CC-Link IE Field

Ethernet-based Open Network

CC-Link IE Field Network
Cable Installation Manual

CC-Link
CLPA
PARTNER ASSOCIATION

This manual describes items to be considered in advance to configure a network system using CC-Link IE Field Network compatible products, items to be checked at the cable installation site, and precautions for wiring. Please use this manual to achieve smooth configuration of a CC-Link IE Field Network system.

Revisions

Sub number	Revision	Issued
A	First edition	June, 2010
B	• Precautions for wiring and installation of connectors and cables were added and modified. Chapter 1 NETWORK CONFIGURATION PROCEDURE Section 2.1 Network Configuration Overview Chapter 3 SELECTING CONNECTION DEVICES Section 3.1 Cables Section 4.1 Wiring Length Section 4.3 Connector and Cable Connection and Precautions Section 4.3.1 RJ45 connector Section 4.3.3 Connector connection precautions Section 5.1 Wiring Precautions Appendix A1. Structure of FA Cable Conductors Appendix A2. Crimp Height Appendix A3. Deformation of Connectors • Descriptions of the M12 connector were added. Section 2.1 Network Configuration Overview Section 2.3 Network Specifications Section 3.2 Connectors Section 3.3 Relay Connectors Section 4.3.2 M12 connector Section 5.1 Wiring Precautions	March, 2017

CONTENTS

Chapter 1 NETWORK CONFIGURATION PROCEDURE

The following figure shows the CC-Link IE Field Network configuration procedure.

For designing a system, refer to the precautions throughout this manual.

