

*Gigabit Speed Industrial Ethernet
Controller Network*

CC-Link IE™

Open technology for high-speed deterministic controller networking

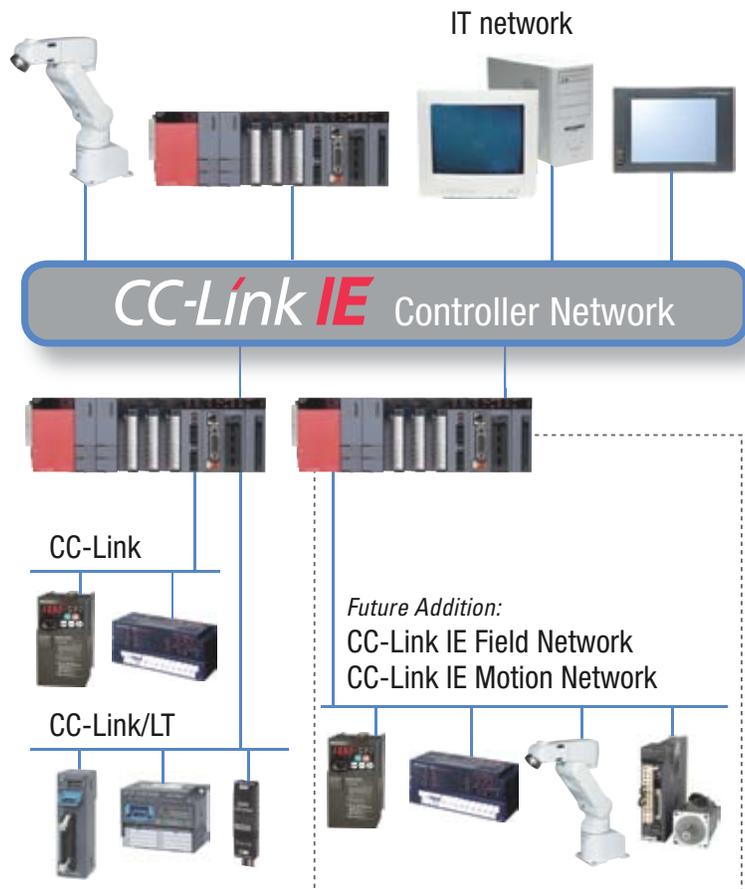


CC-Link IE Controller Network

CC-Link IE Controller Network is the first open-technology, gigabit industrial Ethernet network for automation. It combines the best of existing technologies and applies them in a highly reliable, redundant architecture that provides exceptional data bandwidth and transaction rates. CC-Link IE provides a consistent, integrated controller network that corresponds to the IEEE 802.3 standard and operates at a communication rate of 1Gbps. CC-Link IE provides seamless control data transmission between devices such as PLCs, computers, HMIs, robots, motion controllers and other assets. It serves an important role in enabling comprehensive data connectivity across the shop floor and enterprise levels.

The CC-Link IE controller network uses token passing for data transmission control. The token passing method results in increased communication throughput, and provides deterministic data exchange and constant link scan time by eliminating the possibility of data collisions. There is no need for any external Ethernet switches or hubs. Up to 120 controller stations can be connected on a single network while providing deterministic data exchange at gigabit speed. In addition, hundreds of CC-Link IE networks can be interconnected for coordinated facility-wide control and data integration.

Basic communication function	Network common memory for cyclic real-time deterministic communication. And transient (on-demand) communication.
Transmission speed / data link control	1Gbps / IEEE 802.3
Network topology/reliability	Dual loop, fiber optic cable
Media	1000BASE-SX multimode fiber optic cable
Connector	IEC 61754-20, LC connector
Media access control	Token passing
Size of network common memory	Up to 256K bytes
Number of stations per network	Up to 120 stations
Distance between 2 stations	Up to 550 meters cable length
Number of interconnected networks	Up to 239 networks (w/120 stations ea.)



Data from lower-level field networks can be seamlessly integrated with the CC-Link IE Controller Network.

