the**EXTENSION**

A Technical Supplement to control NETWORK

Affordable Industrial Ethernet - CTRLink™

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INTRODUCTION

CTRLink™ gives its name to a new line of Industrial Ethernet connectivity products that facilitate the use of Ethernet on the plant floor. Ethernet is recognized as the most popular local area network technology—finding more applications in factories and process plants. Why? Ethernet's low cost, its familiarity with customers and use as the simplest means of connecting to the Internet make this technology the preferred choice. CTRLink is an evolving line of Industrial Ethernet media converters, hubs, switches, routers, gateways and adapters that are required when implementing an Ethernet network in an industrial or commercial environment.

INDUSTRIAL ETHERNET or FIELDBUS?

Proponents of Industrial Ethernet proclaim the fieldbus wars have ended with Industrial Ethernet becoming the defacto standard. Contemporary Controls does not share this view. Ethernet is only a data link technology with several physical layer variants. The immense interest in Internet connectivity has made IP the defacto network protocol and TCP the de facto transport layer protocol. However, there still remains no universal agreement on the application layer with several implementations in use such as EtherNet/IP, Modbus/TCP, IDA, PROFInet and Fieldbus Foundation HSE. Some of the CTRLink products can operate with all these implementations and plans exist for gateway products to link legacy fieldbus networks to some of these application layer protocols. Industrial Ethernet cannot address all industrial applications so we see the continued use of fieldbuses, but the need for fieldbuses to connect to Industrial Ethernet will become more important.

INDUSTRIAL ETHERNET or COTS?

Proponents of Ethernet maintain that low-cost commercial-off-the-shelf (COTS) devices can be used in industrial control systems. In some applications this is valid. So what is Industrial Ethernet? Contemporary Controls defines Industrial Ethernet as technology compatible with the IEEE 802.3 family of standards, but designed and packaged for the requirements and rigors of commercial and industrial applications. Process plants and factories want to use commercially available Ethernet chips and media, but these plants have requirements that differ from those in an office. The first obvious concern is environmental with issues such as high temperature, humidity and vibration. The second concern is convenient mounting with other control equipment in the same control panel. Another requirement is

the power source. For safety, some control panels only provide low-voltage AC or DC power to control devices. Wall-mounted power supplies may not be acceptable. The electromagnetic compatibility (EMC) requirements differ with industrial locations requiring a higher immunity to EMI and ESD. Regulatory safety approvals differ from that in an office. Process plants may require hazardous location ratings. A factory may require an industrial control panel approval while a building automation system may necessitate a smoke and fire approval rating. These are unique application standards that low-cost, office-grade Ethernet hubs and switches fail to address. However, the CTRLink™ family addresses these issues.

CTRLink™ ENCLOSURES

All CTRLink™ products are intended to be mounted in control panels and are available in two sizes. The more complex products are housed in aluminum enclosures (174mm H x 44mm W x 140mm D). These units can be panel or DIN-rail mounted by purchasing appropriate mounting clips. The less complex devices are housed in miniature plastic enclosures (79mm H x 40mm W x 74mm D) with a built-in DIN-rail mounting attachment. This series is intended for OEMs seeking simple low-cost Industrial Ethernet connectivity. Both enclosure styles incorporate similar power supplies that will operate from a wide-range, low-voltage AC or DC power source. For DC operation, the voltage can range from 10-36 volts. For AC operation, the voltage can range from 8-24 volts. Provisions exist for redundant power sources so that a CTRLink™ product will continue to operate after a primary power failure.

REPEATING HUBS

Modern Ethernet networks must be wired in a star topology utilizing either twisted-pair or fiber optic cabling. Links, consisting of only two devices, are established between a single Ethernet device and a port on a hub. Hubs are multi-port devices usually capable of having four, eight or twelve ports. Hubs can be cascaded with a hub-to-hub connection.

Repeating hubs must conform to the requirements for IEEE.802.3 repeater units. These requirements include preamble regeneration, symmetry and amplitude compensation. Repeaters must retime signals so that jitter, introduced by transceivers and cabling, does not accumulate over multiple segments. These devices detect runt packets and collisions and react by generating a Jam signal. They automatically partition jabbering ports to maintain network operability.

