PLS – NC1

USER GUIDE

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System Overview

A brief overview of the G3-PLC standard

PLS NC1 nodes are a part of a larger network that uses the existing power lines to set up an IPV6 based network. The network is like the wider internet – with ethernet packets, IPV6 addresses and TCP/IP protocols. There are two key differences. One is the physical communication medium – power lines instead of twisted pair ethernet cabling or Wi-Fi. The other is the network installation and security.

The PLS ecosystem is based on a standard named G3-PLC. It is an international standard designed from the ground up for robust power line-based communications under harsh conditions. There are multiple mechanisms defined in the standard to make it the go to solution for implementing communications on power lines and many years of research and standards work has gone into creating this global standard. Further information about G3-PLC can be obtained at http://www.g3-plc.com/what-is-g3-plc/g3-plc-unique-features/

In addition to the standard AES128 bit security that is part of the G3-PLC standard, PLS networks incorporate two added layers of security. The data packets, which are encoded with AES128 security are further encoded by a 256-bit elliptic curve cryptographic processor on each node and then further encoded with a patented cipher stream encryption. The result is a network node designed with robust security from the ground up. Unlike Wi-Fi, Zigbee or Cellular based IOT products where the communication medium is RF and is accessible to anyone in the vicinity with off the shelf equipment, PLS nodes communicate on power lines and are only accessible to authorized personnel with PLS equipment. The added fact that the entire system can be set up to be completely independent of the wider internet makes isolating command and control of the power line network easy while giving the end user all the benefits of networked infrastructure.

A typical system installation:

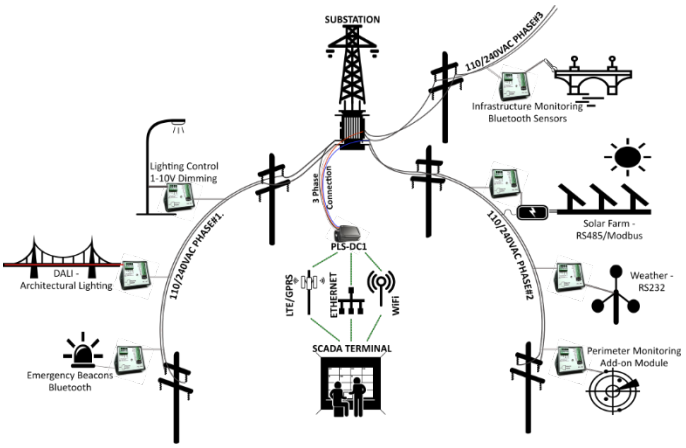

Figure 1: PLS network overview

Figure 1 shows a typical installation. The NC1 nodes are installed on the low voltage side of the transformer – typically between 110 and 240VAC. Each NC1 can communicate with the next NC1 on the same phase and to the data concentrator (PLS-DC) that is typically mounted at the low voltage side in a sub-station. The NC1 nodes form a mesh network and the DC – which is typically connected to up to three phases at the LV transformer end - gathers up all the packets to and from the NC1 nodes and forwards them to the operator terminal (SCADA) via a hardwired ethernet link available at most sub-stations. This is the preferred method of communications as it isolates the network completely from any external connections. The alternative to the hardwired ethernet network is Wi-Fi; another alternative is a cellular based connection to the operator terminal. Both these alternative methods, despite using HTTPS sockets and TLS security, do provide a bridge to the wider internet and one might want to avoid this route if the infrastructure being controlled is not something that should ever be exposed to the world wide internet.

Basic Installation

Figure 2 shows an overview of the PLS-NC1 node. The only connection needed to power up the NC1 is line-in and Neutral-in. Once powered up, a NC1 node automatically looks for and joins the network with the ID that it has been programmed with. The network ID can be changed using the factory supplied installation app running on a smartphone and is assigned just once at power up.

