

Power line communication troubleshooting

Applicable regions: EMEA

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1 About this document

This document provides guidance on overcoming electrical noise when it causes power line communication issues in Enphase Energy Systems.

2 Power line communication noise and attenuation

The IQ Gateway communicates with IQ Series Microinverters over the AC electrical conductors using a 110 kHz communication signal. This technology is known as power line communication or PLC. It is widely used in networking (Ethernet bridges or home plugs) and home automation applications (for example, the X10 protocol).

Some common appliances produce electrical noise at similar frequencies. Noise produced may be continuous or intermittent at certain times of the day. If this noise occurs on the same electrical conductors as the PLC, it can disrupt communication between the IQ Gateway and microinverters. In some cases, noise on the AC circuit can be so great that the IQ Gateway is unable to communicate adequately with the microinverters.

Common examples of appliances that can create noise include:

- Light switches
- Dimmer switches
- Touch lamps
- Export limiting devices using phase angle technology, such as the [Solar iBoost+](#)
- Uninterruptible power supply (UPS)
- Rotating motors such as water pumps or workshop equipment

Other appliances attenuate the PLC signal by presenting a *short* at PLC frequencies. This decreases the PLC signal level such that it is difficult for communication to reach between the IQ Gateway and the microinverters and back.

Problems are often not observed when the microinverters are first installed. When the system owner later purchases a new appliance or piece of equipment, or when older appliances start to fail, issues may appear and the microinverters can fail to communicate. More rarely, the noise comes from a neighbor connected to the same transformer substation.

Follow the best practices described in this document during installation to avoid potential communication issues at the site.

3 Best practices to avoid communication problems

With the correct planning, communication problems due to noise can be avoided or easily overcome by doing the following:

- Install a dedicated PV sub-board for the IQ Gateway and AC branch circuit breakers.
- Keep the cable run between the IQ Gateway and the microinverters as short as possible. Sites with long cable runs from the array to the IQ Gateway are more susceptible to noise interference.

- Connect the IQ Gateway directly to a circuit breaker. Avoid circuits where any appliances or equipment share the circuit with the IQ Gateway.
- Fit gapped ferrite cores to the neutral conductors running from the PV sub-board back to the main distribution board or load center. For more information, see [Installing gapped ferrite cores](#) on page 11. These are a simple, economical, and effective mechanism to prevent attenuation by other equipment and provide some isolation from noise.
- If local standards do not require an IQ Relay, install a phase coupler at three-phase sites. Enphase Support can supply a list of suitable products.
- For sites with multiple IQ Gateways, separate each IQ Gateway and its associated microinverters from other IQ Gateways and microinverters using a PLC filter such as the Radius LCF-250-PC to avoid cross-talk between IQ Gateways. Also, keep PV circuit conductors controlled by each IQ Gateway physically separated from others. They should be installed in different conduits or separated on cable trays.

4 Troubleshooting inadequate PLC and noise

There are several ways to understand if there are issues with the PLC on a specific site or IQ Gateway using the Enphase Installer Portal or Enphase Installer App.

4.1 Viewing the array map using the Enphase Installer Portal

The array map in the Enphase Installer Portal can also indicate communication issues. A site with poor communication will show some PV modules as grey and issue alerts when microinverters are not communicating. PV modules shown in black mean they are communicating but not producing power.