Network configurations

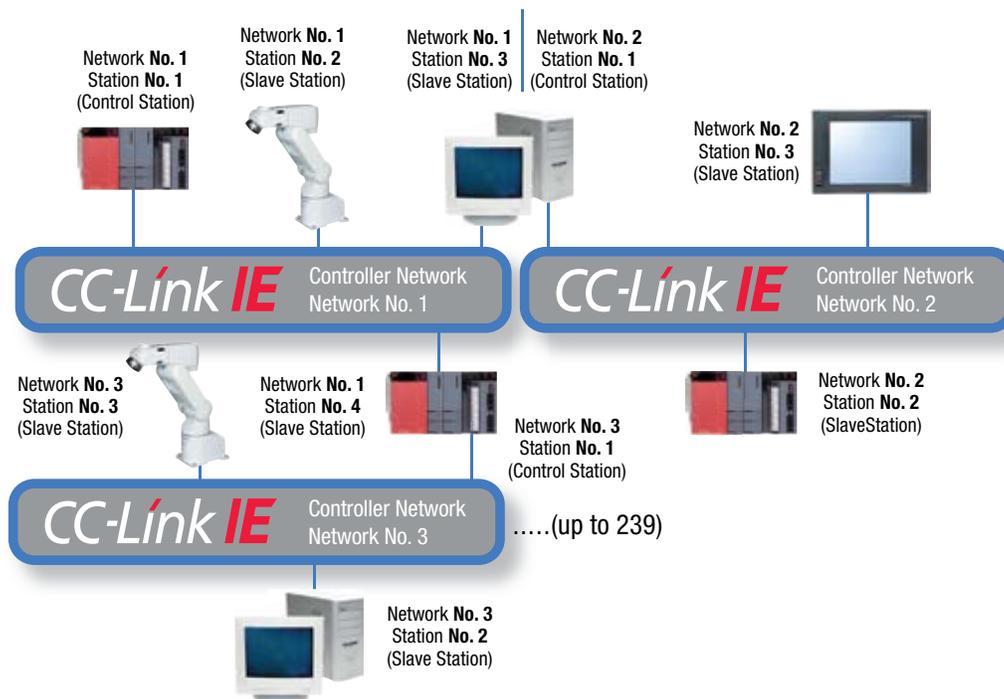
A single CC-Link IE Controller network consists of up to 120 stations (PLCs, computers, HMIs, etc.). One of these stations is designated as the network control station. As in all standard token passing networks, the network control station manages the network and starts the token passing sequence by sending the token to the first slave station on the network. The slave station that receives the token performs its cyclic transmission, and then passes the token to the next station in the sequence. After the last slave station completes the process, it passes the token back to the control station and the entire sequence is started again.

CC-Link IE allows controller networks spanning large areas to be developed. In fact a single ring of 120 stations can include up to 66 kilometers (42 miles) of fiber optic cabling while maintaining the data rate of 1 Gbps. Also, up to 239 of these networks can be linked together, creating systems with over 15,000 km of cabling and integrating more than 28,000 network stations - enough to handle the largest and most complex applications, yet simple enough to easily configure, start-up, and maintain!