CTRLink™ Industrial Ethernet Repeating Hubs and Links

The EI and EIM series of Industrial Ethernet Internconnect hubs and links in the CTRLink™ family allows for the expansion of shared 10 Mbps Ethernet networks on the plant floor. A hub is essential to expanding a 10BASE-T system beyond two nodes or to increase network distances beyond the 100-meter limit of the 10BASE-T specification. To maximize distance, the typical network uses twisted-pair wiring for the end devices and fiber cables for the inter-hub links. Each twisted-pair can be as long as 100m and the total length of inter-hub fiber can be as much as 2000m. The network diameter cannot exceed 2200m so in a shared Ethernet environment the length of each fiber segment depends upon the number of hubs used. Contemporary Controls has complemented its line of the EI series of industrial hubs by introducing a fiber optic version known as the EI6-10T/F. The unit is classified as a six-port hub. Four ports for twisted-pair support the signaling standards of 10BASE-T and the two fiber ports support the

EI Series

10BASE-FL interface while incorporating ST connectors. Also available is an EI5-10T/F with one less fiber port.

The EI6-10T/F's advantage is its ability to link 2km fiber optic segments with 10BASE-T ports, making it ideal for building control and industrial control applications where distance and robustness are important. The hub's fiber optic links also provide a layer of isolation and increased immunity to electrical noise and other external influences usually encountered in an industrial environment.

All models of the EI and EIM series conform to the requirements for IEEE 802.3 repeater units. These requirements include preamble regeneration, symmetry and amplitude compensation. Repeaters must retime signals so that jitter, introduced by transceivers and cabling, does not accumulate over multiple segments. These devices detect runt packets and collisions and react by generating a Jam signal. They automatically partition jabbering ports to maintain network operability.

Both series supply the required digital pre-emphasis to its 10BASE-T transmitting ports in order to compensate for the inherent roll-off of signal strength on the twisted-pair cable. Shielded RJ-45 connectors are used to accommodate either UTP or STP cabling. The Link Integrity function is supported confirming that a functioning adapter or hub is on the other end of the segment. Hubs can be cascaded using a crossover cable. The EIM has a separate uplink port.

EIM

Other features include wide-range, low-voltage AC or DC power requirements, provisions for redundant power connections, and panel or DIN-rail mounting.

There are several LED indicators supplied that aid troubleshooting. Besides one common collision LED, each port has one or more LEDs to indicate link status and port activity.

The EIMC series of Industrial Ethernet media converters in the CTRLink™ family offers a cost-effective approach for adding fiber to a network. Contemporary Controls media converters are available in three models and all support full or half duplex operation. The EIMC-10T/F operates at 10 Mbps and meets the signaling requirements for 10BASE-T and 10BASE-FL. The EIMC-100T/FT is a 100 Mbps device that converts 100BASE-TX twisted-pair signals to 100BASE-FX fiber optic signals and utilizes ST fiber optic connectors. The EIMC-100T/FC is a similar product but uses SC-style fiber optic connectors.

In full duplex mode, all models can span 2 km with $62.5/125 \ \mu m$ fiber cables. If the 100 Mbps devices are operated in half duplex mode, the cable length is limited by the collision domain to 412m. The minimum cable length is 2m. The front of each model provides the DIP switch for selecting the operational mode—be it full duplex mode, half duplex mode or transparent mode.

In transparent mode, the copper segments will auto-negotiate through the media converters. This auto-negotiation will determine the data rate and whether the media converter will operate in full or half duplex mode. This will allow for a fiber optic link between a 10BASE-T device and a

EIMC 100BASE-TX device.

CTRLink™ Industrial Ethernet Switching Hubs

The EIS and EISM series, Ethernet Interconnect Switch in the CTRLink™ family, provides a solution for those industrial applications requiring a larger network diameter and greater throughput. These products become an essential element of the control strategy. Models exist that support both twisted pair and fiber optics.