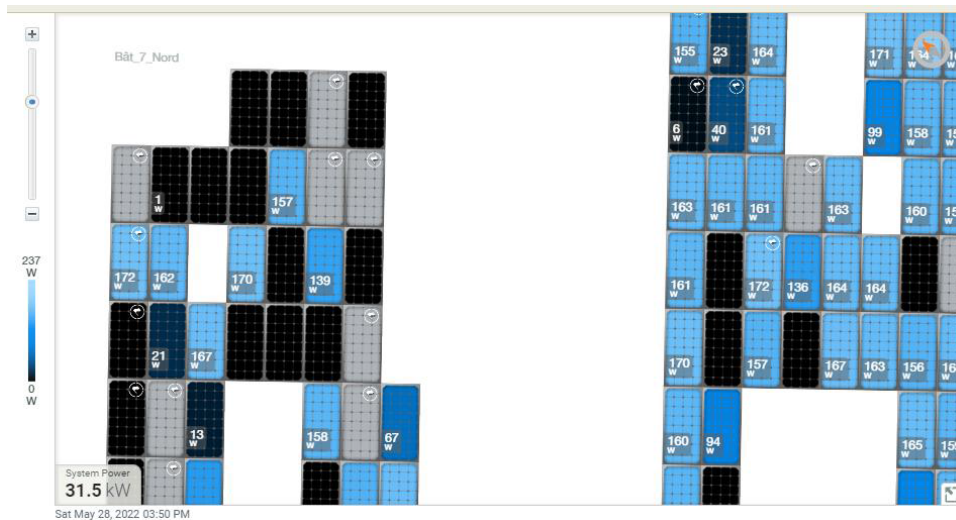


Figure 1: Array view on the Enphase Installer Portal—site with poor PLC

4.2 Checking the IQ Gateway status page using the Enphase Installer Portal

Check the IQ Gateway’s signal strength on the **Devices** page in the Enphase Installer Portal. This will show the following parameters:

- **Signal strength:** 4/5 or 5/5 bars indicates very good communication, fewer than 3/5 bars is poor.



1/5



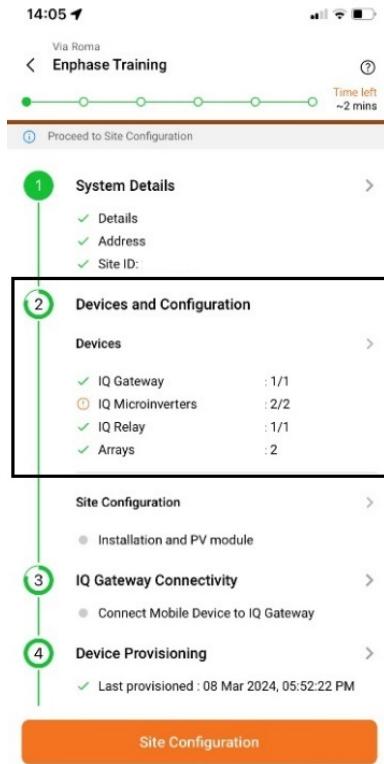
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- **Number of microinverters detected:** This section displays the number of microinverters communicating and indicates when any microinverters have failed to report.

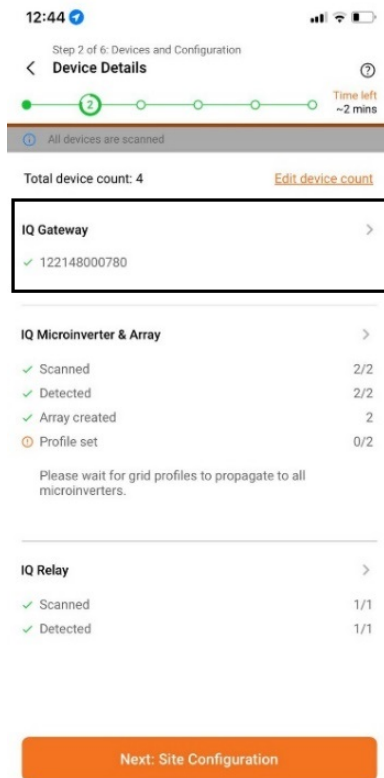
Web Communication	
✓ Connected to Enlighten Last Report: Thu May 26, 2022 06:11 PM CEST	Ethernet
Power Line Communication	
⚠ Poor signal strength Last Check: Fri May 20, 2022 04:50 PM CEST	
15 Microinverters Detected	
✓ 15 Communicating 14 Producing power	

4.3 Checking PLC noise while on-site using the Enphase Installer App

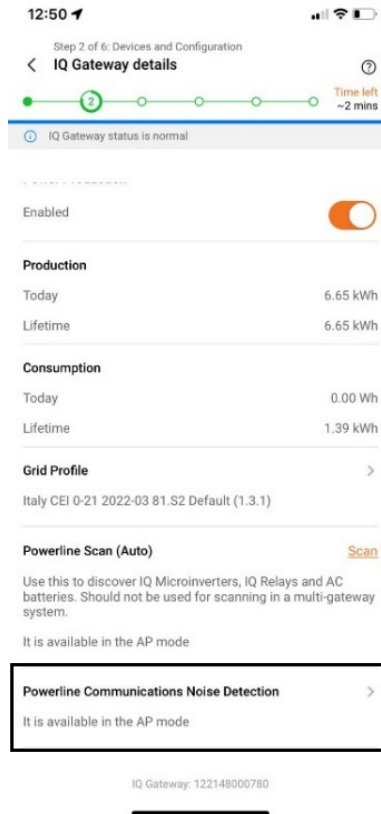
1. To see if a site is affected by PLC noise, check using the Enphase Installer App during on-site system commissioning. The app must be connected directly to the IQ Gateway in AP mode to perform this check. Select **Devices and Configuration** (step 2 of the workflow).



