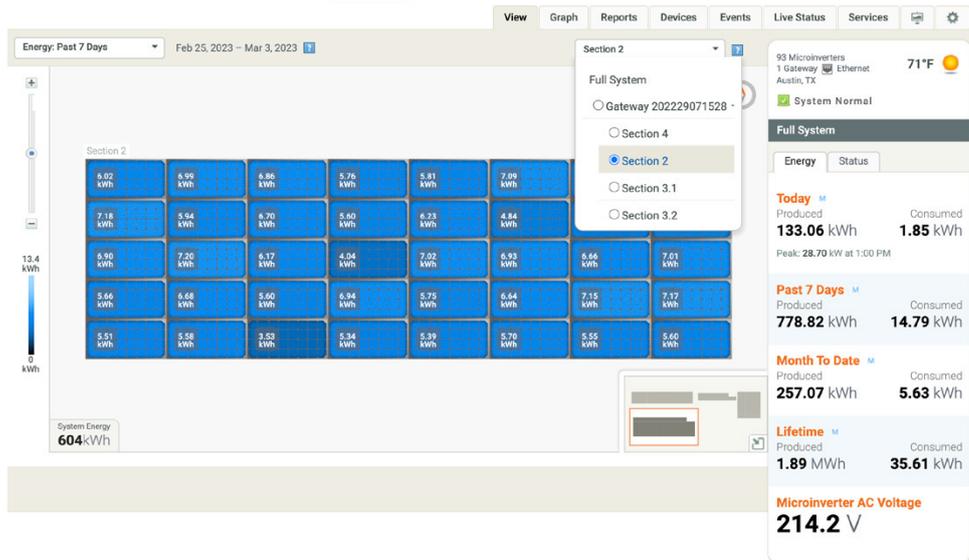


Figure 30: Array-level phase connection details

B. Enphase Installer Portal provides a view of micro-level production and power data in landscape/portrait/landscape-portrait mode of array view. You can filter microinverters based on gateway and subarrays.

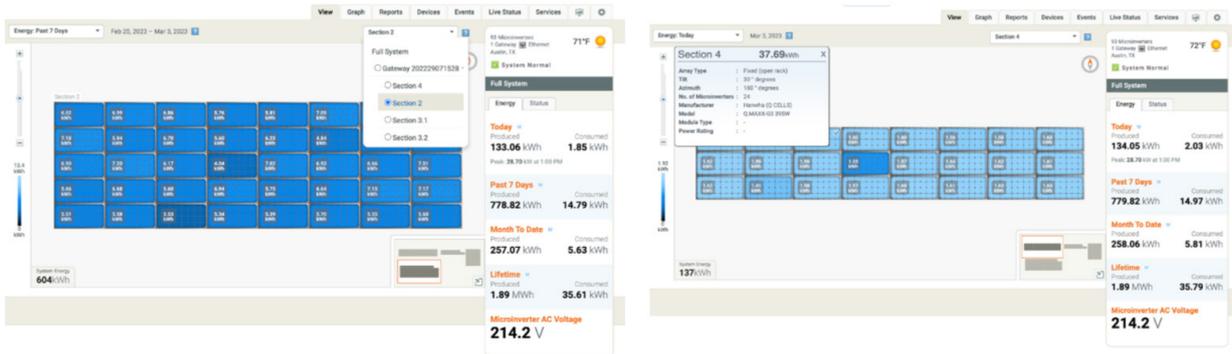


Figure 31: Microinverter array view

C. Enphase Installer Portal provides a view of PV module details: manufacturer, model, module type, and power rating of each microinverter when you click on a module in the array view. You can also see the signal strength for each microinverter in 5 bars.

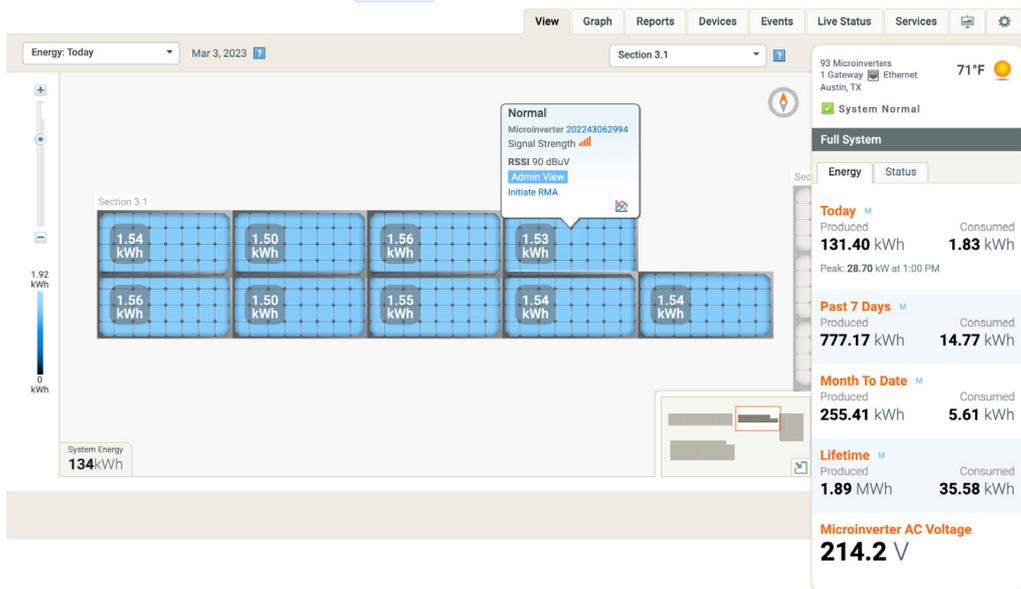


Figure 32: Signal strength

- D. Enphase Installer Portal provides DC Voltage, DC Current, AC Voltage, AC Current, frequency, and temperature readily in array view. Upon selecting the parameter, the data for that parameter should be shown at the microinverter level.

