

Jun. 2020



English version

CC-Link IE TSN Compatible Product Development Method Guide



The CC-Link Partner Association (CLPA) is a global leader in developing a truly open industrial network that accelerates the construction of smart factories.

The CC-Link Family is the first field network in Japan and Asia.

It has acquired international standards such as ISO and IEC, and has grown as a global standard network in various fields of the manufacturing industry.

Now, the CC-Link Partner Association has developed "CC-Link IE TSN", the world's first open industrial network using TSN (Time-Sensitive Networking), which is an extension of standard Ethernet, to accelerate the construction of smart factories utilizing IoT.

We globally offer a wide variety of development methods and truly open industrial networks in response to growing market demands for the use of a wide range of sensors at manufacturing sites, for high-performance drive devices, and for the implementation of protocols for various types of devices, applications, etc.



CC-Link*IE***TSN**
Open the Future of Connected Industries

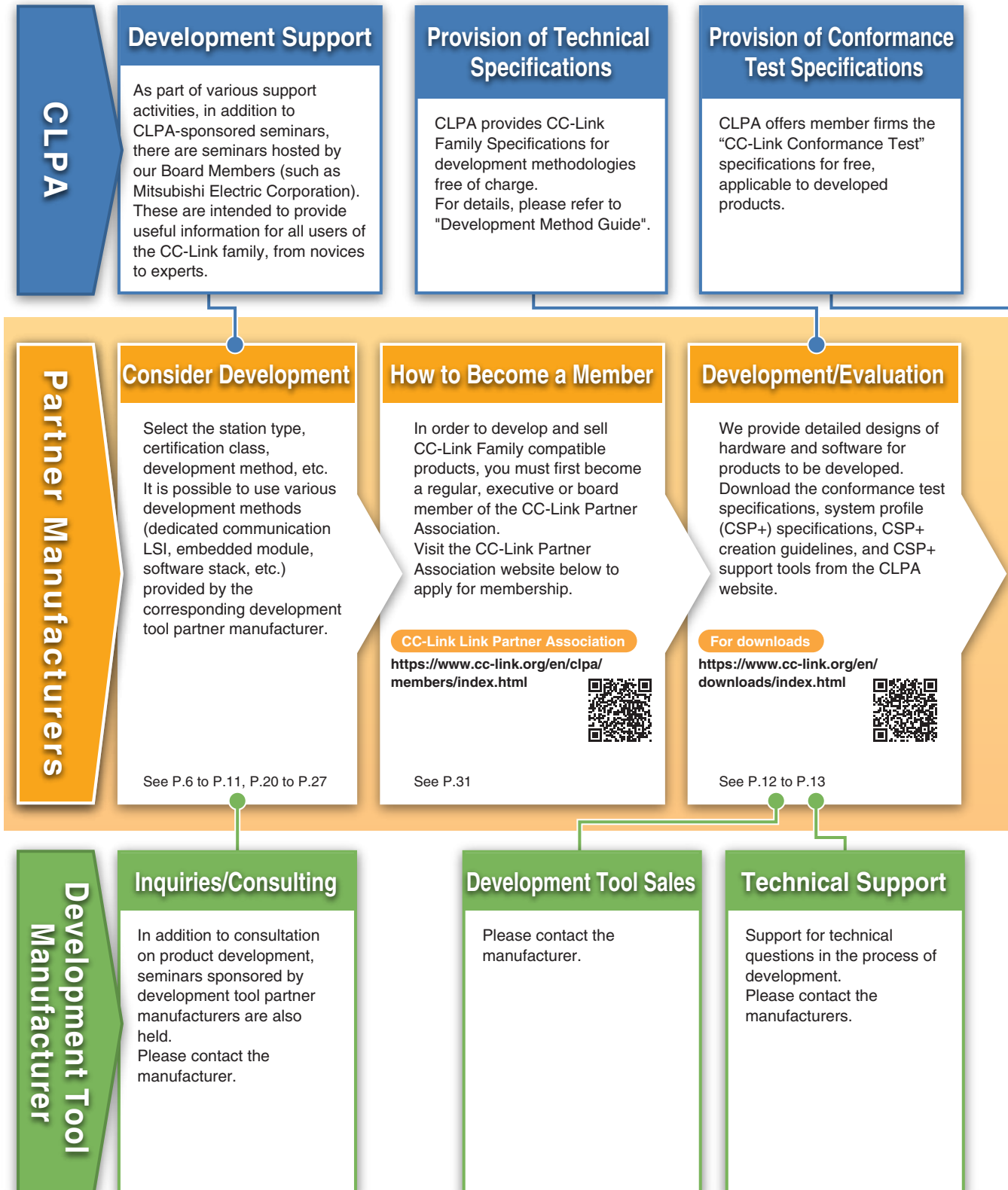


INDEX

Process flow for developing CC-Link IE TSN compatible products	4
Development tool	18
CC-Link IE TSN specification	28
CC-Link IE TSN recommended network wiring parts	29
How to become a CLPA member.....	30

Development flow for CC-Link Family compatible products.

The CC-Link Partner Association will support you from development to sales of
CC-Link Family compatible products.



Testing Laboratory

CLPA conducts conformance tests. The member firms use the conformance test facilities to test CC-Link Family compatible products in various ways. The noise test, hardware test, software test and combined test among others enable verification of correct performance.



Testing Laboratory

<https://www.cc-link.org/en/support/testlab/index.html>



Promotion①

"CLPA Partner Product Search Tool" is available, fully covering all the CC-Link Family compatible products that the member manufacturers have developed and put on the market. CLPA provides users with diversified solutions.

CLPA Partner Product Search Tool

<https://www.cc-link.org/en/downloads/index.html#section-A>



Promotion②

By registering compatible product information, products can be published on the CLPA website.



Mass Production Planning·Evaluation

Make a prototype based on the design and perform various evaluations.

Do Conformance Tests

Perform conformance tests for each model based on the "Conformance Test Specification". To facilitate the conformance testing process, the CC-Link Partner Association has test centers available in Japan and overseas.

※A certificate will be issued after a conformance test is passed.

See P.14 to P.17

Sales

Products that have passed the conformance test can be sold as compatible products. In order to promote products on the CLPA website, the product information must be added by the partner manufacturer.

What is a Conformance Test?

- A conformance test is to be conducted on each model to ensure reliable communication between CC-Link Family compatible products.
- Your products need to be tested to ensure that your products meet the CC-Link Family communication specifications and can be connected to CC-Link networks.
- We offer test tools for CC-Link IE Field Basic, SLMP and open tools for CC-Link IE TSN.

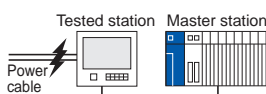
By conducting the conformance test, you can ...

- ensure the communication reliability of your product with the CC-Link Family, and
- easily design system configurations where products of different manufacturers and models are connected.

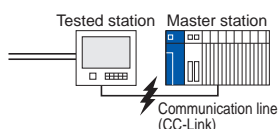
* The conformance test is to ensure that the product meets the common specification of CC-Link Family. The conformance test is not intended to ensure the performance and quality of the product itself.

Test Cases

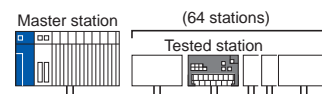
Power supply noise test (AC/DC)



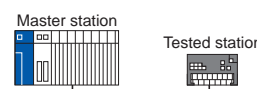
Communication line noise test



Fully loaded network test - 64 stations



Interoperability test



Steps when Considering Development

Step
1

Select the station type

Decide which
station type to support.

Master station

Local station

Remote station

See P.8

Step
2

Select the
certification class

Decide which certification
class to support.

Class A

Class B

Class B devices has higher function than
Class A devices.

■ Class A

- Can be developed by changing the software of existing (Non-TSN) products.

■ Class B

- Guarantees synchronization accuracy of 1μs or less
- Requires either designated LSI or general purpose Ethernet LSI that supports fast communication cycles.

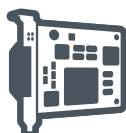
See P.9

* Some of the items to be considered during development are different for recommended wiring components, such as switches, cables, and connectors.

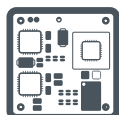
Step 3 Select the development method

Decide which development method to use.

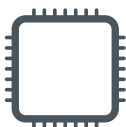
PC board



Embedded Module



Dedicated Communication LSI



Software Development Kit (SDK), etc.



See P.10

Step 4 Select the development location

Decide where to conduct development.

Develop in-house



Use a contracted development manufacturer

See P.11

Process flow for developing CC-Link IE TSN compatible products



Step
1

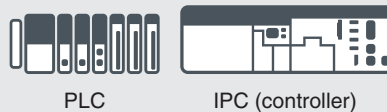
Select the station type

Master station

A station that manages a network. A station that contains control information (parameters) and controls slave stations* and other master stations through cyclic transmission and transient transmission.

* Slave stations : A general term other than master stations such as local stations and remote stations.