2. After scanning the devices, click the **IQ Gateway**.

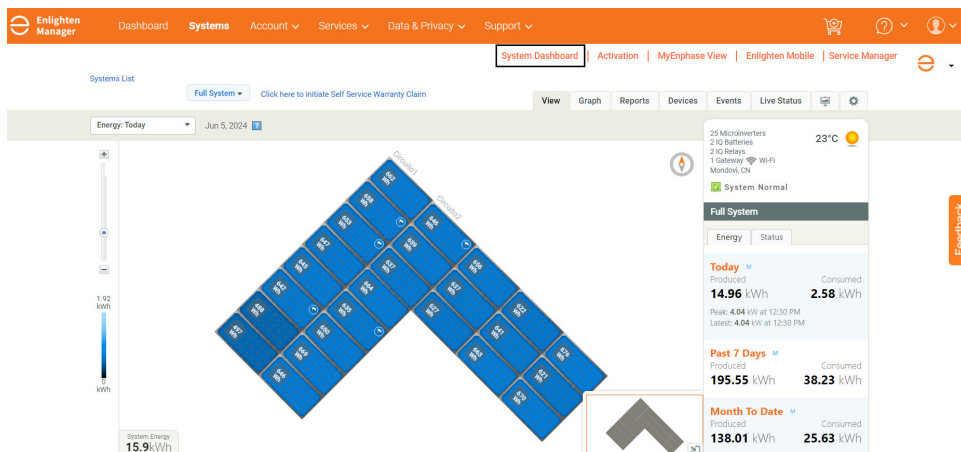


- The app now shows several options. Scroll down to the last item and select **Powerline Communications Noise Detection** to verify the quality of PLC.

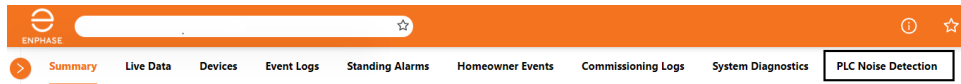


4.4 Checking PLC noise remotely using the Enphase Installer Portal

- To check PLC noise remotely using the Enphase Installer Portal, at the top right, click **System Dashboard**. A new page opens up with additional options.



- To generate the graph with results, select the **PLC Noise Detection** tab.



4.5 Reading the PLC noise detection graph and results

The Enphase Installer Portal and Enphase Installer App show similar graphs, where the colored vertical band represents the range where Enphase PLC takes place between 100 and 120 kHz.

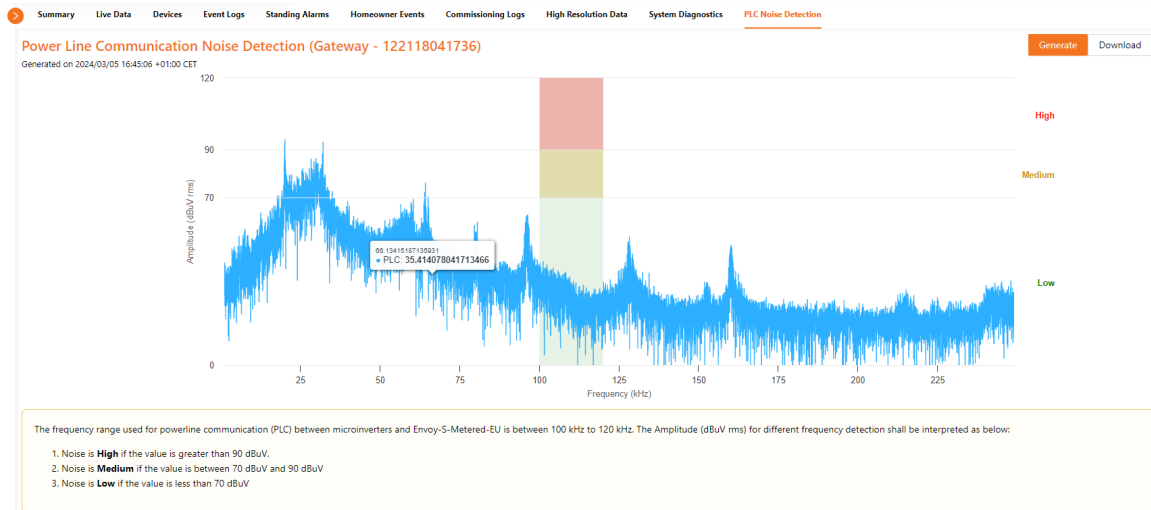


Figure 2: PLC noise detection on the Enphase Installer Portal

The amplitude (dBuV rms) for different frequency detection should be interpreted as follows (see the preceding figure):

- Noise is *High* if the value is higher than 90 dBuV.
- Noise is *Medium* if the value is between 70 dBuV and 90 dBuV.
- Noise is *Low* if the value is lower than 70 dBuV.