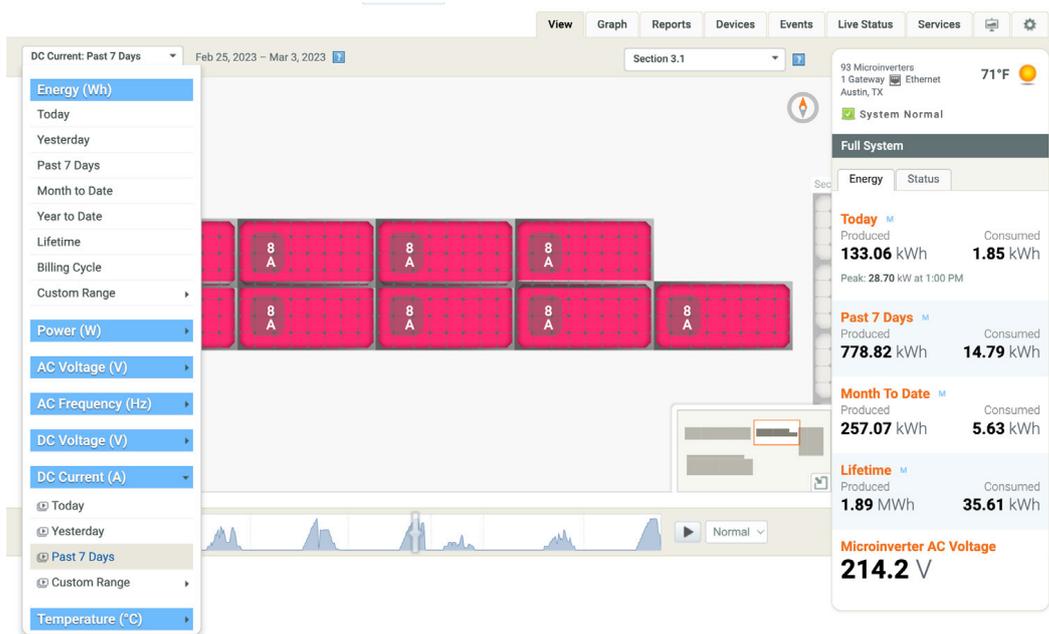


Figure 33: Microinverter-level data

- E. Enphase Installer Portal provides an array view where the array information like array type, azimuth, tilt, and a number of microinverters are shown.

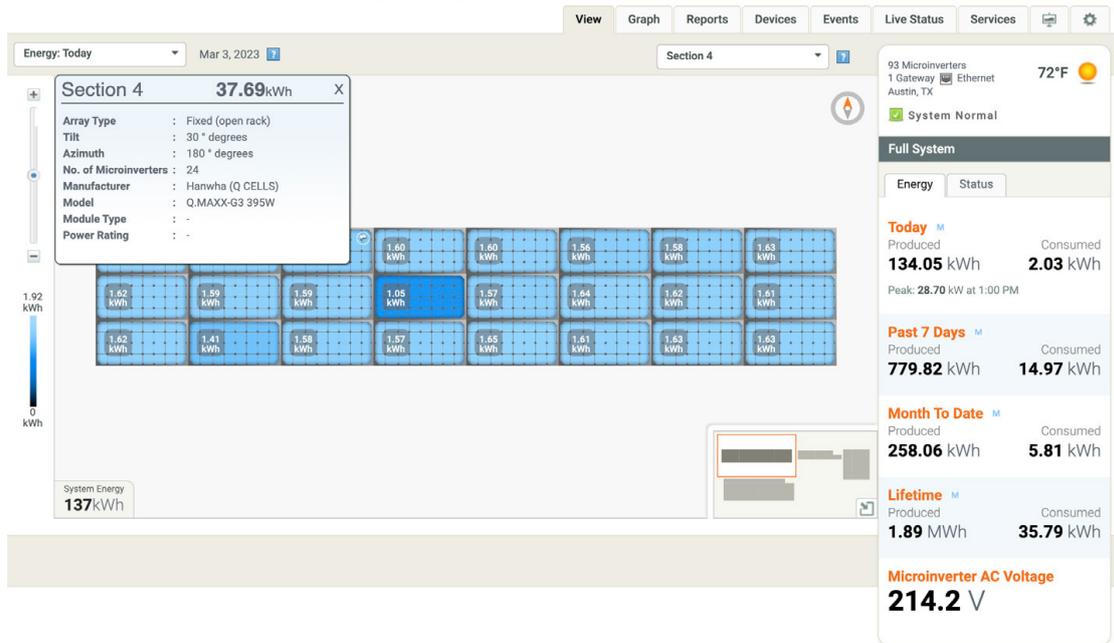


Figure 34: Array information: tilt and azimuth

6.3 Troubleshooting using Enphase Installer Portal and Enphase Installer App

6.3.1 Identifying crosstalking microinverters in the array

Enphase Installer Portal highlights the microinverters in array view that are communicating with multiple gateways that are reporting or have reported at least once in the last 30 minutes.

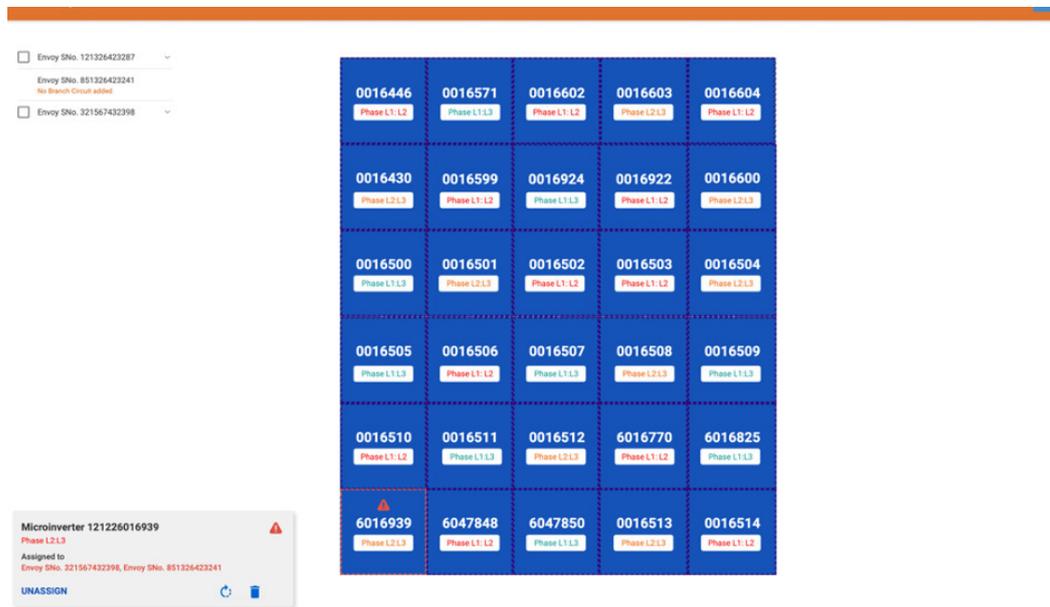


Figure 35: Enphase Installer Portal screen during commissioning in Array Builder

6.3.2 Power line communication analysis FFT scan

The Enphase Installer App provides a way to do Power line communication analysis. This enables the user to troubleshoot and identify conditions where the Power Line Communications (PLC) is

degraded or disrupted by noise in the frequency band that the PLC uses for communication. The installer can export/share the report generated.

