NxBB
Powerline Data Transmission
Manual

CONDUCTIX wampfler

CONDUCTIX INCORPORATED

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SECTION 1 - SAFETY

1.0 Safety Information Responsibility

1.0.1 All owner, operator, and maintenance personnel must read and understand all manuals associated with this product before installation, operation, or maintenance.

1.0.2 The manual provides information on the recommended installation, operation, and maintenance of this product. Failure to read and follow the information provided could cause harm to yourself or others and/or cause product damage. No one should install, operate, or attempt maintenance of this product prior to familiarizing themselves with the information in this manual.

1.1 Safety Messages

The following safety messages are used in this manual to alert you to specific and important safety related information.

CAUTION

- **CAUTION** indicates unsafe actions or situations that have the potential to cause injury, and/or minor equipment or property damage.

DANGER

- **DANGER** indicates hazards that have the potential to cause severe personal injury or death.

WARNING

- **WARNING** indicates unsafe actions or situations that have the potential to cause severe injury, death, and/or major equipment or property damage.

NOTE: **NOTE** is used to alert you to installation, operation, programming, or maintenance information that is important, but not hazard related.

1.2 Limitation of Liability

1.2.1 All data and information in this mounting instructions have been compiled in compliance with the applicable standards and regulations, best practice and our many years of experience and knowledge.

1.2.2 The manufacturer accepts no liability for damages resulting from:

- Failure to comply with this document
- Improper use
- Use by untrained personnel
- Unauthorized modifications
- Technical changes
- Use of unauthorized replacement parts and accessories
- The actual scope of delivery may differ from the explanations and descriptions provided here if the model in question is a special one, if additional equipment has been ordered or due to recent technical changes.

1.2.3 The obligations agreed upon in the delivery agreement and our General Terms and Conditions of business apply, as do the delivery conditions of the manufacturer and the legal regulations applicable at the time the contract was concluded.

1.2.4 All products are subject to technical modifications in the context of improvement of function and further development.

1.3. Personnel Requirements-Qualifications

WARNING

Inadequately trained persons are at risk of injury!
Improper use can result in serious personal injury or material damage. All activities must only be performed by qualified personnel.

1.3.1 Only persons who can be expected to perform their work reliably are acceptable personnel. People whose reactions are impaired by drugs, alcohol or medications, for example, are not authorized.

1.3.2 When selecting personnel, follow all age- and occupation-specific guidelines applicable at the location of use.

1.3.3 The following qualifications are specified in the operating instructions for certain fields of activity.

1.3.4 Trained personnel and operators

- Will have participated in a training session, given by the owner, on the tasks assigned to them and the potential hazards in case of improper conduct.
- The owner of the machine or system must document that the appropriate training has taken place.

1.3.5 Specialist personnel

- Will consist of persons capable of performing assigned tasks and independently identifying and avoiding potential hazards based on their specialist training, knowledge and experience as well as their knowledge of the applicable regulations. Persons are deemed to be technically qualified if they have successfully completed training as a master electrician, apprentice electrician, electrical engineer or electrical technician. Persons are also considered technically qualified if they have been employed in an appropriate capacity for several years, receiving theoretical and practical training in that line, and their knowledge and skills have been tested by a specialist in the appropriate field of training.
- The machine or system owner must document that the appropriate certificates or other proofs of qualification have been or are being provided.

1.4 Personnel Requirements-Unauthorized Personnel

WARNING

Danger due to unauthorized personnel!
Unauthorized persons who do not meet the requirements described here are not acquainted with the dangers in the working area. Keep unauthorized personnel away from the working area. In case of doubt, address the person and direct them away from the working area. Stop working, as long as unauthorized persons are in the working area.

1.5 Personnel Requirements-Training

1.5.1 Before commissioning the equipment, personnel must be trained by the owner. Log the implementation of training for better traceability.

Example of a training log:

Date	Name	Training Type	Training Instructor	Signature
11/5/2019	John Doe	First safety training for personnel	Dave Miller	

1.6 Personal Protective Equipment

1.6.1 For every task, always use:

Safety helmet: For protection against falling or flying parts and materials.

Protective gloves: For the protection of hands against friction, scrapes, puncture or deeper wounds, as well as against contact with hot surfaces.

Protective work clothing: Primarily for protection against entrapment by moving machine parts. Work clothing must be close fitting with a low resistance to tearing; it must have close-fitting sleeves and no protruding parts.

Protective footwear: For protection against heavy failing parts and slipping on slippery floors.

For special tasks, specific protective equipment is required when executing particular tasks:

Safety eye wear: For eye protection against harmful influences such as strong light, chemicals, dust, splinters or weather effects.

Hearing protection: For protection against loud noises and to prevent acoustic trauma.

Breathing mask (FFP-3 - according to country-specific requirements): For protection against materials, particles, and organisms. In this case, for protection against the dust produced by the abrasion of carbon brushes and the PVC insulation of the conductor rail.

SECTION 2 - PRODUCT DISPOSAL

2.0 Product Disposal and Recycling

2.0.1 Once the product has reached it's end of life it must be disassembled and disposed of in accordance with local and regional environmental requirements.

2.0.2 In the absence of a return and disposal agreement, disassembled components must be recycled as follows:

- All metallic parts must be sorted and recycled by material type
- All plastic components must be sorted and recycled by material type
- All other components are to be disposed of in accordance with their material composition. Take care with items identified as Substances of Concern.

2.0.3 Local authorities or special disposal companies can provide information about environmentally appropriate disposal.

CAUTION

Environmental damage due to improper disposal!

Electrical waste, electronic components, lubricants, and other auxiliary materials are subject to hazardous-waste disposal regulations and may only be disposed of by authorized specialists!

Local authorities or specialist disposal companies can provide information about environmentally appropriate disposal.

SECTION 3 - INTRODUCTION

3.0 Purpose of this Manual

3.0.1 This manual provides the information required to plan, install, operate, and maintain the NxBB System.

3.0.2 It defines system boundaries, installation constraints, and operating conditions.

3.0.3 The document is intended for use throughout the product lifecycle.

3.1 Intended Audience

3.1.0 This manual is intended for personnel who perform one or more of the following tasks:

- System integration and commissioning
- Electrical installation
- Operation of equipment using NxBB
- Maintenance and troubleshooting

3.1.1 All tasks described in this manual must be performed by qualified personnel.

3.2 Product Overview

3.2.1 NxBB is a data transmission system that transfers Ethernet communication over physical conductors using power line communication technology.

3.2.2 The system enables reliable data exchange between stationary and mobile equipment without additional data cabling. NxBB is used in industrial applications where power and data are required on moving equipment.

3.3 System Scope

3.3.0 The NxBB system consists of:

- Power line communication modems
- EMC/RFI power line filters
- Optional supporting components such as signal injectors, terminations, and EMI suppression ferrites.

3.3.1 The system provides transparent Ethernet communication between connected devices. All network protocols and data handling are performed by the connected Ethernet equipment.

3.4 Typical Applications

3.4.0 NxBB is used in applications where mobile equipment requires continuous Ethernet communication including:

3.4.1 The system may be implemented on conductor rails, cable-based systems, slip rings, or similar electrified conductors.

SECTION 3 - INTRODUCTION

3.5 Operating Principle

3.5.0 NxBB uses power line communication to transfer Ethernet data over physical conductors.

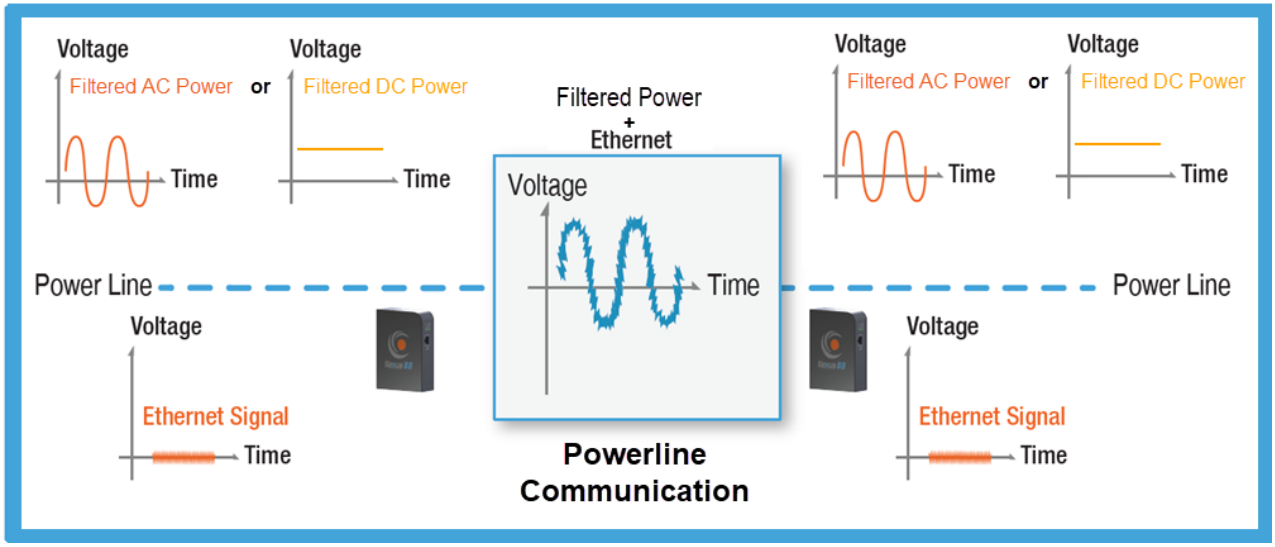


Figure: 3.1 - NxBB Communication Concept

3.5.1 The transmitting modem accepts standard Ethernet frames and converts them into high-frequency communication signals suitable for transmission on the conductor. These signals are coupled onto the conductor without affecting power delivery.

3.5.2 At the receiving end, a corresponding modem extracts the communication signal and reconstructs the original Ethernet frames for use by connected devices.

3.5.3 Power transmission and data communication may occur simultaneously on the same conductors when installed according to this manual.

SECTION 4 - USAGE

4.0 Usage

4.0.1 This section establishes the mandatory safety requirements and usage limitations applicable to all NxBB installation, operation, and maintenance activities.

4.1 Electrical Safety

4.1.1 NxBB components are connected to energized conductors. Improper handling may result in electric shock or equipment damage. Always follow the facility's established electrical safety procedures when working on power distribution or NxBB equipment.

4.1.2 Before performing installation, maintenance or troubleshooting:

- De-energizing the affected conductors when possible
- Verify the absence of voltage using appropriate test equipment
- Secure the work area to prevent unintended re-energization.

WARNING

- **Risk of electrical shock! Failure to disconnect and secure the power supply before working on NxBB components may result in serious injury or death.**

4.2 Intended Use

4.2.1 NxBB components are intended for use only as described in this manual.

4.2.2 The system must be installed and operated within the specific electrical, environmental, and mechanical limits.

4.2.3 Use outside the defined operating conditions may result in malfunction or damage.

4.3 Prohibited Use

4.3.1 NxBB must not be used:

- In application not approved by Conductix-Wampfler
- Outside the specific voltage and current ranges
- In environments that exceed the defined environmental limits

4.3.2 Modifications to NxBB components are not permitted unless explicitly approved.

SECTION 5 - SYSTEM OVERVIEW

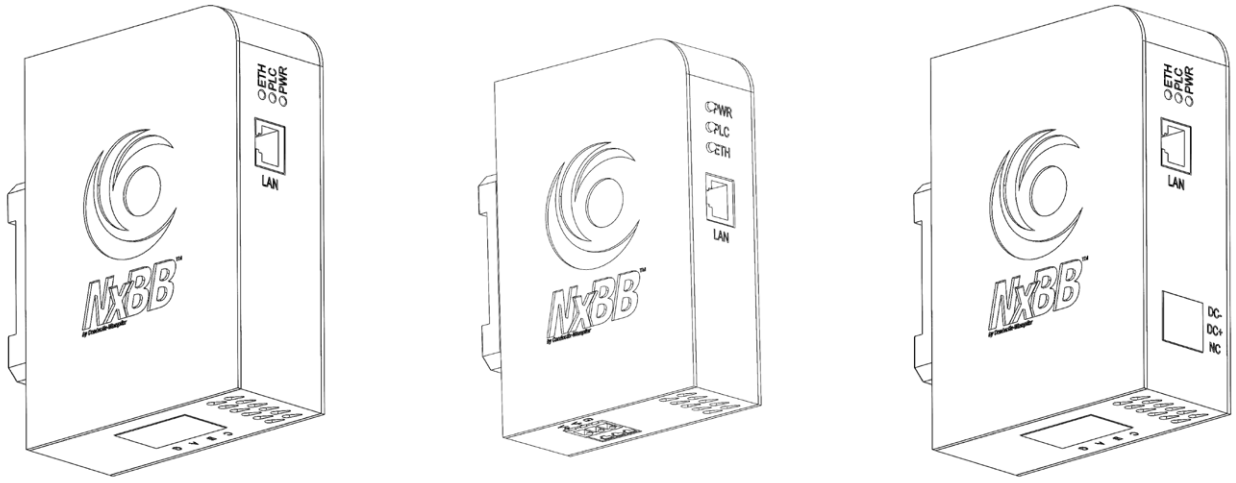
5.0 NxBB System Overview

5.0.1 The NxBB system uses power line communication to transfer Ethernet data over physical conductors.

5.0.2 The system consists of at least two NxBB modems connected through a filtered conductor path. Each modem interfaces with standard Ethernet equipment and exchanges data using high-frequency communication signals coupled to the conductor.

5.0.3 NxBB communication requires the use of dedicated power line filters. These filters reduce electrical noise and ensure reliable signal coupling between modems.

5.1 NxBB Modems



XA-NBB-A... / XA-NBB-B...
Modem

XA-NBB-C...
Modem

XA-NBB-D...
Modem

Figure: 5.1 - NxBB Modem Identification

5.1.1 NxBB modems are installed at locations where an Ethernet communication link is required.

5.1.2 The modems send and receive data over electrified physical conductors such as conductor bars or cables. Power line communication is established using a minimum of two conductors. When up to three conductors are used, higher network throughput may be achieved.

5.1.3 NxBB modems are designed for use with common industrial voltage levels. Variants are available for AC, DC, and externally powered configurations, depending on the available power supply and application requirements. Detailed mechanical and electrical characteristics are described in **Section 10.**

5.1.4 NxBB modems may be configured to operate within a defined NxBB domain. Domains are used to separate multiple NxBB systems operating within the same facility to prevent unintended cross-communication. Domain configuration does not affect the connected Ethernet network and is used only for NxBB system topology. Additional information on domains is provided in **Section 8.2**

SECTION 5 - SYSTEM OVERVIEW

5.2 Power Line Filters

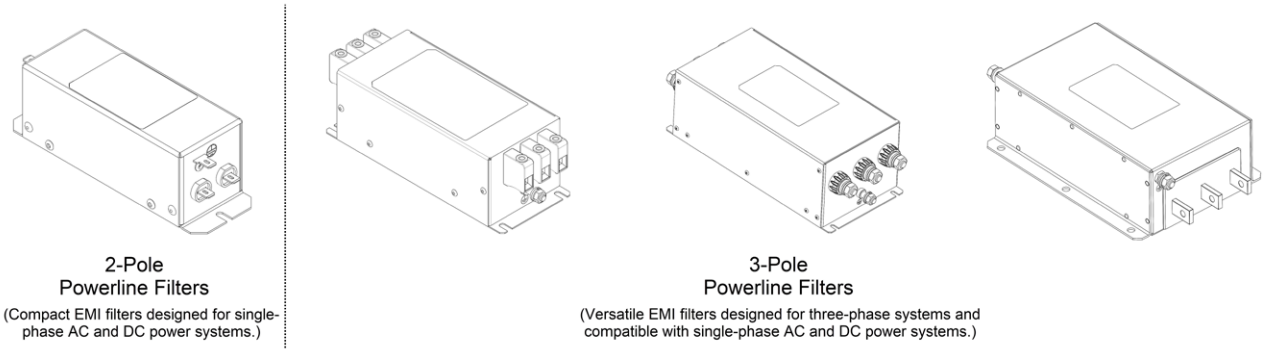


Figure: 5.2 - NxBB Powerline Filter Identification

5.2.1 NxBB systems require EMC/RFI power line filters to ensure reliable communication performance.

5.2.2 Power line filters perform the following functions:

- Suppress electrical noise from power sources and downstream loads
- Isolate NxBB communication signals from external interference
- Support domain separation between multiple NxBB systems

5.2.3 Filters are selected based on system voltage, current rating, and application configuration. Detailed filter ratings, connection types, and selection criteria are provided in **Section 6.2.**

5.2.4 Power line filters provided by Conductix-Wampfler for NxBB applications are tuned to the NxBB communication frequency band and are required for system performance and reliability.

