



Integrated Network for IIoT

CC-Link IE

GIGABIT INDUSTRIAL ETHERNET

Enabling seamless data communication from the
plant-level enterprise network to the production floor network



CC-LINK FAMILY OF NETWORKS

WITH BOTH INDUSTRIAL ETHERNET AND FIELDBUS VERSIONS, THE CC-LINK FAMILY OF NETWORKS PROVIDE A COMPREHENSIVE OPEN NETWORK SOLUTION TO ANY APPLICATION CHALLENGE.

CC-Link is a family of industrial open technology automation networks that process control, information & diagnostics to provide efficient, integrated factory-wide industrial and process automation. The family provides IIoT Ready 1 Gbps speed, deterministic communication seamlessly linking a wide assortment of multi-vendor automation devices from the plant-level enterprise network to the production floor network. The 'Family of CC-Link Networks' is ideally suited for machine automation, cell or process control in a wide variety of industries. The CC-Link family includes fieldbus and safety networks – CC-Link & CC-Link Safety; a general-purpose industrial Ethernet network – CC-Link IE Field Basic; the most advanced Industrial Ethernet networks – CC-Link IE Control & CC-Link IE Field – and introducing the latest cutting-edge network CC-Link IE TSN. These advanced Ethernet networks operate at 1 Gbps providing deterministic behavior for your control and enough bandwidth for all of your Industry 4.0 & IIoT requirements.

Whether you are considering using CC-Link in your system, or developing compatible products, this brochure provides an overview of the CC-Link family of open networks.

CC-Link was introduced as an open network technology in 2000, followed by CC-Link IE in 2007. Both are now managed by the CC-Link Partner Association (CLPA). The CLPA is a global organization, one of the largest network organizations in the world, with offices across the globe. CC-Link IE and CC-Link have one of the largest installed bases of any open automation network in the world. Hundreds of CLPA partner companies offer more than 1800 certified products.

WHY CHOOSE CC-LINK? The reasons are both technical and commercial. Quite simply, CC-Link networks are designed to offer maximum productivity by maintaining high performance operation even in the face of adverse operating conditions. Commercially, while it is used globally, it is particularly strong in Asia, where it has become a de-facto standard in industries such as flat panel displays and automotive.

INDUSTRY 4.0 SOLUTIONS As the only open Ethernet industrial automation solution that offers gigabit bandwidth, CC-Link IE is an obvious choice when it comes to meeting the demands of the upcoming Industry 4.0 applications.

SEAMLESS COMMUNICATION CC-Link handles both control and production data in a high speed deterministic manner between a wide range of devices. Additionally, all levels of the CC-Link hierarchy communicate seamlessly.

CONFORMANCE TESTING Conformance testing through the CLPA ensures that devices meet the CC-Link protocol specifications. Device testing also includes electrical noise immunity testing to ensure trouble-free network communication.

GLOBAL STANDARDS CC-Link IE and CC-Link have both received certification from international bodies such as the IEC, ISO & SEMI. Currently both network technologies have IEC 61158 and 61784. In addition to this, CC-Link IE and CC-Link are also certified to various national, international and other industry standards.

CC-LINK IE INDUSTRIAL ETHERNET CC-Link IE is the first open technology Industrial Ethernet network to operate at gigabit speeds. It combines the best of existing technologies and applies them in a highly reliable architecture that provides exceptional data bandwidth and transaction rates. This makes it especially suitable for the new challenges posed by Industry 4.0 applications.



CC-Link IE TSN

The CC-Link Partner Association introduces CC-Link IE TSN. CC-Link IE TSN builds on our successful pedigree of open automation networks by combining the unmatched bandwidth of open gigabit Ethernet with the future proof technology of Time-Sensitive Networking (TSN).

CC-Link IE TSN – A next generation network based on the current CC-Link IE with the adoption of Time Sensitive Networking (TSN) technology. CC-Link IE TSN provides flexible IIoT system construction along with reduced downtime by using GP Ethernet diagnostic tools compliant with SNMP. CC-Link IE TSN can offer a best in class motion control operation with cycle times better than 31.25µs. For product developers, CC-Link IE TSN provides a diversification of development methods – both hardware and software.

