Connectivity Platforms for Industrial Applications

Industrial environments can be dirty, hot, cold, wet, and potentially hazardous in a wide variety of other ways. The keys to successful deployment of an industrial application are: safeguarding against damage to sensitive electronic equipment; designing data capture and networking solutions that are simple and robust; and using components that can be integrated quickly and easily.

Cabling and Connectors

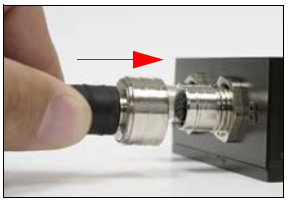
Industrial cabling and connectivity schemes must be able to withstand environmental extremes of heat, cold, and moisture, and be secure enough not to be disconnected or damaged inadvertently in the course of day-to-day operation.

The current industry standard for connectivity is a sealed, circular connector such as the M12. The International Electrotechnical Commission (IEC) **standard for M12 connectors** describes them as fixed and free screw-locking connectors. This type of connector is widely available off-the-shelf from manufacturers such as **Turck**, **Lumberg**, **Phoenix Contact**, **Molex**, or **Binder**.

Providers of industrial automation solutions offer a variety of cabling and connector options—some that are ideally suited to industrial applications, and some that are significantly less ideal. Microscan's industrial products have traditionally featured D-subminiature (D-sub) connectors and cables, but with the introduction of Quick Connect industrial connectivity technology, Microscan has transitioned to a technology that uses sealed, circular connectors with Ultra-Lock™ technology on all new industrial products.

Then: D-sub connectors are better-suited to computer hardware and related peripherals than to rugged industrial environments.

D-sub Connectors



Now: Ultra-Lock connectivity is not only more resistant to harsh industrial conditions, but is also quick and easy to assemble.

Microscan QX-830 with M12 Ultra-Lock Connector

Ultra-Lock vs. Screw-Down Connectors

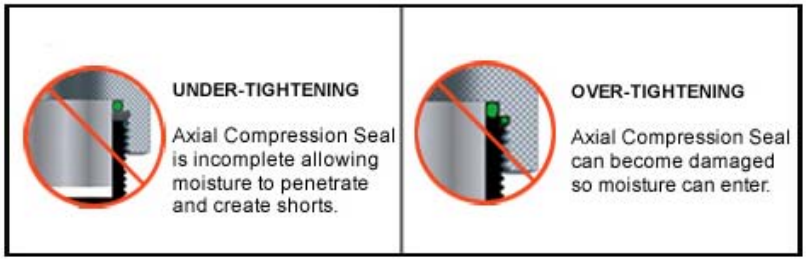
There are multiple types of circular connectors, many of them identified by the prefix "M" followed by the connector's diameter in millimeters (M8, M12, M23). These kinds of connectors can be used for power supply or to bus communications and power between devices. Microscan has chosen the Ultra-Lock connector type as part of its Quick Connect technology because of speed, ease-of-use, and ingress protection considerations. Ultra-Lock connectors can withstand high-pressure, high-temperature "wash-down" conditions. The connectors are made of high-grade stainless steel, with a plastic contact carrier that can withstand high temperatures. The main advantage of the Ultra-Lock system is that only two steps are required at every connection point:

(1.) Align the connector and receptacle keys;

(2.) Push the connector into place. (Do not twist the connector, as this can bend the pins.)

Ultra-Lock connectors are "operator-independent". This means that they are not subject to under-tightening or over-tightening, both of which are common problems with screw-down connectors, and both of which undermine the moisture-resistant seal.

Ultra-Lock Connector



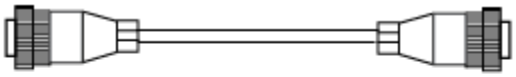
Traditional Threaded Connectors

"Ultra-Lock" is a trademark of Woodhead (Molex).

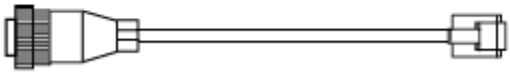
Another advantage of Microscan's switch to an Ultra-Lock connectivity scheme is that Ultra-Lock receptacles (on scanners and connectivity devices) also accept screw-down connectors, giving users the flexibility to use either Ultra-Lock or screw-down connectors.