5.2.5 For correct operation, the filter must be installed in the specified orientation and sufficiently grounded as defined in this manual.

5.3 System Architecture

5.3.1 The NxBB system may be used to connect Ethernet devices between stationary and mobile points.

Figure: 5.3 - NxBB System Architecture

5.3.2 The stationary modem is typically installed in a control cabinet, while mobile modems are installed on vehicles such as shuttles, cranes, or transfer cars. These modems exchange data through conductor rails, cables, slip rings, or other electrified conductors supplying power to downstream equipment.

5.3.3 Each modem connects to the Ethernet device using a standard RJ45 interface and to the filtered conductor path using conventional electrical wiring. Except for externally powered modem variants, the same conductors are used to supply power to the modem.

5.3.4 With an uninterrupted signal path, NxBB modems automatically establish communication and create a transparent Ethernet link between connected devices.

5.3.5 A single stationary modem can support **up to seven mobile modems** within the same domain. Applications requiring additional vehicles must use multiple NxBB domains with independent conductor paths.

5.4 Layout Considerations

5.4.1 NxBB components should be installed to minimize exposure to electromagnetic interference.

5.4.2 Key layout considerations include:

- Separation from variable frequency drives, motor controllers, and other noise sources
- Use of dedicated enclosures when possible
- Minimal conductor length between modems, filters, and power distribution points
- An uninterrupted, filtered signal path between NxBB modems

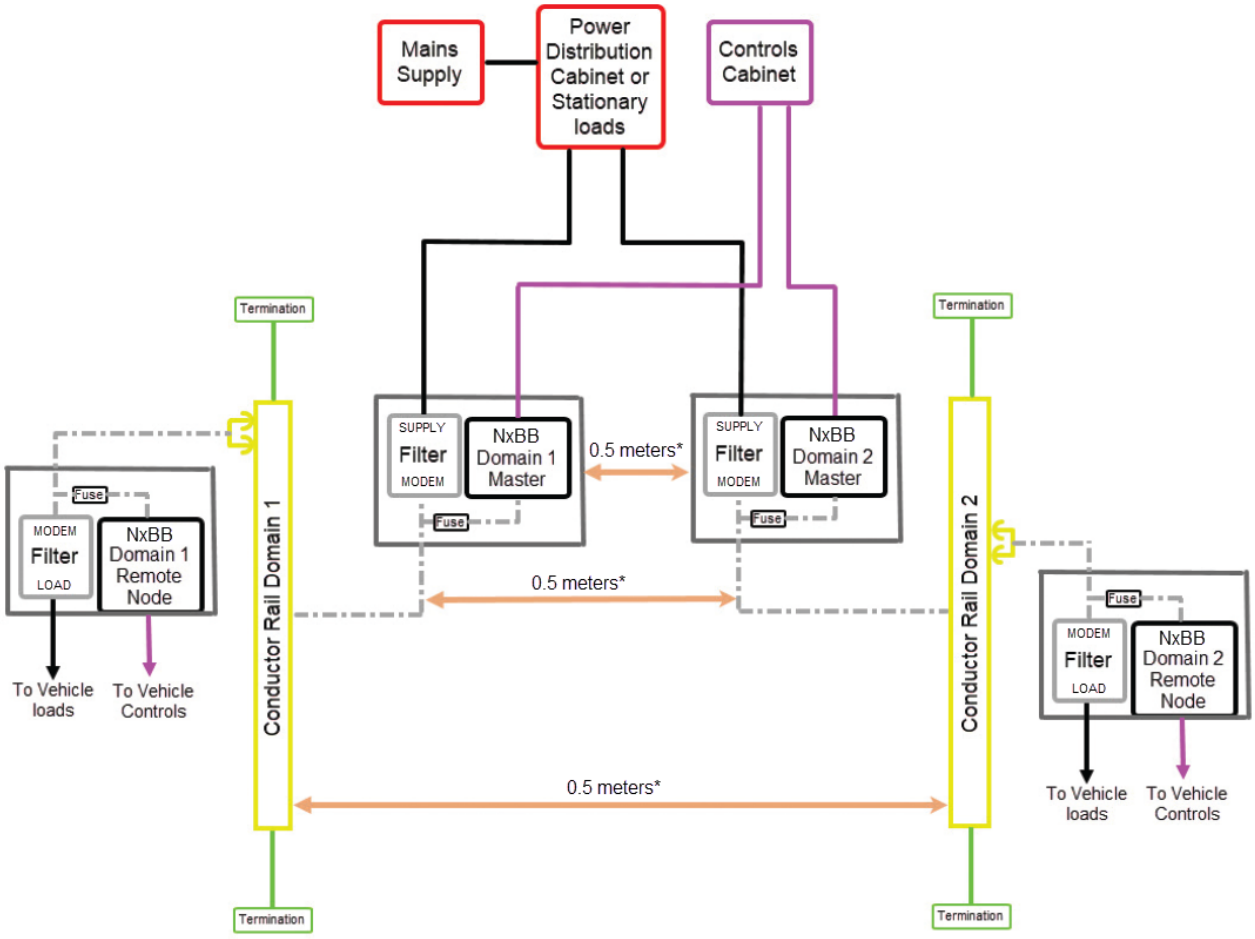
5.4.3 Power line filters must not be installed between modems operating within the same domain, as this will block communication.

5.4.4 Additional electromagnetic compatibility requirements, separation distances, and mitigation techniques are defined in **Section 7.10.**

5.5 NxBB Domains

5.5.1 For any facility with multiple NxBB systems in use, it is recommended to have configured domains.

5.5.2 For facilities with multiple NxBB domains, it is critical to ensure adequate physical separation between modems and signal-carrying conductors to prevent network interference.



*Minimum separation distance between NxBB domain components and cabling should be greater than 0.5 meters for most applications.

NOTE: In special cases, lesser minimum separation distances may be achieved.
If an application requires lesser minimum separation distances than shown above, please contact Conductix-Wampfler for a system evaluation.

Figure: 5.4 - NxBB Domain Separation Concept

5.5.3 Detailed configuration requirements and separation criteria are provided in **Section 8.2.**

SECTION 5 - SYSTEM OVERVIEW

5.6 Application Examples

5.6.0 The NxBB system is used in industrial applications where machines require Ethernet communication while moving. NxBB systems are generally categorized as cable-based systems or conductor rail-based systems.

NOTE: The maximum system length depends on the signal strength in the powerline communication system. Signal strength is influenced by several factors, including the length, material, and cross-sectional size of the conductors (e.g. cable or conductor rail), the number of vehicles, and the overall system layout. These factors must be evaluated to ensure reliable data transmission, and proper system performance.

5.6.A Festoon Cable Applications

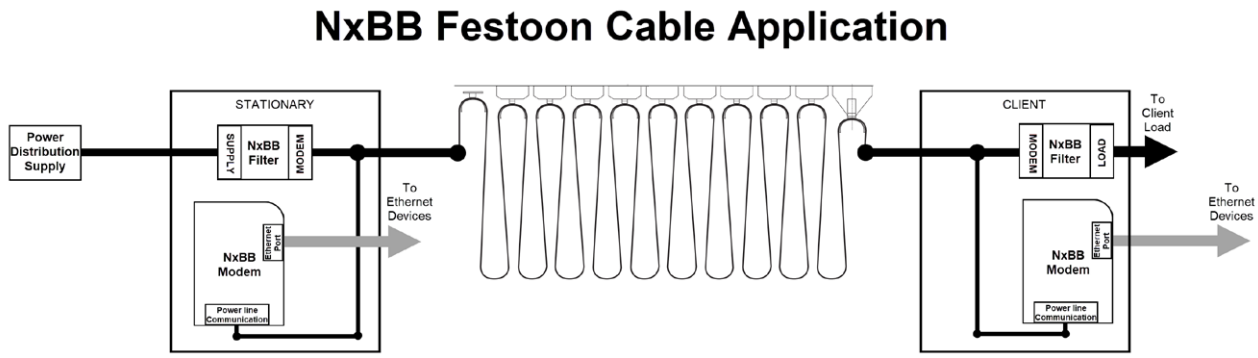


Figure: 5.5 - NxBB Festoon Cable Application

5.6.A.1 NxBB may be used with festoon cable systems for applications requiring combined power and Ethernet communication. Common applications include overhead cranes, hoists, conveyor systems, and automated storage and retrieval systems. The NxBB system is connected at junction points on both the stationary and mobile sides of the festoon cable to establish an Ethernet link between devices.

5.6.B Slip Ring Applications

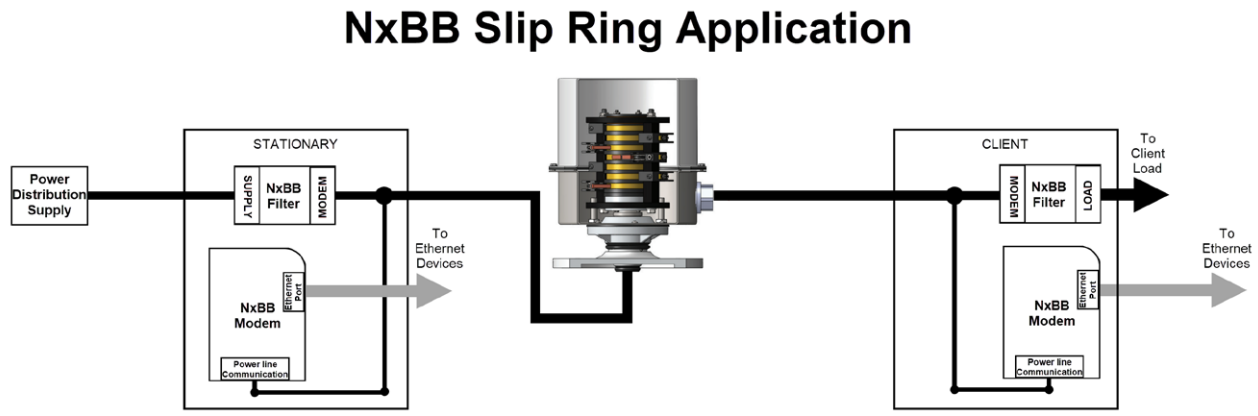


Figure: 5.6 - NxBB Slip Ring Application

5.6.B.1 In slip ring applications, NxBB may be attached to existing power conductors to add Ethernet communication without increasing the number of conductor rings. This configuration is used in systems requiring rotation while transmitting power and data. Typical applications include cable reels, bulk material handling equipment, amusement rides, and robotics. NxBB modems are installed on the stationary and rotating sides of the slip ring to establish an Ethernet link.

5.6.C Conductor Rail Applications

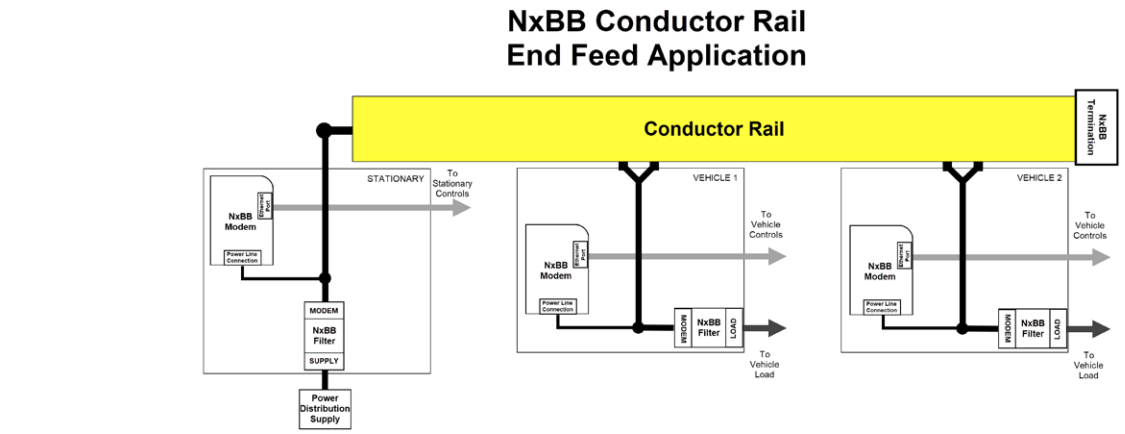


Figure: 5.7 - NxBB Conductor Rail Application: End Feed Application

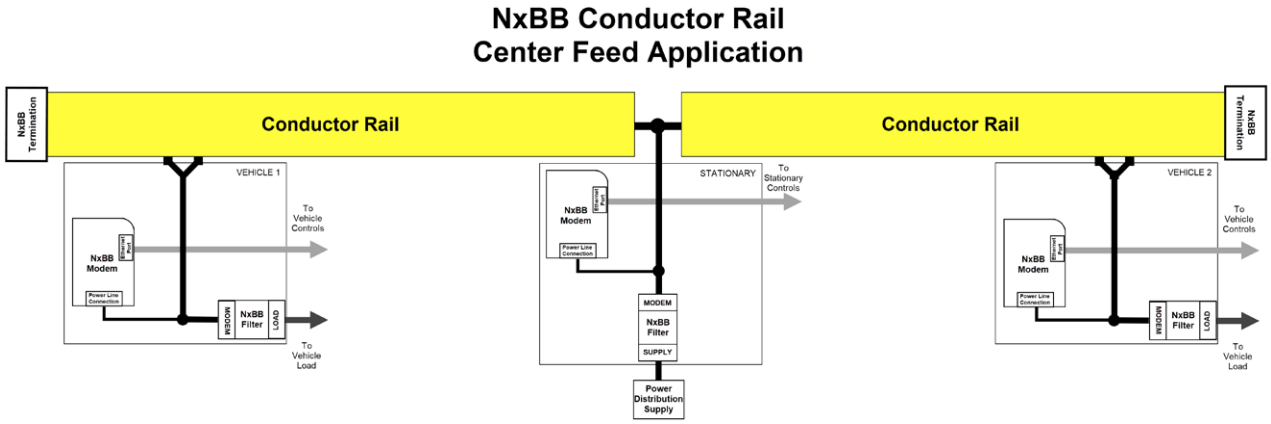


Figure: 5.8 - NxBB Conductor Rail Application: Center Feed Application

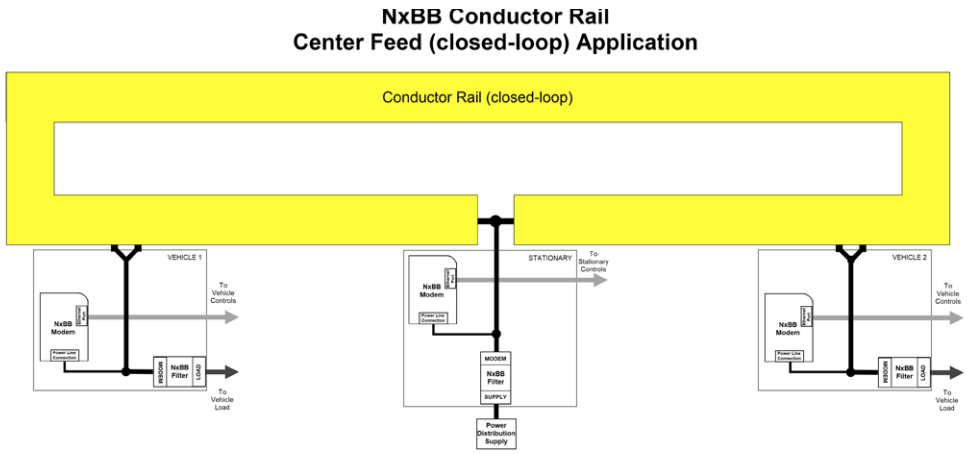


Figure: 5.9 - NxBB Conductor Rail Application: Center Feed (closed loop) Application

5.6.C.1 NxBB may be installed on conductor rail systems requiring power and Ethernet communication with up to seven mobile vehicles. NxBB remote node may operate up to 305 meters (1000 feet) from the stationary modem feed-in point when used with Conductix-Wampfler conductor rail.

NOTE: The achievable system length depends on the signal strength within the powerline communication path. The application layout must be considered during system design to ensure reliable system performance. Please contact Conductix-Wampfler to obtain an application evaluation.

5.6.C.2 Common applications include warehouse shuttles, transfer cars, and overhead cranes. The system is connected at the stationary power feed and the vehicle collector cable to establish Ethernet communication.