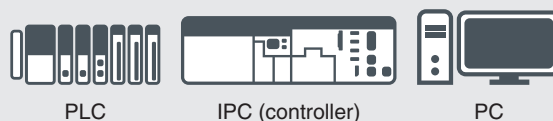
Compatible devices (example)



Local station

A station capable of n:n cyclic transmission with the master station and other local stations, 1:n cyclic transmission with other stations, and transient transmission with other stations. It has a server function and client function for transient transmission.

Compatible devices (example)



Remote station

A station capable of 1:n cyclic transmission, and transient transmission with other stations. It has a server function and client function for transient transmission.

Compatible devices (example)



Step 2 Select the certification class

- The CC-Link IE TSN network has different certification classes depending on the functions and performance of the device (node) and switch.
- Certification classes include A and B, with B being the higher function.

Device

- It is generally recommended to develop certification class B products that have a wide variety of applications. Develop certification class A products only when modifying the software of existing (non-TSN compatible) products.

Certification Classes for Devices

● : Required —: Optional

No.	Function	Conditions	Certification Class	
			A	B
1	Reception/Relay	Full rate reception/relay (*1, *2)	—	●
2	Standards	IEEE1588 compliant	●	●
		IEEE802.1AS compliant	—	●
		IEEE802.1Qbv compliant	—	●
3	Time Synchronization Accuracy	1μs or less	—	● (*4)
4	Communication Mode	Unicast	●	●
		Broadcast/Multicast	— (*3)	●
5	Transient Transmission	NRSV-Transient	●	●

*1 1 port : Reception, More than 2 port : Reception and relay

*2 Communication speed does not matter as long as it is 100 Mbps or more

*3 Implementation is required for local stations

*4 In the case of a system that guarantees time synchronization accuracy of 1 μs, it consists of only products of certification class B. In this case, products of certification class A (including switches) shall not be placed between products of certification class B.

Switches

Certification Classes for Switches

● : Required —: Optional

No.	Standards	Certification Class	
		A	B
1	Link up/Relay	100BASE-T(IEEE802.3ab) compliant	● (*)
		100BASE-TX(IEEE802.3u) compliant	● (*)
		Auto MDI/MDI-X	●
		Auto Negotiation	●
2	Standards	IEEE1588 compliant	—
		IEEE802.1AS compliant	—
3	Time Synchronization Accuracy	1μs or less	—
4	Time Aware Queuing	IEEE802.1Qbv compliant	—

* Supports either 1000BASE or 100BASE, or both

Process flow for developing CC-Link IE TSN compatible products



Step
3

Select the development method

■ Extensive early lineup of supported products

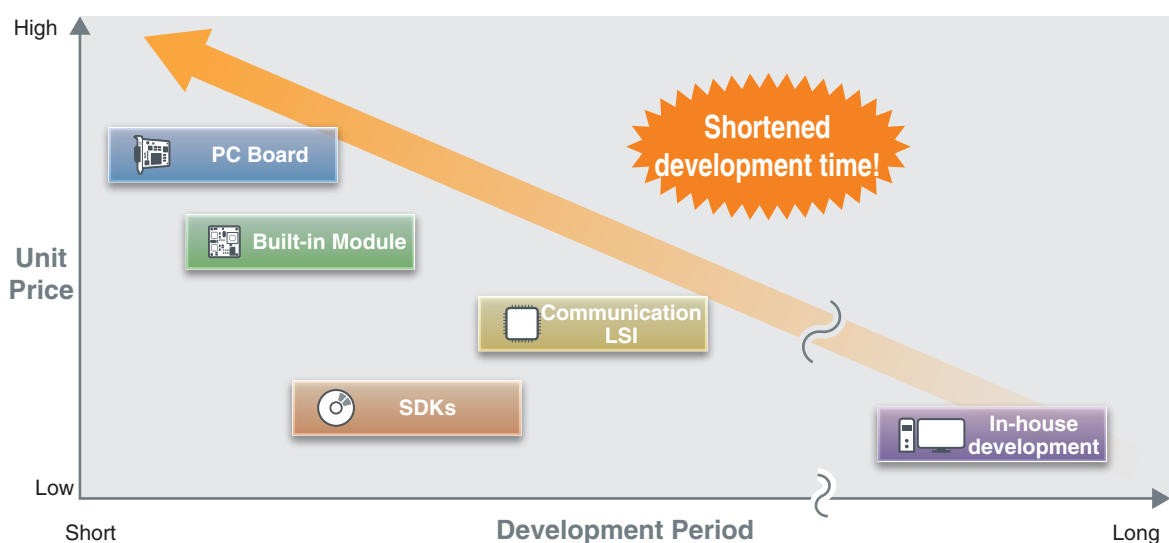
Various types of product development are supported, from high-performance devices implemented on dedicated ASIC/FPGA to low-cost devices implemented on general-purpose Ethernet chips using software protocol stacks.

■ Development using methods provided by various companies

Application	①High Performance, High Function	②For IPC Systems	③Use of Existing Ethernet Products	
Configuration	Hardware Master 1Gbps (/100Mbps) Hardware Slave	Software Master 1Gbps (/100Mbps) Hardware Slave	Hardware Master (1Gbps/) 100Mbps Software Slave	Software Master (1Gbps/) 100Mbps Software Slave
Communication Accuracy				

Hardware : Achieved with communication LSI / PC board / Built-in module

Software : Achieved with SDK



Step 4 Select the development location

Develop in-house

Various development methods can be used to internally develop communication interfaces.



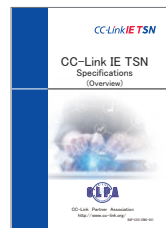
Use a contracted development manufacturer

As one of the methods of clearing the technical and personnel issues in internal development, it is possible to commission a manufacturer to develop communication interface hardware and software.

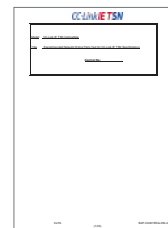
Development/Evaluation

■ Supports from the CC-Link Partner Association during the development and evaluation period

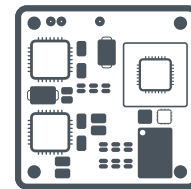
- CC-Link IE TSN specifications are provided free of charge by the CC-Link Partner Association to CLPA partners.
- The CC-Link Partner Association provides conformance test specifications free of charge for the conformance testing of developed products.
- The CC-Link Partner Association introduces tools and evaluation boards manufactured by the partners.



CC-Link IE TSN Specifications



Conformance test specifications



Evaluation Board

■ List of Public Tools

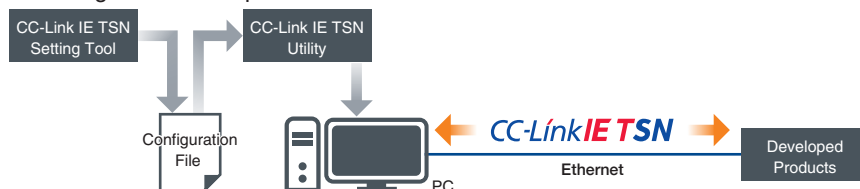
The following tools are available on the CC-Link Partner Association website.

No.	Tool	Application	Additional Information
①	CC-Link IE TSN Configuration Tool	Simple Configuration/Diagnostics	Can be downloaded by Registered members.
②	CC-Link IE TSN Utility	Pseudo Master Station, Pseudo Slave Station	Can be downloaded by Registered members.
③	Profile Creation Support Tool	CSP+ File Creation	Can be downloaded by anyone.

■ Overview of Public Tools

The CC-Link IE TSN communication of developed products can be checked using a computer.

● Configuration example



Operates as a pseudo master station or pseudo slave.

Basic CC-Link IE TSN communication can be confirmed during the product development of our partners.

Overview of CSP+



CSP+

CSP+ is an abbreviation for Control & Communication System Profile Plus. It is a profile that describes information (network parameter information, memory map, etc.) required for the startup, operation and maintenance of CC-Link Family compatible devices.

As CSP+ has integrated profile specifications, all CC-Link Family protocols can be described in the same format.

By using CSP+, CC-Link Family users can easily set parameters for each model with the same engineering tool.

Advantages of CSP+ Development

① Integrated engineering tool environment

Development vendors of CC-Link Family compatible products do not need to create separate engineering tools as long as CSP+ files for the developed products are created. Furthermore, the profile notation according to applications such as diagnostics and energy management makes it possible to display dedicated screens with layouts specialized for each application in the engineering tool.

② Reduced support operations

Since the network parameter information and memory map are described in the CSP+ file, CC-Link Family users can set network parameters and create comments without needing a manual. Also, since device parameters can be set and monitored without a program, user support operations for development vendors will be reduced.

③ XML format adopted

As CSP+ compatible files are in XML format, a general-purpose XML processing library can be used. Therefore, development vendors can reduce the time required for profile development.

CSP+ conformance testing

With the addition of CSP+ test items, conformance tests will be operated as follows.

① Partners developing new CC-Link Family compatible products

As of April 2013, it is necessary to take the CSP+ test in addition to the conventional device tests based on the new conformance test specifications.