4.6 Requesting Enphase Support or customer support to check PLC noise

Enphase Support can also assist in confirming if noise is present by performing a more detailed noise check by remotely connecting with the IQ Gateway installed at the site and performing tests on the microinverter circuits.

The *idle* and *receive* Fast Fourier Transform (FFT) plots can be compared to show if the PLC signal from the microinverters is above the background noise level. The *idle* stage is when there is no active communication, and the *receive* stage is when there is communication between microinverters and IQ Gateway. The following figures show a few examples.

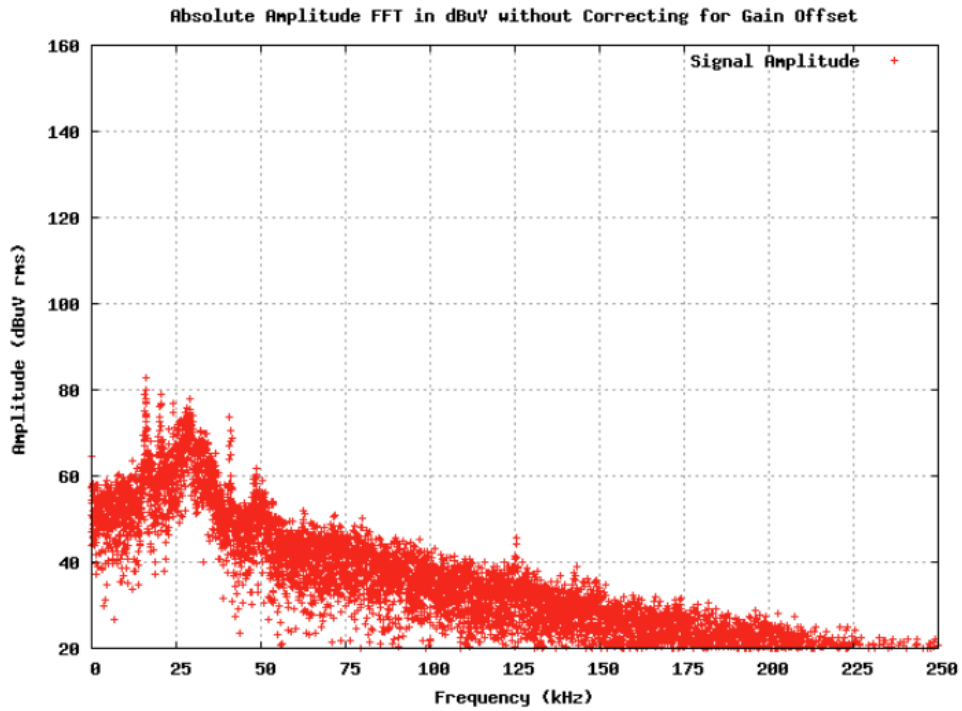


Figure 3: A “clean” electrical line during idle without noise

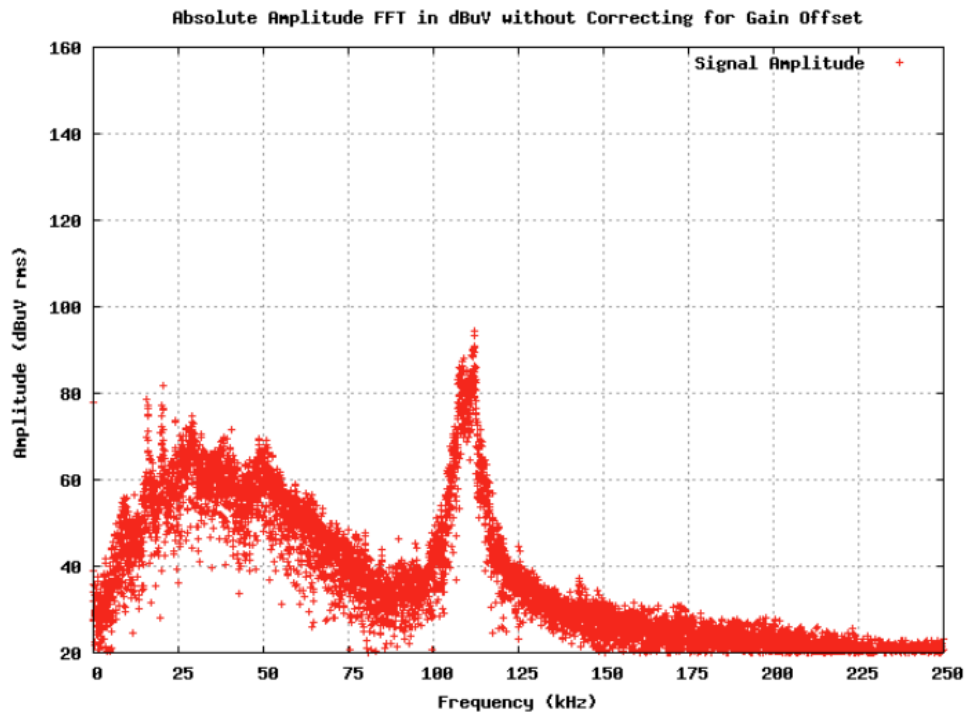


Figure 4: A “clean” electrical line during receive without noise

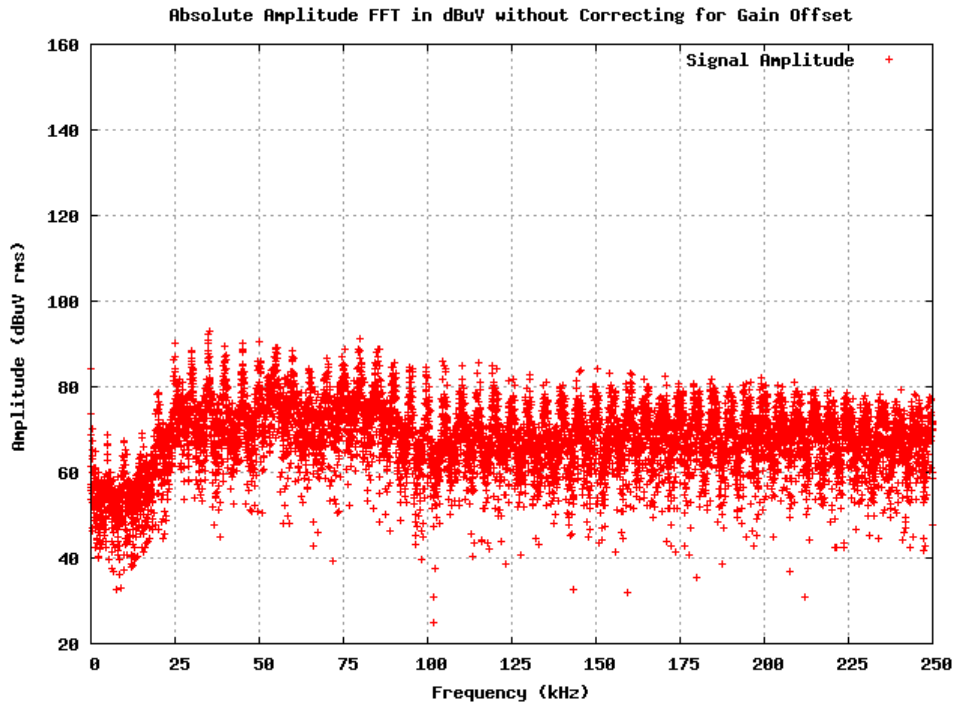


Figure 5: An electrical line with noise

We can use these plots to isolate the source of noise by turning circuits off at the circuit breaker and repeating the check until we find which circuit is contributing to the noise. After the circuit is identified, we can then potentially identify a specific appliance or piece of equipment creating the noise. Enphase Support can also look at the reported PLC conditions from each microinverter in your system and help identify what the issue may be.

5 PLC noise mitigation

PLC noise can be managed by installing gapped ferrite cores or PLC filters. For different scenarios, different solutions must be considered.

5.1 Gapped ferrite cores

A ferrite core is a passive electronic component designed to be a barrier to signals at PLC frequencies. Its primary function is to segregate the circuits that require an Enphase PLC signal for the IQ Gateway, IQ Relay, and microinverters from the circuits with equipment that may create noise or attenuate the signal.