SECTION 6 - DEVICE DESCRIPTION

6.0 Device Description

6.0.1 This section describes the primary hardware components used in an NxBB system, including NxBB modems, NxBB power line filters, and supporting components. Installation, wiring, grounding, and layout requirements for all components described in this section are provided in **Section 7.**

6.1 NxBB Modem Description

6.1.1 NxBB modems are communication devices that connect Ethernet equipment to the NxBB power line communication system. Depending on the modem variant, the modem may receive operating power from the conductor path or from an external low-voltage power supply.

6.1.2 NxBB modems support transparent Ethernet communication and operate independently of network addressing, routing, or switching functions, which are handled entirely by the connected Ethernet devices.

6.1.A Modem Interfaces and Ports

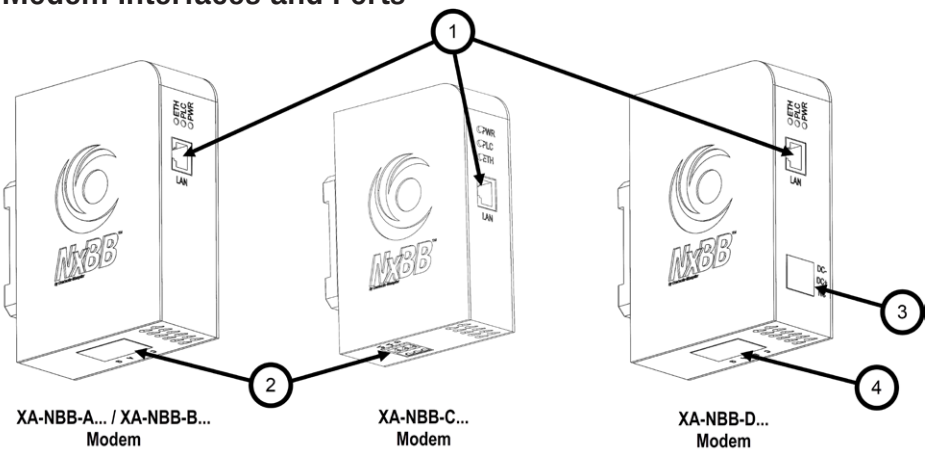


Figure: 6.1 - NxBB Modems and Connection Ports

6.1.A.1 Each NxBB modem includes the following functional ports, depending on the model:

1. **Ethernet Port -** A Standard RJ45 port is provided for connection to Ethernet devices. The modem exchanges Ethernet frames transparently with the connected network equipment.

2. **Power Line Connection Port -** This port connects the modem to the power line conductor and couples the NxBB communication signal to other NxBB modems. For most NxBB modem variants, the same conductors are also used to supply operating power to the modem. For the XA-NBB-A... and XA-NBB-B... modem variants, the use of 5.0-0.75 mm^2 (10-18 AWG) conductors is recommended. For the XA-NBB-C... modem variants the use of 2.5-0.75 mm^2 (12-18 AWG) conductor is recommended.

3. **External Power Port (externally powered variants only) -** Externally powered modems include a dedicated supply input used to power the modem independently of conductor energizing state. This allows the modem to be connected to an uninterrupted power supply or similar mobile power source and maintain communication when the power line is de-energized. The external power port supports 2.5-0.08 mm^2 (12-28 AWG) conductors.

4. **Communication Link Port (externally powered variants only) -** This port connects the modem to the power line conductor for communication only. It does not supply power to the modem and is used solely to couple the NxBB communication signal to other modems. The communication link may be connected by either powered or unpowered conductors. In some applications, spare conductors or dedicated signal conductors may be used exclusively for communication through this port. For optimal performance, the use of 5.0-0.75 mm^2 (10-18 AWG) conductors is recommended.

6.1.A.2 Electrical ratings and terminal specifications for each modem variant are defined in **Section 10.**

SECTION 6 - DEVICE DESCRIPTION

6.1.B SISO and MIMO Communication modes:

- Single-Input, Single-Output (SISO)
  Communication is established using two conductors. SISO provides standard NxBB communication performance.
- Multi-Input, Multi-Output (MIMO)
  Communication is established using three conductors. MIMO operation increases data throughput compared to SISO operation.

6.1.B.1 The available conductors and terminal usage depend on the modem variant. Wiring examples for each modem type are provided in **Section 7.7.**

6.1.C Terminal Usage by Modem Variant

6.1.C.1 Standard Modems (XA-NBB-A..., XA-NBB-B...)

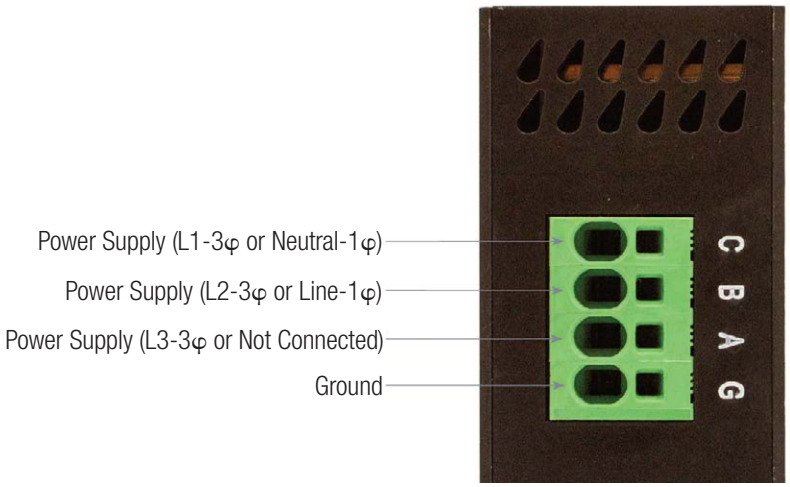


Figure: 6.2 - Standard Modem Connections

6.1.C.1.1 Standard modems use a powerline connection port with terminals labeled C, B, A, and G.

6.1.C.1.2 Terminals C and B are required to provide operating power to the modem and to establish NxBB communication.

6.1.C.1.3 When only terminals C and B are connected, the modem operates in single-input, single-output (SISO) mode.

6.1.C.1.4 When terminals C, B, and A are connected, the modem operates in multi-input, multi-output (MIMO) mode, providing increased data throughput.

6.1.C.1.4 Terminal usage is independent of the power system type (single-phase, three-phase, or DC). Ensure the applied operating voltage is appropriate for the selected modem variant and application.

SECTION 6 - DEVICE DESCRIPTION

6.1.C.2 Low Voltage DC Modems (XA-NBB-C...)

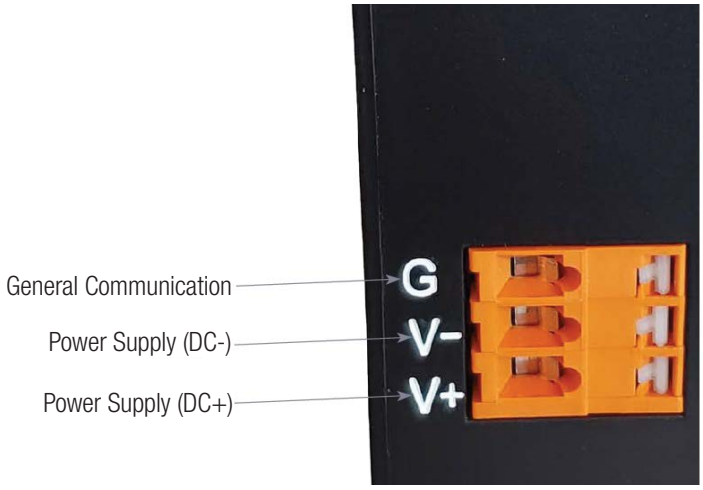


Figure: 6.3 - Low Voltage Modem Connections

6.1.C.2.1 Low voltage DC modems use a powerline connection port with terminals labeled V+, V-, and G.

- V+ and V- supply the low-voltage DC operating power for the modem.
- For Low Voltage Modems only, the G terminal provides an additional general communication conductor used to support NxBB communication coupling when MIMO operation is required.

6.1.C.2.2 When only V+ and V- are connected, the modem operates in SISO mode.

6.1.C.2.3 When V+, V- and G are connected, the modem operates in MIMO mode.

6.1.C.3 Externally Powered Modems (XA-NBB-D...)

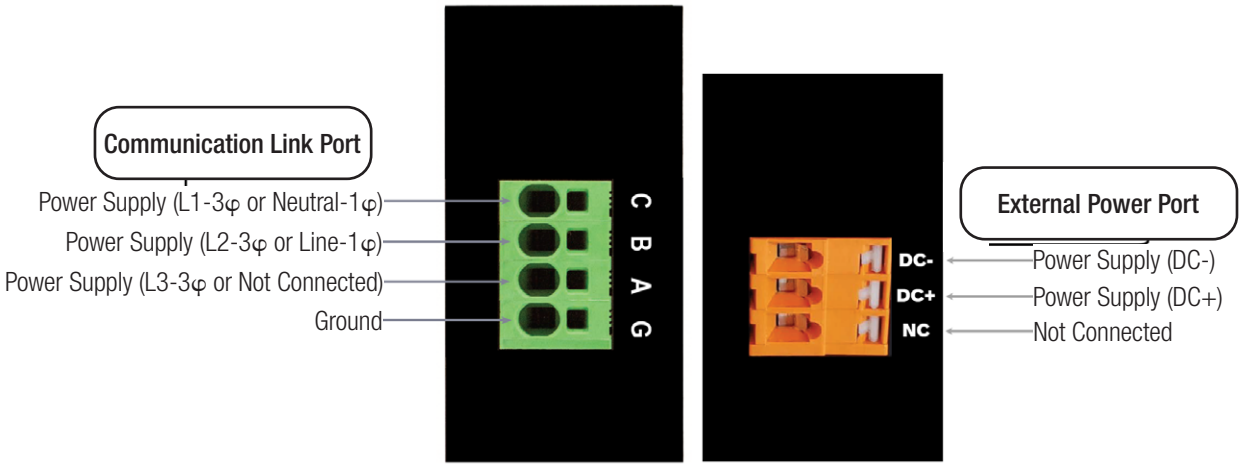


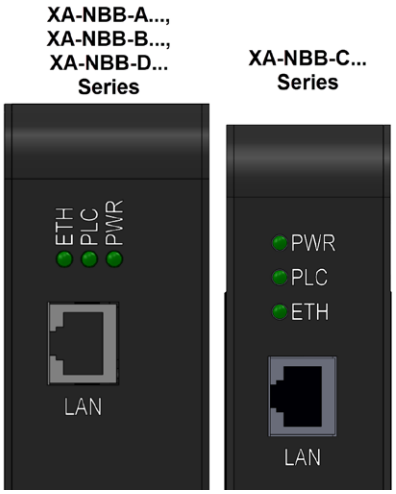
Figure: 6.4 - Externally Powered Modems Connections

6.1.C.3.1 Externally powered modems use two separate ports:

- **Communication Link Port**
  Provides NxBB communication coupling using terminals labeled C, B, A, and G. This port does not supply operating power to the modem.
  - For SISO operation, connect either **C and B** or **B and A**.
  - For MIMO operation, connect terminals, **C, B, and A**.

  The communication link port supports communication link voltages from 0 to 600 VAC or 0 to 300 VDC.
- **External Power Port**
  Supplies low-voltage DC operating power using terminals labeled DC+, DC-, and NC.
  - DC+: low-voltage DC positive
  - DC-: low-voltage DC reference
  - NC: not connected; must remain unused.

6.1.D LED Indicators



6.1.D.1 NxBB modems include LED indicators that provide visual feedback on operating status and communication activity.

Figure: 6.5 - NxBB Modem LED Indicators

- **Power LED**
  On: Indicates that the modem is receiving operating power.
- **Ethernet LED**
  On: A physical Ethernet link is established.
  Flashing: Ethernet data is being transmitted or received.
- **PLC / Communication LED**
  On: Indicates established link with another modem in same domain.
  Flashing: NxBB communication data being transmitted or received.

6.1.6.2 LED behavior and fault patterns are used during installation and troubleshooting **(see Section 9.2)**.

SECTION 6 - DEVICE DESCRIPTION

6.1.E NxBB Modem Parts List

Modem with Internal Power Supply		
Part Number	**Operating Voltage Range**	
XA-NBB-A-I-AA	100-480 VAC / 150-300 VDC	
XA-NBB-B-I-AA	220-600 VAC	
XA-NBB-C-I-AA	18-48 VDC	
Externally Powered Modem		
Part Number	**Communication Link Voltage**	**Supply Voltage**
XA-NBB-D-E-AA	0-600 VAC / 0-300 VDC	18-60 VDC

Table: 6.1 - NxBB Modem Parts Listing

NOTE: Part numbers may be followed by a domain identifier code depending on factory programming. For example, XA-NBB-A-I-AA-DM indicates an XA-NBB-A-I-AA modem configured as a Domain Master by Conductix-Wampfler.

6.2 NxBB Filter Descriptions

6.2.1 NxBB systems require specially designed EMC/RFI power line filters to reduce electrical noise and maintain the integrity of data transmission over the power line communication network.

6.2.2 Conductix-Wampfler EMC/RFI filters are optimized for the NxBB communication frequency band. Filter size, construction, and terminal configuration are determined by system voltage, rated current, and application layout.

6.2.3 NxBB power line filters perform the following functions:

- Reduce conducted electrical noise on the power line
- Prevent interference from upstream and downstream electrical loads
- Protect NxBB communication signals from external disturbances
- Support separation between multiple NxBB domains

6.2.A Filter Selection Overview

6.2.A.1 NxBB power line filters are available in multiple current classes:

- **20 A and 50 A filters**
  Used for low-to-moderate current installations. These filters are compact and typically mounted inside standard electrical enclosures.
- **100 A, 160 A, and 250 A filters**
  Designed for higher current applications. These filters are physically larger and require additional enclosure space.
- **600 A to 1600 A filters**
  Intended for high-power industrial systems. These filters are typically installed in large electrical cabinets or power distribution assemblies.

6.2.B NxBB Power Line Filter Parts List

Part Number	Rated Current (Max Ambient)	Rated AC Voltage (L-L / L-N)	Rated DC Voltage	Power Line Terminal	Ground Terminal
XA-NBB-LF-1-20-KT	20 A (40 °C)	250 / 250 VAC	250 VDC	Quick Disconnect Tab 6.35 mm (1/4 in.)	Quick Disconnect Tab 6.35 mm (1/4 in.)
XA-NBB-LF-3-35-KT	35 A (45 °C)	760 / 440 VAC	460 VDC	10 mm^2 (6 AWG) Screw Clamp	M6 Stud
XA-NBB-LF-3-50-KT	50 A (50 °C)	760 / 440 VAC	460 VDC	25 mm^2 (2 AWG) Screw Clamp	M6 Stud
XA-NBB-LF-3-100-KT	100 A (50 °C)	760 / 440 VAC	460 VDC	M10 stud	M8 Stud
XA-NBB-LF-3-160-KT	160 A (50 °C)	760 / 440 VAC	460 VDC	M10 stud	M10 Stud
XA-NBB-LF-3-250-KT	250 A (50 °C)	760 / 440 VAC	460 VDC	M10 stud	M10 Stud
XA-NBB-LF-3-600-KT	600 A (50 °C)	760 / 440 VAC	460 VDC	Busbar (1 x 10.5 mm hole)	M12 Stud
XA-594411	800 A (50 °C)	760 / 440 VAC	-	Busbar (1 x 14 mm hole)	M12 Stud
XA-594413	1000 A (50 °C)	760 / 440 VAC	-	Busbar (1 x 14 mm hole)	M12 Stud
XA-599177	1600 A (50 °C)	760 / 440 VAC	-	Busbar (2 x 14 mm holes)	M12 Stud

Table: 6.2 - NxBB Power Line Filter Ratings

NOTE: For more information on power line filter specifications, refer to NxBB-LF Series Powerline filter datasheet found on the Conductix-Wampfler website. *https://www.conductix.com/products*

6.2.C Filter Connections

6.2.C.1 Filter connection type depends on rated current and application requirements.

- **2-pole filters** are intended for single-phase or DC systems and provide a compact physical footprint.
- **3-pole filters** are intended for three-phase systems and may also be used for single-phase or DC applications.