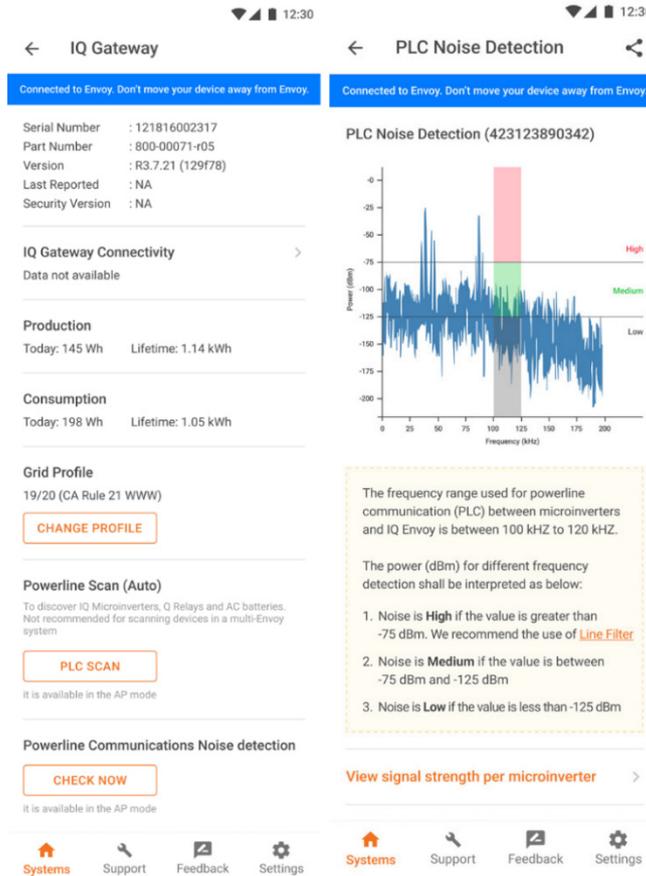


Figure 36: Power line communication analysis FFT scan

6.3.3 Initiate RMA in Enphase Installer Portal

Enphase Installer Portal provides an option to initiate an RMA within the array view so that the installers can initiate an RMA with automated user flow. A Request Return link is provided when the user clicks on the module to initiate an RMA.

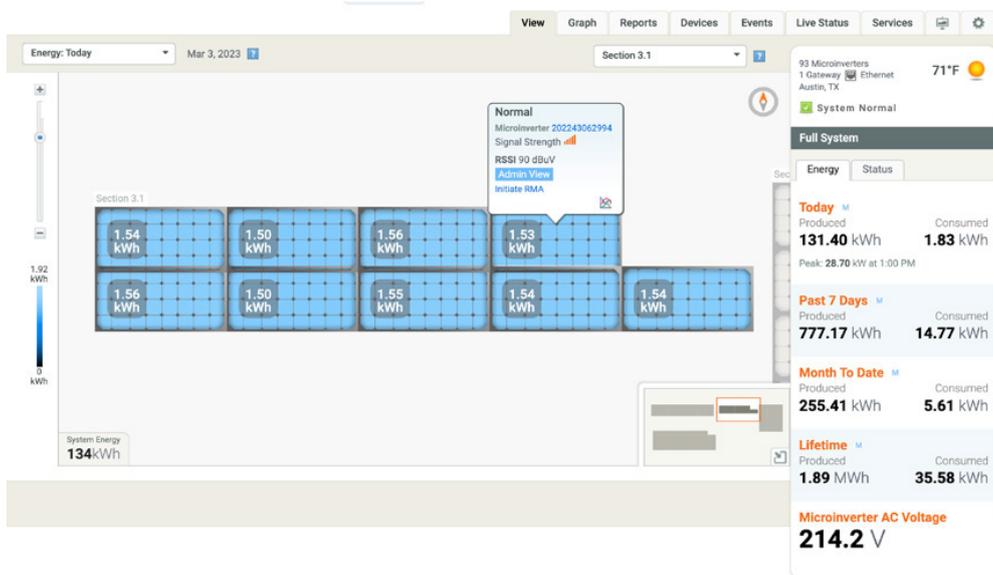


Figure 37: Initiate RMA from Enphase Installer Portal

Request Return

View Graph Reports Devices Events Live Status Services

Select a shipping address

We are unable to ship to PO Boxes, apologies for any inconvenience.

- Austin IQ8 Commercial Roof Created On 021523
1835 Kramer Lane
Austin, TX 78758
United States
- Enphase Energy
47281 Bayside Parkway
Fremont, CA 94538
United States
- New Address

Select device type

Microinverters

Select device(s)

Enter a serial number ...

- 202243061396
- 202243061961
- 202243062424
- 202243061725
- 202243062193

Provide additional information

ENPHASE © 2008-2023 Enphase Energy Inc. All rights reserved. Privacy | Terms English

202243062582

Submit 1 of 93 device(s) selected

Figure 38: Enphase Installer Portal RMA details

7 Troubleshooting of IQ8 Commercial Microinverter

Follow all the safety measures described in this guide. Qualified personnel can use the following troubleshooting steps if the PV system does not operate correctly.



WARNING: Risk of electric shock. Do not attempt to repair the Enphase microinverter; it contains no user-serviceable parts. If it fails, contact [Enphase Support](#) to obtain an RMA (return merchandise authorization) number and start the replacement process.

7.1 LED Operation

The following section describes LED indications.

Table 18: Microinverter LED status

LED color	Description
Flashing green	Normal operation. AC grid function is normal. There is communication with the gateway.
Flashing orange	The AC grid is normal, but there is no communication with the gateway.
Flashing red	The AC grid is either not present or not within specification.
Solid red	There is an active “DC Resistance Low, Power Off Condition.” To reset, see “DC Resistance Low – Power Off Condition.”
Rapid red/Flashing orange	IQ8 Commercial Microinverter has detected a PV panel that is operating outside the arc in the safe region.

The status LED on each microinverter glows green about six seconds after DC power is applied. It remains lit solid for two minutes, followed by six green blinks. After that, red blinks indicate that no grid is present if the system is not yet energized.

Any short red blinks after DC power is first applied to the microinverter indicate a failure during microinverter startup.

7.2 DC Resistance Low—Power Off condition

For all IQ Series models, a solid red status LED when DC power has been cycled indicates the microinverter has detected a DC Resistance Low—Power Off event. The LED will remain red, and the fault will continue to be reported by the gateway until the error has been cleared.

An insulation resistance (IR) sensor in the microinverter measures the resistance between the positive and negative PV inputs to the ground. If either resistance drops below a threshold, the microinverter stops power production and raises this condition. This may indicate defective module insulation, defective wiring or connectors, moisture ingress, or a similar problem. Although the cause may be temporary, this microinverter condition persists until the sensor is manually reset.

An IQ Gateway Commercial 2 is required to clear this condition. The condition clears on operator command unless its cause is still present. If a microinverter registers a “DC Resistance Low - Power Off” condition, you can attempt to clear this condition. If the condition does not clear after you perform the following procedure, contact [Enphase Support](#).

There are two ways to send a clear message to the microinverter. Note that the condition will not clear after the sensor reset if the cause of the failure is still present. If the condition persists, contact your installer.