All the models of the series segment the Ethernet network into separate collision domains. The switch functions as a "bridge" between various data links creating a larger network diameter than can be achieved with repeating hubs. Each twisted-pair port automatically negotiates with its attached device the data rate for that port, be it 10 Mbps or 100 Mbps. The flow control mechanism is also negotiated. For full duplex segments, the PAUSE scheme is used. For half duplex segments, the backpressure approach is used. The switch learns the port locations of Ethernet devices by reading in complete Ethernet frames and observing source addresses. The switch then creates and maintains a table of source addresses and corresponding port assignments. From that time on, traffic is restricted to only those ports involved in a transmission. This allows for improved throughput since simultaneous transmissions can now be initiated on those ports without activity. Table values are aged to automatically accommodate changes to the field wiring.

If a broadcast, multicast or unicast transmission to an unknown destination is received on a port, all other ports are flooded with the transmission.

EIS Series

The EIS series accommodates industrial applications requiring a fiber backbone with the introduction of the EIS6-100T/F. It combines the benefits of switching technology and fiber optics, making it ideal for applications where longer networking distances (up to 2 km) and immunity to EMI/RFI are important. These benefits result in decreased downtime, fewer outages and improved reliability.

The EIS6-100T/F is a six-port, 10/100 Mbps auto-negotiating switching hub with a mix of four 10/100 Mbps twisted-pair copper ports and two 100 Mbps multi-mode fiber ports. There are two models. The EIS6-100T/FC supports SC-style connectors while the EIS6-100T/FT supports ST-style connectors. The EIS5-100T/F is similar to the EIS6 except it has one less fiber port.

All units are equipped with key features including low-voltage AC or DC power and broadcast storm protection. They can be DIN-rail mounted making it easy to deploy switch technology in any application in the field.

The series incorporate LED indicators for data rate, activity/link integrity, and power to aid troubleshooting. Ports that select 100 Mbps operation are so indicated.
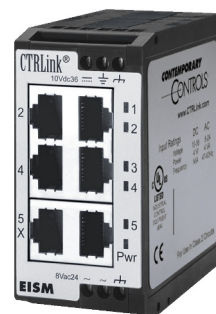
EISM

Current CTRLink™ Product List

EI4-10T	4 PORT 10BASE-T ETHERNET HUB
EI5-10T/F	4 PORT 10BASE-T/1 PORT 10BASE-FL HUB
EI6-10T/F	4 PORT 10BASE-T/2 PORT 10BASE-FL HUB
EI8-10T	8 PORT 10BASE-T ETHERNET HUB
EIM4-10T	4 PORT 10BASE-T ETHERNET HUB (MIN)
EIMC-10T/F	10BASE-T TO 10BASE-FL CONVERTER
EIMC-100T/FC	100BASE-TX TO 100-BASE-FX CONVERTER SC
EIMC-100T/FT	100BASE-TX TO 100BASE-FX CONVERTER ST
EIS5-100T/FC	4 PORT 100BASE-TX/1 PORT 100BASE-FX SC SWITCH
EIS5-100T/FCS	4 PORT 100BASE-TX/1 PORT 100BASE-FX SC SWITCH
EIS5-100T/FT	4 PORT 100BASE-TX/1 PORT 100BASE-FX ST SWITCH
EIS6-100T/FC	4 PORT 100BASE-TX/2 PORT 100BASE-FX SC SWITCH
EIS6-100T/FCS	4 PORT 100BASE-TX/2 PORT 100BASE-FX SC (SM) SWITCH
EIS6-100T/FT	4 PORT 100BASE-TX/2 PORT 100BASE-FX ST SWITCH
EIS8-100T	8 PORT 10/100 ETHERNET SWITCH
EISM5-100T	5 PORT 10/100 ETHERNET SWITCH (MIN)

Visit **www.ccontrols.com** for more information on these products

Point to remember. There is a limit to the number of hubs that can be cascaded. Ethernet's contention-based station arbitration method requires that all stations indicate if a collision has occurred on the network. The limit of this detection is called the collision domain, and it restricts the network's overall size. Exceeding the collision domain by introducing too many repeating hubs creates an unstable network with lost messages and in general poor performance. However, on a properly designed network, repeating hubs are simple to understand and use, not to mention very effective.

