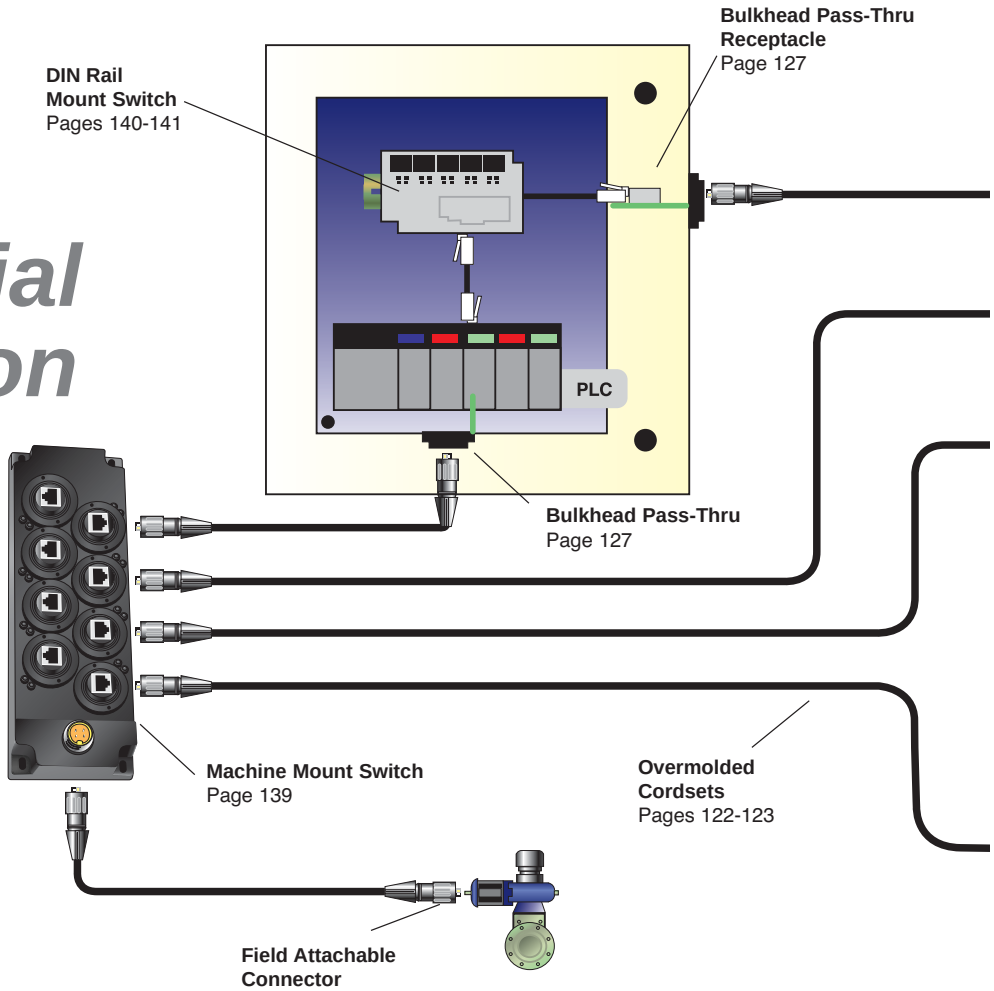
A Dynamic Force in Industrial Automation and Controls



COMPONENTS AND ELEMENTS OF ETHERNET SYSTEM

Control Engine

PC "soft controllers" or PLCs can act as the main control engines, taking the current I/O status off the network and solving these operations through the main control program. The new status of the I/O is then updated via the network interface to the actuators, starters and interface panels. Many times a central control engine acts as the DeviceNet "master" which initiates and controls many of the messaging sequences of the network.

Network Interface

The scanner resides in a controller whether it is a PLC or PC, and provides a network connection. The scanner exchanges a data table, which is loaded with the various values of the inputs and outputs, with the logic controller to solve the various logical expressions. Simultaneously the operation of the master and/or slave protocols is completed. The logical expressions are then re-exchanged with the data table for communication out to the various nodes and I/O residing on the network. The scanner generally supports all standard baud rates of the network.

