For more details, contact Conductix-Wampfler,
1-800-521-4888, press 1 for Customer Service, or
customerservice@conductix.com

Nexus BB
PLC Applications Guide for Ethernet/IP

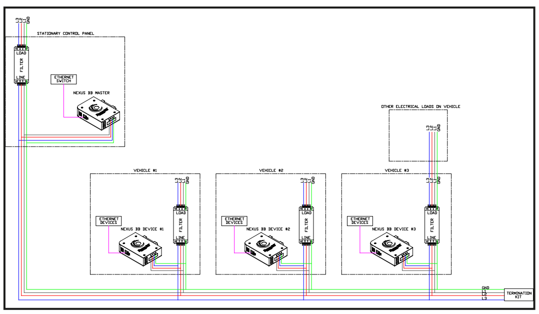
Advances in automation are providing the opportunity for industry leaders to see increased efficiencies in ways we may not have thought possible just a short time ago. As OEMs, installers, and engineers we face new challenges. Not only must we provide a safe and reliable mechanical system, but an electrical system which is able to support the increasing data and energy demands in our customer's dynamic environment. In the past, we have relied heavily on radio technologies such as Wi-Fi to solve these issues in complex moving systems. This solution can run into performance problems in applications where the environment, channel usage, and complex system architecture limits its reliability and ease of use. In these cases, power line communication offers a unique solution to simplify data transfer.

What is Power Line Communication?

Power line communication provides an opportunity to utilize existing power distribution systems to send data. Power line communication is often divided into two categories. The first is Narrowband, which describes communication using low frequency ranges (3-500 kHz). Usage cases are typically low data rate applications, requiring less than 100 kbps. Due to the low frequency, you are able to realize very long and robust systems. Broadband on the other hand, uses higher frequency ranges (2-250 Mhz) to attain data rates many factors higher (100s of Mbps), at the cost of reduced system lengths. We will be focusing on broadband as a method of providing a solution for our customers increasing data demands while avoiding some of the pit falls of existing solutions.

Broadband Systems: Componentry and System Layout

Believe it or not, power lines were not designed to carry data and in fact, act as low-pass filters. The environment is noisy and challenging with various impedance values based on the transfer medium. Maintaining signal integrity requires careful use of signaling technique and proper hardware selection. The Nexus BB system is designed with these challenges in mind.



The Modem

The system starts at the access point, which is typically installed in a stationary enclosure. This modem is the device which interfaces with the building network and hosts the local power line network, creating the effect of a virtual Ethernet wire along the existing power line. The modem utilizes a standard RJ45 Ethernet jack as the point of interface between the building network and the power line. The modem has a dual function supply power input and communication link provided through a simple connector, that requires only 2-4 wire connections.. Depending on the existing wiring and number of phases used, the modem can operate in either Single Input Single Output (SISO) in single phase or Multiple Input Multiple Output (MIMO) on multi-phase systems. Either method will allow for 100 Mb/s bandwidth, but MIMO does provide a layer of redundancy for increased reliability by providing another channel. The access point transmits (Tx) the broadband frequency onto the power line where it can be received (Rx) by a client device. Both the access point and client transmit and receive data continuously. The modem has a transmission power level of 15 dbm, and dynamic range of 90 db. Dbm is the unit used to indicate the power ratio per milliwatt, and is a measure of how much energy the device is able to transmit into the power line. It can also be thought of as how loud the device is and how far away another modem can be and still hear it. The total range of a system is a function of the dynamic range and attenuation (loss) in the system. Attenuation is created by the components that make up the power distribution system. There is a loss per meter of conductor, number of devices, and filters. All decrease the available energy reducing the possible system length. This value can be calculated to ensure the system will behave reliably over the course of the applications lifecycle. The second part of the modem system is the client device. The client device is mounted on the mobile unit and interfaces with an onboard programmable controller, video camera, or other Ethernet based communication devices. The client and access point are in fact the same device. In a standard application, there are no dipswitches or addressing requirements in determining which is which, as the modems make this determination on their own as the devices power up. For customized solutions requiring particular configuration parameters, consult the factory. With a client and access point in place your virtual wire system is almost complete.

Maintaining Clean Communication Filters

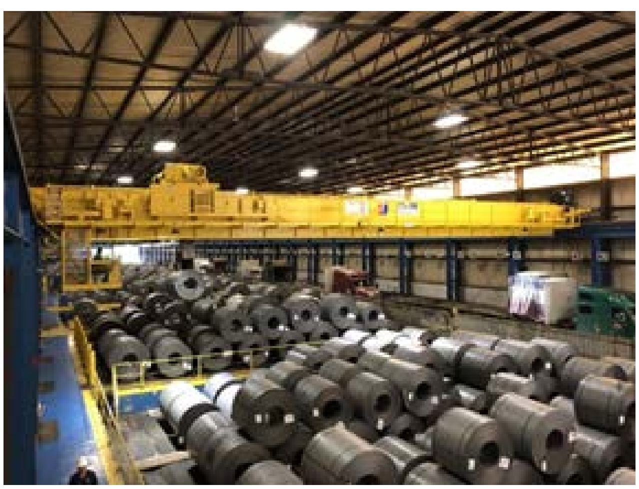
Noise (undesired electrical signals) from devices like VFDs, motor starters, or other communication equipment can damage the integrity of your power line communication link. While noise in any electrical system is unavoidable, installing filters to isolate the link ensures external factors do not degrade the integrity of the system. A filter should be installed at each power feed, as well as at each client modem.

