

Power Line Network Installation Guide



POWER LINE AUTOMATION NETWORKS

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1. Quick Start

A. Connect the gateway to a suitable 80 to 305VAC outlet.



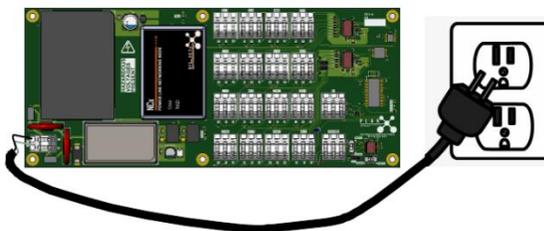
At a minimum, the Line and Neutral need to be connected. If coverage across all three phases of the site is needed, then connect the two other phases of the distribution transformer to the gateway. It is recommended that these connections be made directly to the wall outlet (standard US 15A outlet or equivalent) or the secondary of the transformer without any intermediate surge protection devices.

B. Connect the gateway to the LAN.



The gateway is expecting to receive an IP address assigned by a DHCP server (typically a router) on the local area network. Once the gateway receives an IP address, the status led (STAT) will go solid (from blinking while network access is being setup). If a router with a DHCP server is not available or the PLAN network needs to be kept isolated from the LAN and/or the internet, it is possible to assign a private IP address to the gateway and connect it directly to an isolated computer using a standard ethernet cable. The assignment of the private IP address must be done using the PLAN Admin interface. Please contact PLAN if this is needed.

C. Connect the node to a suitable 80 to 305VAC outlet.



The picture to the left shows the node mounted on an interface board (IB1). The interface board supplies the +3.3V and +15V required by the node in addition to the AC lines and adequate protection from line disturbances.

Once steps A through C are completed, the rest of the process is fully automated. The gateway sets up the network and the nodes join the network if they have the correct credentials (all nodes and gateways are shipped from the factory to connect automatically with the default credentials). The next section gives an overview of the status LEDs; these are useful for a quick visual check of the network health during installation.

2. Network Status Indicators



Figure 2: Gateway Status LEDs

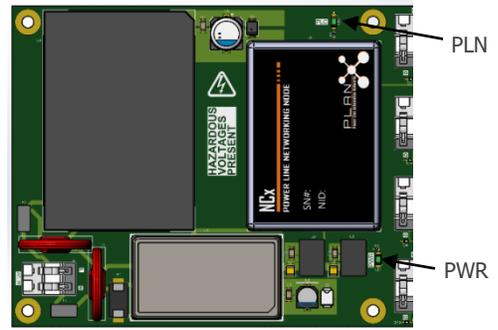


Figure 1: Interface Board Status LEDs

Figures 1 & 2 show the location of the status LEDs on the gateway and a typical interface board, respectively. The Interface board status LED locations could vary with the board type but are always marked as PLC and PWR. The following table shows LED status for the gateway and the interface boards.

DC2 LED Status	OFF	Slow Blink	Fast Blink	ON
STAT	Application not started yet	Application initializing	Network initializing	Application & network fully operational
PLN	Power Line Communications not initialized	Power Line Communications initialized	Power Line Communications in progress	Power Line Communications operational
WiFi	WiFi not initialized or not installed	WiFi initialized	Joining WiFi network	WiFi fully operational
LTE	Cellular connection not initialized or not installed	Cellular connection initialized	Joining cellular network	Cellular connection fully operational

IB LED Status	OFF	Slow Blink	Fast Blink	ON
PLN	Power Line Comms not initialized	Searching for power line communications network	Joining PLC network	PLC network fully operational

3. Troubleshooting guide

A healthy power line network startup should end with all LEDs a solid green (Interface boards could have a blue LED for the PLN status) no more than five minutes after power is supplied to the gateway and the nodes on the interface boards. If this is not the case, the following table should be used as a quick troubleshooting guide and as an aid when contacting PLAN for further troubleshooting:

GATEWAY LED	Diagnosis
PWR OFF	Problem with the gateway power. Ensure the Line and Neutral connections to the rear power inlet block are secure. If this does not solve the issue, please contact PLAN
STAT OFF	If this does not change to a fast blink or a solid green, power down the gateway (simply unplug from the AC power), wait at least a minute, and then plug it back in. If the STAT led does not change to a slow or fast blink within a few minutes of power up, please contact PLAN
STAT slow blink	This is normal at startup. This indicates that the application is running. This should normally change to a fast blink within a few minutes. If this does not change to a fast blink, then there is a problem with the LAN connection. Make sure that the LAN cable is plugged into a switch or a router that can provide the gateway with an IP address. If this is not possible, please contact PLAN to obtain access to an Admin interface that will allow you to set a private IP address for direct connection to a computer without the use of the premise's LAN.
STAT fast blink	This is normal at startup. This indicates the gateway has a LAN connection and is searching for an end point to send data to. If this LED does not change to a solid green, then there is a problem with the gateway access to the end point (either local or in the cloud). This could sometimes be caused by a strict firewall rule setup by the building IT services or a local firewall on the computer that the gateway is connected to locally. The gateway needs to be allowed to access the end point - either a SCADA running on a local computer or a remote end point in the cloud. In either case, a quick way to troubleshoot this problem is to: <ol style="list-style-type: none"> Figure out the IP address of the gateway by looking into the client list on the router admin interface that the gateway is connected to. The gateway should appear as PLAN-DC2. Ping this IP address from the computer that is on the same LAN as the gateway (for example the ping command from the Windows command line). If there is no reply from the gateway, there is a connection problem between the LAN and the gateway and this needs to be solved before data can be pushed out from the gateway.
PLN OFF	This is not typical. The PLN light should start blinking at a slow rate (1 per second) within a minute of the application starting up (STAT slow blink). If the PLN LED has not transitioned to a slow blink, power down and power up the gateway. If this does not solve the issue, please contact PLAN.
PLN slow blink	This is normal at startup. This indicates that the power line network has been initiated and the gateway is waiting for nodes to join. If the LED continues to blink for a long time after power up, this indicates that either: <ol style="list-style-type: none"> There are no nodes with the same NID as the gateway on any of the phases connected to the gateway. Or the phase lines the gateway is connected to and the phase lines the nodes are connected do not have a common pathway (they are not on the same distribution transformer low voltage side). In either case, make sure that the nodes are connected to the same phases of the distribution transformer as the gateway is. It is typical in a large building to have a main medium voltage feed going to different floors of the building with each floor having multiple medium to low voltage distribution transformers. Depending on the age of the transformer, the power line communication signals might not cross the transformer windings. It is recommended that both the gateways and the nodes be on the low voltage side of the same distribution transformer. One can figure out the phase wiring by either getting access to the building single line diagram or by using signal tracing equipment like a fox-and-hound signal tracer.
Wi-Fi OFF/slow blink	This is only applicable if the gateway has been purchased with the optional Wi-Fi module installed. Once the Wi-Fi connection parameters have been entered through the PLAN admin interface, the Wi-Fi led should turn a solid green once the Wi-fi connection is established. If this is not the case, please check the Wi-fi credentials entered and ensure that the building IT does not have firewall rules permitting access to devices only on an internal whitelist. Also ensure that the antenna is properly installed.
LTE OFF/slow blink	This is only applicable is the gateway has been purchased with the optional LTE cellular modem. The LTE LED should transition to a slow blink once the application starts up and then to a solid green once the cellular connection is established. If this is not the case, the issue might be related to: <ol style="list-style-type: none"> Cellular signal strength in the area is not adequate. Try moving the gateway to a different location or contact PLAN to obtain an amplified antenna with a longer antenna cable. The SIM card is not activated. PLAN ships out the gateway without a SIM card. It is the customers responsibility to obtain and install the SIM card into the gateway. Alternatively, PLAN can do this at factory and test the data connectivity upon request.

NODE LED	Diagnosis
PWR OFF	Problem with the interface board power that the NCx node is installed on. Ensure the Line and Neutral connections to the rear power inlet are secure and that there is AC power between 80 to 305 VAC available. If this does not solve the issue, please contact PLAN
PLN OFF	This is not typical. The PLN light should start blinking at a slow rate (1 per second) within a few seconds of the interface board being plugged in. If the PLN LED has not transitioned to a slow blink, power down and power up the interface board. If this does not solve the issue, please contact PLAN.
PLN fast blink	This is normal at startup. This indicates that the node is initializing the network. This should soon (a minute at the most) transition to a slow blink (searching for a gateway) followed by a fast blink (joining gateway) and then a solid color indicating the network is established. If this is not the case and the PLN led remains in the fast blink node, the root causes are similar to the ones in the slow blink diagnosis below.
PLN slow blink	<p>This is normal at startup. This indicates that the node is searching for a power line beacon from the gateway. If the LED continues to blink for a long time after power up, this indicates that either:</p> <ol style="list-style-type: none"> a. There is no gateway with the same NID as the node on the phase line that the node is connected to. b. Or the phase lines the node is connected to and the phase lines the gateway is connected do not have a common pathway (they are not on the same distribution transformer low voltage side). <p>In either case, make sure that the nodes are connected to the same phases of the distribution transformer as the gateway is. It is typical in a large building to have a main medium voltage feed going to different floors of the building with each floor having multiple medium to low voltage distribution transformers. Depending on the age of the transformer, the power line communication signals might not cross the transformer windings. It is recommended that both the gateways and the nodes be on the low voltage side of the same distribution transformer. One can figure out the phase wiring by either getting access to the building single line diagram or by using signal tracing equipment like a fox-and-hound signal tracer.</p>