OVERVIEW CC-Link IE TSN offers manufacturing industries the technology they need to address the challenges of Industry 4.0 by focusing on three key areas: Performance, Connectivity and Intelligence.

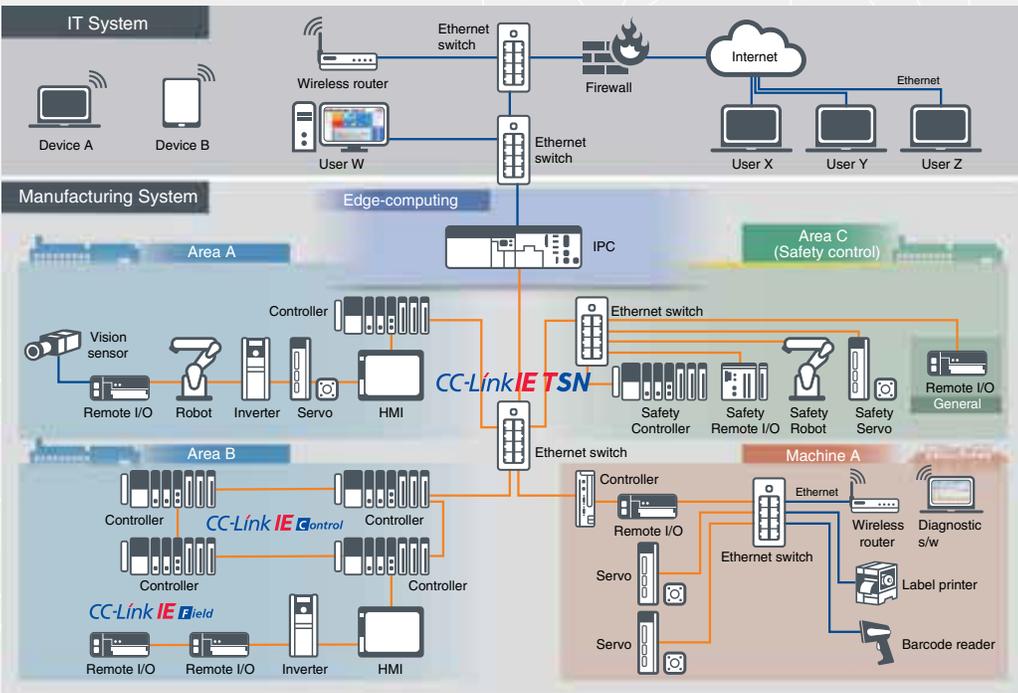
PERFORMANCE Current Industry 4.0 manufacturing trends dictate high speed, accurate cycle times together with the management of large amounts of data in order to meet demanding productivity and quality targets.

CC-Link IE TSN meets these requirements now and in the future by combining unmatched gigabit bandwidth with Time-Sensitive Networking (TSN) as defined by IEEE 802.1. This allows the high productivity shortening of cycle times by integrating control, safety and motion with general TCP/IP traffic, without compromising performance.

CONNECTIVITY Being a fully open technology, CC-Link IE TSN permits full freedom of choice for end users, OEMs and device vendors. Hence systems that use best-in-class devices can be constructed while guaranteeing full multi-vendor interoperability.

Moreover, flexible development methods mean that device vendors can respond to market demands in a variety of different ways, reducing time to market and reducing cost. By using standard Ethernet combined with TSN, CC-Link IE TSN permits support of TCP/IP traffic and even the integration of third-party network protocols. This all runs on a standard Ethernet infrastructure that also includes support for wireless communications.

NETWORK ARCHITECTURE



CC-Link IE TSN



INTELLIGENCE Intelligent networks that allow extensive maintenance and easy setup of devices while maintaining security are essential with industrial communications. CC-Link IE TSN supports third-party diagnostic software such as SNMP tools, enabling trouble-shooting of all network devices (including standard Ethernet). Time-stamping of network event errors is supported to easily evaluate the actual cause of errors, together with the auto-generation of network system architecture and parameters to simplify commissioning.