7.2.1 Method 1: Clear the error using the Enphase Installer Portal

- A. Log in to the Enphase Installer Portal and access the system.
- B. Click the **Events** tab. The next screen shows a current DC Resistance Low—Power Off condition for the system.
- C. Click **DC Resistance Low—Power Off**.
- D. Where “n” is the number of affected devices, click n devices (show details).
- E. Click the serial number of the affected microinverter.
- F. Click **Reset DC Resistance Low—Power Off Sensor**. The system displays, “A DC Resistance Low—Power Off reset task was issued on [date and time] for this microinverter and is still pending.”

7.2.2 Method 2: Use the Enphase Installer App to clear the condition

On the list of detected microinverters, a green dot or red square appears to the left of each microinverter serial number. A green dot indicates the status OK. A red square indicates an event for that microinverter.

- A. Tap the drop-down button to the left of the serial number to view details for a microinverter event.
- B. If the microinverter status shows that there is an active DC Resistance Low—Power Off condition, tap the to send a clear message to the affected microinverter. The app then indicates that a clear message was sent.

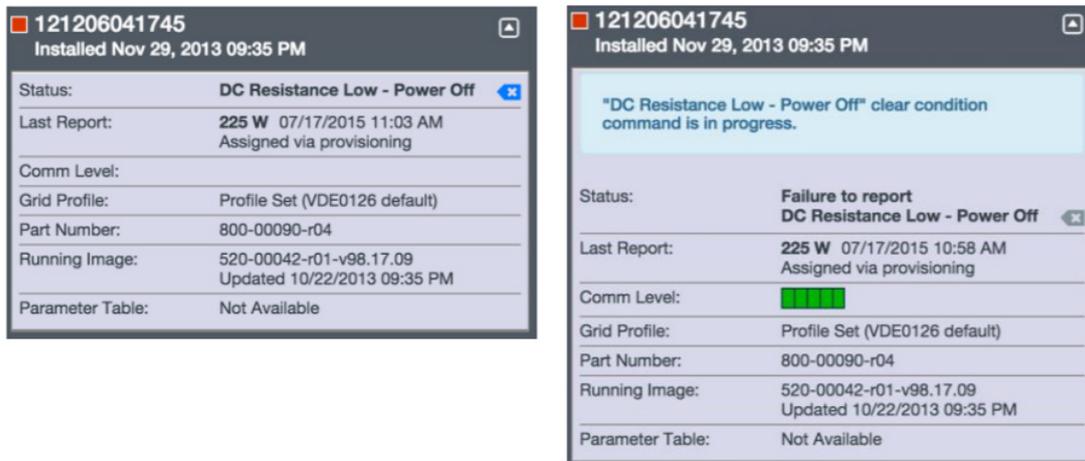


Figure 39: Enphase Installer App to clear DC Resistance Low condition

All other faults are reported to the gateway. Refer to the Enphase IQ Gateway Commercial 2 Installation and Operation Manual at enphase.com/support for troubleshooting procedures.

7.3 Troubleshoot an inoperable microinverter

To troubleshoot an inoperable microinverter, follow these steps.



WARNING: Risk of electric shock. Always de-energize the AC branch circuit before servicing. Never disconnect the DC or AC connectors under load.



WARNING: The Enphase microinverters are powered by DC power from the PV modules. Make sure you disconnect the DC connections and reconnect the DC power, and then watch for the solid green about six seconds after connection to DC power.

- A. Make sure AC breakers and disconnects are closed.
- B. Check the connection to the utility grid and verify that the utility voltage is within allowable ranges.
- C. Verify that AC line voltages at all solar power circuit breakers at the load center and subpanels are within the ranges shown in the following table.
- D. Verify that the AC line voltage at the junction box for each AC branch circuit is within the ranges shown in the following table.

Service type and line voltage	
208 VAC three-phase	183 V–229 V

- E. Using the QD Disconnect Tool, disconnect the AC cable from the Enphase QD Cable for the microinverter in question.
- F. Verify that utility power is present at the microinverter by measuring line to line and line to ground at the Enphase QD Cable connector.
- G. Visually check that the AC branch circuit connections (Enphase QD Cable and AC connections) are properly seated. Reseat if necessary. Check also for damage, such as rodent damage.
- H. Make sure that any upstream AC disconnects and the dedicated circuit breakers for each AC branch circuit are functioning and closed.
- I. Disconnect and reconnect the DC PV module connectors. The status LED of each microinverter will light solid green a few seconds after connection to DC power and then blink green six times to indicate normal start-up operation about two minutes after connecting to DC power. The LED subsequently resumes normal operation if the grid is present.
- J. Attach an ammeter clamp to one conductor of the DC cables from the PV module to measure the microinverter current. This will be under one amp if the AC is disconnected.
- K. Verify the PV module DC voltage is within the allowable range as mentioned in IQ8 Commercial Microinverter specifications.
- L. Swap DC leads with a known good, adjacent PV module. If, after checking the Enphase Installer Portal periodically (this may take up to 30 minutes), the problem moves to the adjacent module, this indicates that the PV module is not functioning correctly. If it stays in place, the problem is with the original microinverter. Contact [Enphase Support](#) for help in reading the microinverter data and for help in obtaining a replacement microinverter, if needed.
- M. Check the DC connections between the microinverter and the PV module. The connection may need to be tightened or reseated. If the connection is worn or damaged, it may need replacement.
- N. Verify with your utility that the line frequency is within range.
- O. If the problem persists, contact [Enphase Support](#).

7.4 Disconnect a microinverter

If problems remain after following the troubleshooting steps listed previously, contact [Enphase Support](#). If Enphase authorizes a replacement, follow the steps below. To ensure the microinverter is not disconnected from the PV modules under load, follow the disconnection steps as follows:

- A. De-energize the AC branch circuit breaker.

- B. Enphase AC connectors are tool-removable only. To disconnect the microinverter from the Enphase QD Cable, insert the disconnect tool and remove the connector.
- C. Cover the PV module with an opaque cover.
- D. Using a clamp-on meter, verify there is no current flowing in the DC wires between the PV module and the microinverter. If the current is still flowing, check that you have completed steps one and two above.



NOTE: Take care when measuring DC current, as most clamp-on meters must be zeroed first and tend to drift with time.

- E. Disconnect the PV module DC wire connectors from the microinverter using the QD Disconnect Tool.
- F. If present, loosen and/or remove any bonding hardware.
- G. Remove the microinverter from the PV racking.



WARNING: Risk of electric shock. Risk of fire. Do not leave any connectors on the PV system disconnected for an extended period. If you do not plan to replace the microinverter immediately, you must cover any unused connector with a sealing cap.