Cordsets vs. Cables

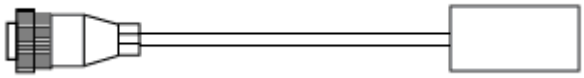
The terms "cordset" and "cable" are both applicable to industrial connectivity, but they are not synonymous. Cordsets enable communications and power between devices using Quick Connect technology. Cordsets have an M12 Ultra-Lock connector at one or both ends. Examples of cordsets are shown below.



M12 Ultra-Lock to M12 Ultra-Lock Cordset

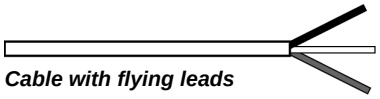


M12 Ultra-Lock to RJ45 (Ethernet) Cordset



M12 Ultra-Lock to Photo Sensor Cordset

Cables do not have M12 Ultra-Lock connectors at either end. An example of a cable is shown below.

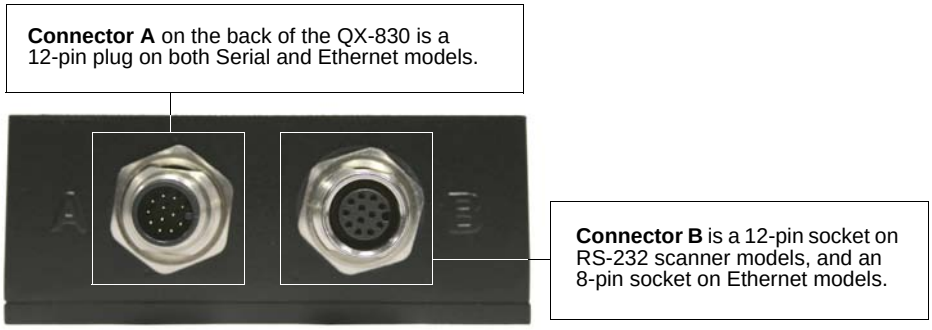


Cable with flying leads

Scanners and Interface Accessories

When deploying a network of scanners and interface devices in an industrial setting, it is important to use components whose pin assignments are arranged in a way that avoids communication errors and equipment damage. The automation engineer's network design task is greatly simplified when components are designed in a way that is logical, consistent, and easy to implement.

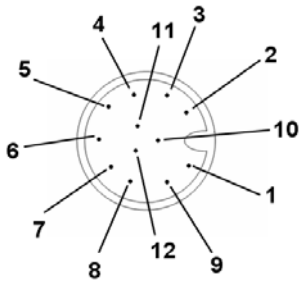
Microscan's QX-830 Compact Industrial Scanner is an example of a scanner with a very simple pin assignment methodology. The clearly identified connectors at the back of the unit can be used to receive and bus power, and also to send and receive data and commands.



QX-830 Connectors

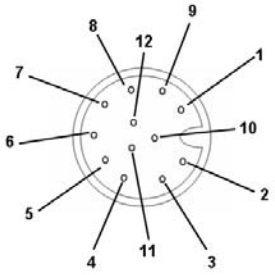
Scanner Connector Pin Assignments

As shown in the diagrams and pin assignment tables below, the QX-830 connectors are designed to facilitate transmission of power and data signals as cleanly as possible. In a practical sense, this means that the connection scheme eliminates the possibility of shorting wires, and signal "cross-talk" is avoided. The consistency of plug and socket design (Connector A is always a plug and Connector B is always a socket), as well as the pin assignments themselves, are intended to help automation engineers avoid such network mishaps.



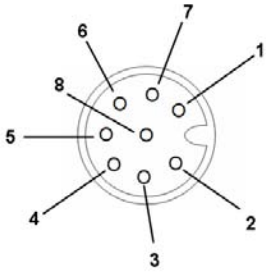
QX-830 Connector A M12 12-pin Plug

Pin	Assignment
9	Host RxD
10	Host TxD
2	Power
7	Ground
1	Trigger
8	Input Common
3	Default
4	New Master
5	Output 1
11	Output 2
6	Output 3
12	Output Common



QX-830 Connector B (Serial) M12 12-pin Socket

Pin	Assignment
9	Port 2 TxD/Port 1 RTS
10	Port 2 RxD/Port 1 CTS
2	Power
7	Ground
1	Trigger
8	Input Common
3	Terminated
4	Input 1
5	Port 3 422/485 TxD (+)
11	Port 3 422/485 TxD (–)
6	Port 3 422/485 RxD (+)
12	Port 3 422/485 RxD (–)