TARGET INDUSTRIES Many different industries can benefit from the array of features CC-Link IE TSN offers:

BACKWARDS COMPATIBILITY CC-Link IE TSN has been designed with the aim of protecting existing plant investments. Therefore, it is compatible with existing gigabit and 100Mbit CC-Link IE networks.

OPEN DEVELOPMENT Since CC-Link IE TSN is an open technology administered by the CLPA, any vendor can develop products for it after becoming a member of the association. In order to offer the maximum flexibility to potential vendors, a full spectrum of development options exist. This includes the possibility to develop devices that use a gigabit or 100Mbit physical layer, implemented using hardware or software. These possibilities apply at both the master and slave levels.

No.	Device Development Options			TSN
	Communication Speed	Master	Slave	
1	Gbps	Hardware	Hardware	Supported
2		Software		
3		Hardware	Software	
4		Software		
5	100 Mbps	Hardware	Hardware	
6		Software		
7		Hardware	Software	
8		Software		

CC-LINK IE FIELD NETWORK

CC-Link IE Field delivers 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 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. Transient messaging provides high priority, on-demand communication for asynchronous traffic such as alarms, diagnostics or maintenance data. CC-Link IE Field allocates transient mode bandwidth so that cyclic communication remains deterministic. A “common memory” model configured by simple parameterization establishes communications for the entire network.

ULTRA HIGH SPEED REALTIME PROTOCOL [Gigabit Industrial Ethernet] 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.

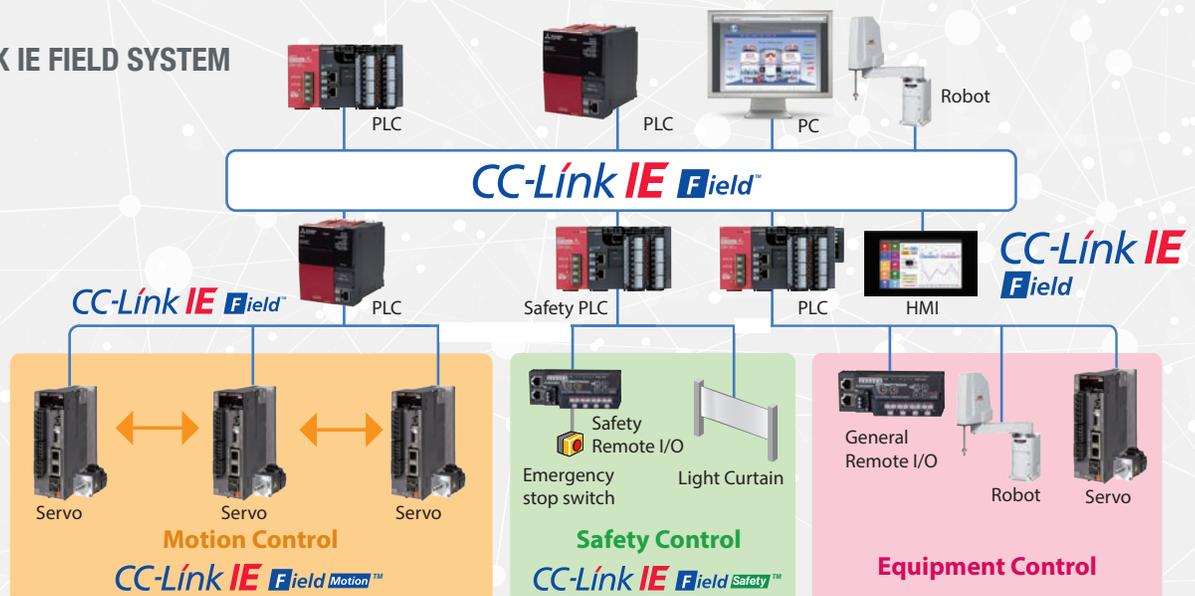
INHERENT DETERMINISM WITHOUT ETHERNET SWITCHES

A significant difference between CC-Link IE Field Network and other Industrial Ethernet options is that CC-Link IE Field Network delivers deterministic control communications without requiring the costly installation and configuration of 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.