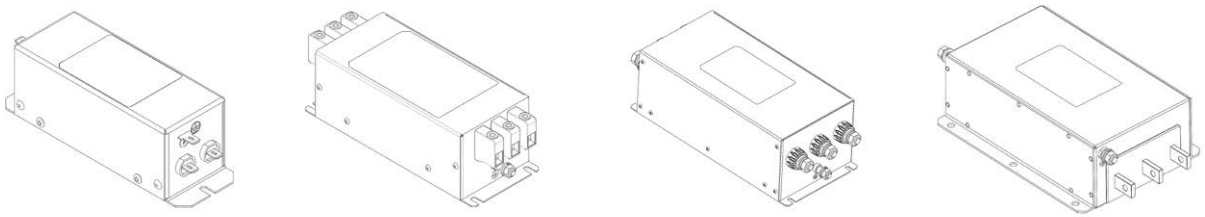


Figure: 6.6 - NxBB Power Line Filter Types

NOTE: Filters designed for three-phase applications may be used in single-phase systems. In this configuration, connect filter terminal L1 to Neutral (N) and terminal L2 to Line (L); the remaining terminal shall not be used.

6.2.C.2 Connection styles include quick-disconnect terminals, screw clamp terminals, threaded studs, and busbar interfaces. Conductor size and routing must match the filter rating and installation constraints.

6.2.D Filter Ground Terminal

6.2.D.1 Each filter includes grounding points on the filter housing to allow direct connection to system ground.

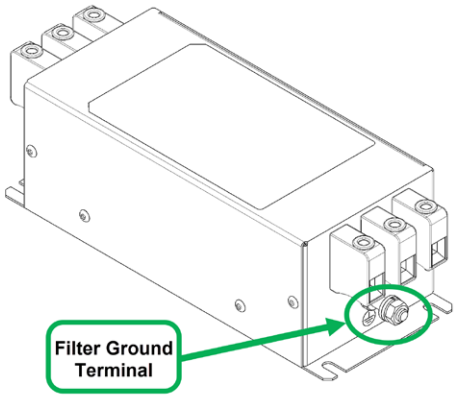


Figure: 6.7 - NxBB Power Line Filter Ground Terminal

6.2.D.2 For proper operation, the filter case must be sufficiently grounded using at least one solid grounding point. Mounting the filter directly to the grounded bare metal backplane within an enclosure is an acceptable grounding method.

6.2.E Filter Case and Labeling

6.2.E.1 The filter case protects internal components and serves as the primary grounding surface. A label affixed to the filter case identifies:

- Filter part number
- Electrical and mechanical ratings
- Terminal identification
- Orientation markings

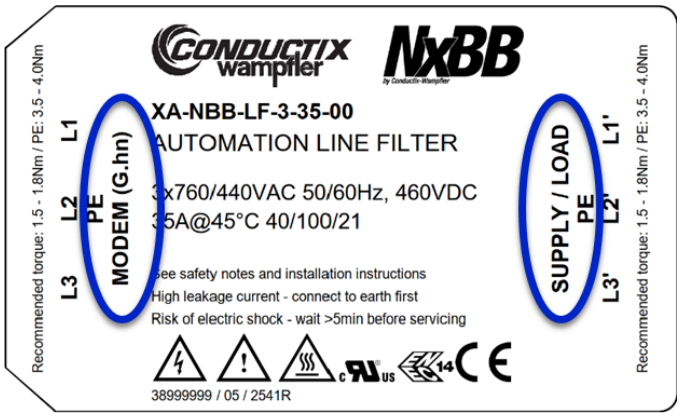


Figure: 6.8 - NxBB Power Line Filter Case Labeling

6.2.E.2 When installing the filter:

- Terminals marked **"MODEM (G.hn)"** must be connected toward the NxBB modem and communication path.
- Terminals marked **"SUPPLY / LOAD"** must be connected toward the power distribution supply or downstream load.

NOTE: **Filter terminal labeling may vary by model. On NxBB LF series filters, the modem connection side is labeled "MODEM (G.hn)" and the supply or load side is labeled "SUPPLY / LOAD". Other filters specified by Conductix-Wampfler may use "LINE" to indicate modem connection side and "LOAD" to indicate the supply or load connection point.**

6.2.E.3 Correct orientation and grounding are required for proper operation.

6.3 Supporting Components

6.3.1 Certain applications require additional components to support NxBB system operation and maintain communication reliability.

6.3.A NxBB Termination Kits

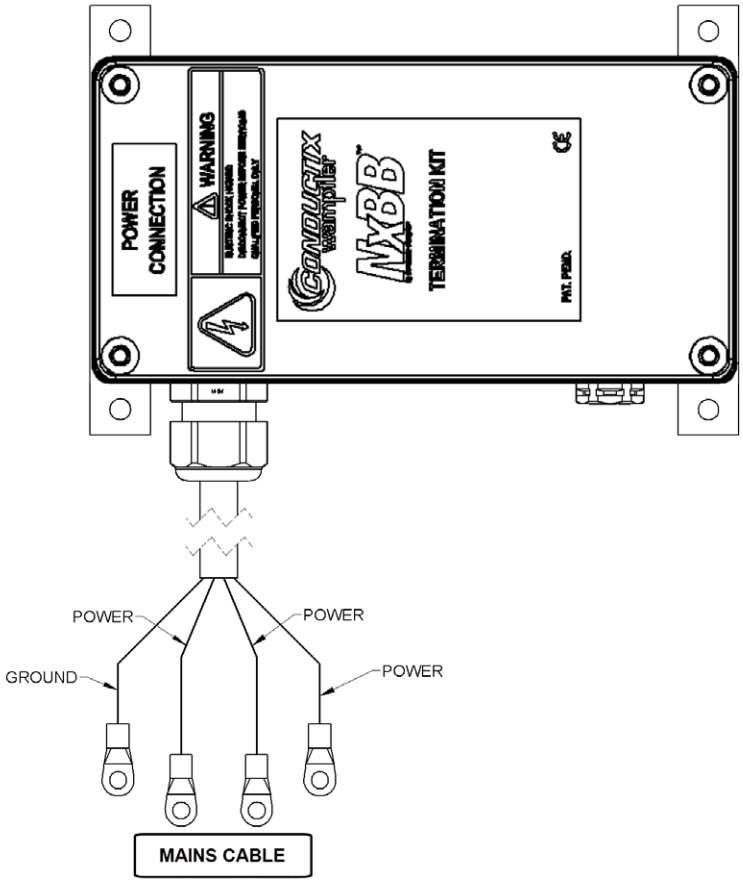


Figure: 6.9 - NxBB Termination Kit

6.3.A.1 NxBB Termination Kits are used to terminate conductor rail ends and absorb signal reflections. Signal reflections can reduce system performance and cause communication instability.

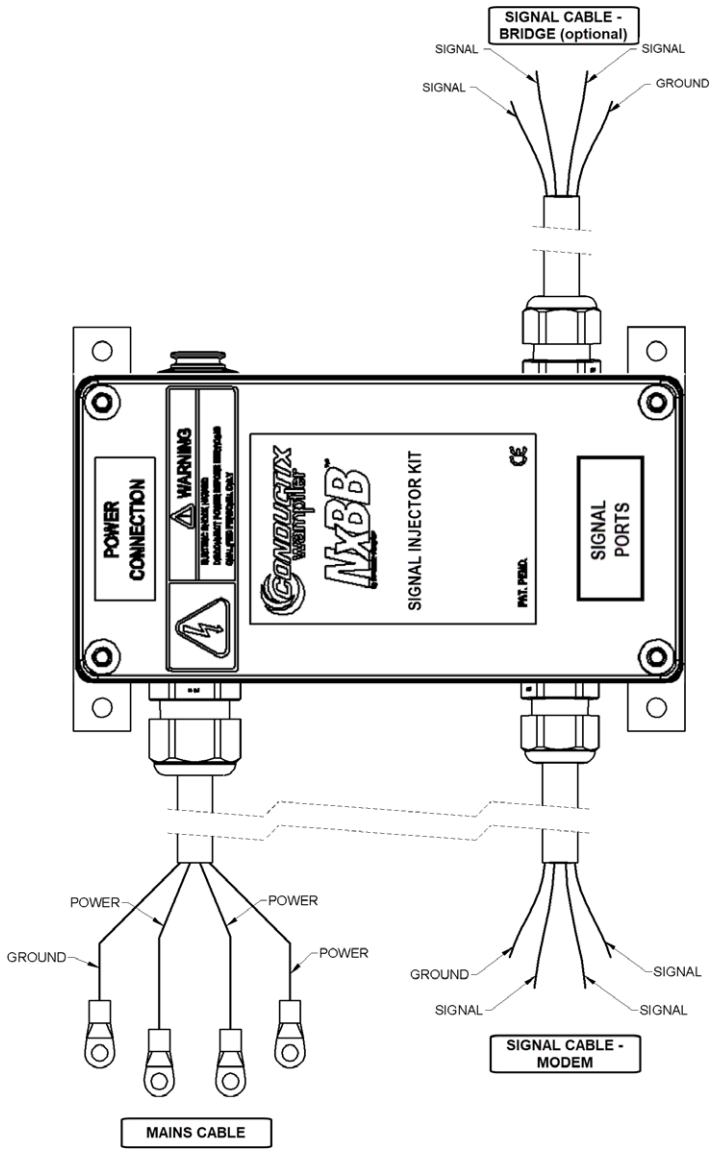
- The termination kit is intended for discontinuous conductor rail sections with a length greater than **1 m (3.3 ft).**
- For best performance, the **power feed connected to the termination kit** must be installed no more than **200 mm (8 in.)** from the end of the conductor rail.

6.3.A.2 Termination kits are impedance-matched to Conductix-Wampfler conductor rail systems. For other conductor rail types, proper termination selection is required.

6.3.A.3 Termination kits are not required for cable reel, festoon, or closed loop conductor rail applications.

6.3.B NxBB Signal Injectors

Figure: 6.10 - NxBB Signal Injectors



6.3.B.1 NxBB Signal Injectors allow NxBB communication signals to be coupled independently of power distribution.

6.3.B.2 By design, signal injectors isolate **power only**, enabling NxBB power line communication to continue even when a section of the conductor rail is not energized.

6.3.B.3 Signal injectors may be used to:

- Extend communication distance using low-loss signal cable
- Bypass power disconnects or isolation zones
- Bridge communication across electrically isolated conductor rail sections

6.3.B.4 Signal injectors are available with **single or dual port designs**. Dual-port models support **daisy-chain communication** between multiple injectors.

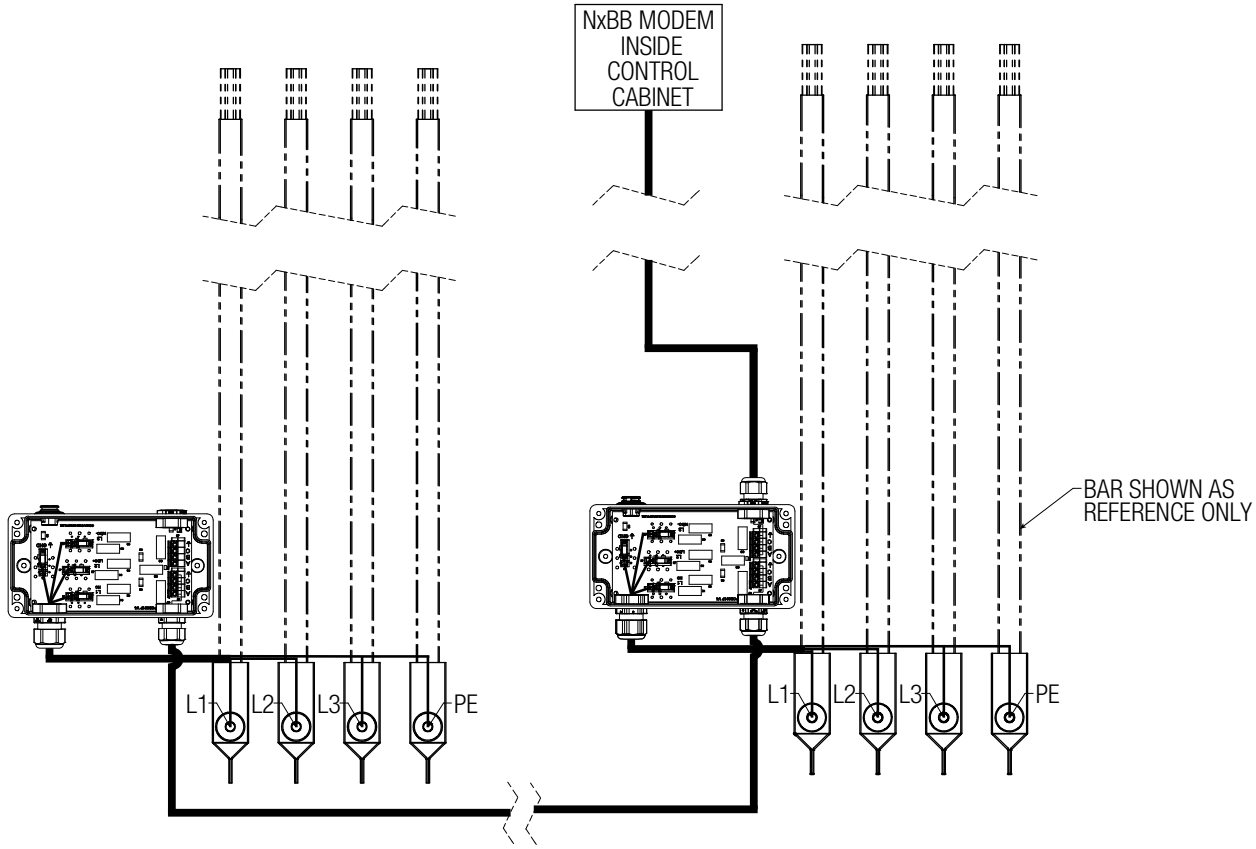


Figure: 6.11 - NxBB Signal Injector Daisy Chain Topology

6.3.B.5 Signal connections are made via a signal cable to either the communication link port of an externally powered modem or to another signal injector in a daisy-chain or signal bridge configuration.

6.3.B.6 Signal injectors connect to the conductor rail via a **power feed** and may be installed at any point along the rail. When connecting a signal injector to a rail using an end power feed, the power feed must be installed within **200 mm (8 in.)of the end of the rail.** Power feeds installed more than 200 mm (8 in.) from the rail end are not considered end feeds for the NxBB system, and a termination must be installed at the rail end.

6.3.C EMI Suppression Ferrites

6.3.C.1 In special circumstances, ferrites may be used for NxBB applications to provide additional EMI suppression. Ferrites can enhance EMC/RFI filter performance or be used for low-level noise suppression. **Ferrites do not replace the requirement for properly designed EMC/RFI filters.**

6.3.C.2 Ferrites must be selected and installed carefully:

- Ferrites should be placed at the power line filter, before the power line junction.
- Ferrites must not be installed in a manner that impedes the NxBB communication signal.
- An uninterrupted signal path must be maintained between NxBB modems.

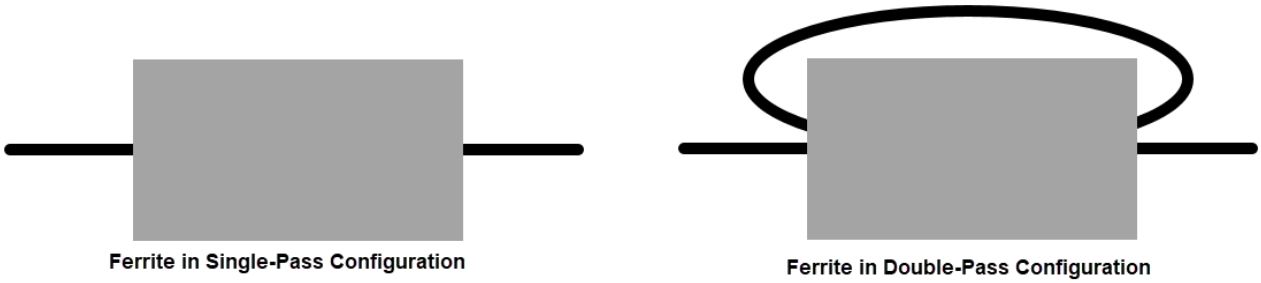


Figure:6-12 - EMI Suppression Ferrites Installation Configuration (Number of Passes)

6.3.C.3 Ferrites may be installed in single-pass or multi-pass configurations. Two to three passes are recommended to provide effective attenuation. Excessive passes may reduce attenuation and allow unintended signal coupling.

SECTION 7 - INSTALLATION AND WIRING

7.0 Installation and Wiring

7.0.1 This section provides step-by-step instructions for installing NxBB components and integrating them into the system. Follow all applicable local electrical codes and site safety procedures.