② Partners who already have certified products

Development of CSP+ is optional for products that have already been certified.

In addition, conformance testing will be conducted free of charge for CSP+.

Flow of CSP+ operations

- (1) Using the CSP+ creation support tool (can be downloaded from the CC-Link Partner Association website), development vendors create profiles for the CC-Link Family compatible devices.
- (2) After the above file is created, a conformance test is conducted at the CC-Link Partner Association, and the certified file will be posted on the CC-Link Partner Association website.
- (3) CC-Link Family users can download the CSP+ files describing the profiles of the CC-Link Protocol Family connected devices created by development vendors of CC-Link Family compatible products from the website of CC-Link Partner Association or the development vendor.
- (4) The CC-Link Family user will use an engineering tool that can use CSP+, import the CSP+ file of the device downloaded in (3), and implement engineering for the device.

Operation Method	Create a profile using the CSP+ creation support tool 		Product packaged  Available online (CC-Link Partner Association Partner / CC-Link Partner Association) 	Engineering Tools (Monitoring, Diagnosis, Parameter Setting, etc.) 
	① Create	② Conformance	③ Release	④ Use
Target Users	• CC-Link Family product development vendor	• CC-Link Partner Association	• CC-Link Family product development vendor • CC-Link Partner Association	• CC-Link users

Refer to the following URL. <https://www.cc-link.org/en/cclink/cspplus/index.html>

Conformance Testing

■ Conformance Testing

Conformance tests are tests of the communication operation defined by the CC-Link Partner Association for CC-Link IE TSN compatible products to confirm that they meet the CC-Link IE TSN communication specifications and can be connected to the CC-Link IE TSN network.

■ Conformance testing means...

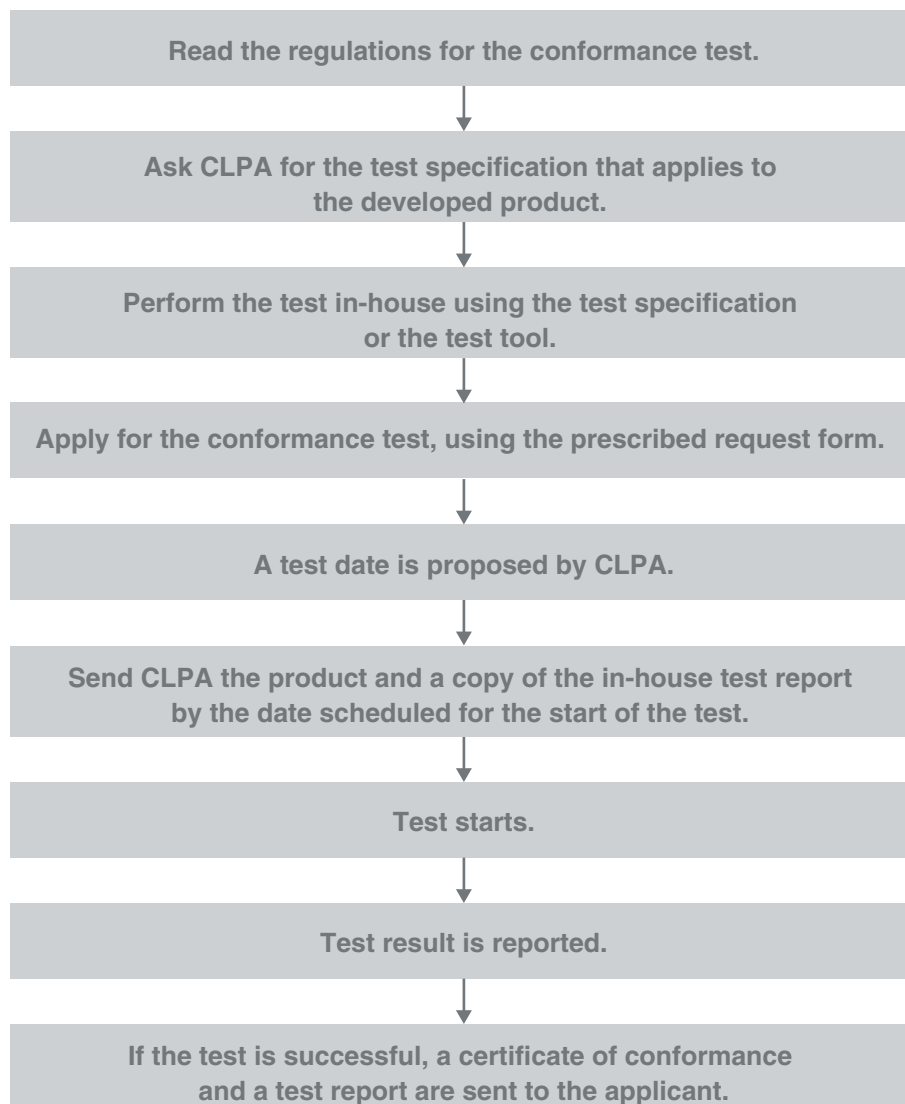
- The reliability of the CC-Link IE TSN communication unit can be guaranteed.
- Smooth system construction is possible with mutual connection among different manufacturers and models.



Caution

- The conformance test is intended to assure that the product meets CC-Link IE TSN communication specifications, and not intended for device-specific functions.
- Passing the conformance test does not mean that the performance or quality of the product itself are guaranteed.
- * Refer to the recommended wiring component specifications for switches, cables, connectors, etc.

■ Workflow for Conformance Testing



CC-Link IE TSN conformance tests include required tests and optional tests.

The test items differ for each certification class.

Test Items

1 Required Tests
The product must pass all of the required tests in order to be certified.

2 Optional Tests
We recommend that you perform these tests when the corresponding functions are implemented.

1 Required Tests

Required items and implementation categories (e.g. remote station)

Certification Class ●: Implemented ▲: Conditionally implemented —: Optional

Classification	Test Items	Certification Class		Category	
		A	B	Partner Manufacturers	CC-Link Association
Hardware test	Noise test				
	① Confirming the CE conformity declaration	—	●		
	② Simulator noise (common mode) test	—			
	③ Cable (wire bundle) noise test	—			
	④ Electrical fast transient / burst test (EFT/B) (power supply application)	—	▲	●	—
	⑤ Electrical fast transient / burst test (EFT/B) (cable application)	—			
	⑥ Conductive immunity test	—			
	Functional Test	—	●		
Software test	Used Parts Check Test	—	●		
	Time Synchronization				
	① IEEE 1588	●	●		
	② IEEE 802.1AS	—	●		
	Cyclic Transmission	●	●		
	Transient Transmission	●	●	●	—
	Topology (line-star)	▲	●		
	Diagnostics	●	●		
Checking the profile description (CSP+)	Error Processing	●	●		
	① Description Contents Check	●	●	●	—
Aging test	① Aging Test	●	●	—	●

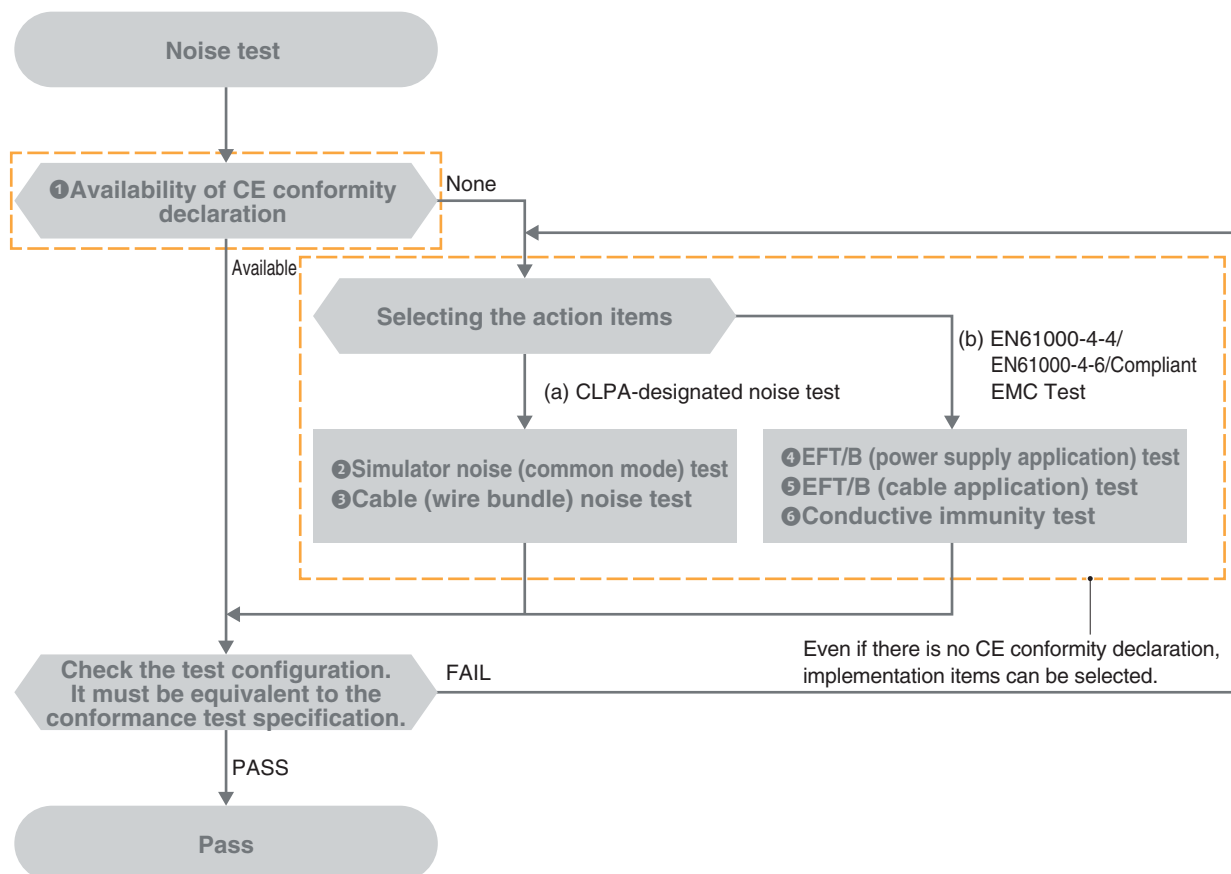
Test items for both 1G/100 Mbps compatible devices