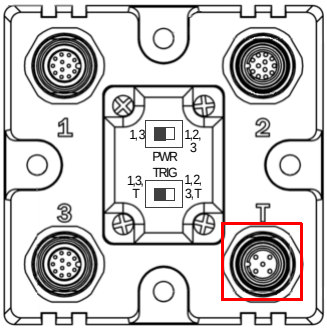
QX-830 Connector B (Ethernet) M12 8-pin Socket

Pin	Assignment
1	Terminated
2	Terminated
3	Terminated
4	Port 4 TX (–)
5	Port 4 RX (+)
6	Port 4 TX (+)
7	Terminated
8	Port 4 RX (–)

Important: The 8-pin Ethernet version of Connector B does not have RS-422/485, Input 1, or RTS/CTS pins.

Interface Accessories

Simplicity of connector and pinout design with Quick Connect technology is complemented by the flexibility of the accompanying interface device. Although the M12 receptacles on the QX-1 interface device physically mirror those on the QX-830 scanner, they do not have explicit pin assignments. The QX-1 allows users to bus power and communications as required by the application.

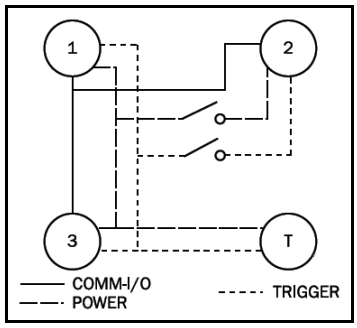


QX-1 Interface Device

Connectors 1 and **3** are 12-pin plugs, and **Connector 2** is a 12-pin socket. All three connectors can be assigned to bus power and data as required by the application.

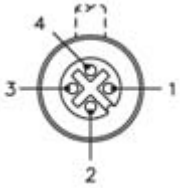
The two switches at the center of the device allow the user to route signals as needed.

The simple diagram at right (also shown on the base of the QX-1 illustrates how power, communications, I/O, and trigger signal can be routed through the QX-1 device depending on the needs of the application. The switches greatly increase signal routing flexibility.



QX-1 Communications - I/O - Power - Trigger

Pin	Assignment
1	+ 10-28V
2	Trig/NM/Input 1 Common
3	Ground
4	Trigger



QX-1 Trigger Connector 4-pin Socket

Port Routing

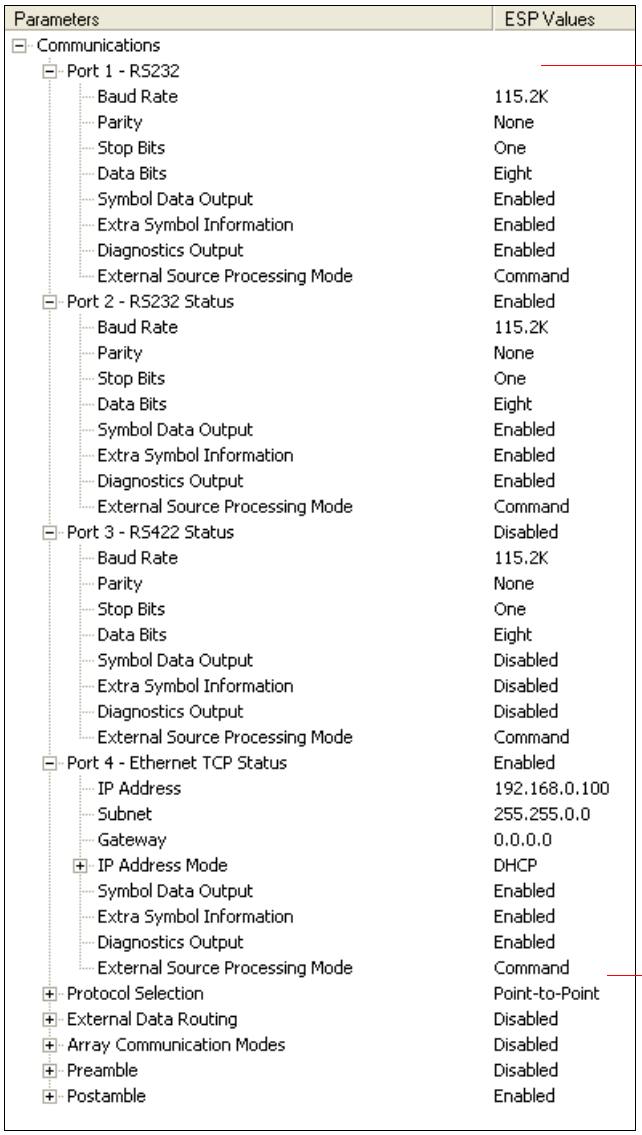
The physical advantages created by flexible signal routing and switching are enhanced further by **Port Routing**, which can be configured in Microscan's **ESP® Software**. Port Routing eliminates the need for dedicated "Host" and "Aux" ports in a traditional sense. With Port Routing, any port can be defined as a Host or Aux port. Port Routing also allows users to define the data types that are accessible from specific ports.

