



**CC-Link *IE* Field**  
INDUSTRIAL ETHERNET  
The First Gigabit Industrial Ethernet Field Network

Ultrahigh Speed  
Flexible Topology  
Seamless Communication  
Inherent Determinism without  
Ethernet Switches



## Guide for using this brochure:

This brochure is designed for users of CC-Link IE Field networking and for automation equipment manufacturers that plan to offer CC-Link IE Field products. CC-Link IE Field compatibility is obtained by embedding an ASIC or FPGA into their Ethernet products. Another alternative is to embed SLMP or CC-Link IE Field Basic firmware into their Ethernet capable products. This brochure describes the network features and the implementation options for CC-Link IE Field. Equipment manufacturers can obtain technical assistance for obtaining CC-Link IE compatibility by contacting the CC-Link Partner Association.

CC-Link IE Field network is the first open-technology Industrial Ethernet network to operate at gigabit speeds at the field device level. It combines the best of existing technologies and applies them in a highly reliable architecture that provides exceptional data bandwidth and transaction rates.

CC-Link IE Field delivers Industry 4.0 [IIoT] Ready Industrial Ethernet network capabilities; seamlessly providing control data transmissions between automation controllers [PLCs, computers, etc.] and field devices [such as digital and analog I/O, pneumatic valve manifolds, RFID readers, VFDs, inverters,

motion controllers and other factory assets]. At an ultra-fast 1 Gigabit, CC-Link IE Field provides the bandwidth necessary for all of your Industry 4.0 [IIoT] requirements while maintaining absolute deterministic communications using its token-based architecture.

It runs effortlessly without the requirement for costly Ethernet switches. CC-Link IE Field offers both “Cyclic” (synchronous) and “Transient” (asynchronous) methods of data exchange communication based on well-proven token passing technology. Cyclic transmissions provide real-time, transparent data delivery to all stations for routine control data. A “common memory” model configured by a few simple parameters establishes the network Cyclic transmissions for deterministic data exchange. Transient messaging provides high priority, on-demand communication for asynchronous traffic such as alarms, diagnostics or maintenance data. Transient messages are initiated “on-demand” from a specific station. Transient messages can be sent to one or more network stations. CC-Link IE Field strategically allocates transient mode bandwidth so that cyclic communication remains deterministic.

## CC-LINK IE FIELD NETWORK FEATURES:

**ULTRAHIGH SPEED** The 1 Gbps transmission rate along with the inherent network design enables control of remote field devices with essentially no transmission delay. This transmission rate allows a full CC-Link IE Field network to be completely updated in under 0.5 milliseconds. Moreover, the gigabit bandwidth allows this performance to be maintained regardless of the amount of simultaneous transient traffic. The network uses commercially available Ethernet physical layer components – such as Cat5e cable, RJ45 connectors or M12 X-Code connectors and network switches if desired.

**INHERENT DETERMINISM** A significant difference between CC-Link IE Field and other Industrial Ethernet network options is that CC-Link IE Field delivers deterministic control communications without requiring the costly installation and configuration of expensive and complicated managed Ethernet switches. This feature eliminates the hardware costs and engineering implementation costs associated with switches. Also, the cost and need for developing communication statements to govern the flow of data is eliminated due to the shared memory concept of CC-Link IE Field. No knowledge of Ethernet technology or the CC-Link IE Field protocol is required, and determinism is guaranteed by the network token-passing technique.

**SEAMLESS COMMUNICATION** CC-Link IE Field networking enables seamless communication of data between all field devices and controllers in order to form an integrated network for transmitting data at gigabit speeds.

**INTEGRATION WITH GENERAL PURPOSE ETHERNET DEVICES** Automation equipment manufacturers can make their products compatible with CC-Link IE Field networking without modifying any product hardware. By adding SLMP firmware to products having an RJ45 Ethernet port and TCP/IP (or UDP/IP) capability, these products can communicate and interact with CC-Link IE Field network devices. The CC-Link Partner Association can assist equipment manufacturers in this process.

**FLEXIBLE TOPOLOGY** A CC-Link IE Field Network allows for a topology best suited to the needs of the particular application thus ensuring greatest flexibility. These topologies include star, line, mixed star and line, and ring.