Certification Class Field ●: Implemented —: Optional

Classification	Test Items	Implementation categories for both 1G/100 Mbps compatible devices	
		1Gbps	100Mbps
Hardware test	Noise test		
	① Confirming the CE conformity declaration	●	—
	② Simulator noise (common mode) test	●	—
	③ Cable (wire bundle) noise test	●	—
	④ Electrical fast transient / burst test (EFT/B) (power supply application)	●	—
	⑤ Electrical fast transient / burst test (EFT/B) (cable application)	●	—
	⑥ Conductive immunity test	●	—
	Functional Test	●	●
Software test	Used Parts Check Test	●	●
		●	—
Checking the profile description (CSP+)		●	—
Aging test		●	●

Process flow for developing CC-Link IE TSN compatible products

Flow of executing the noise test



(a) CLPA-designated noise test

Test Items	Test Configuration	Test Conditions
2 Simulator noise (common mode) test	Refer to the conformance test specifications.	Noise Voltage : $\pm 2,000$ VAC Application Time : 2 hours
3 Cable (wire bundle) noise test	Refer to the conformance test specifications.	Noise Voltage : $\pm 1,000$ V Application Time : 10 minutes

(b) EN61000-4-4/EN61000-4-6 compliant EMC test

Test Items	Test Configuration	Test Conditions *
4 Electrical fast transient / burst test (EFT/B) (power supply application)	Comply with EN61000-4-4.	Noise Voltage : $\pm 2,000$ VAC Application Time : 1 minutes
5 Electrical fast transient / burst test (EFT/B) (cable application)	Comply with EN61000-4-4.	Noise Voltage : $\pm 1,000$ V Application Time : 1 minutes
6 Conductive immunity test	Comply with EN61000-4-4.	Sweep Frequency : 0.15 to 80 MHz Electric Field Strength : 10 Vrms Modulation : 80%AM Frequency Step : 1%

* EN61000-6-2 is an immunity standard for industrial environments of the EMC shared standards.

Requests from CLPA

- Documents that show the test configuration need to be submitted in order to confirm that the configuration is correct.
- As all of the above test items have different noise waveforms, we recommend that you check all the test items.

2 Optional Tests

Classification	Test Items	Remarks
Hardware test	1000BASE-T compliance test	Optional tests are not confirmed by the CC-Link Partner Association.
Software test	Cyclic transmission (checking the transmitting station (local station) status register) Topology (ring connection, mesh connection, mixed) Control (cyclic start/stop / reserved station) Error processing (station number setting mismatch / network number setting mismatch / station type mismatch)	

Requests from CLPA

- These are optional tests, but they are test items related to the communication and functions of the product. The corresponding test items should be implemented when developing a product with applicable functions.
- Although we as an association do not confirm the results through testing, the test results should be submitted.

Differences in conformance testing between CC-Link IE TSN and CC-Link IE Field

Classification	Changes		CC-Link IE TSN	CC-Link IE Field
①	Defined by certification class A,B		Test is conducted for each certification class A, B. See P6 for definition of certification class	No certification class
②	Change in noise test method		(a) CLPA-designated noise test using a simulator (impluse) noise tester. (b) EN61000-4-4/EN61000-4-6 compliant EMC Test	CLPA-desinated noise test using a simulator (impulse) noise tester only.
③	Changes to test item requirements	1000BASE-T Compliance Test	Optional Test	Manufacturer Mandatory Test Items
		Topology Ring Connection	Optional Test	Manufacturer/CLPA Mandatory Test Items
		Reserved Station	Optional Test	Manufacturer/CLPA Mandatory Test Items
		Station Number Setting Mismatch	Optional Test	Manufacturer/CLPA Mandatory Test Items
		Network Number Setting Mismatch	Optional Test	Manufacturer/CLPA Mandatory Test Items
		Station Type Mismatch	Optional Test	Manufacturer/CLPA Mandatory Test Items








CC-Link IE TSN Conformance Test Implementation Division

There are two conformance test types for CC-Link IE TSN; a "Manufacturer Test" and a "Conformance test conducted by the CC-Link Partner Association". You can use the test lab recommended by CLPA when the partner manufacturer conducts the test for the test item whose test category is "Manufacturer Test". (The use of the test lab is chargeable.) If conduct conformance test by CLPA in advance at the same test lab will waive the conformance testing and reduce the testing costs. Please see below for details.

Test Implementation Division	Partner Manufacturers	Test Lab	CC-Link Association		
			Conformance Test	Confirmation of Partner Manufacturer Test Results	Cost (Regular Member)
①	All tests implemented		Implemented	Implemented	100,000 yen
②	Some tests implemented	Partial testing implemented (including conformance testing)		Implemented	50,000 yen
③		All tests implemented (including conformance testing)		Implemented	

■ CC-Link IE TSN Development Tool Partner

Choose a development method to suit your goals.

Company	Development Method	Station Type	Certification Classes A or B	 Dedicated Communication LSI	 SDK	Publication page
	Master/Local station	Master station	B	●		P.20
		Remote station	B	●		P.21
	Master station	Master station	B	●		P.20
		Remote station	A		●	P.21
	Master station	Master station	A / B		Coming soon	P.22
	Remote station	Remote station	A		Coming soon	P.23
	Remote station	Remote station	B	●		P.24
	Remote station	Remote station	A / B		Coming soon	P.25
	Master station	Master station	B		●	P.26
	Remote station	Remote station	A		●*	P.27

Embedded module or PC board are under consideration by partners.

For details, contact the CC-Link Partner Association.

* Support is also planned for Safety.

The partners that are considering development are as follows.



Development too

CC-Link IE TSN specification

CC-Link IE TSN recommended network wiring parts

How to become a CLPA member

Mitsubishi Electric Corporation

Contact Information

2-7-3, Marunouchi Chiyoda-ku, Tokyo 100-8310, Japan
 <Mitsubishi Electric FA Website> <https://www.mitsubishielectric.co.jp/fa/>
 *Or contact your local CLPA office (P.27)



When products are made compatible with CC-Link IE TSN... This not only ensures the system flexibility unique to multi-vendor products, but also provides an opportunity for the competitive strength of the product to reach the global level.
 In order to speedily and reliably develop CC-Link IE TSN compatible products, Mitsubishi Electric provides support in all aspects, including providing development tools.

Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product Name
Communication LSI	Master/ Local station	Class B devices	Designated communication LSI for development of CC-Link IE TSN Master/Local Station (CP610) NEW
Software Development Kit	Master station	Class B devices	CC-Link IE TSN Master Station Software Development Kit

Development Method

■ Designated communication LSI for Master/Local station CP610

This is a communication LSI that allows to develop devices that perform cyclic transmission or transient transmission without being aware of the protocol. The CP610 is controlled by software.



■ CC-Link IE TSN Master Station Software Development Kit SW1DTD-GNSDK1M (the source code bundled version) SW1DTD-GNSDK2M (the Library version)

A method for developing a master station using a software protocol stack.

CC-Link IE TSN compatible devices can be developed without changing the hardware of devices compatible with general-purpose Ethernet.



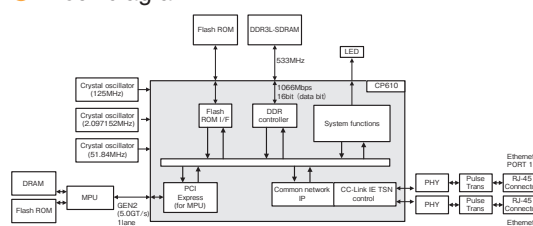
Features and benefits of development methods

■ Designated communication LSI for Master/Local stations CP610

- 1 You can develop a CC-Link IE TSN Master Station/Local Station without having to implement the protocol.
- 2 Available sample code can be customized according to the customer's hardware specifications and applications.
- 3 Freely selectable MPU and OS.
- 4 Can use the CC-Link IE TSN configuration tool included in the source code development kit to set parameters and diagnose the CC-Link IE TSN Master Station/Local Station.