Active I/O Devices

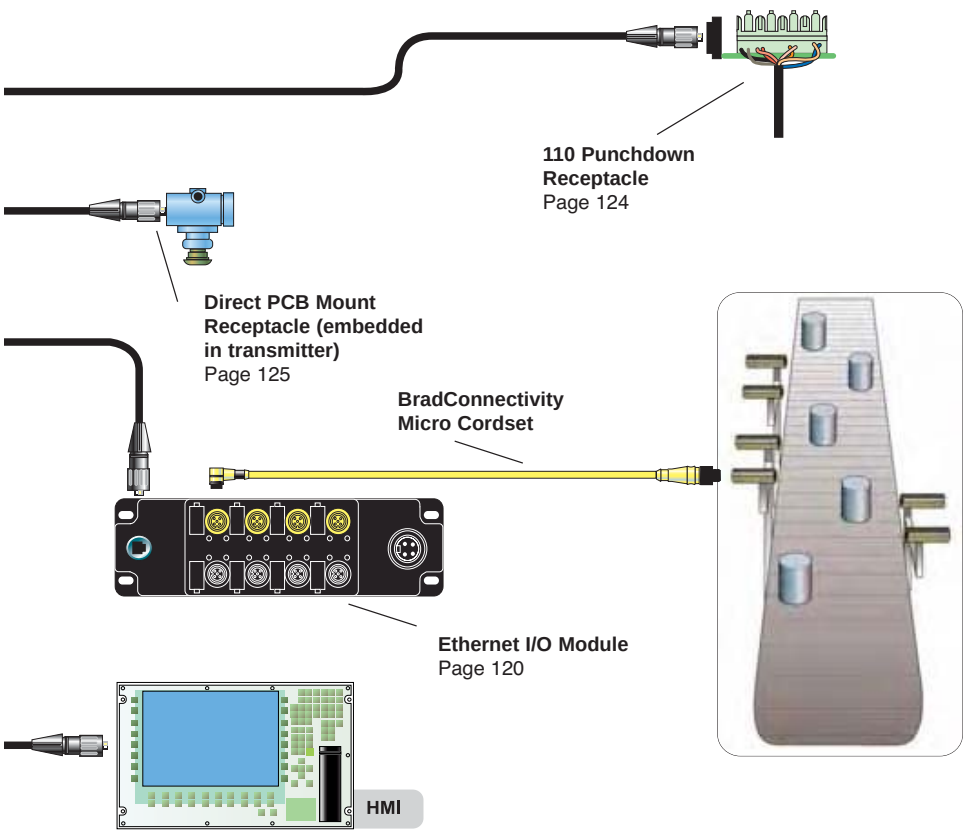
These are devices which incorporate their own Ethernet transceiver and physical network connections. Detailed information can be received back from the I/O devices with a sensor being able to report back such information as distance measurements, power status, last-time to maintenance, etc.

Active I/O Modules

Active blocks serve as a gateway to enable non network input and output devices to send and receive data over the network. The actual I/O send a standard electrical signal via a BradConnectivity quick disconnect cordset, which is then converted to the appropriate Ethernet protocol for network transmission.

Gateways

Seamlessly transfer data in real time between dissimilar network protocols.



BRAD® AND ETHERNET

BradConnectivity™ RJ-Lnxx® ethernet products provide solutions that enable the world's most popular Local Area Network to be reliably utilized on the factory floor or in harsh commercial environments. One option combines an RJ-45 connector with a threaded overmolded connector and another option utilizes industry-standard Micro-Change® M12 connection technology. The BradConnectivity line offers a variety of physical media, including receptacles, bulkhead passthrus and cordsets which provide the robustness needed to survive outside of a benign office environment. Compatible active Ethernet switches play a key role in transmitting time-critical control-related data in a reliable manner, and unlike their commercial grade counterparts are designed to live in either an industrial enclosure or directly on the outside of a machine. With BradConnectivity™ Ethernet products in place, true connectivity between the manufacturing operation and the enterprise system is now a reality.

Media

Ethernet systems are predominately designed in a star topology using twisted pair copper cable and/or fiber optic cable. Twisted pair cables either field terminate, usually to a 110 punchdown block, or utilize an RJ-45 or a Micro-Change M12 connector. A variety of connectors exist for fiber optic cabling including SC, ST and MT-RJ versions.

Twisted Pair Cable/Cordsets

Copper based cable, using 2 or 4 twisted pairs. Several different types of cable are available including Shielded (STP) or Unshielded (UTP), as well Solid Core or Stranded. The cable can either be field terminated to a receptacle via a 110 punchdown block, or can come with RJ-45 or Micro-Change M12 connectors (often referred to as a patch cable).