7.0.2 Component descriptions and port definitions are provided in **Section 6.**
Domain configuration concepts are provided in **Section 8.2.**
LED indicators used for verification are described in **Section 6.1.D.**
Troubleshooting guidance is provided in **Section 9.**

7.1 Tools and Materials

7.1.1 Required Components

- NxBB Modem
- NxBB power line filter
- Terminal blocks or power distribution blocks suitable for conductor size and current rating
- Hardware suitable for mounting the power line filter, as required by the enclosure and installation method

7.1.2 Optional supporting components **(application dependent, see Section 6.3)**

- Signal Injector
- Termination Kit
- EMI Suppression Ferrites

7.2 Secure Power and Prepare the Site

1. Secure and lock out all power sources feeding the installation area in accordance with facility procedures.
2. Verify the installation location allows safe access for wiring, inspection and service.
3. Avoid installing NxBB components in enclosures shared with high-noise equipment such as motors, variable-frequency drives, or high-current switching devices.
4. Verify the selected NxBB modem variant matches the available power source **(see Section 6.1.E).**
5. Verify the selected power line filter matches the system voltage and current rating **(see Section 6.2.B).**

7.3 Domain Planning and Device Placement

1. If domains are used, confirm the domain plan before mounting hardware **(see Section 8.2).**
2. If the system is configured to a specific domain:
    - Install the **Domain Master** at the stationary location.
        - **Conductor rail applications -** In conductor rail systems, stationary components are typically installed near the rail power feed to minimize cable length and exposure to noise sources. If this is not practical due to enclosure layout or system constraints, a **signal injector** may be used to support longer feed distances while maintaining communication performance **(See Section 6.3.B).**
    - Install the **remote node modems (clients)** on mobile vehicles.
3. Ensure all modems within one NxBB system are configured to the same domain, or left at factory default settings if the domains are not used.

7.4 Mount the Modem and Filter

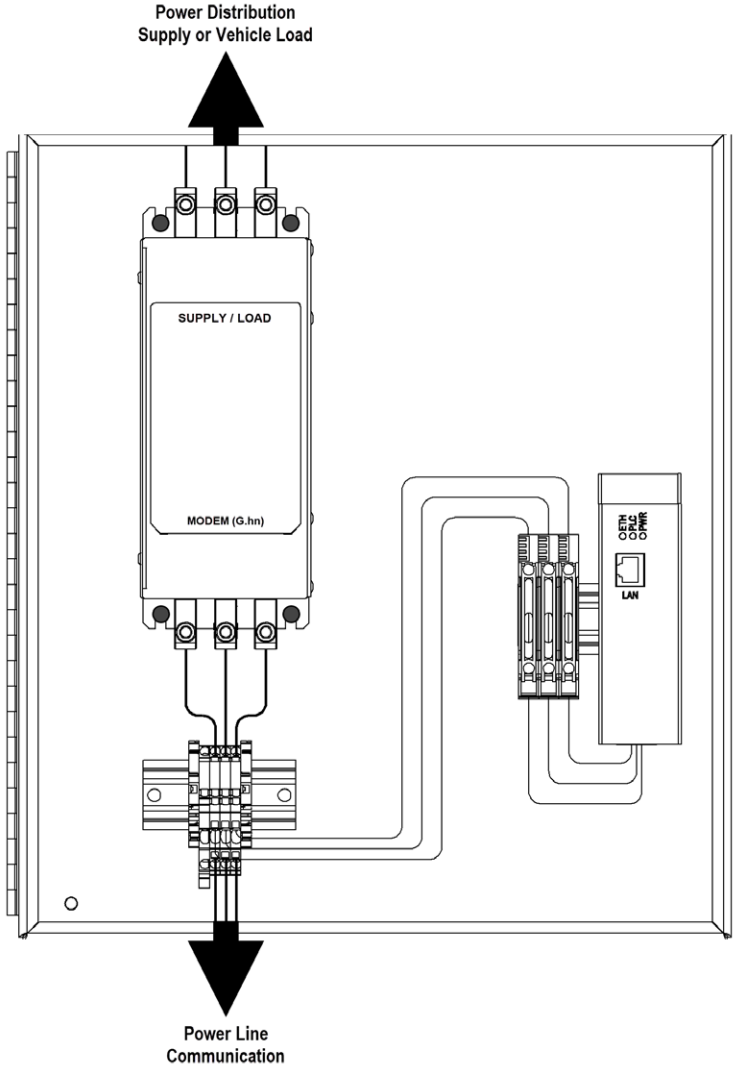


Figure: 7.1 - Example NxBB Panel Layout

1. Install the NxBB modem and the NxBB power line filter inside a **dedicated metal enclosure** whenever possible.
   - A dedicated enclosure reduces exposure to electromagnetic interference and provides controlled grounding and cable routing.
2. Mount the NxBB modem using the appropriate method for the enclosure, such as DIN rail or direct panel mounting.
3. Position the modem so that:
   - Ethernet and power line ports are accessible
   - LED indicators are visible for commissioning and troubleshooting
4. Mount the NxBB power line filter in the enclosure using the required hardware.
   - When possible, mount the filter directly to grounded bare metal backplane.
5. Verify that required clearances are maintained for:
   - Convection Cooling
   - Wiring access and strain relief
   - Inspection and service

SECTION 7 - INSTALLATION AND WIRING

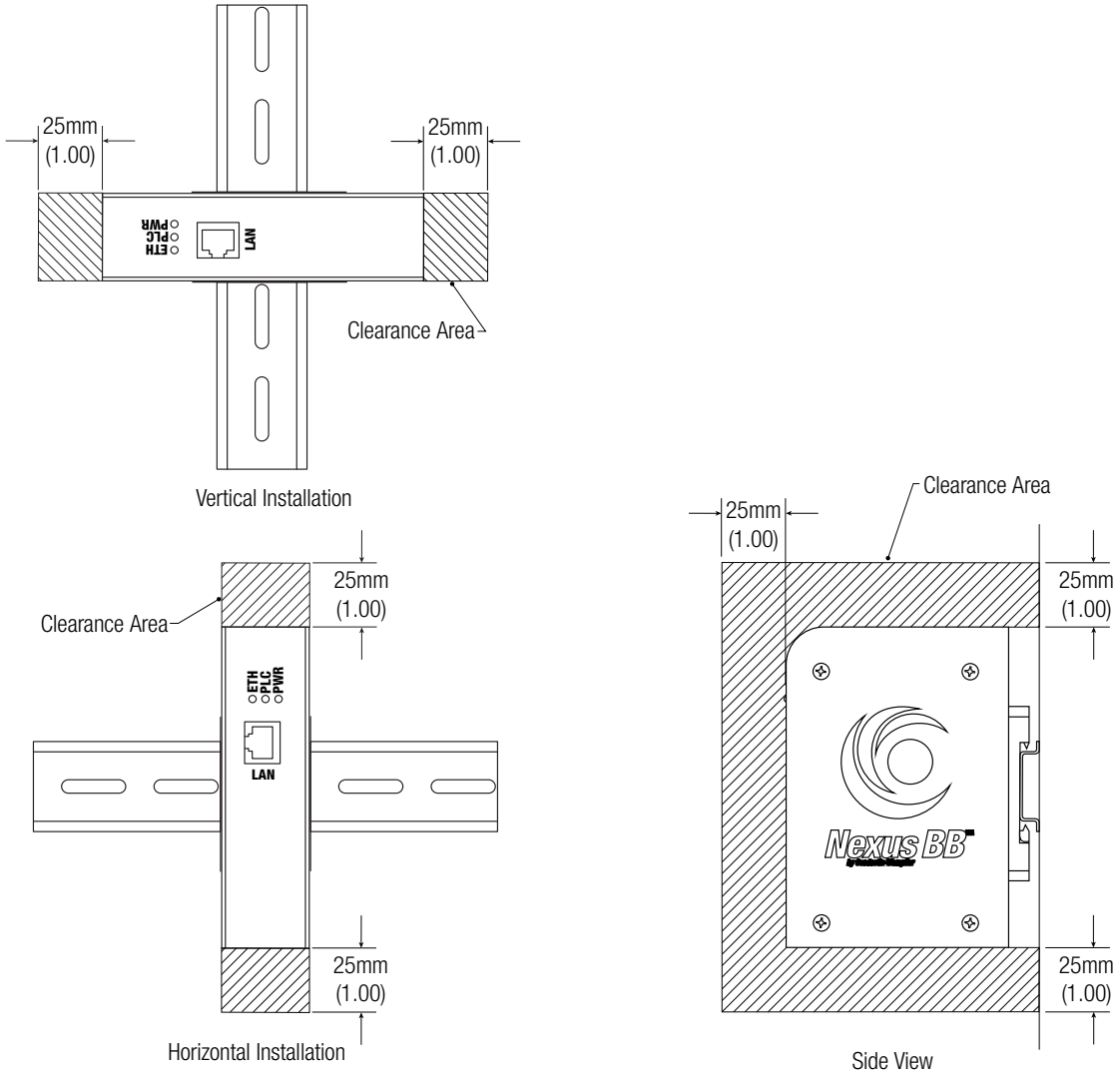


Figure: 7.2 - NxBB Modem Required Installation Clearance

1. Arrange components to support short, direct wiring to terminal blocks and junction points.
   - Keep the modem-to-junction wiring short to reduce signal loss.
   - Total conductor length from modem terminals to the power bus, including fuses, shall not exceed 380 mm (15 in.).

SECTION 7 - INSTALLATION AND WIRING

7.5 Install In-Line-Fuses

1. Install an in-line fuse on each non-grounded conductor between the NxBB modem and the filter or power bus, in accordance with local electrical regulations and applicable safety requirements.
2. Place fuses so total wiring length, including fuse leads, remains within the **380 mm (15 in.)** limit.

NOTE: **Circuit Protection -** Use **fuses** for circuit protection on NxBB signal-carrying conductors. Circuit breakers shall not be used, as they can attenuate the NxBB signal and degrade communication performance. Information regarding NxBB modem current consumption may be found in **Section 10.1.**

7.6 Install Terminal Blocks and Prepare Conductors

1. Install terminal blocks or power distribution blocks sized for conductor size and current rating.
2. Plan conductor routing to keep NxBB signal-carrying conductors separated from unfiltered power conductors.
3. Use the shortest practical conductor length for optimal communication performance.
   - Total conductor length from modem terminals to the power bus, including fuses, shall not exceed 380 mm (15 in.).
4. Select conductors that match terminal requirements:
   - Modem power line terminals: per modem model **(See Section 10.6).**
   - Filter terminals: per filter model **(see Section 6.2.B)**

7.7 NxBB Modem Powerline and Communication Wiring

7.7.1 This section describes the wiring of NxBB modem powerline and communication connections. Installation shall be performed in accordance with the grounding, filtering, and conductor length requirements defined elsewhere in this manual.

7.7.2 Refer to Section 6.1 for modem interface descriptions and communication modes.

7.7.A General Wiring Rules

- NxBB signal-carrying conductors between the modem and the powerline filter or conductor path shall be kept as short as practical.
- Total conductor length from modem terminals to the power bus, including fuses, shall be less than 380 mm (15 in.).
- Do not install filters, ferrites, or circuit breakers in the NxBB communication path between modems operating within the same domain.
- Required in-line fuses shall be installed in accordance with local electrical regulations.

7.7.B Wiring - Standard Modems (XA-NBB-A..., XA-NBB-B...)

7.7.B.1 Standard modems receive operating power and communication through the powerline connection port.

- Connect terminals C and B to establish operating power and NxBB communication (SISO mode).
- For 1-phase AC systems, connect terminal C to Neutral and terminal B to Line.

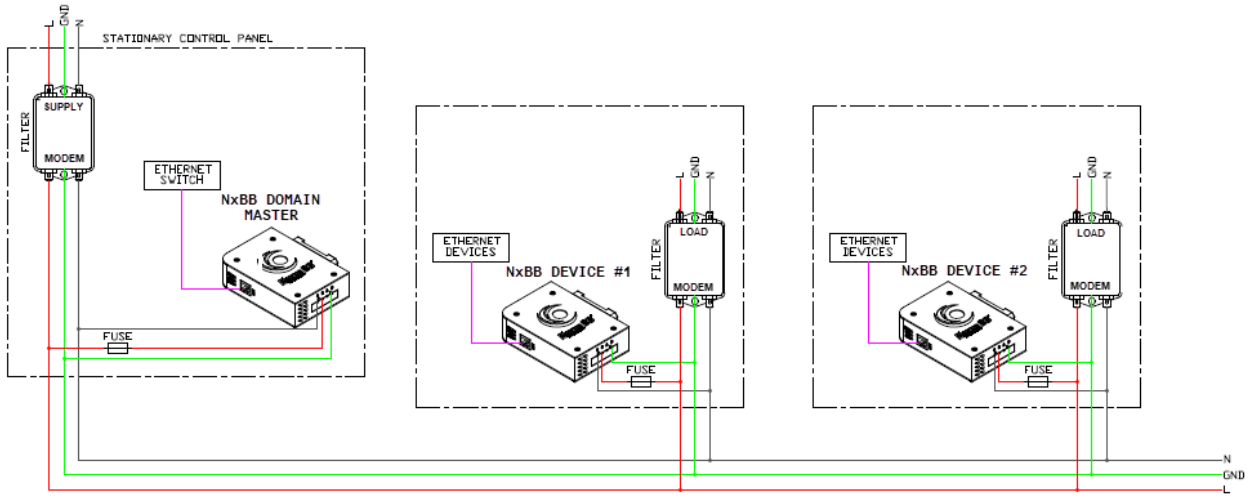


Figure: 7.3 - NxBB SISO Communication Topology for Standard Single-Phase Applications

NOTE: **Filters designed for three-phase applications may be used in single-phase systems. In this configuration, connect filter terminal L1 to Neutral (N) and terminal L2 to Line (L); the remaining terminal shall not be used. Ensure the filter is properly grounded.**

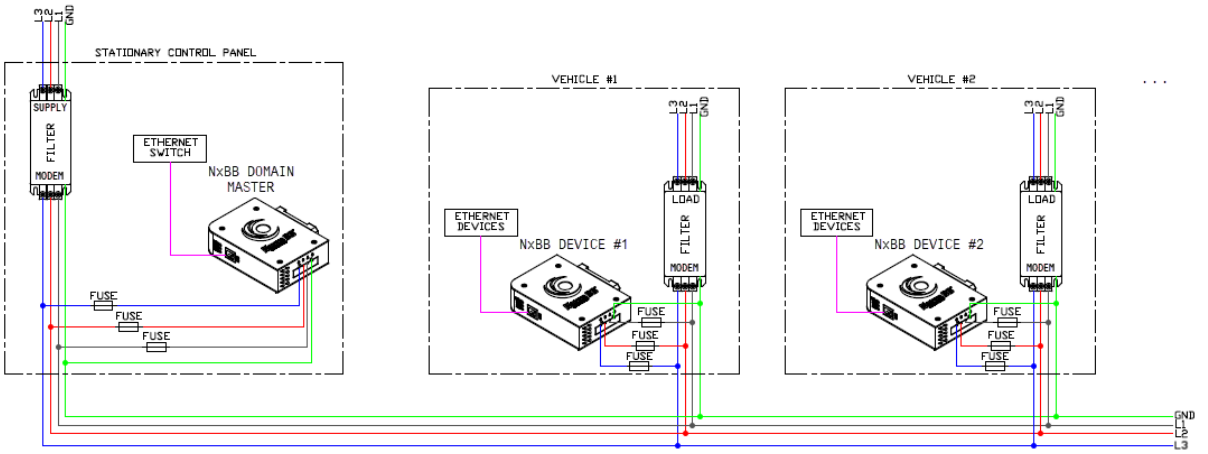


Figure: 7.4 - NxBB MIMO Communication Topology for Standard Three-Phase Applications

- Connect terminals C, B, and A to enable MIMO operation.
- For three-phase AC system, connect Terminal C to L1, terminal B to L2, and terminal A to L3.

7.7.C Wiring - Low-Voltage DC Modems (XA-NBB-C...)

7.7.C.1 Low-Voltage DC modems require a dedicated low-voltage power supply.

- Connect V+ and V- to the low-voltage DC power source to supply operating power.
- For MIMO operation, connect the G general communication conductor in addition to the V+ and V-.