Source code development kit: A software package for developing a CC-Link IE TSN Master Station / Local Station. The source code kit can be downloaded from the Mitsubishi Electric FA site.
 There is also a device kit which is a set of CP610 and a Flash ROM with the source code.

● Block diagram



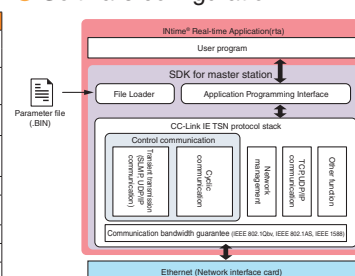
■ CC-Link IE TSN Master Station Software Development Kit SW1DTD-GNSDK1M/SW1DTD-GNSDK2M

- 1 A software protocol that runs on a PC. Regardless of high-performance PC or inexpensive PC, various systems can be constructed.
- 2 CANopen® compliant API. Customers who develop CANopen® compatible products can easily develop CC-Link IE TSN compatible devices.
- 3 The source code bundled version can be customized by the customer. It can be expanded and ported to different development environments. In addition, the library version can build a system at a low cost.

● List of communication specification

No.	Item	Contents
1	Maximum cyclic data size per 1 network	Input data: Total 36KB Output data: Total 36KB
2	Maximum cyclic data size per 1 station	Input data: Total 36KB Output data: Total 36KB
3	Communication speed	1Gbps, 100Mbps
4	Maximum number of connected nodes	129 stations* (Total of Master station + remote station) *Does not include general-purpose TCP / IP communication function
5	Connected cable	Double shielded - straight of Category 5e or higher
6	Distance between stations (max.)	Compliant with 100m (ANSI / TIA / EIA-568-B (Category 5e or higher))
7	Transmission line type	Line type, Star type, Line+star type
8	Communication bandwidth guarantee method	Time sharing
9	Time synchronization protocol	IEEE802.1AS and IEEE 1588
10	Number of Ethernet port	1

● Software configuration



Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product name
Communication LSI with Built-in GbE-PHY	Remote station	Class B devices.	Communication LSI with Built-in GbE-PHY for development of CC-Link IE TSN Remote Station (CP620)
Software Development Kit	Remote station	Class A devices.	CC-Link IE TSN Remote Station for Software Development Kit

Development Method

■ Communication LSI with Built-in GbE-PHY for development of CC-Link IE TSN Remote Station (CP620)

LSI that integrates an ASIC for CC-Link IE TSN communication, MPU and GbE-PHY. It allows devices that perform cyclic transmission and transient transmission to be developed without having to implement the protocol.



■ CC-Link IE TSN Remote Station for Software Development Kit SW1DNC-GNSDK1S-M/ SW1DNC-GNSDK2S-M (TCP/IP stack bundled version)

A method for developing remote stations using a software protocol stack. It enables the development of CC-Link IE TSN compatible devices without changing the hardware of devices compatible with general-purpose Ethernet.

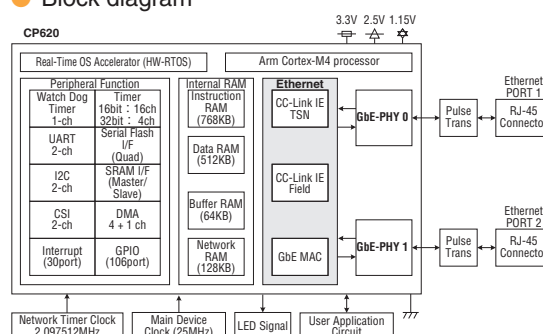


Features and benefits of development methods

■ Communication LSI CP620 with Built-in GbE-PHY for Remote Stations

- 1 GbE-PHY is integrated, making it easy to create pattern designs for communication circuits. In addition, there are only few parts and circuits around the CPU and GbE-PHY, allowing the developed substrate to be compact.
- 2 Sample codes are available that can be customized according to the hardware specifications and applications.
- 3 As it is equipped with a H/W-RTOS, CPU load and power consumption of the developed device can be reduced.

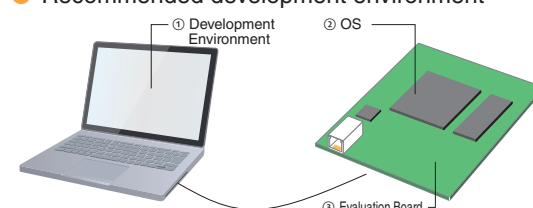
● Block diagram



■ CC-Link IE TSN Remote Station for Software Development Kit SW1DNC-GNSDK1S-M

- 1 Requires few resources for the operation of the software protocol stack, allowing it to be operated even with a microcomputer for low-cost devices.
- 2 Everything is provided as source code, and API and wrapper layers are included, making it easy to port to the customer's development environment.
- 3 By using the log function, errors and processing status in the protocol stack can be traced during debugging.

● Recommended development environment



	Name	Manufacturer
①	IAR Embedded Workbench for Arm	IAR Systems K.K.
②	μC3/Compact	eForce Co., Ltd.
③	NUCLEO-F429ZI	STMicroelectronics

port industrial automation GmbH

Contact Information

Regensburger Strasse 7b / 06132 Halle-Saale
TEL/FAX +49-345-77755-0 (-20)
URL <https://www.port.de/>
E-mail service@port.de



PORT's CC-Link IE TSN Stack products can be obtained in different versions. Whether master or remote station (software stack) - large quantities or small quantities - PORT offers the right solution for every user of CC-Link IE TSN technology.

Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product name
Software Development Kit	Master Station	Class A or Class B* *Class B available if Hardware supports TSN	CC-Link IE TSN Master SDK Coming soon

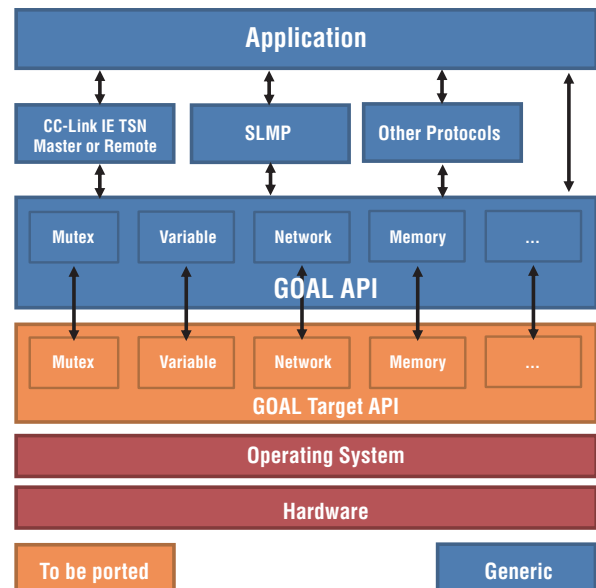
Development Method

■ **The application decides what you need - PORT offers the right CC-Link IE TSN Master solution for your need - Semiconductor independently.**

- SDK uses GOAL, port's Industry 4.0 platform.
- Platform is easily portable to customer's hardware and operating system.
- Master Station sample platform is the NXP LS1028ARDB.
- Port's Design Tool allows easy creation of application data objects (Link Devices or CANopen objects), Stack configurations and Device Description files.

Features and benefits of development methods

- Allows implementation of Management Master station and Control Master station.
 - Management Master Station: Controls other slaves and manages the network (only one station per network).
 - Control Master Station: controls other slaves and masters (one or multiple CM stations per network).
- Supports time synchronization via IEEE 802.1AS and IEEE 1588v2 (both E2E and P2P delay mechanisms are supported).
- Supports both hardware and software implementation of TDMA-scheduling (IEEE 802.1Qbv). (Software implementation is less deterministic but allows support of standard MAC controllers)
- Supports control communication (cyclic communication) with Slave stations and other Master stations.
- Supports Transient Transmissions (acyclic communication) with other stations.
 - Reserved transient Transmission: acyclic communication within timeslot for cyclic communication.
 - Non-reserved Transient Transmission: acyclic communication within timeslot for standard Ethernet traffic.
- Supports SLMP (Seamless Message Protocol) for acyclic data transfer.
- Support of multiple cycle times.
The Master can perform control communication with multiple slaves with different cycle times. All cycle times must be a multiple of the smallest cycle time.
- Cyclic Start/Stop: stop and restart cyclic transmission with other stations.
- Certification Class B is possible.