Single Network Configuration



Multi-Network Configuration

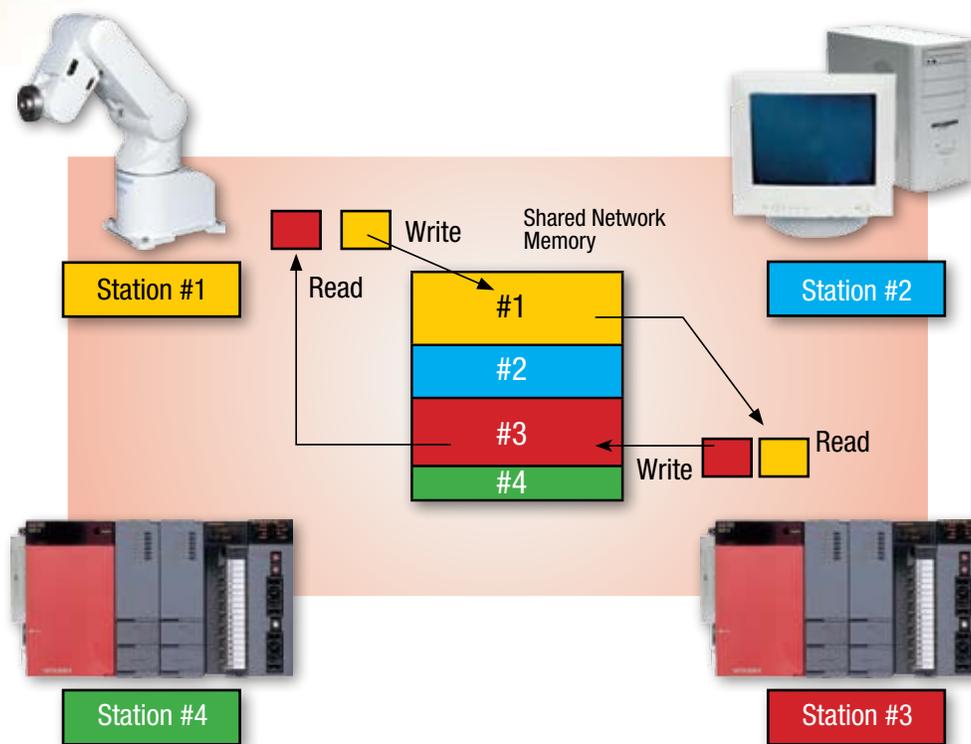


The above figure depicts an interconnected 3 network system. Each network has a unique number and each station can be uniquely specified within the multi-network system by its network number (1 to 239) and its station number (1 to 120).

Basic communication function

Cyclic communication is a function that exchanges control data among all stations connected to the network at a constant transmission rate. Cyclic communication performs station-to-station exchange of data through the use of shared network memory. Using this communication method, the shared network memory allows up to 4KB of bit-oriented data and 256KB of word-oriented data to be transmitted among all the network stations. Each station accesses its own shared memory which contains data from all network stations.

Since the controller network operates at 1 Gbps, the control data of each station is refreshed extremely fast. For example, cyclic communication enables a 32-station network (where each station transfers 4KB of data) to be totally updated in 60 μ s. Cyclic communication always takes precedence over transient/acyclic communication. The network-shared memory enables modifications, such as the addition or deletion of network stations, to be made with ease.



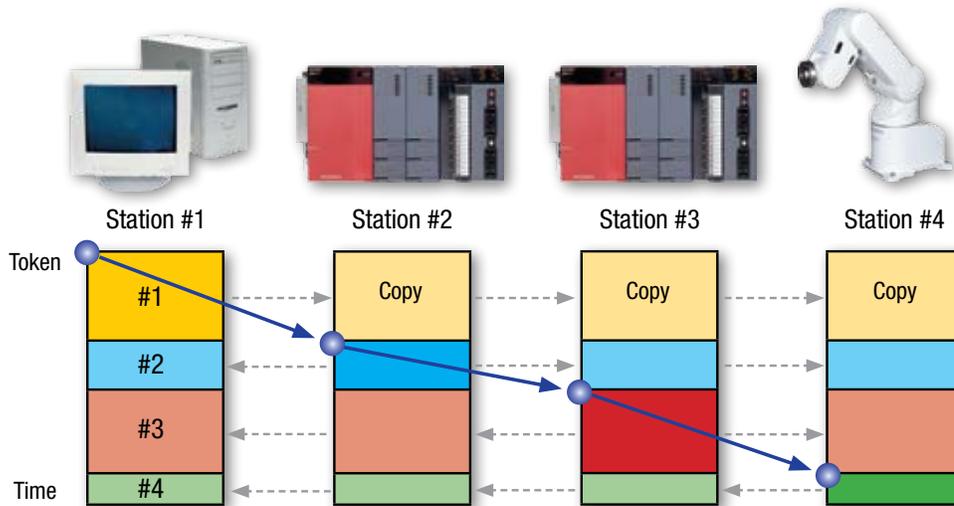
Shared memory communication

In a CC-Link IE Controller network, each controller station exchanges data with all other stations, recognizes the condition of other stations, and performs its own control actions. The most important role of the controller network is to exchange data between controllers in real-time to support coordinated action between controllers. This provides deterministic, synchronized action. CC-Link IE uses network shared memory and cyclic communications to provide real-time communications between network stations.

The figure above shows how the virtual shared memory operates. Each station can write data only to its own assigned area, it can however read information from the entire virtual shared memory which contains data from all stations on the network. All devices connected to the network send and receive data via this common memory resource. No knowledge of CC-Link IE protocol or Ethernet standards is required to read/write data or to control the communication function.

Determinism via token control

Each station transmits data to the network when it possesses the network 'token'. At that time, the station holding the token is able to send the data within its assigned writeable area onto the network. This data is transmitted to each station on the network. At this time, each station copies the information just received into its virtual shared memory. After the data transmission is completed, the network token is passed to the next station and the entire cycle is repeated. This operation results in a completely deterministic network cycle time.