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.

TYPICAL CC-LINK IE FIELD SYSTEM



TOPOLOGY

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.

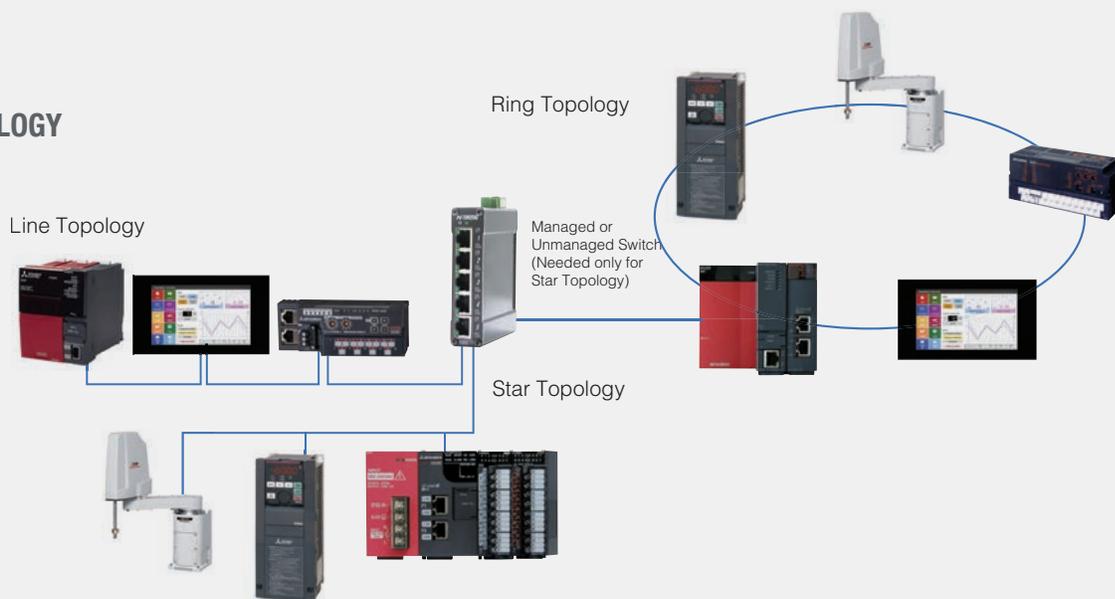
LINE Connecting via a line topology is possible with CC-Link IE Field network devices. This topology does not require the use of any Ethernet switches, since each device is connected in a daisy-chain fashion to the adjacent station(s). This reduces the cost and complexity of the network installation.

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 to connect up to 121 stations.