The primary benefit of Port Routing is that any type of data can be routed to any port, and can be sent through multiple ports simultaneously. Multiple types of data can also be appended to the symbol data that is output from the scanner to the host. Command data, symbol data, extra symbol information, and diagnostic data are enabled by default in the QX-830.

The table below lists different types of data, with examples for each data type.

Data Type	Example
Command Data	Serial commands; scanner responses to serial commands.
Symbol Data	Any string of data encoded in a symbol.
Extra Symbol Information	Decodes per trigger, decode direction, configuration database index number.
Diagnostic Data	Laser status, temperature, service message.

The screen capture below (from ESP Software) shows the QX-830's four communications ports and the parameters for each.



Ports 1, 2, and 3 are serial ports (RS-232 and RS-422). Port 1 is always enabled. Ports 2 and 3 can be enabled or disabled to match the physical requirements of the application. Port 4 is an Ethernet port, and can also be enabled or disabled as required.

Each of the three serial ports can be configured for Baud Rate, Parity, Stop Bits, Data Bits, Symbol Data Output, Extra Symbol Information (Decodes Before Output, Symbol Position Output, etc.), Diagnostics Output, and External Source Processing Mode (Command or Data).

The Ethernet port can be configured for IP Address, Subnet Mask, Gateway, IP Address Mode (Primary or Secondary TCP Port), Symbol Data Output, Extra Symbol Information, Diagnostics Output, and External Source Processing Mode.

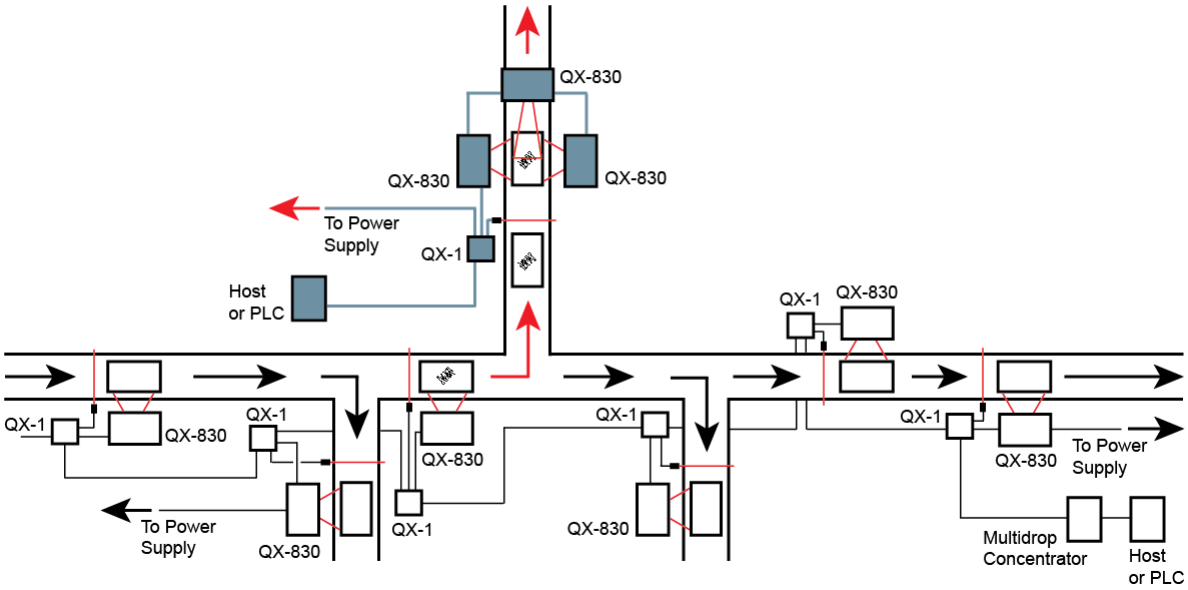
Application Solutions

The following examples demonstrate how the components described in previous pages can be deployed in industrial applications.