7.5 Install a replacement microinverter

- A. When the replacement microinverter is available, verify that the AC branch circuit breaker is de-energized.
- B. Mount the microinverter bracket side up and under the PV module, away from rain and sun. Allow a minimum of 1.9 cm (0.75") between the roof and the microinverter. Also, allow 1.3 cm (0.50") between the back of the PV module and the top of the microinverter.
 - Install the microinverter under the PV module to avoid direct exposure to rain, UV, and other harmful weather events.
 - Always install the microinverter bracket side up.
 - Do not mount the microinverter upside down.
 - Do not expose the AC or DC connectors (on the Enphase QD Cable connection, PV module, or microinverter) to rain or condensation before the connectors are mated.
- C. Torque the mounting fasteners to the values shown. Do not over-torque.
 - 6 mm (1/4") mounting hardware: 5 N m (45 to 50 in-lbs.).
 - 8 mm (5/16") mounting hardware: 9 N m (80 to 85 in-lbs.).
 - When using UL 2703 mounting hardware, use the manufacturer's recommended torque value.
- D. If you are using bonding hardware, the old bonding hardware should be discarded, and new bonding hardware must be used when installing the replacement microinverter.
- E. Connect the microinverter to the QD Cable connector. Listen for a click as connectors engage.
- F. Connect the DC leads of each PV module to the DC input connector of the microinverter.
- G. Re-mount the PV module above the microinverter.
- H. Energize the AC branch circuit breaker and verify the operation of the replacement microinverter by checking the Status LED on the connector side of the microinverter.
- I. Use the Enphase Installer App mobile app to delete the old microinverter serial number from the Enphase IQ Gateway Commercial 2 database. In the Enphase Installer App, once connected to the gateway:
 - Tap **Micros > Manage**.
 - Tap the checkbox to the right of the microinverter serial number that you replaced.

- Tap  to delete the microinverter from the IQ Gateway Commercial 2 database.
- J. Add the new microinverter serial number to the gateway database using the Enphase Installer App camera scan to scan the IQ8 Commercial barcode and assign the device in the array builder.

8 Appendix A: Ampacity calculations for IQ8 Commercial Microinverter system

Enphase IQ8 Commercial Microinverter has a four-pin output configuration (L1, L2, L3, and neutral sense) with Power on two pins and phase sensing on the other two pins.

IQ8 Commercial Microinverters are connected across the L-L 208 V connection. The single-phase IQ8 Commercial Microinverter achieves the three-phase configuration and phase balancing using the three-phase QD Cable rotation. The following figure shows the phase rotation of the QD Cable for a branch circuit of 9 IQ8 Commercial Microinverters. As shown, the QD Cable rotation creates a balanced three-phase configuration with L1-L2: 3 microinverters, L2-L3: 3 microinverters, and L1-L3: 3 microinverters connected across each phase.

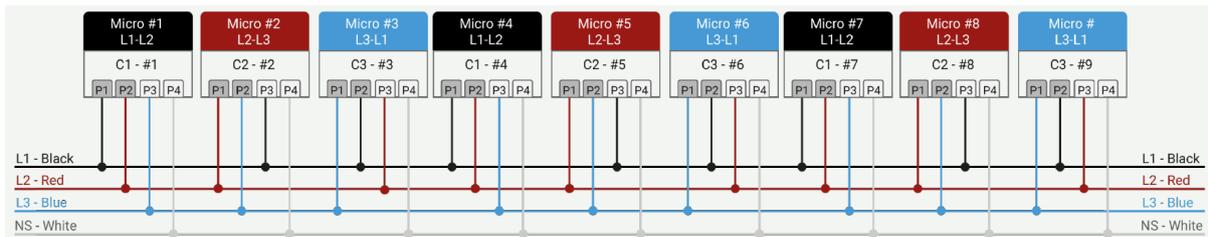


Figure 40: QD Cable rotation for IQ8 AC branch circuit

The branch circuit calculations shall involve vector mathematics for current addition as each microinverter is connected across L-L and shall contribute current to all three lines – L1, L2, and L3 conductors. To simplify the current calculations, refer to the following formulas. We shall use $\sqrt{3}$ multipliers for converting phase current to line current.

8.1 Branch circuit current calculations

The equation to calculate ampacity for one branch in a 208/120 V WYE three-phase system is:

$$\text{Current (amps per branch)} = [(\text{Maximum continuous output power of microinverter}) \times (\text{maximum number of microinverters per phase L-L}) \times \sqrt{3}] \div (208 \text{ volts})$$

The equation to determine OCPD sizing for a three-phase system is:

$$\text{OCPD Sizing} = [(\text{Maximum continuous output power of microinverter}) \times (\text{maximum number of microinverters per phase L-L}) \times \sqrt{3}] \div (208 \text{ volts}) \times 1.25 \text{ (safety factor)}$$

Use these calculations to determine ampacity in three-phase systems, as shown in the following sections.



NOTE: Each of the three-line conductors in a balanced three-phase system carries this current. The neutral sense does not carry any current but is used for microinverter communications and sensing.



NOTE: In case of an imbalanced system where each phase has a different number of microinverters, consider the largest number of microinverters in a phase for OCPD sizing calculations.

Example 1: 12 IQ8 Commercial Microinverters (IQ8P-3P) on a single branch circuit for a 208/120 V WYE three-phase system

The ampacity calculation for a branch circuit of 12 IQ8 Commercial Microinverters (IQ8P-3P) at a three-phase 208 V site is as follows:

Current (A per branch) = [Microinverter power (watts) x Number of microinverters per phase x $\sqrt{3}$] / grid voltage = $480 \times 4 \times \sqrt{3} / 208 = 15.98 \text{ A}$

The ampacity result is 15.98 A

OCPD sizing = $15.98 \text{ A} \times 1.25 = 19.975 \text{ A}$

A branch circuit of 12 IQ8 Commercial Microinverters (IQ8P-3P) requires a three-pole, 20 A circuit breaker or OCPD.

Plan your AC branch circuits to meet the limits for a maximum number of 12 microinverters (IQ8P-3P) per branch when protected with a 3-pole 20 A over-current protection device (OCPD).

In case you are skipping a connector, ensure that each branch circuit has a maximum of four IQ8 Commercial Microinverters (IQ8P-3P) per phase connection, that is, L1-L2, L2-L3, L3-L1. You can check the marking on connectors C1 (L1-L2), C2 (L2-L3), and C3 (L3-L1) to count the number of microinverters per phase in a branch circuit.

If one exceeds the limit of 4 IQ8 Commercial Microinverters (IQ8P-3P) per phase (L-L) in a branch circuit, then the current shall be more than QD Cable capacity. Therefore, it is required to have a maximum of four IQ8 Commercial Microinverters (IQ8P- 3P) per phase in a branch circuit.

Example 2: 84 IQ8 Commercial Microinverters (IQ8P-3P) in a 208/120 V WYE three-phase system

Calculating the ampacity for other wire sections is the same as for a single circuit, but you must know the total number of microinverters per phase on the combined wire run.

In this example, a microinverter subpanel feeds a total of 84 microinverters divided into seven branch circuits with 12 microinverters per circuit with 28 microinverters each for L1:L2, L2:L3 and L3:L1.