Industrial Communication Framework - Middleware GOAL

Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product name
Software Development Kit	Remote Station	Class A	CC-Link IE TSN Remote SDK Coming soon

Development Method

■ **The application decides what you need - PORT offers the right CC-Link IE TSN Remote solution for your need - Semiconductor independently.**

- SDK uses GOAL, port's Industry 4.0 platform.
- Platform is easily portable to customer's hardware and operating system.
- Remote Station sample platform is the STMicroelectronics NUCLEO-F429ZI.
- Port's Design Tool allows easy creation of Application data objects (Link Devices or CANopen objects), Stack configurations and Device Description files.

Features and benefits of development methods

- Allows implementation of Remote Slave Station.
- Supports time synchronization via IEEE 802.1AS and IEEE 1588v2 (both E2E and P2P delay mechanisms are supported).
- Supports both hardware and software implementation of TDMA-scheduling (IEEE 802.1Qbv). (software implementation is less deterministic but allows support of standard MAC controllers)
- Supports control communication (cyclic communication) with Master stations.
- Supports Transient Transmissions (acyclic communication) with other stations.
 - Reserved transient Transmission: acyclic communication within timeslot for cyclic communication.
 - Non-reserved Transient Transmission: acyclic communication within timeslot for standard Ethernet traffic.
- Supports SLMP (Seamless Message Protocol) for acyclic data transfer.

*Please refer to the diagram on the left.

Renesas Electronics Corporation

Contact Information

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

For inquiries regarding products, samples, or purchases, please contact your local sales representative or distributor.

URL <https://www.renesas.com/jp/ja/support/contact.html>

*Or contact your local CLPA office (P.27)



"R-IN32M4-CL3" is a communication LSI for CC-Link IE TSN Class B remote station. CC-Link IE TSN is realized on a single chip by installing 2 port Gigabit Ether PHY, CPU, and large-capacity memory. In addition, OS and software necessary for development are included to realize smooth product development.

Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product name
Communication LSI with built-in GbE-PHY	Remote station	Class B	R-IN32M4-CL3

Development Method

Provides all hardware, software and development environment necessary for CC-Link IE TSN communication. Evaluation can be started immediately according to the procedures in the startup manual.

Communication LSI

- CPU Cortex-M4 large capacity memory
- CC-Link IE TSN dedicated hardware
- 2 port Gigabit Ethernet PHY

Software

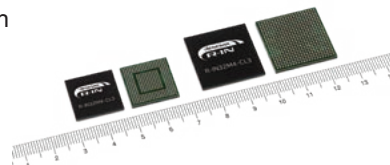
- CC-Link IE TSN remote station
- CC-Link IE Field intelligent device station
- TCP/IP stack, peripheral driver
- Project file for master station

Manual

- Hardware manual
- Users manual
- Startup manual
- etc.

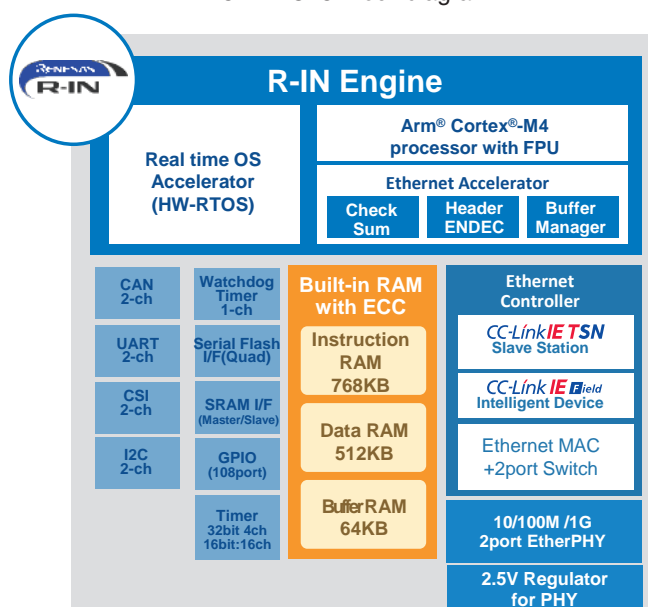
Evaluation board

- Evaluation board with R-IN32M4-CL3



Features and benefits of development methods

R-IN32M4-CL3 Block diagram



Feature of R-IN32M4-CL3

- 1 Built-in hardware for CC-Link IE TSN
High precision time synchronization and time sharing communication
- 2 Built-in Gigabit Ethernet PHY
Reduction of mounting area and development cost
- 3 Equipped with R-IN engine
Fast real-time response
Low power consumption
- 4 Full software
Complete with OS, communication protocol and peripheral drivers to shorten development period
- 5 Package
484PBGA, 23mm□, 1.0mm pitch
356FBGA, 17mm□, 0.8mm pitch

SILA Embedded Solutions GmbH

Contact Information

Linzerstrasse 28, Sankt Pölten, 3100, Austria

TEL/FAX +43-2742-93084

URL <http://www.embedded-solutions.at>

E-mail office@embedded-solutions.at



CC-Link IE TSN software development kit for remote station provided as portable C source code with sample applications for LINUX and STM32. A unified porting layer allows easy adaption of the stack to customer specific hardware. The SDK is self-contained and no further costs are involved for development of a CC-Link IE TSN remote station.

Developable Stations / Certification Classes

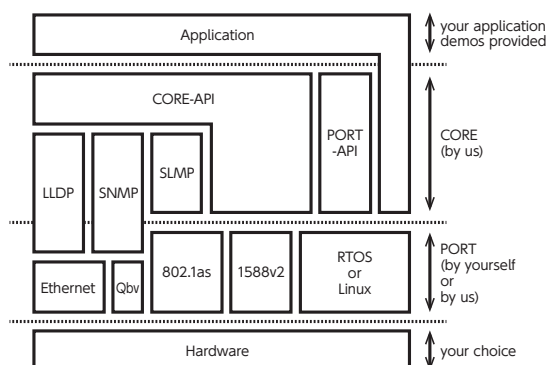
Development Method	Station Type	Certification Class	Product name
Software Development Kit	Remote Station	Class A, Class B	CC-LINK IE TSN STM32 Coming soon
Software Development Kit	Remote Station	Class A	CC-LINK IE TSN LINUX Coming soon

Development Method

- The SDK is self-contained and evaluation can easily be performed on the STM32 NUCLEO or iMX6 evaluation boards as provided by numerous 3rd party vendors.**

- Remote device application development can be started on the evaluation boards using the provided CSP+ files and examples for GX Works3. Other masters will be supported in future demos.
- If hardware and software environment is similar to the demos, they can be used for your own software development. Otherwise, the demos can serve as a starting point to adapt the port to new RTOS and/or hardware platforms.
- Embedded Experts GmbH, a SILA subsidiary, also provides** porting services to existing or new customer hardware.

To further support development, the SDK includes a combined getting started and porting manual.



Features and benefits of development methods

Features:

- Delivered as C source code
- Supports iMX6 and STM32
- TSN ready
 - Use hardware MAC support for IEEE 802.1AS and IEEE 1588v2 if available.
 - Software 802.1Qbv implementation
- Complete with OS, TCP/IP stack, documentation and samples to reduce development time.

	iMX6 UL/ULL	STM32
OS	Linux (Kernel > 4.6)	FreeRTOS
IDE	GCC + CMAKE	STM32CubeIDE or GCC + CMAKE based
TCP/IP stack	Linux	lwIP
Devices	NXP/Freescale i.MX6 UltraLite Cortex A7	STM32F769
TSN	IEEE 802.1AS + IEEE 1588v2	IEEE 802.1AS + IEEE 1588v2 IEEE 802.1Qbv
Ethernet ports	1 (Star)	1 (Star)
Speed	100Mbit/s	100Mbit/s

ZUKEN ELMIC, Inc.

Contact Information

3-1-1 Shin-Yokohama, Kōhoku-ku, Yokohama, Kanagawa, Japan

TEL/FAX 045-624-8002

URL <https://www.elwsc.co.jp/>E-mail info@elwsc.co.jp

*Or contact your local CLPA office (P.27)

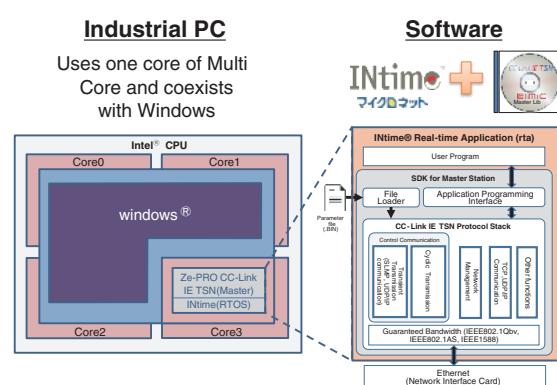
Elmic

Commercialized software development kit (SDK) for product developers of CC-Link IE TSN remote station and master station. SDK based on the know-how cultivated by a long-established communication middleware manufacturer. μ ITRON for remote station and Windows reference environment operation sample for master station are packaged for quick evaluation and development. We support smooth evaluation and development.

Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product name
Software	Master Station	Class B	Ze-PRO CC-Link IE TSN(Master) SDK
Software	Master Station	Class B	Ze-PRO CC-Link IE TSN(Master) Lib for INTime

Development Method



■ Software development kit (SDK or Lib for INTime) for a CC-Link IE TSN master station.

■ Develop the user application for the master station by returning the application interface that operates the stack for the CC-Link IE TSN master station.

■ Develop a user application for a master station by utilizing the packaged sample application that uses an application interface to operate the stack.

Example of packaged sample applications:

- 1 Sample application for cyclic transmission.
- 2 Sample application of CC-Link IE TSN and CANopen® compatible devices.
- 3 Sample SLMP server and SLMP client functions.

Features and benefits of development methods

- CC-Link IE TSN Standards Compliant
Can connect to CC-Link IE TSN compatible remote station (Class A / Class B) devices.
- High Versatility
 - Windows-based industrial PC environment
 - Supports Visual Studio
 - Supports API with C Language
 - Supports API compatible with CANopen®
- High Performance
 - Operates on RTOS (INTime) coexisting with Windows
 - High precision clock with Intel® Ethernet Controller I210
- Continuous Function Expansion
 - Quickly respond to standard version upgrades
- Product lineup according to application
 - SDK version by providing source code that can support OS changes and function expansion.
 - A library version that binarizes the core part of the protocol stack for application developers.

*Both products are equipped with sample application in C language.

CC-Link IE TSN Master Station Communication Specification

No.	Item	Communication Specification
1	CC-Link IE TSN Certification Class	Certification Class B
2	Maximum cyclic size per network	Input data Output data Total 36Kbytes
3	Maximum cyclic size per station	Input data Output data Total 36Kbytes
4	Transient transmission	Total 1920bytes
5	Communication speed	1Gbps, 100Mbps
6	Connectable device type	<ul style="list-style-type: none"> • CC-Link IE TSN compatible Slave Station (Certification Class A or certification Class B) * Does not include general-purpose TCP/IP communication devices * Only remote stations can be connected, local stations cannot be connected • General-purpose TCP/IP communication device • Switch *1
7	Shortest communication cycle	250μs
8	Maximum number of connected stations	129 stations ** (total of Master station + Remote station) * Does not include general-purpose TCP/IP communication devices
9	Connection cable	Category 5e or higher double shielded : straight
10	Total network length	Line 12,800m (when connected 129 stations) Others Depends on network configuration
11	Maximum distance between nodes	100m (compliant with ANSI/TIA/EIA-568-B(Category 5e))
12	Number of possible switch cascade layers	1 layer *1
13	Topology	Line, Star, Line+Star
14	Communication bandwidth guarantee method	Time sharing method
15	Time synchronization protocol	IEEE802.1AS and IEEE1588
16	Number of Ethernet ports	1

*1 When configuring a network with only certification Class B, only one CC-Link IE TSN compatible switch certified by the CC-Link Partner Association can be connected. Also, when using a general-purpose switch, you can connect only to the end of the network. Please contact us for details regarding the use of the switch.

*2 When using time synchronization protocol IEEE802.1AS. When the time synchronization protocol is set to IEEE1588, up to 30 slave stations can be connected. However, the number of slave stations of certification class B must be 8 or less. For details on setting the time synchronization protocol to IEEE1588, please contact us.

Developable Stations / Certification Classes

Development Method	Station Type	Certification Class	Product name
Software	Remote station	Class A	Ze-PRO CC-Link IE TSN (Remote) SDK

Development Method

- Software development kit (SDK) for TSN remote station.
- Wrap blocks with high transplant dependency with API.
- Can be easily implemented by combining the OS, TCP/IP stack and Ethernet driver according to the customer environment.
- Operation confirmation after porting can be easily confirmed by using it as a CC-Link IE TSN utility * simple master station.

SDK Specification

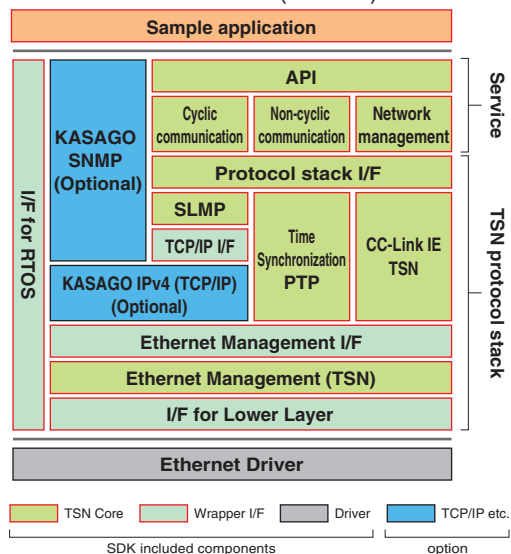
No.	Item	Specifications
1	Supported OS	μITRON4.0 specification
2	Supported devices	STMicroelectronics Inc. STM32F4 series
3	Recommended PHY devices	Texas Instruments Inc. DP83848CVV
4	Recommended TCP/IP stack	Zuken Elmic KASAGO IPv4 Lite
5	Minimum required memory (ROM/RAM)	ROM:512KB RAM:200KB

* CC-Link IE TSN utility can be obtained from the CLPA Members Site.

Features and benefits of development methods

Development method details

Ze-PRO CC-Link IE TSN (Remote) SDK



Kit contents

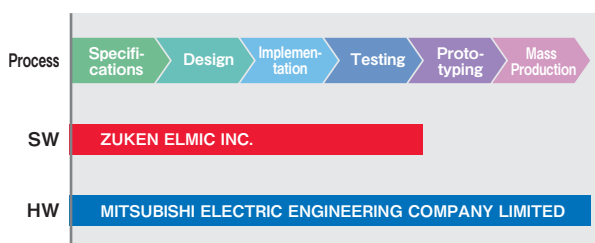
- TSN stack SDK (source code)
- Sample application
- CC-Link IE TSN (Remote) SDK Reference Manual
- CC-Link IE TSN (Remote) SDK porting manual

Confirmed operation environment

No.	Operation check environment	Product name	Manufacture name	Remarks
1	Evaluation Board & Integrated Development Environment (STM32F4)	NUCLEO-F429ZI	STMicroelectronics	Cortex-M4 (180MHz)
		IAR Embedded Workbench for ARM	IAR Systems	Version: 8.3
2	Evaluation Board & Integrated Development Environment (RX72M)	TS-RX72M-COM	TESSERA TECHNOLOGY INC.	Renesas Electronics Corporation RXv3(240MHz)
		E2studio+CCRX Compiler	Renesas Electronics Corporation	E2studio(V7.5.0) CCRX(V3.01)
3	OS	μC3/Compact (μITRON4.0 specification OS)	eForce Co.,Ltd.	Package version: 2.2.6 Kernel version: 2.11.00
4	TCP/IP stack	KASAGO IPv4 Lite	ZUKEN ELMIC, Inc.	Version: 6.0.1.33
5	SNMP	KASAGO SNMP	ZUKEN ELMIC, Inc.	Version: 6.0.1.33
6	IP duplicate detection	KASAGO AutoIP	ZUKEN ELMIC, Inc.	Version: 6.0.1.33

Contract development service

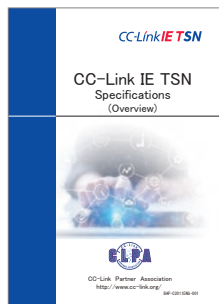
- MITSUBISHI ELECTRIC ENGINEERING COMPANY LIMITED.
- From product development to conformance testing, prototyping and mass production, we support users from both software and hardware.



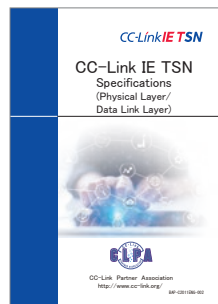
■ CC-Link IE TSN Specifications

No	Item	Details
①	Transmission Speed	1 Gbps, 100 Mbps
②	Maximum I/O Size Per Station	Up to 4G (4,294,967,296) octets in I/O total for each station
③	Transient Transmission	Each station has server function and client function. Transmission capacity is the same as SLMP.
④	Communication Method	Time Sharing Method
⑤	Synchronization Function	Complies with IEEE 802.1AS and IEEE 1588v2
⑥	Number of Nodes Connected to One Network	64,770 units (total number of master and slave stations)
⑦	Maximum Distance Between Nodes	<ul style="list-style-type: none"> • For twisted pair cable (IEEE 802.3 compliant): 100 m • For optical fiber (IEEE 802.3 compliant multi-mode fiber): 550 m • For optical fiber (SI-POF): 20 m • For optical fiber (SI-HPCF): 100 m
⑧	Maximum Number of Branches	No upper limit
⑨	Topology	Line, star, line/star mixed, ring, ring/star mixed, mesh

■ CC-Link IE TSN Specifications



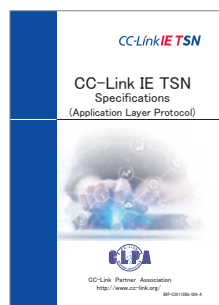
BAP-C2011ENG-001
CC-Link IE TSN Specifications
(Overview)



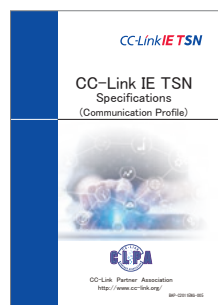
BAP-C2011ENG-002
CC-Link IE TSN Specifications
(Physical Layer / Data Link Layer)



BAP-C2011ENG-003
CC-Link IE TSN Specifications
(Application Layer Service)



BAP-C2011ENG-004
CC-Link IE TSN Specifications
(Application Layer Protocol)



BAP-C2011ENG-005
CC-Link IE TSN Specifications
(Communication Profile)



BAP-C2011ENG-006
CC-Link IE TSN Specifications
(Implementation Rules)

■ CC-Link IE TSN recommended network wiring parts

Recommended network wiring parts

CC-Link IE TSN wiring components such as cables, connectors and switches can be used as long as they comply with applicable standards such as ANSI/TIA/EIA-568-B (Category 5 or Category 5e).