Fiber Optic Cable

Transmits data by means of light pulses emitted from a laser or LED. This method provides for longer transmission distances (2 km) and the ability to support higher transmission speeds. Because of this capability, fiber is popular for use as a backbone cable connecting various network segments. Cordsets are available with several types of connectors including ST, SC and MT-RJ.

Switching Hub

Ethernet uses a star topology, requiring a message to be sent through a central device. A switching hub is a islayer 2ll device which connects to an Ethernet station, stores the transmitted message, then forwards it out the appropriate port.

Cordsets

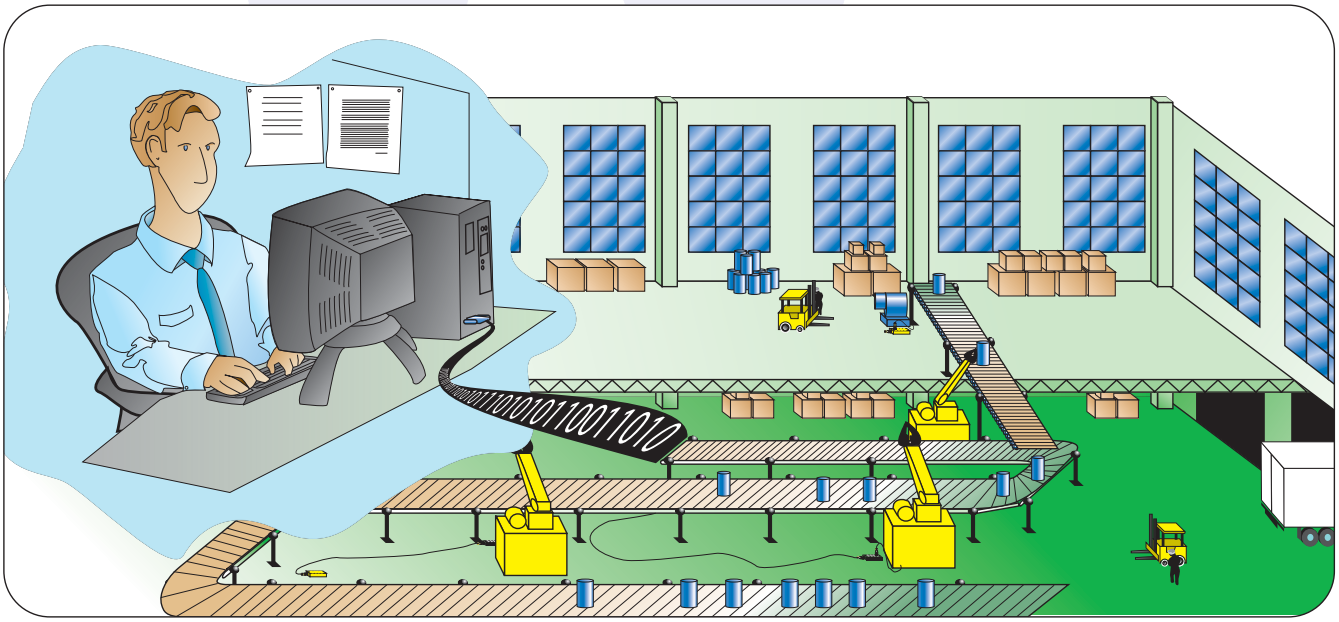
Input and output connections from the blocks to devices like sensors or valves are made with industry standard 12mm Micro-Change® DC style connections.

Server/Firewall

As the network requirements of a factory, particularly one used to transmit time critical control data, are different than those of the front office, it is often desirable to have all factory communications be linked to their own server. This form of network design not only assists in minimizing front office transmissions from using up factory floor bandwidth, but provides a security function which regulates access to sensitive data and functions.

BENEFITS OF USING ETHERNET IN A MANUFACTURING OPERATION

- Enhanced information flow between the manufacturing process and the enterprise computing system: Numerous manufacturing entities have recently invested large amounts of money in installing Enterprise Resource Planning (ERP) software, and implementing Just in Time (JIT), cellular production systems. One key to realizing a return on these types of initiatives is extracting real time data from the factory floor. Having to traverse multiple networks to get this data to the point it can be utilized adds a great deal of complexity to the endeavor. Having a single network simplifies the process, and in the case of Ethernet, the ability to carry multiple application layers on the same wire enables both factory floor and front office computing devices to receive information without excessive amounts of data manipulation.
- Ease of maintainability: One obstacle that prevents customers from implementing networks in their plant is the issue of who's responsible for its operation. For current open industrial networks, the common solution is to designate a specific controls/maintenance engineer to be specially trained to provide support. By standardizing on Ethernet, the number of support options greatly increase, and in many cases the Ethernet experts already in your IT department can be utilized.
- Ability to web enable machinery: Once the plant floor equipment and controls are wired together via Ethernet, it is a simple next step to collect information and provide a Human Machine Interface (HMI) via intranet/Internet, often by utilizing standard browser technology. Individual machines can also be designed to serve up web pages that can provide key diagnostic information, potentially preventing having to send service personnel to a remote site.
- Leverage commercial technology: With the myriad of resources devoted on the commercial side, Ethernet technology and products evolve at a highly dynamic pace. The vast market volumes can often lead to lower hardware costs, particularly in the area of Network Interface Cards (NIC).