The calculation for the main breaker size is as follows:

Current (A per branch) = [480 Watts/microinverter x 28 microinverters x $\sqrt{3}$] ÷ 208 volts = 111.9 A The ampacity result is 111.9 A

OCPD sizing = $111.9 \text{ Amps} \times 1.25 = 139.8 \text{ A}$

A PV system with 84 IQ8 Commercial Microinverters requires a 150 A (minimum) circuit breaker or OCPD.



NOTE: The above methodology is used only for ease of calculations for an unbalanced system. The real current calculations shall involve vector mathematics for current addition as each microinverter is connected across each phase and shall contribute current to all three lines: L1, L2, and L3 cables.

9 Appendix B: Phase balancing in IQ8 Commercial installations using the three-phase QD Cable phase rotation

Enphase IQ8 Commercial Microinverters has a 4-pin output configuration (L1, L2, L3, and neutral sense) with power on two pins and sensing on the other two pins. The single-phase IQ8 Commercial Microinverter achieves the three-phase configuration and phase balancing using the three-phase QD Cable phase rotation. This topic helps you understand the phase rotation configuration for QD Cable and how phase balancing is achieved for IQ8 Commercial Microinverter System.

9.1 AC QD Cable for IQ8 Commercial Microinverter

QD Cable is a 12 AWG cable with four conductors for L1, L2, L3, and neutral sense. QD Cable has power on two phases (P1, P2 Pins) and sensing on the other phase and neutral for phase loss sensing (P3, P4 Pins). This arrangement alternates between phases for each drop to achieve self-phase balancing. The QD Cable 4-pin male connectors plug directly into the IQ8 Commercial Microinverters, whose double insulated rating requires no ground conductors.

Based on PV module orientation specific to the installation site, QD Cable provides the following ordering options.

Table 19: QD Cable types/ordering options

QD Cable types/ordering options					
Model number	Max voltage	Size	Connector spacing	PV module orientation	Connectors count per box
QD-12-13-120	277 VAC	12 AWG	1.3 m (4.3 ft)	Portrait	120
QD-12-20-120	277 VAC	12 AWG	2.0 m (6.6 ft)	Landscape	120
QD-12-25-108	277 VAC	12 AWG	2.5 m (8.2 ft)	Landscape	108

9.1.1 Phase rotation for QD Cable

Each connector on the QD Cable is marked with Phase ID C1, C2, and C3, which shows the phase rotation across the connectors in the QD Cable as shown below, and the similar phase rotation arrangement continues across the cable.

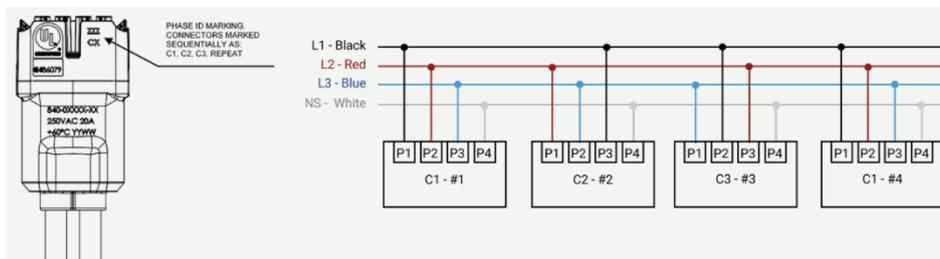


Figure 41: QD Cable connector and typical phase rotation arrangement

QD Cable configuration helps in achieving phase rotation and phase balancing and to maintain a maximum 1% voltage rise in QD Cable.

9.1.2 Cable configurations for QD Cabling SKUs

The QD Cable includes a center-tapping connector after every six connectors, as shown in the following figure. The center-tapping connector follows a similar pattern of sequence throughout the QD Cable. Utilizing the center-tapping connectors for the AC branch connection shall ensure a <1% voltage rise in the QD Cable. Therefore, center-feeding is recommended for all installations.

For details on voltage rise calculations and installation guidelines for center-tapping of branch circuit with QD-12-42-63 cable installations, see the *Technical Brief on Calculating AC line voltage rise for IQ8 Commercial Microinverter with QD Cable*.

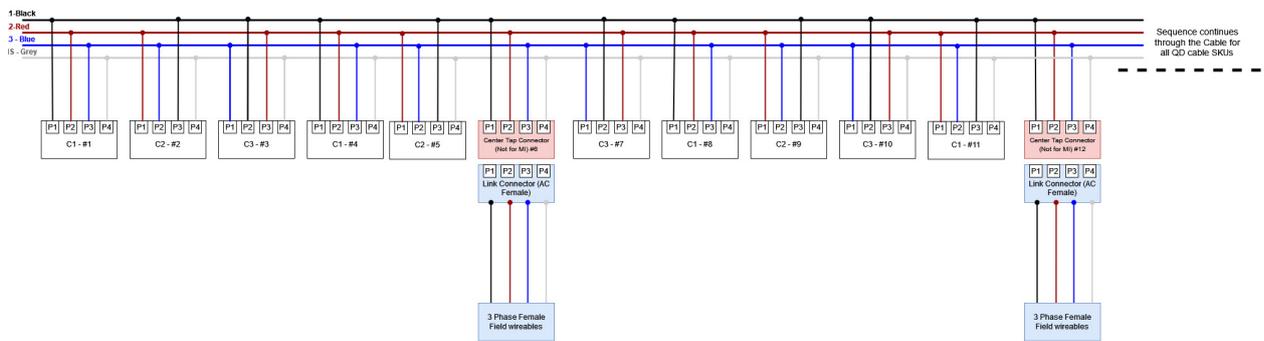


Figure 42: QD Cable configuration

9.1.3 Phase balancing for IQ8 Commercial Microinverter system

This section explains how phase balancing can be achieved in IQ8 Commercial Microinverter system with different system configurations. If the site layout does not allow the installer to meet all required design considerations, then calculate the expected phase power imbalance due to the additional number of microinverters on each phase. Refer to local AHJ rules for acceptable phase imbalance across the system.

- If the number of microinverters in the IQ8 Commercial Microinverter system is in multiples of 3 with individual branch circuits of any size (max. 12 microinverters of IQ8P-3P and 15 microinverters of IQ8H-3P), then IQ8 Commercial System shall have balanced configuration across all three phases if no connectors in QD Cable are skipped during installation.
- If the number of microinverters in the IQ8 Commercial Microinverter system is not in multiples of 3, then the number of microinverters across each phase (L1-L2, L2-L3 & L3-L1) may differ by a maximum of 1 microinverter per phase if no connectors in QD Cable are skipped during installation. Refer to local AHJ rules on acceptable phase imbalance across the system.
- When connectors in QD Cable are left unused in a three-phase system, it creates a phase imbalance for the system, with each phase (L1-L2, L2-L3, L3-L1) having a different number of microinverters. If multiple connectors in QD Cable are skipped over multiple branch circuits, the imbalance shall multiply.
 - Minimize the number of unused QD Cable connectors: You can avoid skipping the QD Cable connectors with the use of three-phase Field Wireable QD Connectors (QD-CONN-10F and QD-CONN-10M) along with Raw QD Cable to extend the cable drop length.
 - If the installation requires a few connectors to be skipped during installations, it is recommended to ensure an equal number of microinverters connected to C1(L1-L2), C2(L2-L3), and C3(L3-L1) type connectors.
 - If the number of microinverters connected to C1, C2, and C3 types of

connectors is not the same, refer to local AHJ rules for acceptable phase imbalance across the system.