However, unlike general office (OA) use, they are often used in industrial applications with devices that generate electromagnetic noise, requiring functions that are different from that for office use, such as grounding the noise induced in the cable without affecting the communication.

Therefore, the CC-Link Partner Association has conducted tests to ensure that our customers can use them safely for industrial purposes, and provides information on products that passed these tests as the recommended products.

Mutual Certification System

- Cables and connectors that can be used in CC-Link IE Field can also be used in CC-Link IE TSN, enabling mutual certification.

The following recommended components that have passed the CC-Link IE Field network recommended wiring component test can be similarly recommended for CC-Link IE TSN. Testing is not required at this time.

- Cable
- RJ45 plug/jack
- RJ45 relay connector
- M12 plug/jack

Switches that have passed the CC-Link IE Field network recommended wiring component test can be classified as recommended products that have passed certification class A in CC-Link IE TSN without further testing.

How to become a CLPA member

■ In order to develop CC-Link IE TSN compatible products...

You need to join the CC-Link Partner Association.

Sign up for a new membership.

<https://www.cc-link.org/en/clpa/members/index.html>



■ CC-Link Partner Association Membership Category

Regular Members Executive Members Board Members	<ul style="list-style-type: none"> • Development of CC-Link Family compatible products • Sales of CC-Link Family compatible products • Use of CC-Link logo • Technical support from the CC-Link Partner Association • Product promotion (website, exhibition, etc.) by the CC-Link Partner Association
Registered Members	<ul style="list-style-type: none"> • Only provides access to CC-Link Family specifications

■ CC-Link Partner Association Member Categories

(Tax excluded)

		Registered member	Regular member	Executive member	Board member
Annual fees () shows monthly fees for intermediate enrollment		—	JPY 100,000 (JPY 9,000)	JPY 200,000 (JPY 18,000)	JPY 1,000,000 (JPY 84,000)
Initiation fee		—	—	—	JPY 1,000,000
Acquisition of product specifications		Provided for free upon membership registration			
License to use CC-Link Family technology	SLMP*1 CC-Link Family Specifications (Other than SLMP)	—	Included		
Conformance test fee (per device)	CC-Link IE TSN Master, local and intelligent device stations for CC-Link and normal stations of CC-Link IE Control Master and local stations, intelligent device stations, remote device stations of CC-Link IE Field CC-Link IE Safety IESMAP(master) IESSLP(slave)	—	JPY 100,000*3	JPY 50,000*3	Included in the annual membership fee *Contact your local CLPA office.
	CC-Link remote device and I/O stations, cables and miscellaneous products CC-Link/LT master and slave stations, cables and miscellaneous products		JPY 300,000	JPY 200,000	
	CC-Link IE Field Basic*2		JPY 200,000	JPY 100,000	
	SLMP*1 connectable products		—	—	
	Recommended network wiring parts for CC-Link IE TSN CC-Link IE Control and CC-Link IE Field		JPY 100,000	JPY 50,000	
Recommended product test fees (per model)					
Use of CC-Link Family logo		—	Included		
Technical support		—	Included		
Publishing products in home page-CLPA Partner Product Search Tool (No charge)		—	Included		
Promotion at fairs		—	Included		
Information about events Posting of company name on CLPA web site			Included		

*1 SLMP: Seamless Message Protocol

*2 Download the test tools and conduct a self-test.

*3 If you submit the result of a test conducted on behalf of the CC-Link Partner Association at a testing organization recognized by the CC-Link Partner Association, the cost will be as follows.

· Regular : 50,000 yen · Executive: 20,000 yen

Global support system

The CC-Link Partner Association has branches not only in Japan but also in overseas countries to provide global support



① Headquarters (Japan)

6F Ozone-front Building, 3-15-58, Ozone, Kita-ku,
Nagoya 462-0825, Japan
TEL : +81-52-919-1588 FAX : +81-52-916-8655
E-mail : info@cc-link.org
URL : <https://www.cc-link.org/>

② China

Headquarters(Tongji University) : School of Electronics
and Information Engineering, Jiading Campus, Tongji
University, Shanghai, P.R.China Head Office : 19F
No.1386 Hong Qiao Road, Shanghai, P.R.China
TEL : +86-21-64940523 FAX : +86-21-64940525
E-mail : support@cn.cc-link.org
URL : <https://www.cc-linkchina.org/cn/>

③ Europe

Postfach 10 12 17, 40832 Ratingen, Germany
TEL : +49-2102-486-7988 FAX : +49-2102-532-9740
E-mail : partners@eu.cc-link.org
URL : <https://eu.cc-link.org/en/>

④ North America

500 Corporate Woods Parkway, Vernon Hills, IL60061, USA
TEL : +1-847-478-2647 FAX : +1-847-876-6611
E-mail : info@cclinkamerica.org
URL : <http://am.cc-link.org/en/>

⑤ Korea

RM. 711, 7F GANGSEO HANGANG XI-TOWER A,
401 Yangcheon-ro, Gangseo-gu, Seoul 07528 Korea
TEL : +82-2-3663-6178 FAX : +82-2-6224-0158
E-mail : clpakor@meak.co.kr
URL : <http://kr.cc-link.org/ko/>

⑥ Taiwan

No.105, Wugong 3rd Rd., Wugu Dist., New Taipei City
24889, Taiwan(R.O.C.)
TEL : +886-2-8990-1573 FAX : +886-2-8990-1572
E-mail : cclink01@ms63.hinet.net
URL : <https://tw.cc-link.org/zh/>

⑦ ASEAN

307 Alexandra Road #05-01/02 Mitsubishi Electric
Building Singapore 159943
TEL : +656-470-2480 FAX : +656-476-7439
E-mail : cclink@asia.meap.com
URL : <http://as.cc-link.org/en/>

⑧ India

Emerald House, EL-3, J Block, M.I.D.C. Bhosari,
Pune - 411 026, Maharashtra, INDIA
Tel : +91-20-4624 2100 FAX : +91-20-4624 2200
E-mail : Clpa_India@asia.meap.com
URL : <https://in.cc-link.org/en/>

⑨ Turkey

Serifali Mahallesi Nutuk Sokak.No:5 34775Umraniye-
istanbul /Turkey
TEL : +90-216-526-39-90 FAX : +90-216-526-39-95
E-mail : partners@tr.cc-link.org
URL : <https://eu.cc-link.org/en/>

⑩ Mexico

Mariano Escobedo 69, Zona Industrial - Tlalnepantla,
54030, Estado de Mexico, Mexico
TEL : +52-55-3067-7517
E-mail : info@cclinkamerica.org
URL : <http://am.cc-link.org/sp/>

⑪ Thailand

CC-Link Promotion Center - Thailand
101, True Digital Park Office, 5th Floor, Sukhumvit Road,
Bangchak, Phra Khanong, Bangkok 10260
Phone: +66(2) 092-8600 Ext. 5506
Fax : +66(2) 043-1231-33
URL : <http://th.cc-link.org/th/>

●How to become a member

Would you like to improve your FA, BA, and PA devices by making them compatible with the CC-Link Family? Are you interested in open FA devices that satisfy international standards? CLPA will support you by promoting related technologies and holding exhibitions and seminars in Japan and overseas.

◎ How to apply for a membership: Please access from our website.

※FA:Factory Automation / BA:Building Automation / PA:Process Automation



<https://www.cc-link.org>



([Japan](#) · [China](#) · [Europe](#) · [Americas](#) · [Korea](#) · [Taiwan](#) · [ASEAN](#) · [India](#) · [Turkey](#) · [Mexico](#) · [Thailand](#))

CC-Link Partner Association

6F Ozone-front Building, 3-15-58, Ozone, Kita-ku, Nagoya
462-0825, Japan

TEL: 052-919-1588 FAX: 052-916-8655

<https://www.cc-link.org> E-mail: info@cc-link.org

New publication, effective Jun, 2020