Daisy Chain

Daisy chain configurations are used in applications such as product packaging, where single items have multiple symbols. For example, a box with one symbol on the top and symbols on either side requires at least three scanners to ensure that all symbols will be decoded.

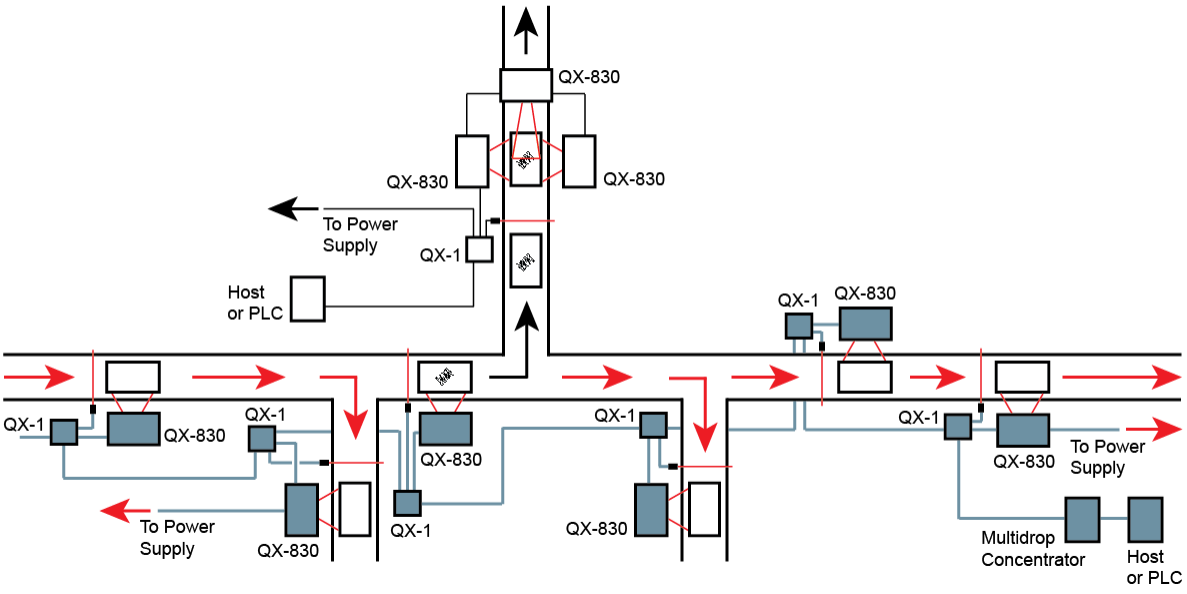
The highlighted areas below demonstrate how a daisy chain can be arranged. One scanner is placed above the conveyor line and one scanner is placed on each side of the line. The three scanners essentially function as a single scanner, and data is sent from the primary scanner to the host or PLC.



Multidrop

Multidrop networks are used in applications where it is necessary to decode symbols at multiple locations within an industrial process. Scanners are placed at stations located between manufacturing steps, and data from those scanners is directed to a multidrop concentrator before being sent to a host. An example of this type of application is food packaging, in which part number data is collected and tracked throughout the packaging process.

The highlighted areas below demonstrate how a multidrop network can be arranged.