3 COMMON OBSTACLES TO USING ETHERNET ON THE FACTORY FLOOR WHICH CAN NOW BE OVERCOME:

Determinism

Ethernet networks regulate how devices gain access to the channel for message transmission through a concept known as Carrier Sense Multiple Access Collision Detect (CSMA/CD). All devices listen to the network, and may try to send a message if they do not sense any other traffic on the channel. However, if more than one device tries to access the channel at the same time, a collision occurs. All of the devices backoff and will try again a random amount of time later. This is different than many other industrial networks which use arbitration schemes so critical messages receive priority in reaching their destination. CSMA/CD makes Ethernet inherently non-deterministic because it can't be known exactly how many times a collision may occur. While this may seem to preclude the use of Ethernet to deliver control-related information, there are two factors that need to be looked at:

Throughput: The network user needs to understand if what they really need is determinism (the ability to calculate a repeatable amount of time in which the message will be delivered) or throughput (having the message reliably delivered within a certain time frame, even if that time is variable within that range). The wire speeds of Ethernet are often orders of magnitude faster than other industrial networks, meaning that even with multiple collisions there is an extremely high likelihood that Ethernet will provide much quicker delivery of control related messages.

Switching technology: When devices are connected to a repeater hub, those devices are all part of a collision domain, vying for channel access. Using a switching hub eliminates collisions by creating dedicated bandwidth between the device and the switch. While there is still a latency variable for the switch to forward the message, using only switches for network design can satisfy a large amount of applications that do require determinism.

BradCommunications™ Industrial Ethernet DIN Rail-Mounted Switch

Lack of an open application layer

Ethernet, even when combined with TCP/IP, still does not provide the complete specification for network transmission, as it does not call out an application layer (analogous to the language the network speaks). Unlike in an office where a handful of application layers (FTP, SMTP) are supported by most computing devices, most vendors of factory automation equipment have implemented their own application layer, precluding interoperability. Recently standards for open application layers have evolved, including Modbus TCP, and Ethernet/IP, which utilizes the application layer from DeviceNet. As vendors begin to adopt these open applications layers for use in their devices, the issue of multi-vendor interoperability will rapidly decrease.

Durability in Harsh Environments

Standard Ethernet cabling and connectors were designed with an office environment in mind, and aren't intended to withstand the environmental conditions commonly found on a factory floor or in harsh commercial applications. The BradConnectivity™ line of Ethernet products overcomes this obstacle by combining standard RJ-45 connection technology with the industrially proven form-factor, or by utilizing industry-standard Micro-Change® M12 connection technology. The result is a lineup of products designed to preserve the integrity of your data transmission even in the harshest settings. Specific benefits include:

- Sealing against environmental contaminants: BradConnectivity™ industrial Ethernet connectors provide protection from ingress of typical factory hazards such as water, oil, dirt and dust, which would corrupt a standard RJ-45 connection.
- Protection against the effects of vibration: While commercial RJ-45 connectors can expect a long life when mounted in a communications closet, they are not designed to withstand any level of vibration. For the BradConnectivity™ form-factor (threaded style), the overmolding process and addition of the mini connector on the cordsets, isolates the gold contacts from the effects of vibration, significantly increasing the life of the product. The Micro-Change M12 form-factor is an inherently vibration-resistant connection technology.
- Provides a secure robust connection: In the industrial world it is not uncommon for maintenance personnel and operators to come in contact with the cabling system. Our connectors, with integrated strain relief, make it nearly impossible for the connection to be broken when force is applied to the cable.
- Performs in electrically noisy conditions: Motors, drives, transmitters are all elements found on the factory floor, and all generate EMI (Electro-Magnetic Interference). BradConnectivity™ shielded cordsets and receptacles enhance data integrity in this environment while PUR jacketed cables protect against oxidation.