Peer-to-peer communication

The CC-Link IE Controller network also provides for "on-demand", direct peer-to-peer communication for periodic messages that do not require determinism. While cyclic communication occurs at a constant deterministic rate, peer-to-peer/transient message communication occurs irregularly. Transient messages are non-real-time communications from one station to another, but they do not affect the cyclic real-time operation of the CC-Link IE network.

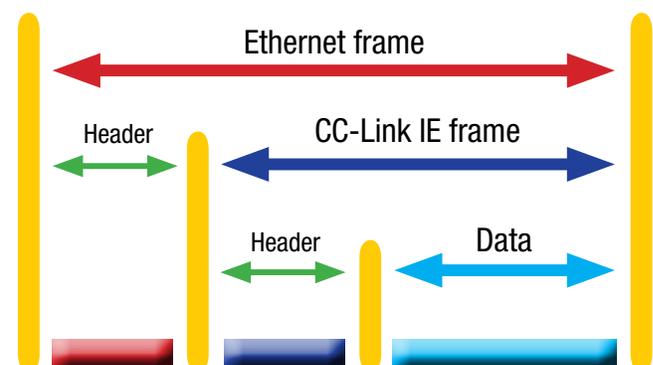
In order to guarantee a stable data transfer cycle for cyclic real-time information, CC-Link IE assigns a transmission bandwidth for peer-to-peer/transient message communication without impacting cyclic communication. This assures determinism for high quality production operations while still allowing for significant amounts of peer-to-peer/transient messaging.

Communications protocol

The physical and data link layers of the CC-Link IE Controller network utilize Ethernet technology (IEEE 802.3). This enables the use of commercially-available Ethernet multimode fiber cables and network analyzers. Therefore, the availability of materials and

selection of equipment for network installation, adjustment, and troubleshooting are greatly simplified. TCP/IP communications are supported by way of the transient/acyclic communication function. Shown below is the CC-Link IE protocol stack and frame format.

	User Application	
Application layer	Common object access	Network-orientated common memory
Transport Layer	Transient Transmission	Cyclic Transmission
Network Layer	IEEE 802.3	
Data link Layer	IEEE 802.3z (1000BASE-SX)	
Physical Layer		

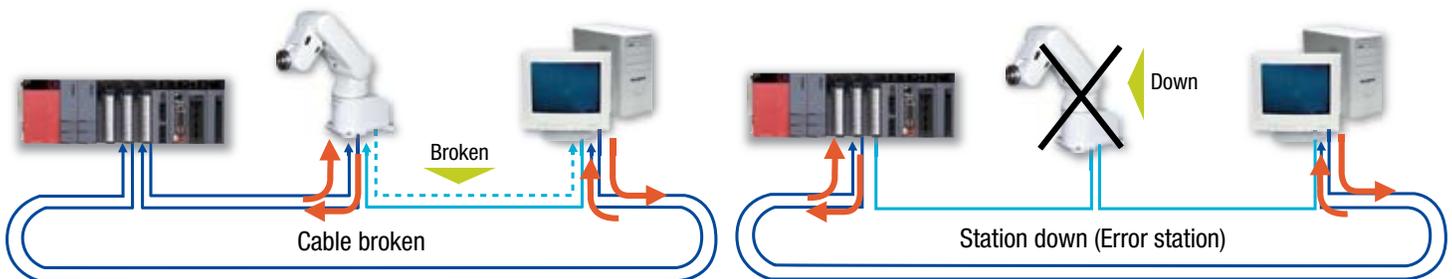


Network topology/redundancy

The CC-Link IE Controller network uses optical cable as its transmission media, (1000BASE-SX multimode fiber optic cable) and connectors (per IEC61754-20, LC duplex connector). Most newly installed IT networks utilize fiber optic backbones. This has led to the availability of a new generation of lower cost compact optical networking devices. Optical cable improves network stability. It solves the electrical interference problems that can affect copper communication cables in industrial environments. Optical cable allows longer network distances at faster speeds than are possible with copper cables. CC-Link IE uses duplex loop topology which generally uses less cable than star configurations. Duplex loop

eliminates the problem of a single failure taking down the entire network.