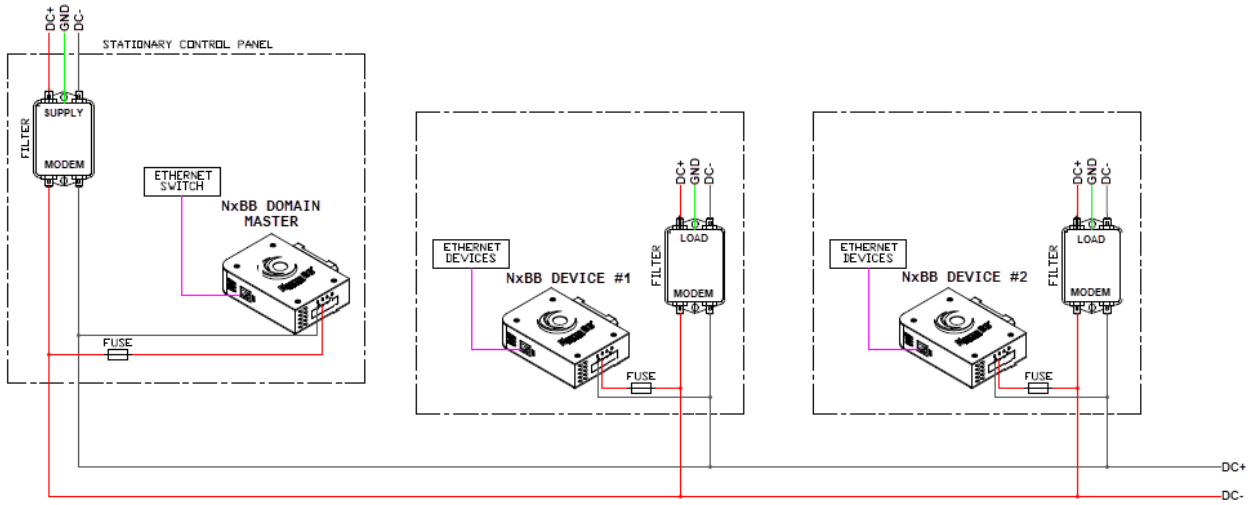


Figure: 7.5 - NxBB SISO Communication Topology for Low-Voltage DC Applications

7.7.C.2 When only V+ and V- are connected, the modem operates in SISO mode.

NOTE: **Some filters designed for three-phase applications may be used in DC systems depending on the filter specification. When used in a DC configuration, connect filter terminal L1 to DC reference (DC-) and terminal L2 to DC positive (DC+), the remaining terminal shall not be used. Ensure the filter is properly grounded.**

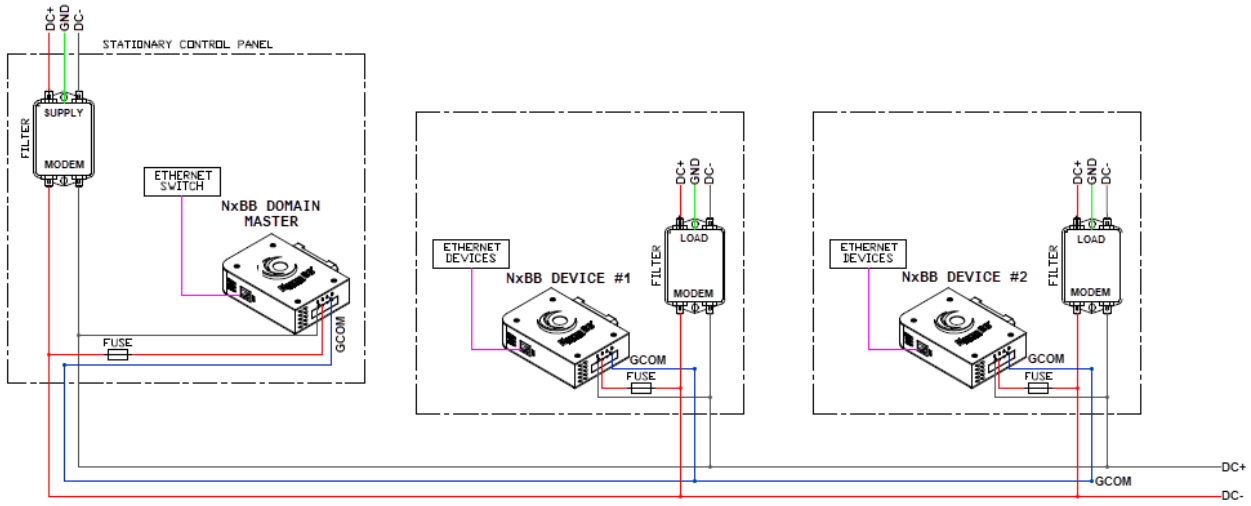


Figure: 7.6 - NxBB MIMO Communication Topology for Low-Voltage DC with additional General Communication Conductor.

7.7.C.3 When the V+, V-, and G are connected, the modem operates in MIMO mode.

7.7.D Wiring - Externally Powered Modems (XA-NBB-D...)

7.7.D.1 Externally powered modems separate communication coupling from operating power.

7.7.D.2 Communication Link Port

- Use terminals **C and B** or **B and A** for SISO operation. **(see Figure: 7.7)**.
- Use terminals C, B, and A for MIMO operation. **(see Figure: 7.8).**

7.7.D.3 No operating voltage is required on the communication link connectors.

7.7.D.4 External Power Port

- Connect DC+ to the low-voltage DC positive supply.
- Connect DC- to the low-voltage DC reference.
- Leave NC unconnected.

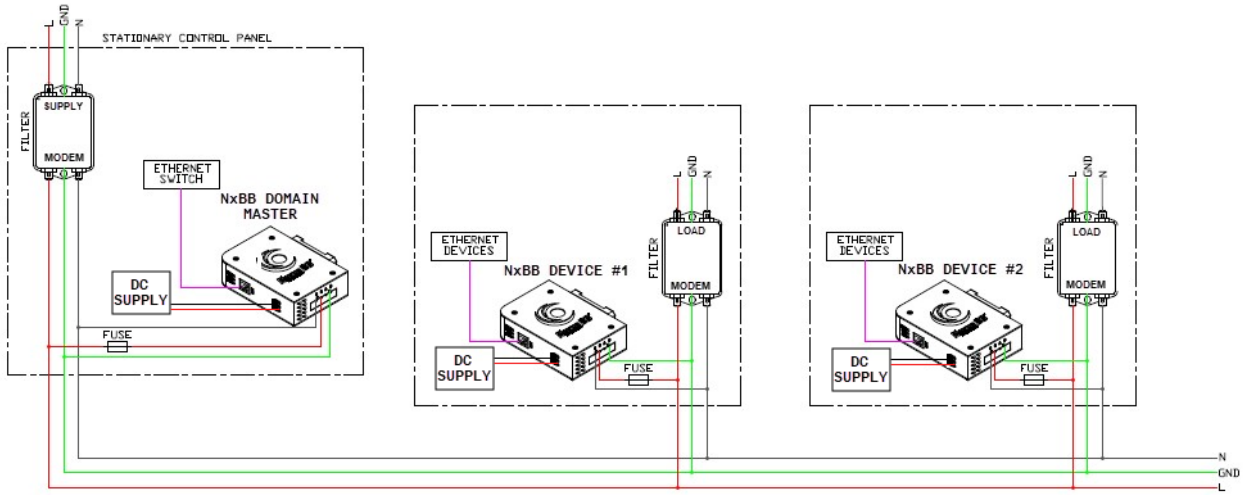


Figure: 7.7 - Example NxBB SISO Communication Topology for Externally-Powered Modems

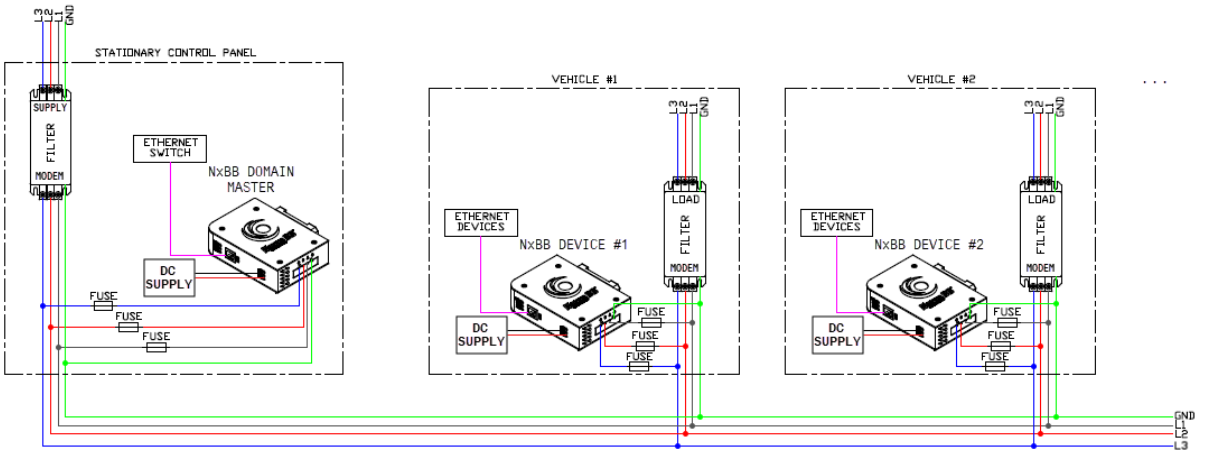


Figure: 7.8 - NxBB MIMO Communication Topology for Externally-Powered modems

7.7.E Connect the Modem to the Filter

1. Route the modem power line conductor from the modem to in-line fuse.
2. From the in-line fuse, route conductors to the terminal blocks.
3. From the terminal blocks, route conductors to the filter side marked **MODEM (G.hn).**
4. Keep this wiring short and direct.
    - Total conductor length from modem terminals to the power bus, including fuses, shall be less than **380 mm (15 in.).**

NOTE: **Filter terminal labeling may vary by model. ON NxBB LF series filters, the modem connection side is labeled "MODEM (G.hn)" Equivalent filters may use "LINE" to indicate this same connection point.**

7.7.F Connect the Power Network to the SUPPLY / LOAD Side

7.7.6.1 The filter side marked **SUPPLY / LOAD** is used to connect the NxBB system to the power network.

7.7.6.2 **Only one connection method applies,** depending on the installation location.

1. If the filter is installed at the power distribution point, connect the facility power supply to the terminals marked **SUPPLY / LOAD.**
2. If the filter is installed in-line on a **downstream power feed**, connect the downstream load conductors to the terminals marked **SUPPLY / LOAD.**
3. Verify that power feeding the NxBB conductor path passes through the filter before reaching the system.

NOTE: **On NxBB LF series filters, the power network connection side is labeled "SUPPLY / LOAD". Equivalent filters may use "LOAD" to indicate this same connection point.**

IMPORTANT: Do not install a power line filter between modems operating within the same NxBB domain. This will block communication **(see Section 8.2).**

7.8 Ethernet Connections

1. Connect a standard Ethernet cable from the NxBB modem **Ethernet Port** to the Ethernet device (PLC, switch, controller gateway).
2. Route Ethernet cable away from **unfiltered power cables**, motor drive conductors, and other high-current switching conductors where practical.
3. Use of **shielded Ethernet cable** is recommended in environments with elevated EMI.

7.9 NxBB Communication Path Integrity

7.9.1 The NxBB communication path between modems must remain uninterrupted at all times. Filters, ferrites, or other components that could attenuate the communication signal shall not be installed in the NxBB communication path between modems operating within the same domain.

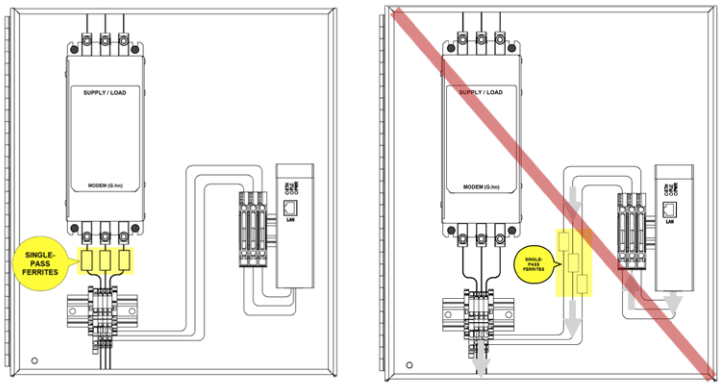


Figure: 7.9 - NxBB Communication Path Integrity: Ferrite installation (Proper vs. Improper)

NOTE: Ferrites intended to attenuate NxBB signal power are factory-directed items. If ferrite attenuation is required for a specific layout, installation instructions will be provided by Conductix-Wampfler.

7.10 EMC and Cable Routing Guidelines

7.10.1 NxBB system should be routed away from electrically noisy equipment such as motors, variable-frequency drives, welding equipment, and high-current switching devices whenever possible.

7.10.2 **Noise coupling classification**

- **Class 4 (Noisy):** AC power, chassis ground, motor drives, welding equipment
- **Class 3 (Slightly Noisy):** DC power, filtered AC, contactor and solenoid circuits
- **Class 2 (Slightly Sensitive):** low-power signals, 4-20 mA, 0-10 V, serial communication
- **Class 1 (Sensitive):** low-level analog and wideband communication such as Ethernet

7.10.3 The medium used to transmit the NxBB signal should be treated as **Class 2.**

7.10.4 **Minimum separation distances**

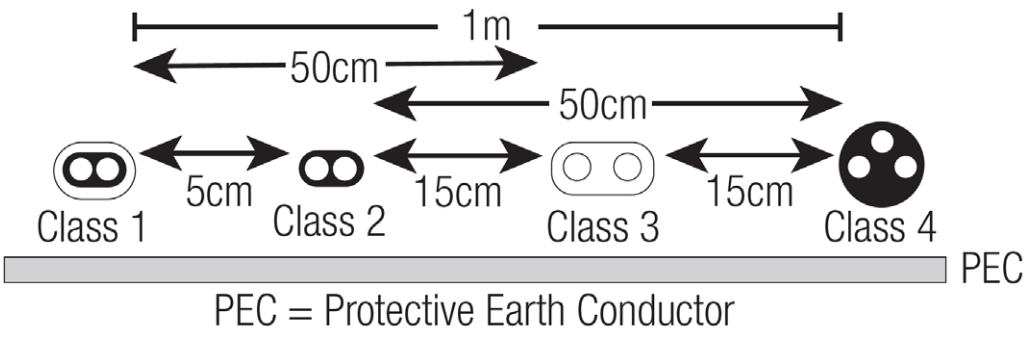


Figure: 7.10 - Minimum Separation Distances Between Cable with Different Classes

- Class 2 to Class 1: 5 cm (2 in.) minimum
- Class 2 to Class 3: 15 cm (6 in.) minimum
- Class 2 to Class 4: 50 cm (20 in.) minimum
- Between different NxBB domains: 50 cm (20 in.) minimum

7.10.5 Avoid parallel runs between NxBB signal-carrying conductors and noisy unfiltered power conductors. If crossing is required, cross at approximately 90 degrees and use an **S-bend** routing technique to reduce coupling.

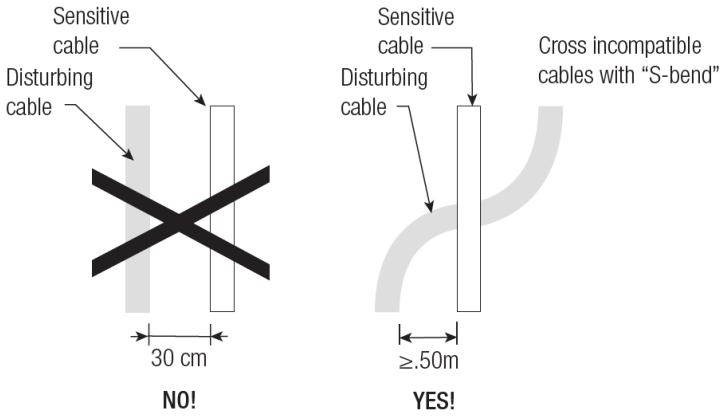


Figure: 7.11 - Illustration of "S-bend" cable routing technique

7.10.6 **Shielded Cable and Shield Grounding**

- If separation cannot be maintained:
  a. Shielding of the noise source cables is preferred.
  b. If shielded the noise source is not practical, shielding the NxBB conductors is acceptable.

7.10.7 Shielded cables shall use **single-point grounding only**, with the shield bonded at **one end** of the cable. The grounding point should be located at the **primary noise source** and connected using a low-impedance connection to the enclosure, or chassis ground. Single-point grounding prevents ground loops that could otherwise introduce additional electromagnetic interference (EMI).

NOTE: Do not connect the cable shield to the modem ground port.

7.11 Variable Frequency Drive (VFD) Considerations

7.11.1 NxBB systems installed downstream of, or in proximity to, Variable Frequency Drives (VFDs) require additional attention to EMI mitigation. Switching frequencies generated by inverter output can be conducted onto the power line or coupled into adjacent NxBB signal-carrying conductors.