- Enphase Installer App provides phase connection details during the array builder or commissioning process. Validate your imbalance expectations through the Enphase Installer App.
- Enphase Installer App shall be able to share a consolidated report of all microinverters with each phase connection.

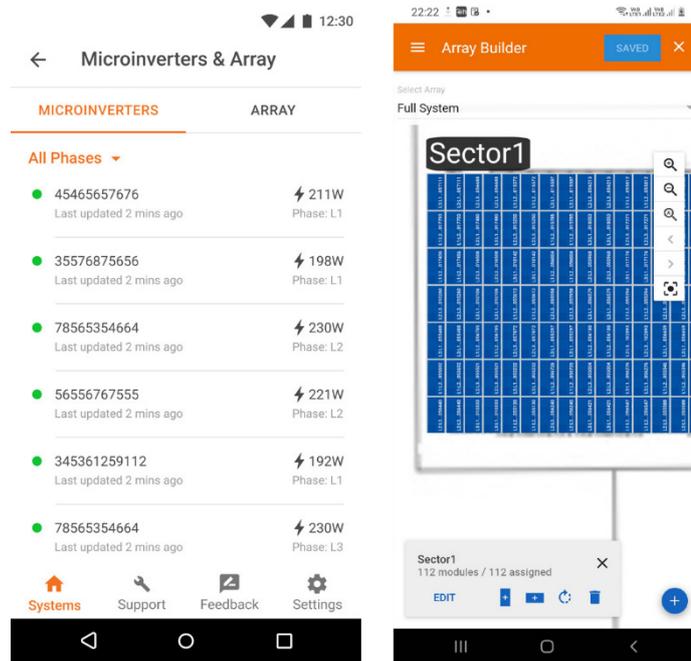


Figure 43: Enphase Installer App phase connection

10 Appendix C: Specifications

10.1 IQ8 Commercial Microinverters

Input data (DC)	IQ8P-3P-72-2-US	IQ8H-3P-72-2-US
Commonly used modules for pairing ¹	380 W-640 W	320 W-540 W
Module compatibility ¹	54-cell/108 half-cell, 60-cell/120 half-cell, 66-cell/132 half-cells, and 72-cell/144 half-cell	54-cell/108 half-cell, 60-cell/120 half-cell, 66-cell/132 half-cells, and 72-cell/144 half-cell
Maximum input DC voltage	63 V	63 V
Peak power tracking voltage	35.5-53 V	28.5-45 V
Operating range	16-63 V	16-63 V
Min/Max start voltage	22/65 V	22/65 V
Max DC short circuit current (module I _{sc})	20 A	20 A
Overtoltage class DC ports	II	II
DC port back feed current	0 A	0 A

	1 × 1 ungrounded array; no additional DC side protection required; AC side	1 × 1 ungrounded array; no additional DC side protection required; AC side
PV array configuration	Protection requires a 20 A per branch circuit	Protection requires a 20 A per branch circuit
Output data (AC)	IQ8P-3P-72-2-US	IQ8H-3P-72-2-US
Peak output power	480 VA	384 VA
Maximum continuous output power	475 VA	380 VA
Nominal (L-L) voltage/range ²	208 V/183–229 V; 220 V/198–242	208 V/183–229 V; 220 V/198–242
Maximum continuous output current	2.28 A (208 V); 2.16 (220 V)	1.83 A (208 V); 1.73 A (220 V)
Nominal frequency	60 Hz	60 Hz
Extended frequency range	50–68 Hz	50–68 Hz
AC short circuit fault current over three cycles	5.8 Arms	5.8 Arms
Maximum Microinverters per 20 A branch circuit ³	12	15
Overvoltage class AC port	III	III
AC port back feed current	2.2 mA	2.2 mA
Power factor setting	1.0	1.0
Power factor (adjustable)	0.85–1.0 leading or lagging	0.85–1.0 leading or lagging
Efficiency @ 208 V	IQ8P-3P-72-2-US	IQ8H-3P-72-2-US
MPPT efficiency	99.5%	99.5%
CEC weighted efficiency	97.5%	96.5%

Mechanical data	IQ8P-3P-72-2-US	IQ8H-3P-72-2-US
Ambient temperature range	-40°C to 65°C (-40°F to 140°F) ⁴	-40°C to 65°C (-40°F to 149°F) ⁴
Relative humidity range	4% to 100% (condensing)	4% to 100% (condensing)
DC connector type ⁸	Enphase EN4 bulkhead ECA-EN4-S22 : EN4 (TE PV4-S SOLARLOK) 150mm/5.9" to Stäubli MC4 adapter cable pair (Default Supply) ⁵	Enphase EN4 bulkhead ECA-EN4-S22 : EN4 (TE PV4-S SOLARLOK) 150mm/5.9" to Stäubli MC4 adapter cable pair (Default Supply) ⁵
Adapters (Optional) ⁸	ECA-EN4-FW-12: EN4 (TE PV4-S SOLARLOK) to 150mm/5.9" non-terminated cable (Pack of 12 pairs - Optional) ⁶ ECA-EN4-S22-10-12 : EN4 (TE PV4-S SOLARLOK) 1000mm/39.4" to Stäubli MC4 (Pack of 12 pairs - Optional) ⁵	
Dimensions (H x W x D)	265 mm × 200 mm × 35 mm (10.4" × 7.9" × 1.4") without bracket	265 mm × 200 mm × 35 mm (10.4" × 7.9" × 1.4") without bracket
Weight	1.6 kg (3.4 lb)	1.6 kg (3.4 lb)

Cooling	Natural convection	Natural convection
Approved for wet locations	Yes	Yes
Enclosure	Class II double-insulated, corrosion-resistant polymeric enclosure	Class II double-insulated, corrosion-resistant polymeric enclosure
Environmental category/UV exposure rating	IP67/Sunlight resistant	IP67/Sunlight resistant

1. No enforced DC/AC ratio. See the [compatibility calculator](#).
2. The nominal voltage range can be configured if required by the utility.
3. Limits may vary. Refer to local requirements to define the number of microinverters per branch in your area.
4. Full power up to 50°C, derate after.
5. Qualified per UL subject 9703.
7. For field wiring of UL-certified DC connectors.
8. Enphase IQ8 Commercial Microinverter bulkhead and adapter cable male and female DC connectors must only be mated with the identical type and manufacturer brand of male/female connector.