RING 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

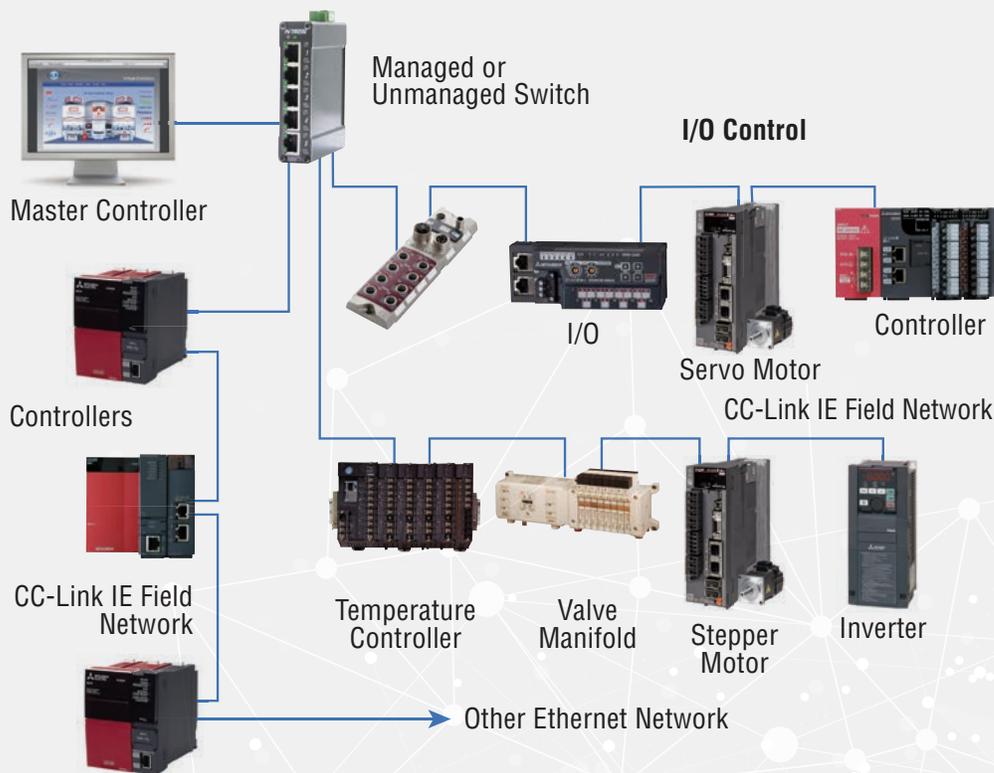
Communication Standard	Ethernet – IEEE 802.3ab (1000Base-T)
Communication Speed	1Gbps
Cable	Shielded Copper Cable (ANSI/TIA/EIA-568-B Cat. 5e)
Connector	RJ-45 '8P8C' Connector or M12 X-Coded Connector
Media Access Control	Token Passing
Network Topology	Star/Line/Ring/Mixture of Star and Line

CC-LINK IE FIELD NETWORKING SUPPORTS CONTROLLER-TO-CONTROLLER COMMUNICATION IN ADDITION TO HANDLING THE CONTROL OF FIELD DEVICES.

COMPLETE NETWORK OPERATIONS The CC-Link IE Field network is designed to simultaneously handle Standard Control (Distributed control, I/O control), Functional Safety and Motion Control as well as provide for Energy Management Functionality.

DISTRIBUTED CONTROL 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.

DISTRIBUTED CONTROL



SEAMLESS NETWORKING

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.

SEAMLESS MULTIPLE NETWORK CONFIGURATION Within a single CC-Link IE Field network there can be a total of 121 stations with up to 100 meters of Ethernet cable between each station. As many as 239 CC-Link family networks can be interconnected allowing vast exchange of data to suit any application. This provides great flexibility when adding to existing control systems or in the initial design of a new integrated control network structure.

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 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.

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

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

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 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 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.

ENERGY MANAGEMENT The CC-Link IE Energy Management Communication (EMC) function provides optimized 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.

CC-LINK IE FIELD BASIC

CC-Link IE Field Basic [IE Field Basic] is the latest addition to the family of CC-Link IE open network technologies that will enable device vendors to easily add CC-Link IE compatibility to any product with an Ethernet communication capability. IE Field Basic is implemented on devices or master controllers by software alone, enabling compatibility to be added to existing products without any hardware modification. This significantly reduces the cost of development and time to market.

CC-Link IE was the first, and is still the only open industrial Ethernet protocol offering gigabit speeds and the high bandwidth required in modern data critical, real-time Industry 4.0 applications. As such it has become a de-facto protocol for businesses looking to optimize productivity and futureproof their operations in line with anticipated increases in data transmission required by an Industry 4.0 production environment. However, there are products and applications where the benefits of gigabit performance are not required, so CLPA has responded with IE Field Basic which can be implemented on any existing 100Mbit Ethernet platform. Moreover, because IE Field Basic's stack is compatible with TCP/IP & UDP/IP, it blends seamlessly with general purpose Ethernet-based technologies (including switches, cables, connectors and wireless systems). Finally, since the master controller for the IE Field Basic network is also software based, any industrial PC or other Ethernet equipped controller can be deployed to control an IE Field Basic network without the need for any special interface cards, driver development or other additional work.

PRODUCT DEVELOPMENT Any existing product with a 100Mbit Ethernet platform can implement IE Field Basic functionality. The CLPA can provide C-Language based sample code along with development guidelines to show how such an implementation should be carried out. Since the code also uses Winsock (Windows API socket), porting to other environments is made simple. A CSP+ (device profile) creation tool is available to produce the necessary files for configuring a network. Finally, a semi-automated conformance test tool is also available to check the overall function of the device in order to assure correct operation.