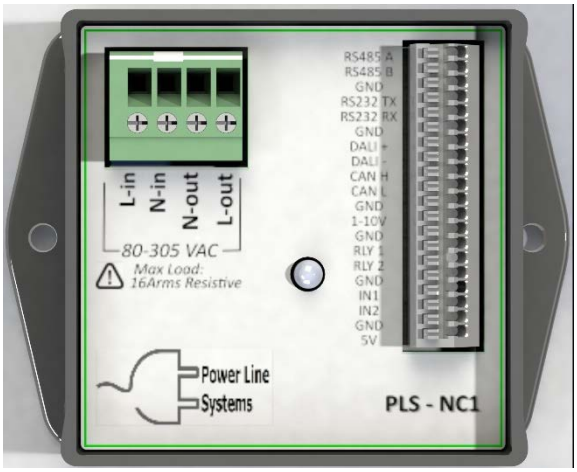

Figure 2: PLS-NC1 Connectivity

Marking	Description
L-in	Line in – needed. Connect to mains line between 0 to 305VAC
N-In	Neutral in – needed. Connect to mains
N-out	Connect to the downstream load Neutral – if controlling an external load
L-out	Connect to the downstream load Line – if controlling an external load
RS485A, RS485B, GND	RS485 bus
RS232 TX	RS232 Transmit out from NC1
RS232 RX	RS232 receive input to NC1
GND	Use for RS232 GND. Connected internally to isolated system ground
DALI+, DALI-	DALI Bus
CAN H, CANL	CAN bus high and low lines
GND	Use for the CAN bus connection. Connected internally to isolated system ground.
1-10V	Analog out for 1-10V dimming
GND	Use for the 1-10V dimming line. Connected internally to isolated system ground.
RLY1, RLY2	External relay control. Open drain capable of sinking up to 150mA at 12VDC
GND	Use for the RLYx channels. Connected internally to isolated system ground
IN1, IN2	External TTL inputs. Not isolated. Transient protected
GND	Use for the external TTL channels. Connected internally to isolated system ground
5V	For powering external sensors. Max 50mA. Use the TTL ground for return

Load Control

PLS-NC1 node can control and measure the power of an external load (such as street lights or area lighting) up to 16Arms at 240VAC. Load control is performed by a dual coil latching relay and will keep the last state in case of a power loss. The power consumed by the external load as well as the line voltage and line current are measured internally and reported at a period rate. The reporting rate is set by the user from the SCADA. Please refer to the programmer's guide for details on power metering and reporting interval.

One external in-line fuse connected to line-in is recommended as shown:

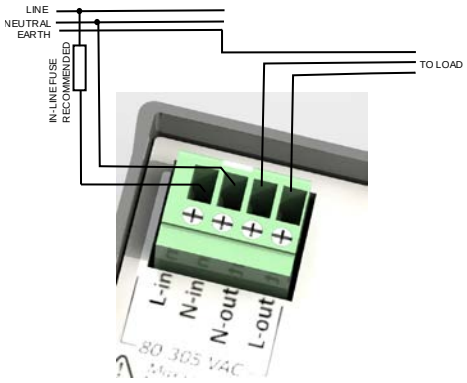

Figure 3: Wiring for external AC Loads

CAUTION – Do not exceed the 16Arms rating for the external load. Doing so will damage the power relay

The NC1 has the capability to meter external loads controlled through the load control relay. Built into the NC1 is a revenue grade metering circuit that can measure active power, true RMS current, RMS voltage, line frequency and power factor. The rate at which these are measured and the type of measurements can be configured from the software interface described in the programmers guide.

External Relays

There are two open drain outputs available on an NC1. These can be used to control external relays or contactors that can in turn control high power loads. Each open drain output is capable of sinking 150mA at voltages up to 28VDC and is enough to power most mechanical relays or contactors as shown (Figure 4)

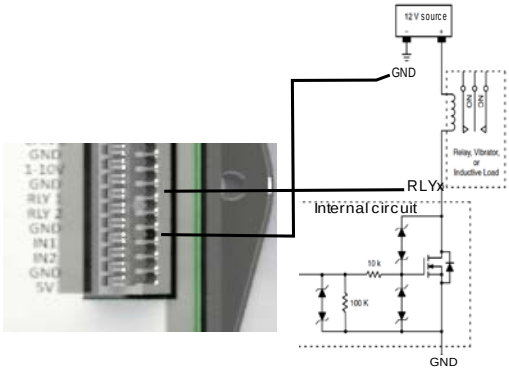

Figure 4: Wiring external relays

CAUTION – The maximum voltage tolerated by the internal circuit of the NC1 for the external relay supply is 28Vdc. The largest continuous current that can be sunk safely is 150mA.

1-10V Dimming

This is an analog signal typically used for the dimming control of LED drivers. It was originally developed for use with fluorescent fixtures and is still commonly used today with LED drivers. Typical dimming range is from 10% to 100%. It is recommended that the LED driver be wired through the L-out and N-out terminal for complete load control (Figure 5) as the dimming signal is not enough by itself to turn off the LED fixture.