A gapped ferrite core is a magnetic core with an air gap to alter its properties. This specific item significantly increases the performance of PLC where other equipment is suppressing it.

5.2 Recommended gapped ferrite core products

3M Kapton tape is a film used in electronic applications to increase electrical isolation. Here, it creates a gap that allows the ferrite to work up to higher currents. Enphase recommends using either of the following gapped ferrite core products in combination with [3M Kapton tape](#), as shown:

- For up to 30 A, use a [small Fair-Rite 0475164181 ferrite](#) core with one layer of 3M Kapton tape on both sides of half of the ferrite core. Two strips of Kapton tape in total.

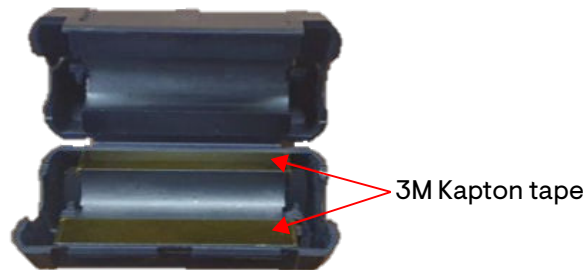


Figure 6: 30 A, small Fair-Rite 0475164181 ferrite core with 3M Kapton tape applied

- For up to 65 A, use a [large Fair-Rite 0475176451 ferrite](#) core with one layer of 3M Kapton tape on both sides of both halves of the ferrite core, four strips of Kapton tape in total.

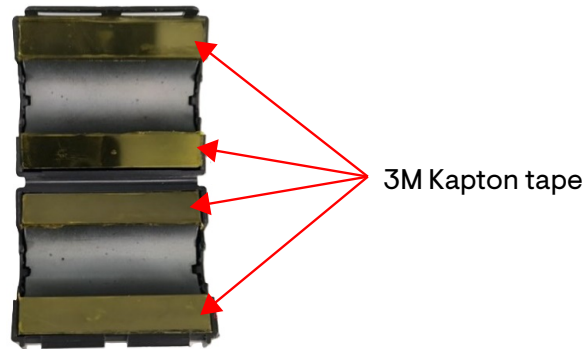


Figure 7: 65 A, large Fair-Rite 0475176451 ferrite core with 3M Kapton tape applied

5.3 Installing gapped ferrite cores

Ideally, you will fit the gapped ferrite core between the PV sub-board and the main distribution board or load center. Alternatively, if a specific piece of fixed equipment is identified as the source of the electrical noise, fit the ferrite on the supply to that equipment.

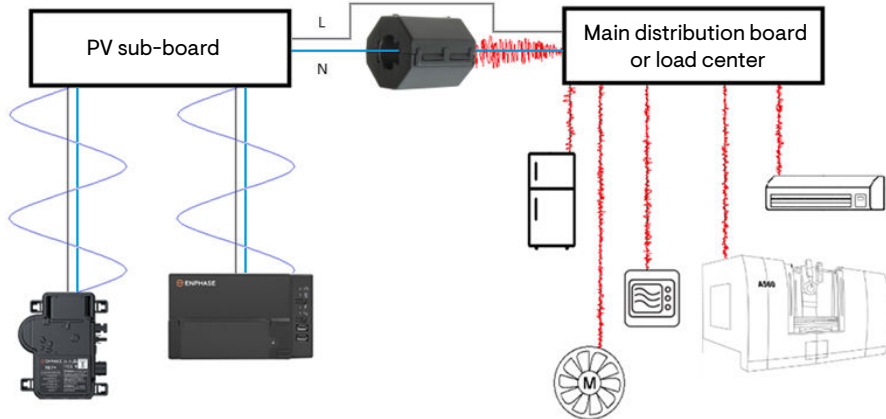


Figure 8: Gapped ferrite core placement

The ferrite should be placed on the *neutral* conductor. Importantly, in three-phase systems, one ferrite on the neutral will give the same performance on the core in each phase. Multiple ferrites can be used to provide even better performance by adding them in series. Ensure that the current rating of the ferrite applies to the maximum current carried by the conductor the ferrite is clipped around. For three-phase systems, the maximum neutral current is the maximum current on one phase, and not the sum of all phases.



Figure 9: Gapped ferrite core on the neutral conductor with the 3M Kapton tape applied between the two parts of the ferrite core

Not all installations can be ideal. Where there is no dedicated neutral common to only the IQ Gateway and microinverters, you can clamp the ferrites around the separate neutral wires together as shown in the following figure.