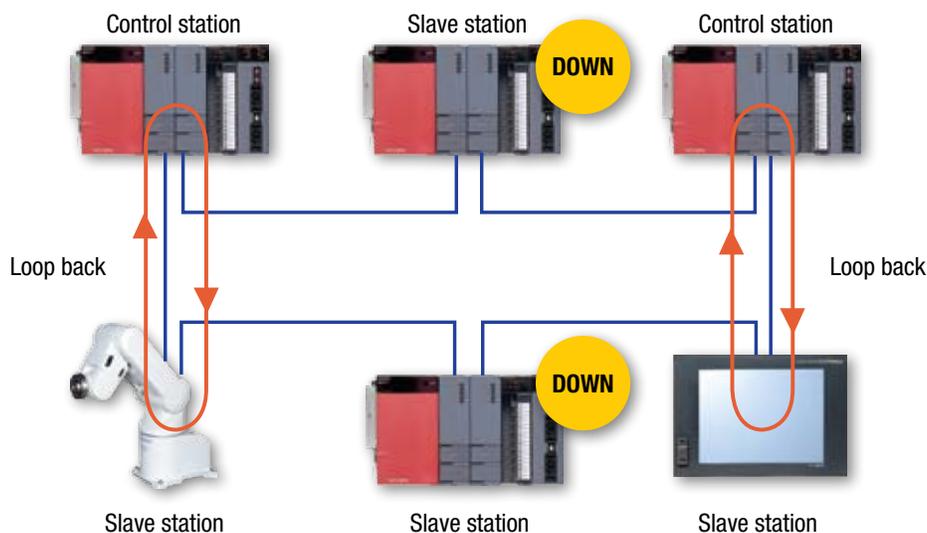
In the event of a cable failure between stations or the failure of a station as shown below, the logical loops are disrupted. The network will then reconfigure the communication path automatically so that the transmission between operational stations can continue. This function is a basic feature of the CC-Link IE Controller network and requires no special setup or additional devices. It was designed to realize redundancy and network availability at no extra cost.



Automatic control station re-assignment

The network control station maintains transmission between all stations on the network. In the event of a failure of the control station for any reason, another network station will assume the role of the network control station. This function enables transmissions to continue between all other operational stations even if the original control station has malfunctioned. This function even

address situations where the network is broken into totally separate segments due to multiple equipment failures as shown in the figure below. In this case, another controller will assume the function of network controller and communications will continue between those operational stations that are still physically connected to each other.



Support by the global CC-Link Partner Association

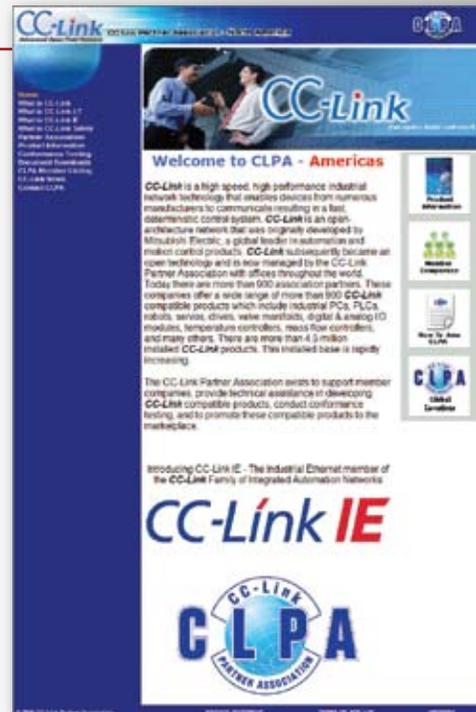
The CC-Link Partner Association (CLPA) is an organization of manufacturers of CC-Link compatible products and users of CC-Link technology. The CLPA oversees and manages the CC-Link specifications and promotes the worldwide adoption of CC-Link technology for network communications in industrial automation.

The CLPA-Americas branch serves North, Central, and South America. There are additional CLPA branches in Europe, Japan, China, South Korea, Taiwan and Singapore. CLPA-Americas has application engineering personnel on staff to assist members in applying CC-Link technology, and to perform conformance testing and product certification.



CLPA services provided to Association members

- Managing and distributing the CC-Link protocol specifications
- Providing technical support during the design phase to members who incorporate CC-Link compatibility in their products
- Conducting CC-Link educational seminars
- Providing CC-Link conformance-testing of member products
- Issuing conformance certificates for successfully-tested products
- Listing and promoting CC-Link compatible products on the CLPA web site, in the product catalog and other publications
- Organizing task forces to improve the functionality and acceptance of CC-Link technology – Task forces include:
 - Technical Task Force
 - Marketing Task Force
- Promoting CC-Link and CLPA partners and products via trade shows, publications, seminars and the worldwide web



CLPA Web Site



Conformance Test Facilities



Trade Shows

Seminars



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