HOW DOES IT WORK? A CC-Link IE Field Basic network consists of a network master and a number of slave

stations. For each device [slaves and the network master], the IE Field Basic network operation is implemented in the product software. In addition to simplicity, this allows for a variety of network masters to be developed – an industrial PC, a PLC, an embedded board or some other type of controller. The devices all communicate using a cyclic (synchronous) exchange of data. This cyclic exchange provides network updates on a regular schedule. A wide variety of different devices such as I/O, HMI, robots, vision systems, barcode scanners, inverters and servo drives can have IE Field Basic support added to make a comprehensive automation solution that addresses I/O and control. Conventional Ethernet infrastructure is used to construct the network, so existing switches, cable and wireless LAN adapters can all be used. Finally, an IE Field Basic network can be setup to communicate with the gigabit CC-Link IE Field network.

THE BENEFITS CC-Link IE Field Basic now provides all device makers the chance to develop products for the network using their existing Ethernet devices with only software development. This means that now a potentially much larger catalog of devices can be developed. This provides an ever increasing freedom of choice and application flexibility to machine builders and end users. It also allows a diverse portfolio of products to be developed – both gigabit for higher performance applications, and 100Mbit for less demanding uses.

Communication Standard	Ethernet - IEEE 802.3 (100Base-T)		
Communication Speed	100Mbps or 1 Gbps		
Implementation Method	Software		
Topology	Star		
Cable	Category 5e or better		
Cyclic Communication	Supported		
TC/IP & UDP/IP	Compatible		
Number of Connected Stations per Network (Max)	64		
Number of I/O Points (Bits) (Max)	Network	4096 in	4096 out
	Station	64 in	64 out
Number of Numerical Values (Words) [Max] (Max 4 Stations Occupied)	Network	2048 in	2048 out
	Station	32 in	32 out

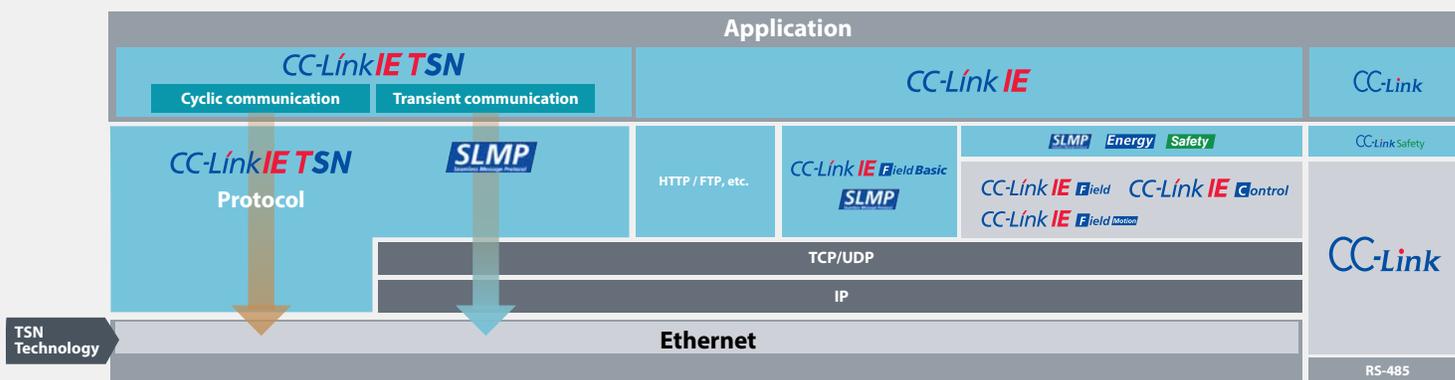
CC-LINK SLMP PROTOCOL

SLMP (Seamless Message Protocol) is the common protocol that binds the family of CC-Link networks together. SLMP is a protocol that operates using a Client/Server model. No specific hardware is required to implement the SLMP communication option.