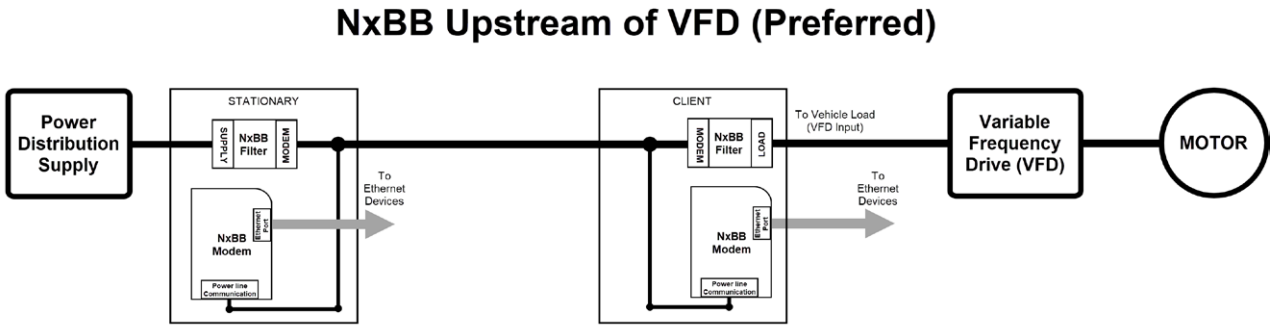


Figure: 7.12 - NxBB Downstream of Variable Frequency Drive output

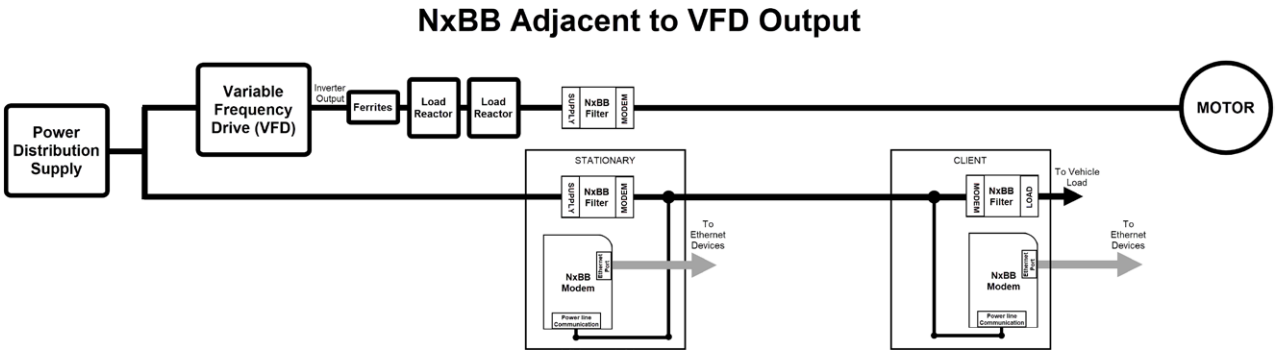


Figure: 7.13 - NxBB Cabling Routed Adjacent to Variable Frequency Drive Output

7.11.2 To ensure reliable NxBB communication, VFD outputs supplying or operating near NxBB systems shall be managed using appropriate combinations of load reactors, power line filters, ferrites. Load reactors, when required, are customer-supplied components and are not provided by Conductix-Wampfler. In applications requiring output filtering, multiple load reactors may be necessary to protect the drive output filter from excessive heating. Improper reactor selection can result in elevated temperatures that may lead to thermal stress or damage to the filter or reactor components.

7.11.3 Selection and sizing of load reactors is the responsibility of the customer and shall be based on the electrical characteristics and operating requirements of the VFD. As a general recommendation, load reactors rated at 2-3% impedance are commonly used for inverter output noise mitigation, unless otherwise specified by the VFD manufacturer.

7.11.4 Routing unfiltered VFD output cables adjacent to NxBB conductors should be avoided where practical.

7.11.5 Failure to mitigate inverter-generated noise may result in intermittent communication, increased retransmissions, or loss of NxBB connectivity.

NOTE: VFDs may be supplied with integrated input filtering. If the VFD in use does not include sufficient filtering, a line reactor may be required between the NxBB filter and the VFD, failure to provide proper filtering may result in overheating of the NxBB filter.

SECTION 7 - INSTALLATION AND WIRING

7.12 Common Installation Pitfalls

7.12.1 This subsection highlights common mistakes during NxBB installation to improve system reliability and reduce troubleshooting effort.

- Exceeding conductor length limits: Ensure total wiring from modem to power bus junction, including fuses, does not exceed 380 mm (15 in.).
- Incorrect domain assignment: Verify only one Domain Master per domain and that all Remote Nodes are configured correctly **(see Section 8.2)**.
- Filters placed between modems in the same domain: Installing a filter between modems within the same domain will block communication.
- Improper grounding or EMC separation: Ensure the filter is connected to a low-impedance ground, and NxBB signal-carrying conductors are routed away from unfiltered or noisy power cables.
- Replacing in-line fuses with breakers: Circuit breakers may attenuate the signal and disrupt communication. Always use in-line fuses for circuit protection per local regulations.
- Incorrect domain pairing: NxBB modems may be factory configured to different domains within the same shipment. Installing modems from different domains will not enable communication. Always check the QR code label and domain identification on each factory configured modem to ensure the correct Domain Master and Remote Node(s) are paired **(see Section 8.6).**

7.13 Power-Up and Verification

1. Restore system power per facility procedures.
2. Verify modem LED's **(see Section 6.1.D).**
    - **Power LED** ON
    - **Ethernet LED** ON with activity
    - **PLC / Communication LED** indicating NxBB communication
3. If communication is not established:
    - Verify filter orientation and grounding **(see Section 6.2).**
    - Verify NxBB communication path integrity
    - Verify domain configuration **(see Section 8.2).**
    - Follow basic troubleshooting guidance **(see Section 9).**

SECTION 8 - SYSTEM CONFIGURATION

8.0 System Configuration

8.0.1 This section describes the NxBB network behavior and configuration requirements, including domain structure and operation, installation guidelines, and commissioning procedures. It defines how NxBB devices interact within a system and parameters necessary to ensure stable and reliable operation.

8.1 Network Behavior

8.1.1 The NxBB system operates as a transparent Ethernet communication link between connected devices. Ethernet frames, including VLAN-tagged traffic and Quality of Service (QoS) prioritization, are transmitted without modification by the NxBB system.

8.1.2 Network protocols, addressing, routing, switching, traffic prioritization, and security functions are handled entirely by the connected Ethernet devices. NxBB does not perform any network management or packet processing functions beyond transport.

8.1.3 NxBB modems operate internally on a fixed link-local IP address range (169.254.xxx.xxx). This addressing is used solely for local configuration and diagnostics and does not impose any requirements on the facility Ethernet network addressing scheme.

8.2 Domains

8.2.1 Domains are used to logically separate NxBB systems and control which modems are permitted to communicate with each other. Domains prevent interference between multiple NxBB systems operating within the same facility.

8.2.2 Each NxBB modem belongs to a single domain. Only modems assigned to the same domain are able to exchange communication data.

8.2.3 Domains may be configured at the factory or programmed in the field using the G.hn Installation Tool.

8.2.A Domain Master and Communication Routing

8.2.A.1 Each NxBB domain contains exactly one Domain Master. All other modems within the same domain operate as remote nodes.

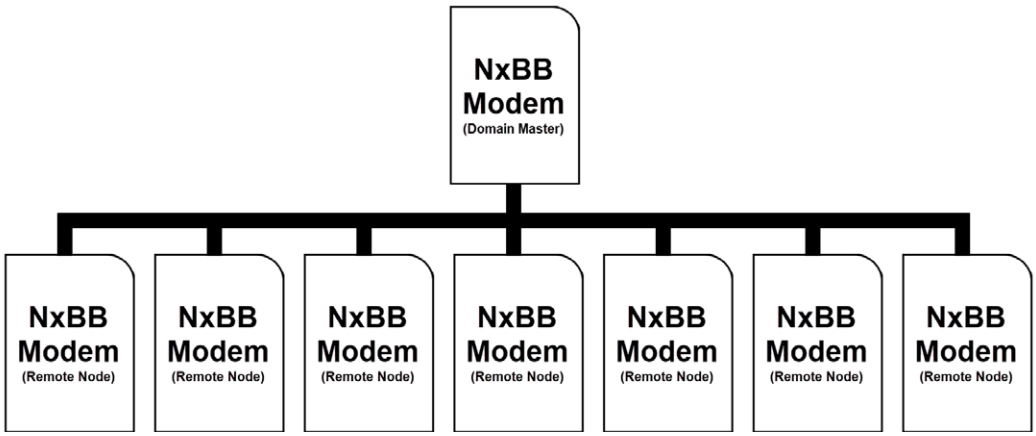


Figure: 8.1 - Example NxBB Domain Topology

8.2.A.2 All NxBB communication within a domain is routed through the Domain Master. Direct communication between remote nodes does not occur.

8.2.A.3 When a remote node sends data to another remote node, the communication path is:

- Remote node → Domain Master
- Domain Master → Destination remote node

8.2.A.4 Because all traffic is routed through the Domain Master, the physical placement of the Domain Master directly affects:

- Communication path length
- Latency
- Overall communication performance

8.2.A.5 For best performance, the Domain Master should be positioned to minimize the total conductor distance between itself and all remote nodes.

8.2.A.6 A single Domain Master can support up to seven (7) remote nodes within the same domain. Applications requiring more than seven remote nodes must use additional NxBB domains with appropriate physical separation.

8.2.A.7 Only one Domain Master is permitted per domain. Configuring more than one Domain Master within the same domain will prevent normal operation.

8.2.B Domain Configuration

8.2.B.1 Any modems within a single NxBB system must be configured to the same domain, or left in factory default configuration if domain separation is not required.

8.2.B.2 Domain configuration parameters include:

- Domain identification
- Security credentials
- Device role (Domain Master or remote node)

8.2.B.3 Domain configuration controls NxBB topology only and operates transparently to the Ethernet network.

8.2.C Domain Separation Between Systems

8.2.C.1 When multiple NxBB domains are present in the same facility, physical separation between domains is required to reduce the risk of unintended signal coupling.

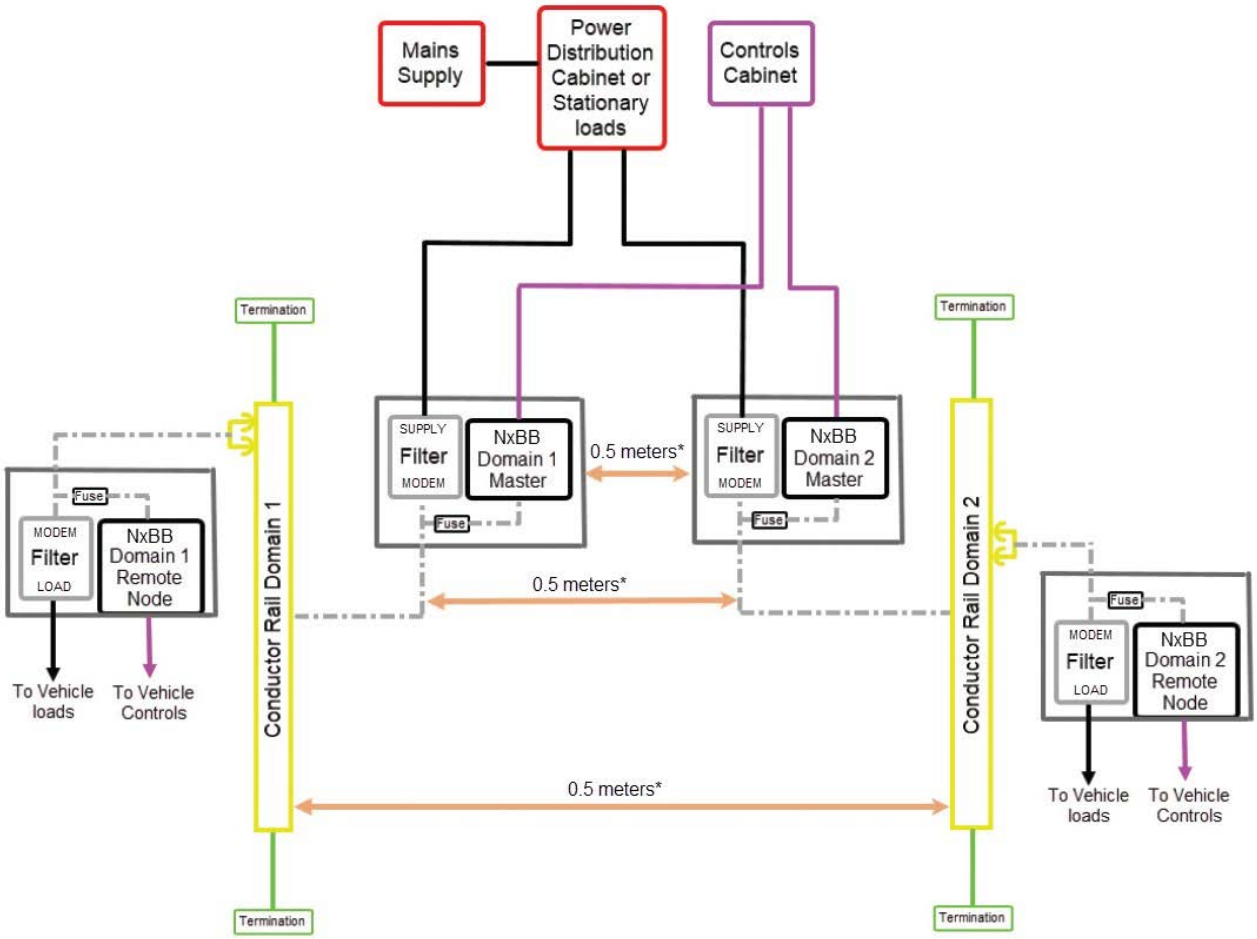


Figure: 8.2 - NxBB Domain Topology Recommended Separation

8.2.C.2 The minimum recommended separation distance between NxBB domains is:

- 0.5 m (1.65 ft) or greater between NxBB signal-carrying conductors and NxBB modems
- 0.5 m (1.65 ft) or greater between conductor rail systems operating in different NxBB domains

8.2.C.3 In most applications, maintaining separation greater than 0.5 m (1.65 ft) provides sufficient isolation. In special cases, reduced separation distances may be achievable depending on system layout, conductor spacing, and attenuation characteristics.

8.2.C.4 If an application cannot meet these separation distances, Conductix-Wampfler should be contacted for system evaluation and application-specific guidance.

SECTION 8 - SYSTEM CONFIGURATION

8.2.D Domain Performance Considerations

8.2.D.1 Adequate signal isolation between NxBB domains is required to maintain stable communication.

8.2.D.2 The G.hn diagnostic software reports a Received Signal Strength Indicator (RSSI) value that represents the observed signal between the NxBB devices. RSSI values may be used to assess relative isolation between domains during troubleshooting or system validation.

8.2.D.3 An RSSI value of -30 dB or less between domains indicates sufficient isolation and stable separation. RSSI values above -30 dB may result in intermittent communication or reduced system stability.

8.3 G.hn Installation Tool Overview

8.3.1 The G.hn Installation Tool is used to configure, commission, and verify NxBB systems. The tool communicates directly with an NxBB modem through the Ethernet interface and provides access to configuration parameters and system visibility.

8.3.2 The G.hn Installation Tool supports:

- Domain configuration and verification
- Assignment of Domain Master and remote node roles
- Visibility of NxBB devices operating within the same domain
- Restoration of factory network configuration settings when required

8.3.3 This section provides an overview only. Detailed instructions for software installation and operation are provided in Appendix 12.1.

8.4 Configuration and Commissioning Considerations

8.4.1 Before commissioning an NxBB system:

- Ensure all modems within a single system are configured to the same domain, or remain in factory default configuration if domains are not used
- Verify that only one Domain Master is configured per domain
- Confirm that the number of remote nodes does not exceed the supported limit
- Verify physical separation between different NxBB domains

8.4.2 Configuration changes require the modem to reboot before taking affect.

8.5 Factory Default Configuration

8.5.1 NxBB modems are shipped from the factory in a default configuration unless otherwise specified at time of order.

8.5.2 If required, factory network configuration settings may be restored using the **G.hn Installation Tool**. Restoring factory settings removes all programmed domain and security parameters. Information regarding the G.hn Installation Tool software may be found on the website referenced in Appendix 12.1.

SECTION 8 - SYSTEM CONFIGURATION

8.6 Domain QR Code Labeling

8.6.1 Modems factory-programmed to a specific domain include a domain suffix in the part number (-DM or -RN) indicating the configured device role.