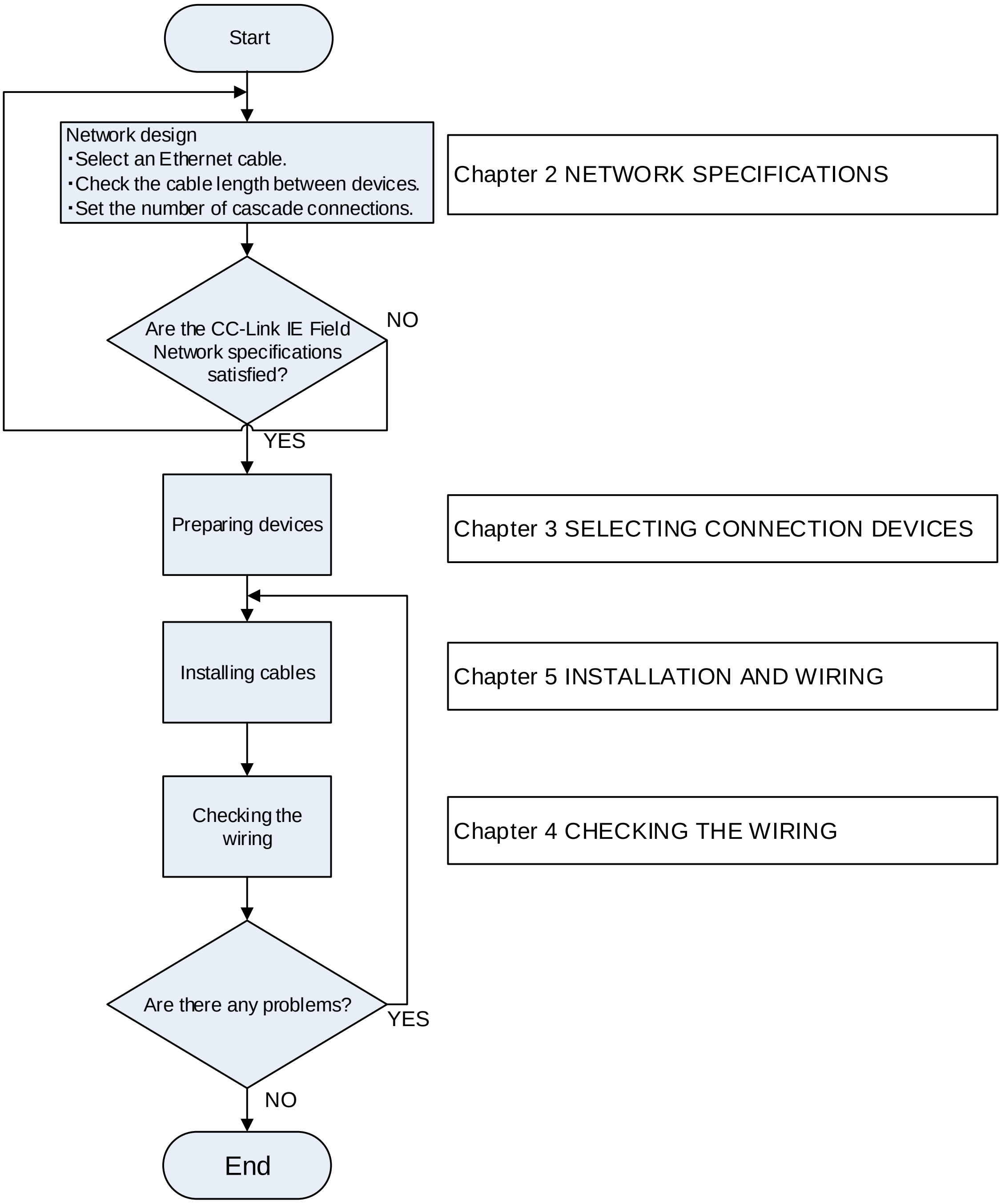


Figure 1 Network Configuration Procedure

Chapter 2 NETWORK SPECIFICATIONS

2.1 Network Configuration Overview

CC-Link IE Field Network components

Station: A device that is connected over CC-Link IE Field Network to which any of station numbers 0 to 253 can be assigned.
The station types are described below.

Master station
A node that has control information (parameters) and manages cyclic transmission

Local station
A node capable of performing n:n bit data and word data cyclic transmission and transient transmission with the master station and other local stations, and performing transient transmission with slave stations, excluding remote I/O stations. It has server functions and client functions during transient transmission.

Intelligent device station
A node capable of performing 1:n bit data and word data cyclic transmission and transient transmission with the master station, and performing transient transmission with slave stations, excluding remote I/O stations. It has server functions and client functions during transient transmission.

Remote device station
A node capable of performing 1:n bit data and word data cyclic transmission and transient transmission with the master station, and performing transient transmission with slave stations, excluding remote I/O stations. It has server functions during transient transmission.

Remote I/O station
A node capable of performing 1:n bit data cyclic transmission with the master station

Slave station
A generic term for a node (local station, remote I/O station, remote device station, intelligent device station) other than the master station

Connection cable: An ANSI/TIA/EIA-568-B (Category 5e) compliant cable

Connector: An ANSI/TIA/EIA-568-B (Category 5e) compliant RJ45 connector, or an IEC 61076-2-109 compliant X-coding 8-pin M12 connector.

Relay connector: A relay connector used for connecting cables to ensure independence, maintainability, and environmental resistance of the machine.
It is also used when stranded-wire cables are used for in-panel wiring and solid-wire cables for out-panel wiring, to reduce stress on connector connection areas of the machine. (Refer to Section 5.1 "Wiring Precautions".)

Layer 2 switch: A relay device having multiple Ethernet ports that transfer frames in data link layer processing. It is also referred to as a switching hub.
The layer 2 switch enables to use star topology.
In addition, line topology and star topology can be used together in a network.

2.2 Network Configuration

A CC-Link IE Field Network station is specified by its network number and station number. A network number is used to identify each network. Relay stations relay communication data between the networks to enable stations connected to different networks to be communicated with each other.