INTEGRATION BETWEEN CC-LINK IE & TCP/IP FIELD DEVICES SLMP can be used to provide a seamless connection between CC-Link IE and general purpose office Ethernet products [TCP (UDP)/IP]. Implementing SLMP within the application layer provides CC-Link IE connectivity by software development alone. Hence development effort is reduced, and conformance

testing is simplified. With SLMP, an OEM can choose to implement any of the available functions to communicate between a general purpose office Ethernet device and the CC-Link IE networks.

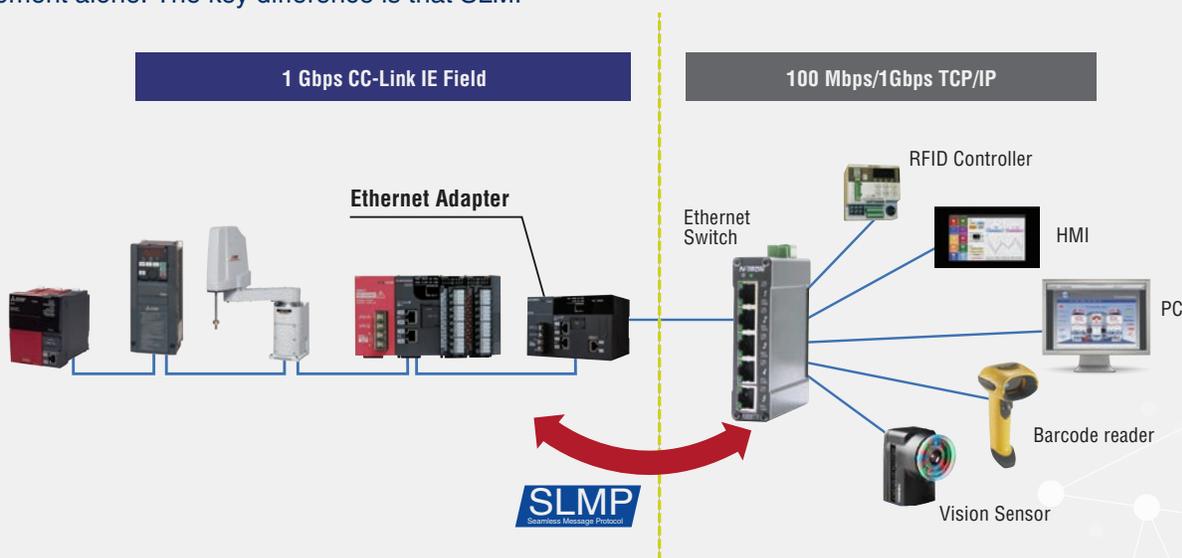
SLMP can be incorporated into the application layer of any Ethernet TCP/IP field device, without changing the hardware of the product. Implementing SLMP into products having an Ethernet port and TCP/IP capability provides these products the ability to communicate and interact with CC-Link IE Field network devices.



The above diagram depicts where the SLMP firmware resides within the OSI communication reference model.

CC-LINK IE FIELD BASIC AND SLMP CC-Link IE Field Basic and SLMP (Seamless Message Protocol) are complementary technologies offered by the CLPA. Each of these communication technologies allows CC-Link IE network support to be added to a device by software development alone. The key difference is that SLMP

is intended for transient (asynchronous) individual connections between a client and a server, whereas CC-Link IE Field Basic is intended for the creation of a network where the devices all communicate cyclically (synchronously).



CC-LINK

The CC-Link fieldbus network is a high speed, high performance open industrial network technology that enables devices from numerous manufacturers to communicate resulting in a fast, deterministic control system. This is the first of the family of open-architecture networks originally developed by Mitsubishi Electric, a global leader in automation and motion control products.

Products include industrial PCs, PLCs, robots, servos, drives, valve manifolds, digital & analog I/O modules, temperature controllers, mass flow controllers, bar code & RFID readers, and many others.