8.6.2 Modems with domain suffix are programmed at the factory with a unique domain name (e.g. CxW-DM85). The assigned domain name is displayed on a QR code label affixed to the modem for identification purposes.

Figure: 8.3 - Domain QR Code

8.6.3 This labeling allows the Domain Master (DM) at the feed in location to be correctly matched with the corresponding Remote Node(s) (RN) installed on the vehicles. The domain name must match between the Domain Master and all associated Remote Nodes to ensure proper communication.

SECTION 9 - DIAGNOSTICS AND TROUBLESHOOTING

9.0 Diagnostics and Troubleshooting

9.0 This section provides guidance for identifying and resolving NxBB communication issue. Troubleshooting is based on observable modem behavior, LED status, and system-level symptoms. Diagnostic tools are referenced only to support system evaluation; this section focuses on the NxBB system itself.

9.1 General Troubleshooting Approach

9.1.1 When troubleshooting an NxBB system:

- Observe modem LED indications and operating behavior
- Verify correct installation of power line filters, wiring, grounding, and EMI mitigation as defined in **Section 7**
- Confirm domain configuration and device roles
- Evaluate exposure to electrical noise sources
- Use diagnostics to observe system behavior when required

9.1.2 Correction actions should address the **root cause** indicated by observed conditions rather than symptoms alone.

9.2 Common Fault Conditions and Corrective Actions

9.2.1 Common troubleshooting conditions, likely causes, and recommended corrective actions can be seen in Table 7.1. Conditions related to NxBB communication have been consolidated to reflect how issues typically present in the field.

Observed Condition	Likely Cause	Corrective Action
No LEDs illuminated	Power supply connections are incorrect or supply voltage is outside the specified range	Check power supply connections. Ensure the power source is present within the modem's specified operating range.
Power LED illuminated, Ethernet LED not illuminated	No ethernet device connected or Ethernet link inactive	Verify that an Ethernet device is connected and powered. Confirm Ethernet cable integrity and correct port usage.
Ethernet LED illuminated **PLC / Communication LED** not illuminated	NxBB signal path continuity issue	Inspect the NxBB signal path for unintended components such as filters, circuit breakers, or excessive wiring. Verify continuity of the conductor path between all modems.
	EMI mitigation requirements are not met	Verify grounding of the filter case. Confirm NxBB signal-carrying conductors are routed with adequate separation from unfiltered noise-generating power cables.
	Domain configuration mismatch	Confirm all modems are configured to the same domain. Verify that only one Domain Master is present and energized.
	Insufficient domain separation	Ensure physical separation between systems operating in different NxBB domains is at least 0.5 m (1.65 ft). Contact Conductix-Wampfler if recommended separation cannot be achieved.

Table: 7.1 - NxBB Fault Conditions and Corrective Actions

SECTION 9 - DIAGNOSTICS AND TROUBLESHOOTING

Observed Condition	Likely Cause	Corrective Action
Communication intermittent or unstable	Grounding or EMI mitigation deficiencies	Confirm correct installation and grounding of power line filters. Review conductor routing and separation from noise sources.
	Domain separation not sufficient	Verify physical separation between systems operating in different domains. Contact Conductix-Wampfler for evaluation if issue persists.
Communication quality degrades under electrical load	Noise introduced by upstream or adjacent equipment	Verify filter selection and installation. Reduce proximity to high-current switching devices and confirm low-impedance grounding of power line filters and any shielded cable.
Modem restarts periodically	Ethernet link not present (Ethernet LED off)	Connect an active ethernet device to the modem and verify Ethernet LED illumination.
	G.hn link not present (**PLC / Communication LED** off)	Connect another NxBB modem configured to the same NxBB Domain and confirm the **PLC / Communication LED** illuminates.
Modem restarts repeatedly or fails to remain powered	Power supply irregularity or absence	Verify that the supply voltage is present and within the modems specified operating range. Check wiring to the modem and terminal connections for proper polarity and continuity. Confirm that the external power supply (if applicable) is energized and stable.
Modem restarts immediately upon startup	Two modems configured as Domain Master within the same domain	Identify the second Domain Master. Power down or temporarily remove the modem from the power line network. Connect directly to the affected modem and reconfigure it as a Remote Node using the **G.hn Installation Tool**.

Table: 7.1 *(continued)* - NxBB Fault Conditions and Corrective Actions

9.3 Electrical Noise Considerations

9.3.1 Electrical noise is a common contributor to degraded NxBB communication performance. Sources such as variable-frequency drives (VFDs), inverters, and high-current switching equipment may introduce or coupled noise onto the power line network.

9.3.2 In some installations, noise generated upstream of the NxBB system may propagate through the conductor path, or noise from adjacent power cabling may couple into NxBB signal-carrying conductors. These conditions can result in intermittent communication, reduced throughput, or increased error activity.

9.3.3 Mitigation of electrical noise shall follow the EMC and noise-reduction practices defined in **Section 7**. Typical mitigation measures may include proper selection and installation of power line filters, controlled cable routing, and adequate grounding.

9.3.4 If noise sources cannot be sufficiently controlled by using the methods described in **Section 7**, contact Conductix-Wampfler for application-specific evaluation and guidance.

SECTION 9 - DIAGNOSTICS AND TROUBLESHOOTING

9.4 Diagnostic Visibility using G.hn Diagnostic Tool Software

9.4.1 The G.hn Diagnostic Tool software connects directly to an NxBB modem to monitor network performance and evaluate communication quality. Customers can obtain the software from the Conductix-Wampfler website; download instructions are provided in **Appendix 12.1.**

9.4.2 The software provides observation of the following:

- **Estimated RX Power and SNR**
  Received signal power and signal-to-noise ratio at the modem. Values may be used to interpret cumulative attenuation and coupling along the NxBB path.
- **PHY Block CRC Ratio**
  Percentage of corrupted data blocks requiring retransmission. Retransmissions often indicate noise interference on the power line network.
- **Effective PHY Throughput**
  Net physical-layer data rate after accounting for retransmissions.
- **Header Checksum Error Rate**
  Rate of detected Ethernet frame errors at the interface level.
- **Preamble Transition Missed Detection Rate**
  Rate of incorrect symbol detections during G.hn demodulation.
- **Total Information Bits per Symbol**
  Encoded bit count per symbol across carrier groups, providing modulation efficiency visibility.
- **Payload Bit Rate**
  Available raw data bandwidth for payload transmission.
- **Estimated Host-Level Throughput**
  Direct measurement of Ethernet throughput through the modem. Observed values depending on traffic direction and application behavior. *This metric is only available during a Network Traffic Test, not during Self-Generated Traffic Tests.*
- **Frame Rate**
  Total Ethernet frame activity, including errant frames.
- **Bit Loading Graph**
  Bits transmitted per carrier across the frequency spectrum, showing available transmission capacity.

9.4.A Diagnostic Directionality Considerations

9.4.A.1 G.hn diagnostics measurements are captured in one communication direction at a time. Both directions must be evaluated for a complete system assessment.

9.4.A.2 Observed impairments primarily reflect conditions experienced at the **receiving modem** in the selected direction. Directional differences provide insight into how noise, attenuation, or coupling affects each side of the NxBB system.

9.5 Installation-Related Considerations

9.5.1 Many NxBB communication issues originate from installation conditions rather than device faults. Common contributions include excessive conductor length, improper filter placement, insufficient grounding of the filter or shielded cable, and proximity to noise sources.

9.5.2 Installation requirements and mitigation practices are defines in **Section 7**. When troubleshooting persistent issues, review installation practices against those requirements to ensure compliance.

SECTION 9 - DIAGNOSTICS AND TROUBLESHOOTING

9.6 Escalation Criteria

9.6.1 If correct system operation cannot be achieved after verification of installation conditions and corrective actions described in this section, further evaluation is required.

9.6.2 Before contacting technical support:

- Record **modem serial numbers**
- Document installation layout and conductor routing
- Note observed system behavior and operating conditions

9.6.3 Contact Conductix-Wampfler technical support for application-specific evaluation and guidance.

SECTION 10 - TECHNICAL SPECIFICATIONS

10.0 Technical Specifications

10.0.1 This section provides detailed technical specifications for the NxBB modem series, including electrical, communication, environmental, and mechanical parameters. This reference is intended for proper selection, evaluation, and understanding of modem capabilities.

10.1 Modem Electrical Ratings

Modem Type	Part Number	Operating Voltage Range	Supply Voltage	Max. Current Consumption
Internal Power Supply	XA-NBB-A-I-AA	100-480 VAC / 150-300 VDC	Internal	150 mA
Internal Power Supply	XA-NBB-B-I-AA	220-600 VAC	Internal	100 mA
Internal Power Supply	XA-NBB-C-I-AA	18-48 VDC	Internal	400 mA
Externally Powered	XA-NBB-D-E-AA	Communication Link: 0-600 VAC / 0-300 VDC	18-60 VDC (external)	300 mA

Table: 10.1 - NxBB Modem Electrical Ratings

NOTE: Part numbers on system quotations or order confirmations may include a domain identifier suffix (e.g. -DM for Domain Master and -RN for Remote Node). This designation indicates factory configuration only and does not change the modems electrical ratings.

10.2 Communication Specifications

Specification	Details
Ethernet Standard	IEEE 802.3, IEEE 802.3x, IEEE 802.3u
Powerline Communication Standard	G.hn
Transfer Band	2-50 MHz SISO/MIMO
Security	128-AES
Ethernet interface Type	RJ45
Number of Ethernet Ports	1
Automatic Detection of Transmission Rate	Yes
Auto Negotiation	Yes*
Auto Crossing	Yes
Supported Industrial Ethernet Protocols	Ethernet/IP, PROFINET, TCP/IP, UDP, Modbus TCP/IP, EtherCAT**
Transmission Rate	SISO 175 Mbps / MIMO 350 Mbps
Recommended PLC Refresh Rate	64 ms with 3 retries (or greater)

Table: 10.2 - NxBB Modem Communication Specifications

*NxBB devices automatically negotiate their domain role unless a specific Domain Master or remote node role is manually configured.

**EtherCAT support: Integration depends on application-specific data throughput and latency requirements.

SECTION 10 - TECHNICAL SPECIFICATIONS

10.3 Environmental Ratings

Parameter	XA-NBB-A/B/C/D
Ambient Temperature (Operation)	-20°C to +60°C (A) / -20°C to +50°C (B) / -20°C to +70°C (C/D)
Ambient Temperature (Storage)	-40°C to +70°C
Humidity	0-95% non-condensing
Air Pressure (Operation)	795-1080 hPa
Air Pressure (Storage)	660-1080 hPa
Altitude (Operation)	-1000 m to 2000 m

Table: 8.3 - NxBB Modem Environmental Ratings

10.4 EMC and Safety

Specification	Details
Interference Immunity (IEC 61000 series)	Electrostatic discharge, cable-borne interference, voltage surge, high-frequency field interference
Emission of Radio Interference	EN 55011
Degree of Protection	IP20
CE Mark	Yes
UL Approval	Yes
cULus	Yes

Table: 10.4 - NxBB Modem EMC and Safety

10.5 Mechanical Ratings

Specification	XA-NBB-A/B/D	XA-NBB-C
Width	135 mm (5.32 in.)	125 mm (4.92 in.)
Height	105 mm (4.13 in.)	95 mm (3.74 in.)
Depth	42 mm (1.65 in.)	35 mm (1.38 in.)
Weight	A/B - 340g (0.75 lbs.), D - 285 g (0.63 lbs.)	210g (0.46 lbs.)
Vibration Resistance (IEC 60068-2-6)	2 g (m/s^2) wall mounting, 1 g (m/s^2) DIN rail	2 g (m/s^2) wall mounting, 1 g (m/s^2) DIN rail
Shock Resistance (IEC 60068-2-27)	Yes	Yes

Table: 10.5 - NxBB Modem Mechanical Ratings

10.6 NxBB Modem Connections

Part Number	Modem Connection	Interface / Wire Size
XA-NBB-A... / XA-NBB-B...	Ethernet Port	RJ45
	Powerline Communication Port	5.0-0.25 mm^2 (10-24 AWG)
XA-NBB-C...	Ethernet Port	RJ45
	Powerline Communication Port	2.5-0.08 mm^2 (12-28 AWG)
XA-NBB-D...	Ethernet Port	RJ45
	External Power Port	2.5-0.08 mm^2 (12-28 AWG)
	Communication Link Port	5.0-0.25 mm^2 (10-24 AWG)

Table 10.6 - NxBB Modem Connections

SECTION 11 - SECURITY

11.0 Security

11.0.1 The NxBB system is designed with inherent security advantages due to its use of powerline communication, which requires physical access to the conductor path. Additional measurers enhance communication integrity and access control.

11.1 Physical Access Control

11.1.1 NxBB communication requires physical connection to the powerline network.

11.1.2 Access to modems, filters, and conductor circuits should be restricted to authorized personnel only.

11.1.3 Enclosures housing NxBB components should be secured and monitored to prevent unauthorized tampering.

11.2 Powerline Communication Network Security

11.2.A Encryption

11.2.A.1 All communication within the NxBB network is protected using **AES-128 encryption.**

11.2.A.2 Encryption ensures confidentiality and integrity of data transmitted over the powerline network.

11.2.A.3 This security measure applies to all modems and domains within the NxBB network.

11.2.B Domain Assignment

11.2.B.1 NxBB modems may be configured into **separate networks (domains)** to logically separate different groups of devices.

11.2.B.2 Domain assignment ensures that only modems configured in the same domain can exchange data.

11.2.B.3 Each domain can be protected with a password to prevent unauthorized addition of modems.

11.3 Network Configuration and Firewall

11.3.1 Users are responsible for managing network configurations to prevent unauthorized access.

11.3.2 Proper configuration of connected Ethernet devices, including firewalls and VLAN settings, is essential to ensure secure operation.

11.3.3 NxBB modems do not provide routing or firewall functionality; these responsibilities reside with the connected network equipment.

11.4 User Responsibilities

11.4.1 Management of **Powerline Communication Network, Domain Assignment, Network Configuration,** and **Physical Access Control** is the responsibility of the user.

11.4.2 Follow facility and organizational policies to restrict access, maintain secure passwords, and implement proper network segmentation.

11.4.3 Regularly review access and permissions and monitor for any unauthorized connection attempts.

SECTION 12 - APPENDIX

12.0 Glossary of Terms

12.0.1 This section provides definitions for technical terms used throughout this manual. Definitions are presented in clear, concise language to assist users in understanding NxBB system documentation.

Term	Definition
AES-128	Advanced Encryption Standard with 128-bit key length, used to secure communication over the NxBB network.
Domain	A logical network grouping within the NxBB system that separates communication between different sets of devices.
EMC (Electromagnetic Compatibility)	The ability of equipment to operate without interference from, or causing interference to, other devices.
EMI (Electromagnetic Interference)	Disruption of an electrical circuit caused by electromagnetic radiation from another source.
G.hn	A standardized technology for transmitting high-speed data over existing wiring, such as powerlines.
IP Rating	Ingress Protection rating, a standardized measure of resistance to dust and water.
MIMO	Multiple-Input Multiple-Output; a method for increasing data transmission rates using multiple simultaneous communication paths.
Modem	A device that converts data from Ethernet into signals suitable for transmission over power lines.
Power Line Communication (PLC)	A method of transmitting data over electrical power lines using specialized modems.
QoS (Quality of Service)	Mechanisms for prioritizing network traffic to ensure reliable communication performance.
RSSI (Received Signal Strength Indicator)	A measure of signal strength received by a modem, primarily used to evaluate separation between NxBB domains.
SNR (Signal-to-Noise Ratio)	A measure of signal strength relative to background noise, expressed in decibels (dB).
SISO	Single-Input Single-Output; a single communication channel for data transmission.
VLAN (Virtual Local Area Network)	A logical subdivision of an Ethernet network that separates traffic for management, security, or performance purposes.

Table: 12.1 - NxBB Glossary of Terms

12.1 Additional Resources

12.1.1 This section links and references for additional support, including tools, manuals and training materials to assist with installation, configuration, and troubleshooting of NxBB systems.

- **Training Videos, Manuals, and Software Tools**
  View instructional videos, installation guides, detailed manuals, and download the G.hn Installation and Diagnostic Tools for NxBB systems. All resources are available on the Conductix-Wampfler product page: *https://www.conductix.com/products*
- **Technical Support**
  For additional technical assistance or product support, contact your regional Conductix-Wampfler representative. Locate your regional contact here: *https://www.conductix.com/contact*

NOTES

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To provide you with energy and data transmission systems that will keep your operations up and running 24/7/365.

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