Features	IQ8P-3P-72-2-US	IQ8H-3P-72-2-US
Communication	Power line communication (PLC)	
Monitoring	Enphase Installer Portal monitoring options. Both options require the installation of an IQ Gateway Commercial 2.	
Compliance	CA Rule 21 (UL 1741-SB), UL 62109-1, UL1741/IEEE1547, FCC Part 15 Class B, ICES-0003 Class B, CAN/CSA-C22.2 NO. 107.1-01. This product is UL Listed as PV rapid shutdown equipment and conforms with NEC 2014, NEC 2017, and NEC 2020 section 690.12 and C22.1-2018 Rule 64-218 Rapid shutdown of PV Systems for AC and DC conductors when installed according to manufacturer's instructions	

10.2 QD Cables

Specification	Value
Voltage rating	600 V
Voltage withstand test (kV/1min)	AC 3.0 KV/1 min
Max DC conductor resistance (20°C) (Ω/km)	12 AWG 5.43 Ω/km and 14 AWG 8.62 Ω/km
Insulation resistance (20°C)	20 MΩ*km
System temperature range (ambient)	60°C
Cable temperature rating	90°C
Cable rating	20 A
Certification	Type DG, THHN/THWN-2, UL3003
Flame rating	FT4
Cable conductor insulator rating	THHN/THWN-2
Environmental protection rating	IEC 60529 IP67NEMA 6

UV resistance	720 h
Compliance	Type DG, THHN/THWN-2, UL3003
Minimum bending radius	R = 4 × OD
Cable dimensions	Diameter 11.5 mm
Sealing Cap dimensions	28 × 60 × 23
Cable Connector dimensions	82 × 60 × 18

10.3 IQ Gateway Commercial 2

Model numbers	
Enphase IQ Gateway Commercial 2 ENV2-IQC2-AM3-3P	Three-phase communications gateway with integrated, revenue-grade PV production metering (+/- 0.5%) and optional consumption monitoring (+/- 2.5%). Includes three 400 A continuous-rated production CTs.
Accessories (order separately)	
Enphase Mobile Connect <ul style="list-style-type: none"> ○ CELLMODEM-M1-06-SP-05 ○ CELLMODEM-C1-01-TM-05 	Plug-and-play industrial-grade cellular modem with a five-year data plan (expandable to 12 years). Available in the US, Canada, Mexico, Puerto Rico, and the US Virgin Islands, where there is adequate cellular service in the installation area.
Consumption Monitoring CTs CT-600-SPLIT (Order three or six, as needed)	Split-core current transformers enable consumption metering.
Power requirements	
Power requirements	208Y/120 VAC three-phase 220Y/127 VAC three-phase Max 20 A overcurrent protection is required
Capacity	
Number of microinverters polled	Up to 276
Mechanical and electrical data	
Dimensions (W×H×D)	21.3 × 12.6 × 4.5 cm (8.4" × 5" × 1.8")
Weight	17.6 oz (498 g)
Ambient temperature range	-40° to 65°C (-40° to 149°F) -40° to 46°C (-40° to 115°F) if installed in an enclosure
Environmental rating	IP30. For installation indoors or in an NRTL-certified, NEMA-type 3R enclosure.

Altitude	Up to 2000 m (6,560 feet)
Production CTs	<ul style="list-style-type: none"> ○ Capable of measuring 400 A of continuous current with 1.0% accuracy ○ Accuracy of +/-0.5% for revenue grade production metering (ANSI C12.20 certified) ○ Internal aperture measures 43 mm to support up to a maximum size of 1000 KCMil conductors ○ UL2808 certified

Internet connection options	
Integrated Wi-Fi	Yes
Ethernet	Yes
Mobile	Optional, CELLMODEM-M1-06-SP-05 or CELLMODEM-C1-01-TM-05, not included

Compliance	
Compliance	<ul style="list-style-type: none"> ○ UL 916 ○ CAN/CSA C22.2 No. 61010-1 47 CFR, Part 15, Class B, ICES 003 ○ IEC/EN 61010-1:2010 ○ EN50065-1, EN61000-4-5, EN61000-6-1, EN61000-6-2 ANSI C12.20 ○ NoM

11 Appendix E: Transformer recommendations

Enphase IQ8 Commercial Microinverters support grid interconnection for 208/120 V WYE three-phase applications. For interconnection with systems other than 208/120 V WYE three-phase, a transformer is required to connect to the grid.

Specify the transformer kVA size to meet the inverter output in kW AC. Some additional deratings, such as adjustments for power factor and temperature, may apply. Refer to the transformer manufacturer’s specifications for transformer sizing. The transformer’s primary connection must match the grid configuration at the site, and its secondary connection should be a 208/120 V WYE configuration for IQ8 Commercial PV systems. The following table lists utility voltage values and transformer requirements. Consult the transformer manufacturer for appropriate sizing and loss analysis for the system. Also, refer to AHJ requirements in your region for transformer installation.

Utility voltage configuration	Nominal primary voltage L-L	Nominal primary voltage L-N/G	Secondary voltage	Transformer requirements
208/120 V WYE	—	—	—	No transformer required for interconnection depending on the existing meter service panel size

480/277 V WYE	480 V	277 V	208/120 V WYE	Transformer configuration should be selected by the installer according to NEC and the local code
480 V delta	480 V	—	208/120 V WYE	
240 V high-leg delta	240 V	—	208/120 V WYE	
Other	Other	Other	208/120 V WYE	For interconnection to systems other than 208/120 V WYE three-phase, a transformer is required to connect to the grid.

Installers can choose transformers with adjustable taps. Use the tap to make minor adjustments when the utility-provided voltage is high or when optimizing conductor sizing versus expected voltage rise for the value-engineered PV system. It is common to specify high-efficiency or ultra-high efficiency, general purpose, and dry-type transformers for an Enphase microinverter system.



NOTE: Installers are responsible for transformer procurement, installation, maintenance, and support. Damage to the IQ8 Commercial Microinverter due to incorrect transformer installation will invalidate the Enphase warranty.



NOTE: Enphase IQ8 Commercial system interconnection using transformers for grid voltage other than 208/120 V complies with the IEEE 1547: 2018 standards only if a third-party meter instrument is added at the primary meter service location. Installers should install the IQ8 Commercial system with transformers only when the system meets all the compliance standards applicable to your AHJ.

Revision history

Revision	Date	Description
USG-00026-3.0	February 2024	Added the “Transformer recommendations” section.
USG-00026-2.0	December 2023	<ul style="list-style-type: none"> Updated the “IQ8 Commercial System startup and commissioning” section. Removed the “Appendix D: Photovoltaic Hazard Control System” section.
USG-00026-1.0	November 2023	Initial release.
Preliminary release.		