4. Installation Overview

An example of a PLAN network installation is shown in **Error! Reference source not found.** and consists of the following components:

1. PLAN-DC2 gateway that connects to all three phases on the low voltage side of a distribution transformer (Y-connected with a common neutral and no more than 305VAC between phase and neutral).
2. Multiple PLAN-NCx nodes mounted on application interface boards connected to any of the three phases and neutral.

This system can be used to create a wide area, narrowband, 40KBps, secure, private network using the existing power lines in a building or outdoors based on the IEEE G3-PLC standard on the CENELEC-B band that is approved for end customer use on power lines. Connecting the gateway to all three phases allows communications across all the power wiring downstream of the distribution transformer. One gateway should be installed per distribution transformer with all the gateways connected to a local LAN, Wi-Fi or Cellular to a central SCADA.

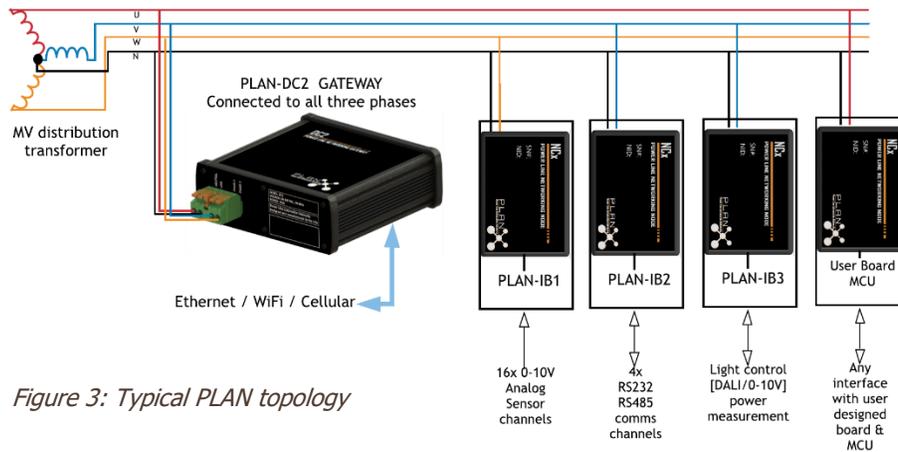


Figure 3: Typical PLAN topology

Every PLAN network uses two pieces of information to establish the power line network:

- a. **Network ID (NID)**: This is visible on the gateway back panel and the label on the NCx core modules. The NID is a four-digit hexadecimal number; 7542 is the default NID that the gateway and the nodes ship out with. The network id determines which gateway the nodes connect to in situations where there are multiple PLAN networks on the power lines. The gateway and node NIDs must match for the nodes to join the gateway. The NID can be changed in the field using the PLAN Admin interface¹
- b. **Private Security Key (PSK)**: This is a 16-byte private security key that is installed at the factory and is stored in a secure location in both the gateway and on the nodes. This key cannot be read back but a new one can be generated and stored on the gateway and the nodes using the PLAN Admin interface. The PSK for the nodes and the gateway must match for the nodes to join the power line network set up by the gateway. It is strongly recommended that this change be done using the PLAN Admin interface in consultation with PLAN.

Both the NID and the PSK are installed at factory before shipment and in most cases, there would be no need to change these in the field. PLAN does provide the option to have a unique (or a series of unique) NID and PSKs for customers. Please contact PLAN-US¹ for more information regarding this process and the situations under which this is desirable.

¹ Please contact PLAN-US to obtain a copy of the program if the need arises to change either the NID or the PSK for your network: <mailto:info@plan-us.com?subject=PLAN%20Network%20customization%20information%20request>