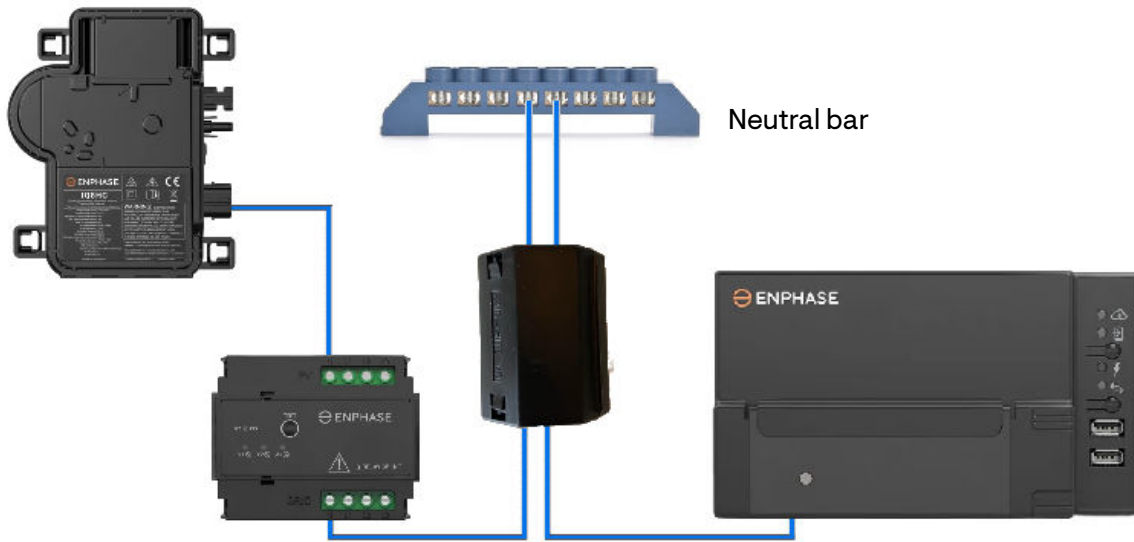


Figure 10: Gapped ferrite core when there is no dedicated neutral common to IQ Gateway and microinverters

5.4 PLC filters

PLC filters are designed to reduce all kinds of noise coming from end-user equipment to ensure more reliable PLC communication. They will also assist at sites where there are multiple IQ Gateways installed. Here they can be used not only to mitigate noise but also to separate each IQ Gateway and its associated microinverters from the other installed IQ Gateways and microinverters at the same site or a neighboring site to avoid PLC cross-talk.

For installation of a PLC filter refer to the product documentation associated with the specific product. The following sections describe how and when to use a PLC filter.