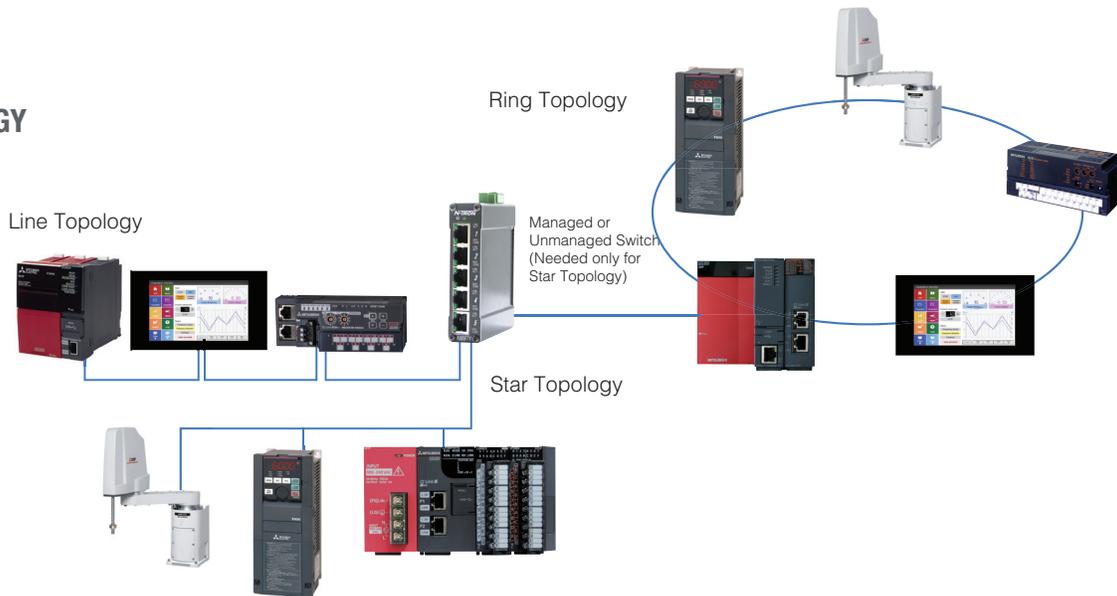
**LINE** Connecting via a line topology is possible with CC-Link IE Field network devices. This topology does not require the use of any Ethernet switches, since each device is connected in a daisy-chain fashion to the adjacent station(s). This reduces the cost and complexity of the network installation.

**STAR** The Star topology may be implemented by using one or more unmanaged (or managed) Ethernet switches. The use of unmanaged Ethernet switches reduces the complexity of the installation.

**MIXED LINE AND STAR** Any combination of Line and Star topologies can be intermixed.

**RING TOPOLOGY** With two Ethernet ports, the CC-Link IE Field network has the capability to connect via a ring topology. This topology does not use any Ethernet switches, since each device is connected in a daisy-chain fashion to each adjacent station. This reduces the cost and complexity of the network installation and prevents a loss of communication due to a cable break or a damaged network station. This allows the network to continue communicating, allowing uninterrupted control operation.