Termination

Terminating a communication link reduces the amplitude of signal reflection that cause distortion and loss of communication integrity. A typical communication cable is designed to a standard of 50 ohms. However, power conductors have a wide range of characteristic impedances which need to be matched. A termination must be present at the end of only conductor bar system. If the application is data over a power cable, and a modem is on either end, termination is not required.

Applications of Broadband and Allen Bradly Programmable Controllers

With an understanding of the required components, let's discuss how Nexus BB could be implemented to solve a customer application. In this example, a customer who manufactures steel coils would like to add intelligence to their crane used to sort and store coils in their warehouse. They want to add the ability to automatically sort coils by part number and customer order to support their new expedited members shipping program. Providing a data link along the entire runway will be critical. The Allen Bradly PLC on the crane must have network connection to the building to receive order coordinates for storage location. A link to the both X and Y axis positioning sensors will also be required to identify the position of the crane relative to where the order is to be stored. A camera on the trolley provides the operator feedback for monitoring locally or remotely. Due to the environment, industrial Wi-Fi would require several repeaters to be reliable, and time to identify problem locations. With Nexus BB, providing data along this dynamic system becomes the simplest part of the project.



What Does Installation Look Like To The Installer?

An access point modem is installed at the power feed of the system with a filter to ensure a clean transmission line. Connect the modem to a Ethernet drop and the phases to the existing power bar feed in through a distribution block. The PLC which manages the bridge and trolley operation is installed in the bridge enclosure. A client modem will be installed next to the PLC, again wired into the three phases of power and connected to the PLC through the RJ45 connection. In this case a Ethernet switch is required to add additional ports for the positioning sensor, Nexus modem, and PLC. Another filter will be used here to isolate the power from the bridge VFD. The existing crane used a festoon to transmit the power and trolley control, but there is no cabling for an Ethernet connection which is required for the camera and positioning sensor. Not a problem. Another Nexus BB unit can be installed at the trolley using the trolley power line as the new data link. The modem and another Ethernet switch can be added the existing enclosure and mounted to din rail. A switch will be required to connect the positioning sensor and TCP/IP camera used to monitor the system. Both the EtherNET and TCP protocols can be passed through Nexus BB simultaneously. One last filter should be installed to keep the data link clean. The last item to install is the terminating resistor, which should be placed at the end of the bridge runway to ensure signals do not reflect. This is another simple installation item, with one wire per phase used. The connection is made through the provided power feed lugs to the terminating resistor. With that you are done. No need to mess with configurations, cable runs, or IP addresses.

What Does Interface With Nexus BB Look Like For The Automation Integrator?

The Allen Bradly PLC treats the Nexus BB unit as a direct Ethernet connection. No EDS file is required, and it is not a device which needs accounted for in your PLC's system architecture. That being said, there are still some things you will want to know about the operation of the modems to ensure project success. Nexus BB supports nearly all industrial Ethernet protocols, including EtherNET/IP, TCP/IP, ProfiNET, ProfiSAFE, Modbus TCP and EtherCAT. The modem will indicate via the LEDs on the front of the device the status of connection. In the event of lost communication, the modems will continually search until communication is reestablished. The maximum bandwidth of the device is 100 Mbps, un-prioritized. A typical PLC application using a CompactLogix 5000 series will require significantly less bandwidth for example, as individual I/O points require at most 32 bits a piece. While the limitations of devices on a link vary based on communication module used and message count, a 100 Mbps link could support the full 128 Logix communication connections, or 64 TCP/IP communication connections. Cameras have higher bandwidth requirements, and there are several factors which impact bandwidth usage. Assuming 1080p resolution, H.264 High compression, and 30 fps, you would require 6 Mb/s. This would mean 4 cameras of this type could be easily supported. A managed switch can be used to provide message priority if required or ports if additional devices need to be added to the link, as only one Ethernet connection is provided on the modem. The Nexus modem can also support multiple communication protocols over the same link. The minimum supported request packet interval (RPI) is 64ms. This interval should be accounted for to allow time for the modems to encode and decode signals. This does not mean that the signal will take 64ms to be received, but that the PLC will wait for 64ms after sending all signals to expect a response. This setting should be adjusted for communication between devices and for sending and receiving tags. You will also want to adjust the out of range RPI to allow for appropriate error flagging. If using the Produced/Consumed model, you may need to adjust these values per tag. This latency requirement is the same as standard recommended settings for industrial Wi-Fi products such a ProSoft radio. To put this into perspective, a response time of under 100ms is perceived as instantaneous. The average human reaction time is 250ms, while VoIP (Voice over IP) requires 150ms, and many IP surveillance cameras requiring between 200-300ms due to signal processing.

Summary

Power line communication offers another tool for solving complex customer problems. Nexus BB can be used on new and existing systems to add a secure data communication layer, and does not require any networking expertise or special equipment. Nexus BB can eliminate WiFi for mobile equipment communication, with the same minimal maintenance as a WiFi solution. The innovative design adapts to noisy environments for dependable performance. Nexus BB is a plug and play solution that allows for easy modernization to existing installations with minimal downtime. Nexus BB is a data over power solution that provides a contained signal for security through signal isolation.

About Conductix Wampfler

Conductix Wampfler is a leading global provider of energy and data transmission systems. We strive to provide solutions that keep our customers' vital business moving forward.

Contact us:
Phone: (402)339-9300
Email: info.us@conductix.com