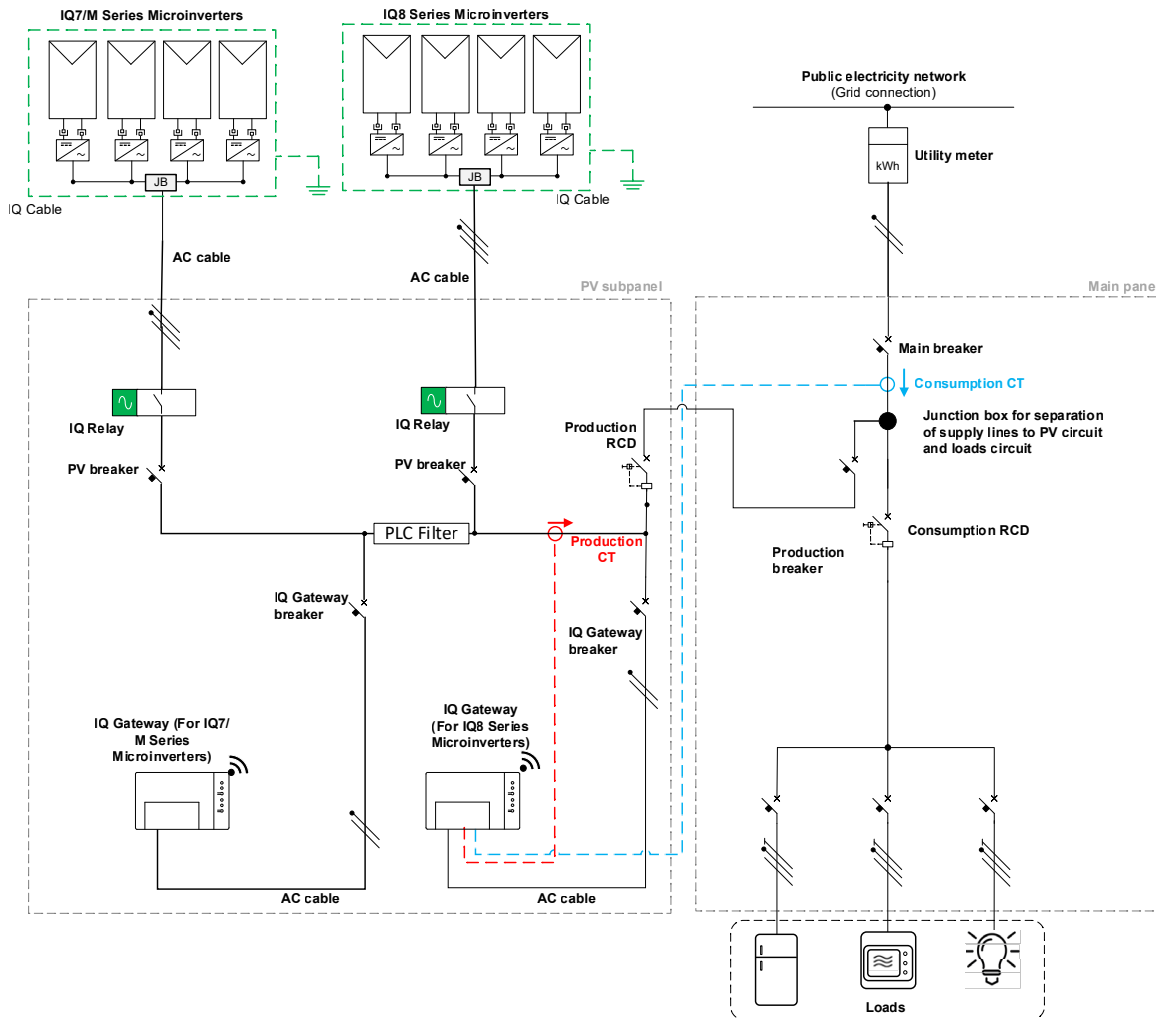


Figure 11: Example of a PLC filter to separate communication between IQ7 and IQ8 Series Microinverters associated with different IQ Gateways

5.5 Using PLC filters

Enphase recommends the use of a PLC filter on commercial sites.

Line filtering is recommended where:

- A site has two IQ Gateways due to IQ8 and IQ7 Series (or M Series) Microinverters being installed at the same site and requiring one IQ Gateway for each part of the system. For more information, see [PLC filters](#) on page 13.
- A site has more than 30 microinverters per phase installed and where the IQ Gateway Metered provides power export limitation and/or phase imbalance control so robust communication at all times is essential.
- A large site with more than 300 microinverters installed that requires multiple IQ Gateways to communicate with all the installed devices.
- Where large capacitive and inductive loads are present and likely to create substantial electrical noise that may disrupt communication.

5.6 Recommended PLC filters

When choosing the PLC filter for your application, verify that the current rating of the filter meets the current capacity of the total sum of all the microinverter output at the PV subpanel where the line filter is located, including temperature derating.

Check the product specifications to ensure a suitable location for the installation as line filters vary in size and weight. Four-pole filters are required, with strong attenuation at the PLC frequencies of 100–150 kHz.

Recommended PLC filter suitable for applications with Enphase microinverters:

- [Radius LCF-250-PC: 250 A three-phase filter with phase coupler](#)
- [Bialon FF-01: 63 A single-phase filter](#)



Figure 12: Example of a PLC filter usage in a commercial environment with three Radius LCF-250-PC 250 A filters to separate the communication domains for three IQ Gateways

Gapped ferrites may not be suitable for usage in a commercial environment. They may be difficult to fit due to limited space in the distribution board or it could be that there is significant noise generated by the on-site equipment and gapped ferrites may not resolve the issue.

6 FAQs

If there is no communication, do the microinverters still produce electricity?

Yes. Unless power export limitation (PEL) or phase imbalance management (PIM) is required, communication is only necessary for system monitoring and remote assistance.

If poor communication interrupts data transfer, are the system's total kWh figures still accurate?

Yes, they are. When communication levels improve and the microinverters resume communication with the IQ Gateway the production data stored in the microinverters will be uploaded. However, the data will not be as detailed, which may result in flat lines in the Enphase Installer Portal graph view during periods of poor communication.

7 Revision history

Revision	Date	Description
TEB-00189-1.0	August 2024	Initial release.