## TOPOLOGY



## Specifications

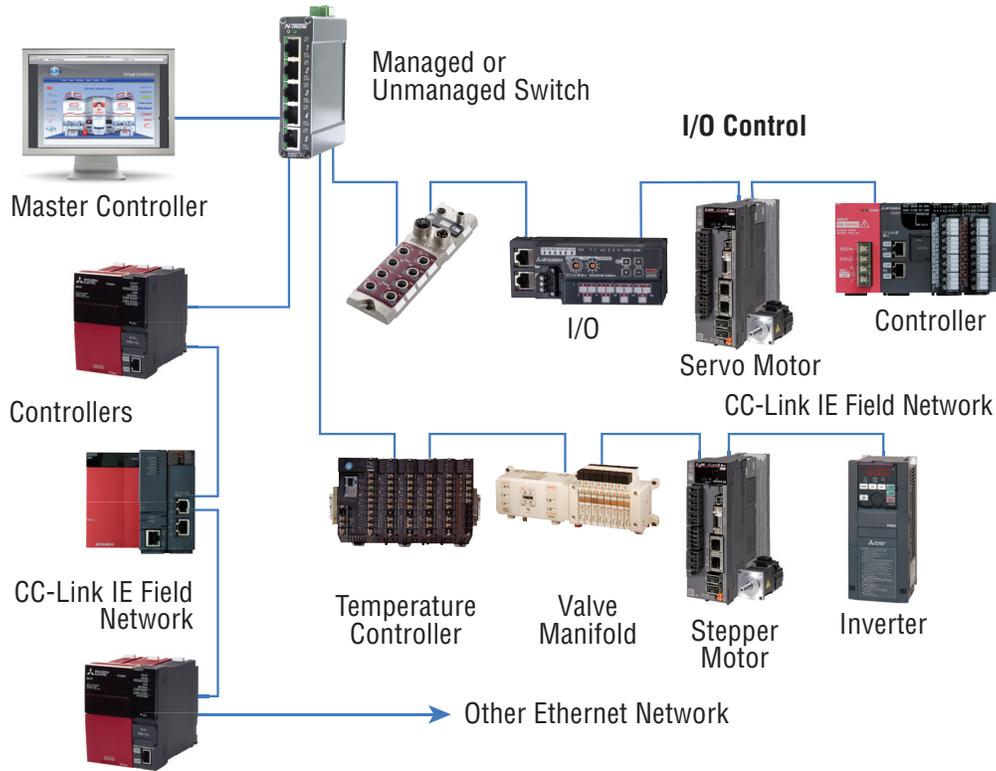
|                        |  |
|------------------------|--|
| Communication Standard | Ethernet - IEEE 802.3ab (1000Base-T)               |
| Communication Speed    | 1Gbps  |
| Cable                  | Shielded Copper Cable (ANSI/TIA/EIA-568-B Cat. 5e) |
| Connector              | RJ-45 '8P8C' Connector or M12 X-Coded Connector    |
| Media Access Control   | Token Passing                                      |
| Network Topology       | Star/Line/Ring/Mixture of Star and Line            |

**DISTRIBUTED CONTROL FUNCTIONALITY** CC-Link IE Field networking supports controller-to-controller communication in addition to handling the control of field devices. This provides great flexibility in establishing an effective control and information system.

**SCALABILITY** Within a single network there can be a total of 121 stations with up to 328 feet (100 meters) of Cat5e cable between each station. In addition, as many as 239 CC-Link family networks can be interconnected allowing vast exchange of data to suit any application.

**MULTIPLE NETWORK CONFIGURATIONS** When a single CC-Link IE network is insufficient for a particular application, it is possible to interconnect up to 239 CC-Link IE (both Field and Control) networks (each having 120 stations). This enables data from thousands of network stations to be exchanged for a coordinated control system.

**DISTRIBUTED CONTROL**



**COMPATIBILITY WITH EXISTING CC-LINK NETWORKS** An existing CC-Link network can be integrated with a CC-Link IE Field network. A major benefit to this capability is that any existing CC-Link (RS-485) network can communicate and become part of a CC-Link IE Field network.

**COMPATIBILITY WITH TCP/IP FIELD DEVICES** Automation field devices (RFID readers, vision systems, valve manifolds, etc.) that have an Ethernet port with TCP/IP (or UDP/IP) capability and incorporate SLMP (Seamless Message Protocol) firmware can be connected to a CC-Link IE Field network via an Ethernet Adapter. Such SLMP firmware can be incorporated into any Ethernet TCP/IP (or UDP/IP) field device, into the application layer without changing the hardware of the product. The CC-Link Partner Association can assist automation equipment manufacturers to incorporate this SLMP firmware into their devices in order to make them compatible with the CC-Link IE Field network.

One Ethernet Adapter can service up to 32 TCP/IP (or UDP/IP) SLMP field devices via an unmanaged Ethernet Switch. Up to 120 Ethernet Adapters can be connected to a single CC-Link IE Field network. Therefore, up to 3840 TCP/IP SLMP field devices can be connected to a single CC-Link IE Field network.

**SEAMLESS COMMUNICATION THROUGH ALL NETWORK LEVELS** A CC-Link IE Field network can operate as an isolated single network, or interconnected with up to 239 other CC-Link IE networks. This provides great flexibility when adding to existing control systems or in the initial design of a new integrated control network scheme.

The CC-Link IE Field network is designed to simultaneously handle Standard Control (distributed control, I/O control), Safety Control and Motion Control.

**FUNCTIONAL SAFETY** CC-Link IE Field Network with Safety Communication Functions meets international safety standards IEC61508 SIL3 and IEC61784-3(2010). CC-Link IE Field Safety follows the basic concept of functional safety communication specified in IEC 61784-3. It implements corrective measures in response to communication errors and performs safety communication that significantly minimizes the likelihood of communication errors occurring on the communication path to a permissible value.