It is important to note that some LED drivers can accept dimming signals below 1V to produce a 5.7% dimming level instead of the 10% at 1V. However, using a voltage below 1V with LED drivers that are meant to be controlled with a 1-10V analog input leads to unspecified behavior. NC1 can produce either a 1-10V signal (standard) or a 0-10V signal (programmed to do so from the operator terminal).

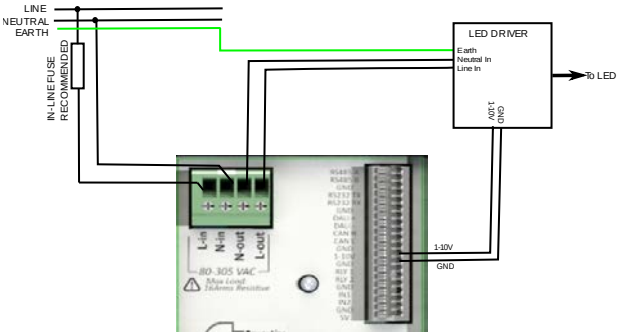

Figure 5: LED drive with 1-10V dimming

CAUTION – Two key checks to be performed: (a) ensure that the power drawn by the LED driver does not exceed 16Arms at 240VAC or 3.8KVA. (b) ensure that the dimming level expected by the LED driver matches the output from the 1-10V port of the NC1

DALI

NC1 can connect to and send commands over an existing DALI network. The DALI network that the NC1 connects to needs to be powered independently. Additionally, the nodes in the network should have been commissioned prior to connecting to the NC1. All the parameters of the network and the command types are fully configurable from the software interface and are described in the programmers guide.

Digital Inputs

NC1 has two TTL level (5V) inputs that automatically trigger a message transmission from the node when their level changes. Typical use would be a connection to a presence sensor or a water level sensor. The inputs will trigger a message with any change from 0V (normal state) to 5V and back to 0V (removal of the external input). The inputs are not opto isolated and care should be taken to ensure that high voltages are not inadvertently applied to the inputs. The inputs do have transient voltage protection.

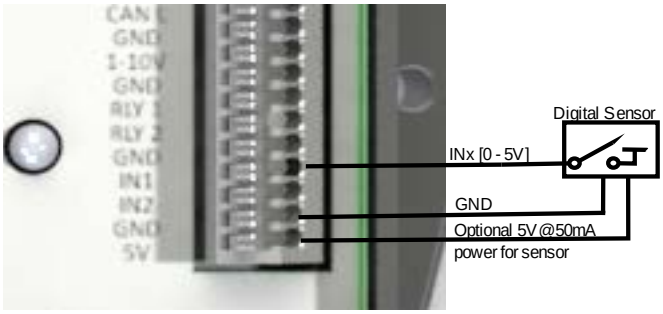

Figure 6: Wiring for digital inputs

CAUTION – The inputs can tolerate up to 5V logic. Applying any voltage higher than 5V will damage the NC1 inputs.

Communication Channels

NC1 supports three parallel communications channels all of which can be configured from the front-end software interface and act as transparent pass through channels. Any message sent from the software interface will be transferred without any changes to the end device for any of the three channels. Each of the channels are independent of each other and are capable of asynchronous communications along with a host of configurable parameters, all of which are described in the programmer's guide.

RS232

The RS232 channel is compliant to EIA RS232 levels and is protected against transients and line surges. The maximum baud rate possible is 115200 KBPS. All other parameters of the channel are configurable from the software interface and are described in the programmer's guide.

RS232 TX : transmit out from the NC1. Connect to receive input of the external device

RS232 RX: receive input to the NC1. Connect to the transmit output of the external device

GND : NC1 ground. Connect to the ground of the external device.

RS485A

The half-duplex RS485 channel is capable of communications up to 15Mbps. The channel is 5V tolerant and can withstand -7 up to 12V common mode voltage range. It is also protected to ±15KV of electrostatic discharge.

RS485A : Positive Data channel A

RS485N: Negative Data channel B

GND: common ground to external RS485 device

CAN

The CAN channel is CAN2.0 compliant and is capable of baud rates up to 1Mbps. All of the parameters are configurable from the software interface and are described in the programmer's guide.