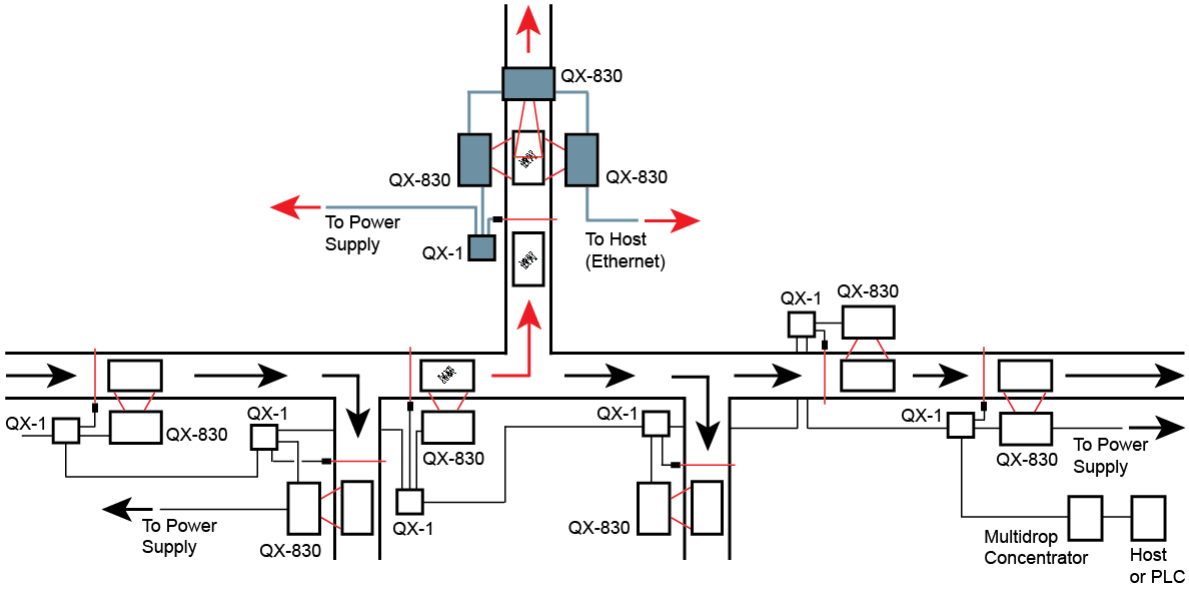


Ethernet TCP/IP and EtherNet/IP

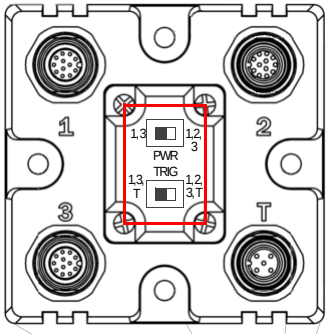
Ethernet TCP/IP is the standard Ethernet interface used to connect multiple locations in a network, such as computers in an office network. It can also be used to network other communications devices, such as scanners and PLCs on a factory floor.

EtherNet/IP™ is a protocol developed and governed by **ODVA** (Open DeviceNet Vendors Association). It is based on the Common Industrial Protocol (CIP™). The CIP layer is an additional layer within the standard Ethernet interface (Ethernet TCP/IP). EtherNet/IP is common in control systems and PLCs, especially in the United States.

The highlighted areas below demonstrate how an Ethernet daisy chain can be arranged. Ethernet-enabled scanners can also be set up in standalone configurations, or multiple Ethernet-enabled scanners along a production or packaging line can be connected to Ethernet.

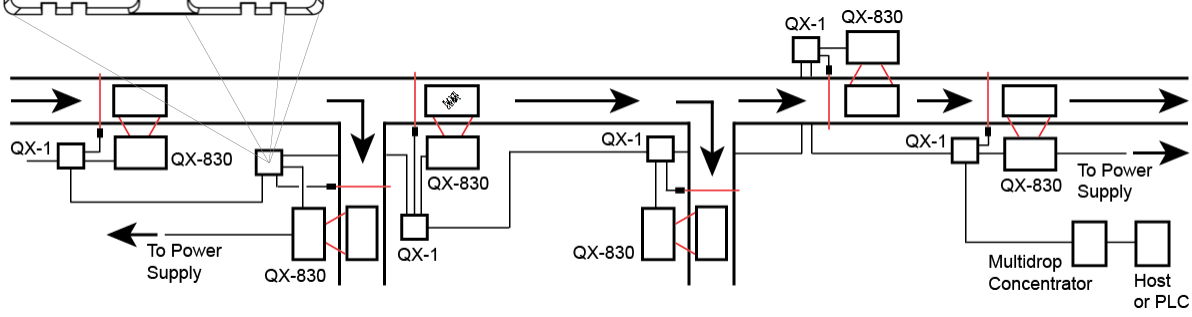


Power and Trigger Switching



Power can be bussed between scanners and interface devices. At each location on a network where a new power supply is added, the Power switch on the QX-1 can be used to break power between Connector 2 and Connectors 1, 3, and T.

The **Trigger** signal between Connector 2 and Connectors 1, 3, and T can be broken using the Trigger switch. This isolates trigger signals as required by the application.



"EtherNet/IP" and "CIP" are trademarks of the Open DeviceNet Vendors Association.