CC-Link IE Field Safety uses multiple communication error detection methods:

- Time stamp  
CC-Link IE Field Safety uses time stamps to detect the occurrence of an unintended repetition, invalid order, loss, or unacceptable delay.
- Connection ID  
CC-Link IE Field Safety uses connections IDs to detect insertion of unknown messages and transmission to an unintended destination.
- 32-bit CRC for safety communication  
CC-Link IE Field Safety uses the 32-bit CRC for safety communication to detect damage and identity fraud.

Within the Ethernet Data transmission frame is a CC-Link IE Field Safety communication Safety Protocol Data Unit (PDU). The CC-Link IE Field Safety communication Safety PDU is used to transfer safety data. The figure below shows the frame structure of a safety PDU (not the entire Ethernet frame). The safety PDU comprises three sections: safety protocol header information (S-Header), safety data (S-Data), and the 32-bit CRC (CRC32), all necessary for safety communication.

The table below lists the safety PDU elements. One safety PDU can transfer a maximum of 128 bits (16 octets) of safety data. Each device can maintain up to two (2) Safety PDU connections – with each connection maintaining an input and an output.

| Name            | Size              | Description                         |
|-----------------|-------------------|-------------------------------------|
| <b>S-Header</b> | 96 bits           | Safety protocol header information  |
| <b>CTRL</b>     | 32 bits           | Command type, status, etc.          |
| <b>CID</b>      | 32 bits           | Safety connection identifier        |
| <b>TS</b>       | 16 bits           | Time stamp                          |
| <b>OBL</b>      | 16 bits           | Offset generation information       |
| <b>S-Data</b>   | 128 bits, maximum | Safety data                         |
| <b>CRC32</b>    | 32 bits           | 32-bit CRC for safety communication |

**MOTION CONTROL** CC-Link IE Field Motion is a complete motion control network that provides for the use of synchronous motion control. This Motion Function is a fixed-cycle command/response communication function between the motion controller and the servo amplifier. This function provides inter-station synchronization functions. These synchronization functions (commands) enable highly accurate multi-axis interpolation and synchronous command and control. This Motion Function is a sequential position command method which enables highly accurate locus control. This allows for the detailed position control from the start point to the end point.

Synchronized motion control is accomplished using the new time synchronized function within CC-Link IE Field. With the measurement of data transmission delay and a clock synchronized function, CC-Link IE Field Motion can be used in high precision motion control applications.

The CC-Link IE Field asynchronous feature still provides for simple motion via the built-in positioning control method. This method provides end-point command control motion capability, although the locus from the start point to the end point cannot be specifically controlled.

**PRODUCT DEVELOPMENT** Automation equipment manufacturers (OEMs) have two options for incorporating CC-Link IE Field compatibility into their automation devices. By adding CC-Link IE Field compatibility to their products, OEMs can increase the sales of their products to the growing number of companies throughout the world that employ CC-Link IE Field networks.

**OPTION 1: Firmware-only Implementation**

The first option allows the OEM to adapt any existing Ethernet TCP/IP (or UDP/IP) field device, to CC-Link IE Field networking [incorporating CC-Link IE Field Basic or SLMP]. This can be done for devices having either a 100MB or 1GB Ethernet port. This is done by adding SLMP or CC-Link IE Field Basic firmware to the application layer of the device. No specific hardware modifications are required in order to implement either IEF Basic or SLMP into your Ethernet automation device.

SLMP is a simple protocol that operates using a client/server model. Implementing SLMP protocol is an easy task supported by complete specification documents. CC-Link IE Field Basic [IEF Basic] is a general purpose UDP/IP Ethernet network implementing a master / slave communication scheme. An IEF Basic sample software stack is available to CLPA members.

