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Power Line Systems—Key Features

**SIMPLE**

- Simple two wire connection (line & neutral) between the power lines and nodes
- Auto connecting, auto healing mesh network
- Transparent data pipeline between the operator interface (SCADA) and end devices
- Multiple communication protocols—RS232, RS485, CAN, DALI—all available in parallel

**SECURE**

- No need for the internet, cloud service or any third party servers
- Completely restricted remote access by default— the system is not connected to the wider internet
- Multiple layers of encryption—patented cypher stream encryption on top of a 256-bit ECC

**RELIABLE**

- Installed user base of over 50 million G3-PLC nodes across the world
- Extensive field testing conducted by G3-PLC alliance and multiple G3-PLC chip vendors
- Standards based with multi-vendor interoperability
Power Line Systems—Technology

Designed from the ground up for long range, secure, reliable communications based on IEEE G3-PLC protocol

**FEATURES**

- Power Line Systems networks, based on G3-PLC (ITU-T G.9903) architecture, consist of multiple network nodes (NC1/NC2/NM7) and a single network data concentrator - DC

- The network nodes can exist on *any of the three phases* of the low voltage (80 – 300VAC) side of the power grid

- The network *automatically installs and is self-healing*; there is no field installation necessary other than mounting and wiring of the NC1 node to the power lines

- Each NC1 can be as far as 3 miles out from the nearest NC1 and still maintain network connectivity

- The data concentrator, DC, connects to all three phases of the power grid on the low voltage side, at a suitable location; this is typically either the substation for the neighborhood or a pole mount medium to low voltage transformer

- The data communications can *jump medium voltage to low voltage transformers* allowing communications to take place between nodes that are not all on the same side of the low voltage transformer

- Each DC can support up to 255 network nodes

- Each DC has the capability to communicate with the central SCADA terminal via secure ethernet, WiFi, or LTE/CDMA/GSM cellular network with secure ethernet being the preferred option to prevent any network intrusion

**About G3-PLC:**

- G3-PLC was developed to facilitate long range communications over harsh power line conditions

- G3-PLC alliance was created in 2011 to support the adoption of this technology worldwide

- The standard has now been ratified by ITU (G.9903) and IEEE (1901.2)

- This technology is being used widely for smart metering and utility side communications

- G3-PLC is a OFDM based physical layer and is compliant with worldwide regulatory bodies such as CENELEC, ARIB and FCC

- The standard supports IPv6 which enables the implementation of Internet-of-things protocols over power lines
Power Line Systems—Architecture

Monitoring and control of critical infrastructure over a wide area

No new wires. No wireless infrastructure. No need for the internet or cloud connectivity.
Power Line Systems—Applications

**Lighting**

Street lighting control
- Scheduled dimming
- Energy monitoring
- Lamp burn out notifications
- Geo location tagged data

Architectural lighting control
- DALI control via power line
- Transparent data pipeline enables large area lighting control using the DALI bus

Environmental monitoring
- Weather, Air quality, water level detection...
- Interface to off-the-shelf sensors via RS232, RS485 or CAN bus
- Patent pending transparent pipeline to interact directly with sensors

Safety and Security
- Pedestrian and traffic monitoring with mm Wave sensor (add on accessory)
- RGB light beacons for remote signaling (add on accessory)
- Perimeter monitoring with mm Wave sensor with automatic local control loop for activating floodlights or gates

Structural monitoring
- Monitoring of bridges, roadways, water and gas pipelines using the nearest NC nodes mounted on light poles
- Off-the-shelf sensor via RS232, RS485 or CAN channels
- Data is transmitted automatically over the power lines to the nearest DC

Traffic and parking management
- Traffic and pedestrian counting using mm Wave sensors
- RGB dual sided light beacons for remote traffic flow management in emergencies
- Air quality and traffic density monitoring using a combination of mm Wave and Off-the-shelf air quality sensors
**PLS-NC1**

*Power Line Network Node—Multiple Communications Channels & Load Control over Power Lines*

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**Key Features**

- Load/Lighting control, 1-10V dimming and energy monitoring up to 4KVA.
- DALI bus
- Multiple communications channels – RS232, RS485, CAN, Bluetooth LE.
- Two external relay/contactor controls for larger loads
- Two general purpose inputs for logic level sensors
- Works over long distances over power lines and in areas where installing regular wired or wireless networks would be cost prohibitive or insecure.
- Industry leading 256-bit Elliptic Curve Cryptographic security, along with the isolation from the internet, provides a very secure, private control and communications network.
### Network
- G3-PLC (ITU-T G.9903) standards based and certified.
- OFDM based IPV6 Auto Connect / Auto Healing Mesh network
- 98.4 - 121.9KHz CENELEC B Band
- 40Kbps minimum data rate
- Up to 3-mile range between nodes
- 255 nodes per sub-net with one DC (data concentrator)
- PLS-DC can connect directly to the SCADA system via local Ethernet
- Alternative Cellular or WIFI connection supported by PLS-DC