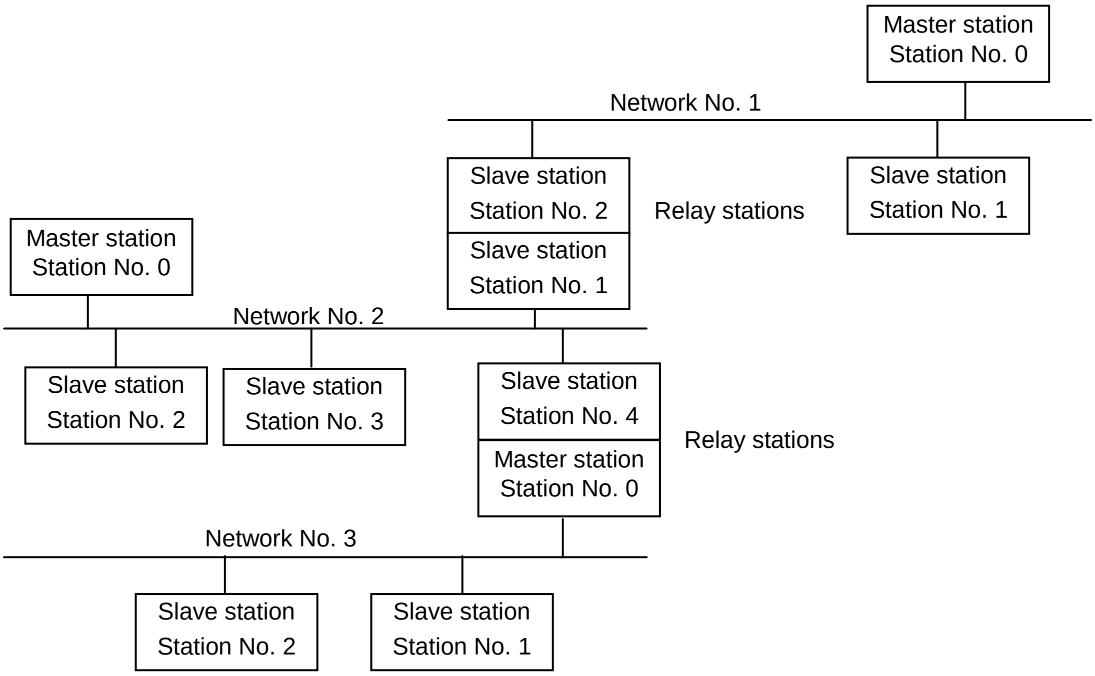


Figure 2 Network Configuration

2.3 Network Specifications

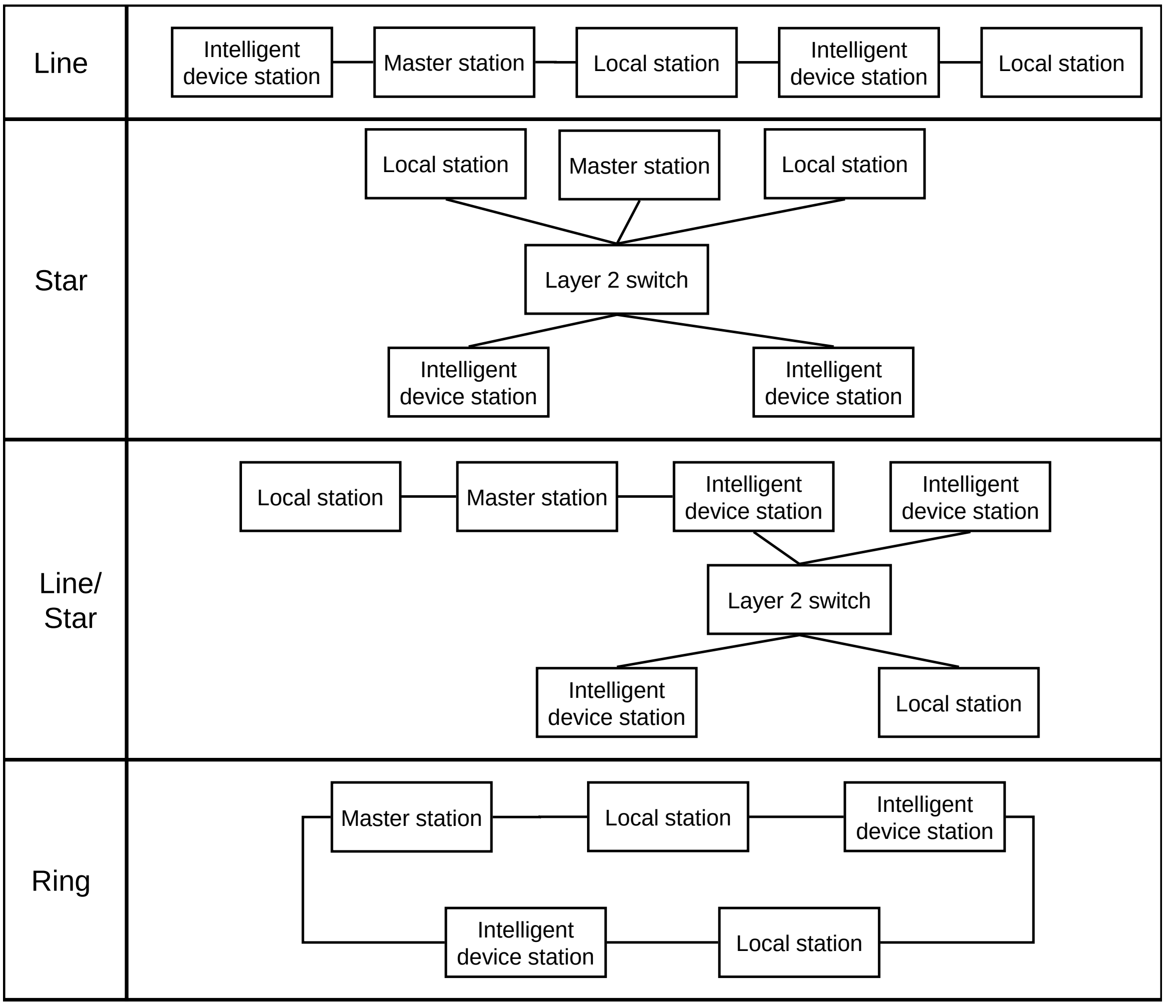
CC-Link IE Field Network is an Ethernet based network that employs IEEE 802.3 (1000BASE-T) technology on its physical and data link layers. Table 1 describes the communication specifications related to the cable installation of CC-Link IE Field Network.