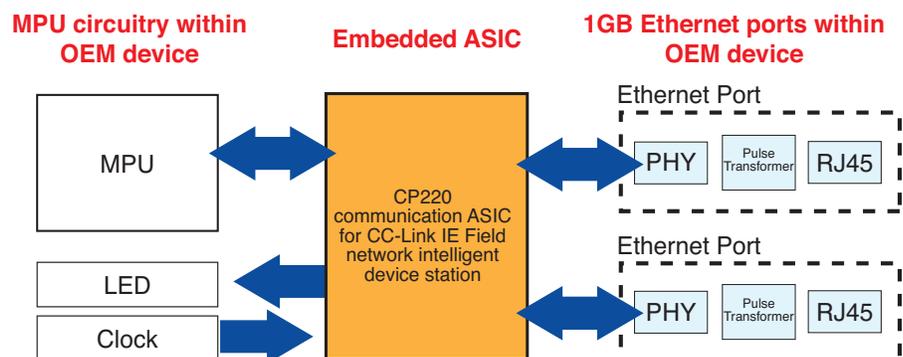
**OPTION 2: HARDWARE IMPLEMENTATION**

The second option for the OEM to develop CC-Link IE Field compatibility is to embed an available CC Link IE Field ASIC or FPGA into the automation device - available ASICs include the Mitsubishi CP220 Communication ASIC or the Renesas Electronics R-IN32M3 Series Low-Power Industrial Ethernet Communications Chip with integrated Real-Time OS Offload Engine; the available FPGA is from Altera/Altera – the Altera Cyclone IV E with the NIOS II and Avalon-M core. The CC-link IE Field protocol is handled by ASIC/FPGA; therefore the OEM does not need to implement SLMP as described in Option #1 above. This ASIC/FPGA implementation requires that the automation device incorporates two 1GB Ethernet PHYs. Shown below is a diagram of the OEM device using the CP220.

A reference manual and sample code is available to aid with implementation. In addition, support from the CLPA is always available.

An alternative to the above ASIC/FPGA implementation is the use of a CC-Link IE Field interface board that is available from 3rd party CLPA partners. These interface boards include a CP220 (or equivalent) and two GB Ethernet ports.

By using the ASIC/FPGA approach or the CC-Link IE Field interface board approach, the OEM automation device is able to connect directly to the gigabit speed CC-Link IE Field network. This approach eliminates the need for the OEM device to be connected to an adapter module and switch – as is required for a product that uses the SLMP firmware only approach described in option #1



**ENERGY MANAGEMENT** The CC-Link IE Energy Management Communication (EMC) feature optimizes detailed energy consumption monitoring. This function facilitates the collection and monitoring of energy data at the device/equipment level. The EMC function enables detailed control of energy demand. This provides for the comprehension of energy consumption

rate information at the device/equipment level and enables maximum energy saving methods. All of these features provide the potential to automate the control of device/equipment during low-energy operation (breaks, short-term shutdowns, lunch, etc. ...) to yield maximum energy savings for the application and facility.

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### **SUPPORT FROM CLPA**

Technical support for either option #1 or #2 is available from CLPA-Americas. We can arrange for the development documentation and conformance testing of your device, and we are able to lend equipment to OEMs to assist during the development and testing phases.

The CC-Link IE Field network is designed to simultaneously handle Standard Control (distributed control, I/O Control), Safety Control, Motion Control and Energy Management.

**CC-LINK PARTNER ASSOCIATION** CLPA is an international association whose members comprise the world's leading factory automation companies. Our goal is to advance open, interoperable information and communication technologies in industrial automation.

SLMP or Seamless Message Protocol is the CLPA's core technology – along with its network implementations – CC-Link and CC-Link IE. CLPA acknowledges the adoption of commercial-off-the-shelf (COTS) and standard Ethernet technologies as a guiding principle. This principle is characterized via the Family of CC-Link networks – the world's most advanced industrial automation networks.

The CLPA is the organization tasked with the worldwide promotion and technical development of the CC-Link IE and CC-Link family of open networks. The CLPA is a global organization with 11 regional offices and conformance test centers worldwide. Each office works to increase the market perception of CC-Link networks and improve the adoption of CLPA networks by device makers, machine builders and end-users.

### **CC-LINK SUPPORT BRANCHES PROVIDE CLPA MEMBERS WITH A RANGE OF SERVICES THAT INCLUDE:**

- Distributing the CC-Link Family of Networks protocol specifications
- Providing technical and development support to members designing CC-Link products
- Conducting CC-Link educational seminars
- Providing CC-Link conformance-testing of member products
- Issuing conformance certificates for successfully tested products
- Worldwide promotion of CC-Link products and CLPA partners via trade shows, product catalog and other publications, seminars, social media, and the worldwide web
- Organizing working groups to improve the functionality and acceptance of CC-Link technology

### **WORKING GROUPS INCLUDE:**

- Technical Working Group
- Marketing Working Group
- Communication Security Working Group
- Working Groups to develop standardized interfaces with other networks – (Including cooperating with other network organizations)

## CC-LINK PARTNER ASSOCIATION LOCATIONS



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