### Security
- 256-bit Elliptic Curve Cryptographic security between nodes and data concentrator
- Secure TLS/SSL based connection between data concentrator and operator terminal (SCADA)
- Biometric and two factor authentications at the operator terminal

### Power
- 80 – 305VAC, 50-60Hz, Single phase via screw terminal block
- ANSI C136.37 surge requirements compliant
- Fully protected against transients and brownouts with EN55022 Class B isolation
- Screw terminal block for Line in and Load out connections

### Load Control & Metering
- IEC 600335-1 compliant latching relay
- Nominal switching capacity: 16A, 277VAC, inrush capable
- Max switching power (resistive load): 4.432KVA
- Single phase line & neutral screw terminal block
- 0.1% accurate energy metering
- Active power, true RMS current, RMS voltage, Line frequency and power factor metering
- 2x relay/contactor drivers. 12V, 150mA Open Drain for external load control
- 2x TTL inputs for logic level sensors like PIR motion or dry contact closure

### Lighting Control
- 1-10V analog dimming output
- DALI control for clusters of lighting loads – all device types supported
- Built-in energy metering of connected loads

### Communication Channels
- **RS232**: variable up to 115Kbps. EIA-RS232 levels, transient and surge protected
- **RS485**: 15Mbps, 5V tolerant, Half duplex, -7 to 12V common mode range, ±15KV ESD protection
- **CAN**: 2.0B compliant, 1Mbps, 3 Tx and 2Rx buffers, six available filters and 2 masks, ±8KV ESD protection. Suitable for 12 and 24V systems
- **Bluetooth Low Energy 4.2**: – 100m effective range, 8x simultaneous connections, Beacon/Broadcast modes
- Tool less cage clamp connector for all signals

### Mechanical
- Potted enclosure 3.05 x 3.05 x 1.56 in [77.5 x 77.5 x 39.6 mm]
- IP66 protection level when mounted with connectors pointing down
- -40°C to +75°C Operating temperature

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**Applications—NC1**

*Load control, Power monitoring, Dimming, DALI, RS232, RS485, CAN, Relay control over Power lines*
PLS-NC2
Power Line Network Node—Load Control and monitoring over Power Lines

Key Features

- Load /Lighting control, 1-10V dimming and energy monitoring up to 4KVA.

- Works over long distances over power lines and in areas where installing regular wired or wireless networks would be cost prohibitive or insecure.

- Industry leading 256-bit Elliptic Curve Cryptographic security, along with the isolation from the internet, provides a very secure, private control and communications network.
### Network
- G3-PLC (ITU-T G.9903) standards based and certified.
- OFDM based IPv6 Auto Connect / Auto Healing Mesh network
- 98.4 - 121.9KHz CENELEC Band
- 40Kbps minimum data rate
- Up to 3-mile range between nodes
- 255 nodes per sub-net with one DC (data concentrator)
- PLS-DC can connect directly to the SCADA system via local Ethernet
- Alternative Cellular or WIFI connection supported by PLS-DC

### Security
- 256-bit Elliptic Curve Cryptographic security between nodes and data concentrator
- Secure TLS/SSL based connection between data concentrator and operator terminal (SCADA)
- Biometric and two factor authentications at the operator terminal

### Power
- 80 – 305VAC, 50-60Hz, Single phase
- ANSI C136.37 surge requirements compliant
- Fully protected against transients and brownouts with EN55022 Class B isolation
- 12AWG wires for Line in and Load out connections

### Load Control & Metering
- IEC 600335-1 compliant latching relay
- Nominal switching capacity: 16A, 277VAC, inrush capable
- Max switching power (resistive load): 4.432KVA
- 0.1% accurate energy metering
- Active power, true RMS current, RMS voltage, Line frequency and power factor metering

### Lighting Control
- 0/1-10V analog dimming output OR optional DALI (installed as a factory option)
- Built-in energy metering of connected loads

### Mechanical
- Fully potted mechanical enclosure. 3.05 x 2.05 x 1.08 in [78 x 52 x 27.5 mm]
- IP66 protection level
- -40°C to +75°C Operating temperature
**PLS-NM7**

*Power Line Network Node for simple drop in installation into ANSI C136.41 receptacles on street lights*

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### Key Features

- Installs on the existing ANSI C136.41 twist lock receptacles present on most street lights that are commonly used for photoelectric control.

- Lighting control, 1-10V dimming and energy monitoring up to 4KVA without the use of any new wired or wireless infrastructure.

- Works over long distances over power lines and in areas where installing regular wired or wireless networks would be cost prohibitive or insecure.