CC-Link handles both control and information data at high speed, to provide efficient, integrated factory and process automation. It provides 10 Mbps, deterministic communication across all devices regardless of type, linking a wide range of multi-vendor automation devices with a single cable. Determinism is assured by the master/slave method of communication, while also allowing for transient (asynchronous) communications that enable peer-to-peer messaging without affecting determinism.

CC-Link is ideally suited for machine, cell or process control in industries ranging from semiconductors to food & beverage, automotive to pharmaceuticals, material handling to building automation. CC-Link is the dominant open technology network in Asia and is growing fast in the Americas and Europe.

CC-LINK FEATURES

- Reduces wiring and installation costs
- Simple memory map architecture
- Outstanding I/O update performance
- Fast throughput of large amounts of data
- Deterministic response for reliable, real-time control
- Simple communication programming eliminates the need for device personality files
- Allows controllers to be programmed and monitored over the network
- Provides network diagnostic information to identify problem areas
- Standby network master for hot back-up
- Bypasses network devices needing service without disrupting network traffic

INTEGRATED FUNCTIONAL SAFETY CC-Link Safety adds the option of safety control to the CC-Link fieldbus technology. CC-Link Safety maintains the standard 10Mbit bandwidth of CC-Link. The safety function layer of the protocol has no impact on performance. CC-Link Safety is intended for fieldbus applications that require IEC 61508 SIL 3 and associated compliance. This is achieved by adding an additional safety function layer to the normal CC-Link fieldbus protocol, allowing compliance with the SIL 3 requirements. CC-Link Safety is fully compatible with CC-Link. Existing CC-Link cable installations can be used for the safety network and standard CC-Link devices can be used on a CC-Link Safety network. This avoids the use of safety devices for network stations where a safety function is not required.

	Version 1.10	Version 2.0 [V2]	Safety
Number of Slave Stations [Max]	64		
Number of I/O Points (Bits) [Max]	2048 in 2048 out	8192 in 8192 out	2048 safety in 2048 safety out
Number of Numerical Values (Words) [Max]	256 in 256 out	2048 in 2048 out	128 safety in 128 safety out
Typical Scan Rate (64 Stations @10Mbps)	4 ms	4-16 ms (based on #I/O and extended cyclic setting)	4 ms
Error Detection System	CRC16 (X16+X12+X5+1), RAS		CRC32 *1, RAS
Network Typology	Multi-Drop, T-Branch, Star		
Transmission Speed	10M / 5M / 2.5M / 625K / 156kbps		
Physical Layer	EIA RS485 compliant		
Communication Media	Certified shielded twisted 3-wire cable		
Communication Method	Broadcast polling		
Synchronization Method	Frame synchronization		
Transformation Format	HDLC		

*1 - X32+X26+X23+X22+X16+X12+X11+X10+X8+X7+X5+X4+X2+X1 [identical to IEEE802.3]



CC-LINK PARTNER ASSOCIATION [CLPA]

The CC-Link Partner Association is the organization tasked with the promotion and technical development of the CC-Link Family of Open Networks worldwide. The CLPA is a global organization with offices and conformance test centers worldwide.

CLPA REGIONAL OFFICES PROVIDE 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
- Organizing working groups to improve the functionality and acceptance of CC-Link technology
- Worldwide promotion of CC-Link products and CLPA partners and via trade shows, product catalog and other publications, seminars, social media, and the worldwide web

- Recommendation of your product when appropriate
- Participation in Trade Shows, Training and other Activities

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)

Cost/Privileges		Membership Categories		
		Registered	Regular	Executive
Annual Membership Fee*		\$0	\$1,000	\$2,000
Protocol specifications		Included	Included	Included
License to use CLPA SLMP technology		yes	yes	yes
License to use CLPA CC-Link technology (other than SLMP)		no	yes	yes
Technical support		no	yes	yes
Conformance Test Fee* (per device)	Cables, Remote I/O Device, Remote Device, Master/Local & Intelligent device stations	not applicable	\$1,000 to \$5,000 depending on device type	consult CLPA
Marketing	Use of the CLPA CC-Link logo(s)	no	yes	yes
	Display or listing of products on websites			
	Display or listing of products @ exhibitions			

*Fees are subject to change.



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