The EI series of repeating hubs has either four or eight twisted-pair ports and up to two fiber optic ports. The miniature EIM is only available with four ports with a provision for a hub-to-hub crossover connection. Both the EI and EIM operate on 10 Mbps shared Ethernet (half duplex) networks.

SWITCHING HUBS

It is possible to replace repeating hubs with switching hubs and achieve higher network performance. Unlike repeating hubs, which are physical layer devices, the switching hub is actually a bridge that connects two data links together. By doing so, collision domains terminate at each switch port. Therefore, adding a switch doubles the possible geographic limit of the network. Switches can be cascaded for an even larger network.

Switches are much more complex than repeating hubs. Each twisted-pair port automatically negotiates with its attached device the data rate for that port, be it 10 Mbps or 100 Mbps. The flow control mechanism is also negotiated. For full duplex segments, the PAUSE scheme is used. For half duplex segments, the backpressure approach is used. The switch learns the port locations of Ethernet devices by reading in complete Ethernet frames and observing source addresses. The switch then creates and maintains a table of source addresses and corresponding port assignments. From that time on, traffic is restricted to only those ports involved in a transmission. This allows for improved throughput since simultaneous transmissions can be initiated on those ports without activity. Table values are aged to automatically accommodate changes to the field wiring.

If a broacast, multicast or unicast transmission to an unknown destination is received on a port, all other ports are flooded with the transmission.

The EIS series of switching hubs support twisted-pair or fiber connections. The EIS8-100T has eight 10/100 Mbps auto-negotiating twisted-pair ports.

The EIS6-100T/F is a six-port, 10/100 Mbps auto-negotiating switching hub with a mix of four 10/100 Mbps twisted-pair copper ports and two 100 Mbps multi-mode fiber ports. There are two models. The EIS6-100T/FC supports SC-style connectors while the EIS6-100T/FT supports ST-style connectors. The EIS5-100T/F is similar to the EIS6 except it has one less fiber port.

When operating in full duplex mode, multi-mode fiber optic segment lengths can be up to 2km.

The EIS5-100T/FCS and the EIS6-100T/FCS provide the greatest distances by incorporating single-mode fiber optic transceivers. Maximum segment lengths can be as great as 15km in full duplex mode. Both models utilize SC connectors, but the number of fiber ports differ. The EIS5 has one fiber port and the EIS6 has two fiber ports.

MEDIA CONVERTERS

Another class of physical devices are the media converters. Appearing as transparent devices, media converters are a cost-effective approach for adding fiber to the network. They are two-port devices that do not store frames or detect collisions. They only convert the signals sent over one medium to compatible signals over another. Contemporary Controls media converters are available in three models. The EIMC-10T/F operates at 10 Mbps and conforms to the requirements of 10BASE-T and 10BASE-FL. It will operate with either half or full duplex links. The EIMC-100T/FT is a 100 Mbps device that will convert a 100BASE-TX twisted-pair connection to a100BASE-FX fiber optic connection. It will operate with either half or full duplex links and utilizes ST fiber optic connectors. The EIMC-100T/FC is a similar product but uses SC connectors.

FUTURE PRODUCTS

Contemporary Controls will continue to expand the CTRLink™ product line, providing solutions for the unique needs of Industrial Ethernet. These products will include routers that will segregate two networks, but allow only those messages of interest to span the two networks. With the need to support legacy fieldbus devices, there will always be demand for gateway products that allow these devices to connect to Industrial Ethernet. Other areas of interest include managed switches, powered Ethernet, redundant media, commissioning tools and network analyzers. Finally, there will be a need for adapters that allow for the connection of non-networked devices to Industrial Ethernet. Where possible, these future products will be packaged in either miniature or standard-sized CTRLink™ enclosures; thereby, maintaining the family image. The CTRLink™ family represents Contemporary Controls' commitment to the evolving needs of Industrial Ethernet.

ADDITIONAL INFORMATION

For additional information on the CTRLink™ family of Industrial Ethernet connectivity products, visit the Web site at www.ccontrols.com.

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