- Industry leading 256-bit Elliptic Curve Cryptographic security, along with the isolation from the internet, provides a very secure, private control and communications network.
Applications—NM7

Load control, Power monitoring, Dimming over Power lines

Network
- G3-PLC (ITU-T G.9903) standards based and certified.
- OFDM based IPV6 Auto Connect / Auto Healing Mesh network
- 98.4 - 121.9KHz CENELEC Band
- 40Kbps minimum data rate
- Up to 3-mile range between nodes,
- 255 nodes per sub-net with one DC1 (data concentrator)
- PLS-DC can connect directly to the SCADA system via local Ethernet
- Alternative Cellular or WIFI connection supported by PLS-DC

Security
- 256-bit Elliptic Curve Cryptographic security between nodes and data concentrator
- Secure TLS/SSL based connection between data concentrator and operator terminal (SCADA)
- Biometric and two factor authentications at the operator terminal

Power
- 80 – 305VAC, 50-60Hz, Single phase
- ANSI C136.37 surge requirements compliant
- Fully protected against transients and brownouts with EN55022 Class B isolation

Load Control & Metering
- IEC 600335-1 compliant latching relay
- Nominal switching capacity: 16A, 277VAC, inrush capable
- Max switching power (resistive load): 4.432KVA
- 0.1% accurate energy metering
-Active power, true RMS current, RMS voltage, Line frequency and power factor metering

Lighting Control
- 0/1-10V analog dimming output
- Built-in energy metering of connected loads

Mechanical
- ANSI C136.41 receptacle mount
- Fully sealed 95mm tall x 80mm diameter enclosure
- NEMA4x, IP65 Molded Fiberglass polyester enclosure
- -40°C to +75°C Operating temperature
PLS-DC

Power Line Network Gateway

Key Features

- Used to connect and control all neighborhood NC1/NC2/NM7 nodes distributed on any of the three phases of the local power grid

- Open source API – allowing end users to write their own front-end SCADA or to modify the standard SCADA provided at no cost

- Internet independent – allowing users to connect directly to a terminal using local Ethernet and control all the network nodes, independent of the internet

- Flexible communication channels: Ethernet, WIFI, and Cellular

- A highly secure, transparent, patent-pending, multi-protocol communications pipeline to remote devices using existing power lines

- Secure industry leading communications on all channels of communications
### Applications—DC

**Bi-directional data transmission to edge nodes over power lines**

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<tr>
<th>Network</th>
<th>Security</th>
<th>Cellular</th>
<th>WiFi</th>
<th>Ethernet</th>
<th>Software</th>
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<tbody>
<tr>
<td>• G3-PLC (ITU-T G.9903) standards based and certified.</td>
<td>• 256-bit Elliptic Curve Cryptographic security between nodes and data concentrator</td>
<td>• LTE/4G – QPSK, 16QAM with Verizon carrier certification for use in the USA</td>
<td>• 802.11 b/g/n support</td>
<td>• IP68 panel mount connector</td>
<td>• Open API for building front-end SCADA.</td>
</tr>
<tr>
<td>• OFDM based IPV6 Auto Connect / Auto Healing Mesh network</td>
<td>• Secure TLS/SSL based connection between data concentrator and operator terminal (SCADA)</td>
<td>• Global 3G HSPA/GSM quad band with 2G fall back and multiple carrier certifications for international use</td>
<td>• WPA-PSK, WPA2-PSK, and WEP security</td>
<td>• 10/100LAN with built-in surge suppression</td>
<td>• Standard SCADA is provided at no cost and is under GPL license—allowing modification as needed</td>
</tr>
<tr>
<td>• 98.4 - 121.9KHz CENELEC Band</td>
<td>• Biometric and two factor authentications at the operator terminal</td>
<td>• 24dBm class 3 transmit power with two internal antennae</td>
<td>• Built-in internal antenna with up to 16dBm transmit power</td>
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<td>• Windows based admin software for commissioning and control of nodes with biometric authentication</td>
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<td>• 40Kbps minimum data rate</td>
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<td>• 44FF (nano sized) SIM card slot</td>
<td></td>
<td></td>
<td>• Automatic logging of network and node statistics</td>
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<td>• Up to 3-mile range between nodes</td>
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<td></td>
<td>• Automatic powerline network intrusion detection using a patented cipher stream encryption technique</td>
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<tr>
<td>• 255 nodes per sub-net with one DC</td>
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<tr>
<td>• 80 – 305VAC, 50-60Hz, Single phase via screw terminal block</td>
<td>• ANSI C136.37 surge requirements compliant</td>
<td>• Fully protected against transients and brownouts with EN55022 Class B isolation</td>
<td>• 8.65 x 4.68 x 2.4 in [169 x 119 x 61 mm]</td>
<td>• Quick connect field installable wiring for 3 phase + neutral power connection</td>
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<tr>
<td>• 6.65 x 4.68 x 2.4 in [169 x 119 x 61 mm]</td>
<td>• IP66 protection level</td>
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<td></td>
<td>• -40°C to 65°C operating temperature</td>
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