Table 1 Communication Specifications

Item		Specifications
Communication speed		1 Gbps
Maximum number of networks		239
Number of connected nodes per network	Master station	1
	Slave station	253
Cable specifications		IEEE 802.3 1000BASE-T cable. ANSI/TIA/EIA-568-B (Category 5e) compliant 4-pair balanced-type shielded cable. A double-shielded type cable is recommended.
Connector specifications		ANSI/TIA/EIA-568-B (Category 5e) compliant RJ45 connector with shields
		IEC 61076-2-109 compliant X-coding 8-pin M12 connector
Cable length between devices		Maximum length: 100 m (ANSI/TIA/EIA-568-B (Category 5e) compliant)

2.4 Topologies

CC-Link IE Field Network supports line, star, and ring topologies. Star topology requires a layer 2 switch. Line topology and star topology can be used together in a network.



2.5 Effects of Temperature

The maximum length between devices in CC-Link IE Field Network differs according to the temperature environment (cable installation environment) where they operate. Determine the cable length between devices, referring to Table 2.

For details, calculate the insertion loss between devices using the calculation formula described in Section 4.4, and check that the value is within the specified value.

Table 2 Temperature Environment and Maximum Length Between Devices (Examples)

Cable ambient temperature (ºC)	Maximum cable length L [m]	Maximum length between devices [m] (Channel including patch cords in Figure 3)
20	90.0	100.0
25	89.5	99.5
30	88.5	98.5
35	87.7	97.7
40	87.0	97.0
45	86.5	96.5
50	85.5	95.5
55	84.7	94.7
60	83.0	93.0

(Referenced standard: ANSI/TIA/EIA-568-B.2-1 Annex G)

Condition) Table 2 assumes a channel that includes a 10 m patch cord or device cord (under an environment of 20˚C) as shown in Figure 3.

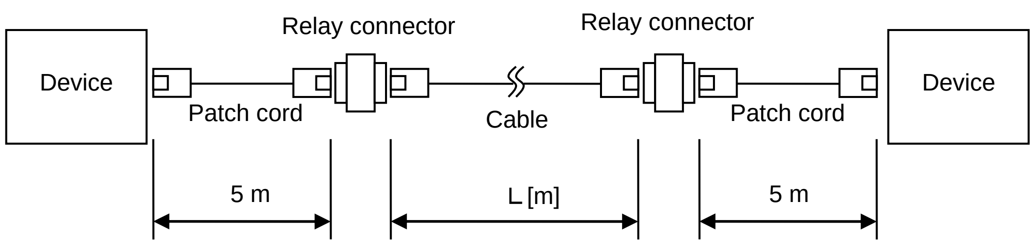


Figure 3 Temperature Environment and Channel Block Diagram

Chapter 3 SELECTING CONNECTION DEVICES

It is advisable to use recommended products that have passed the CLPA tests.

In addition, in the selection of cables and connectors, check that the combination of a cable and a connector is appropriate in terms of the wire conductor size (AWG), the structure of conductor (solid wire or stranded wire), the outside diameter of the insulator, the outside diameter of the cable, shield, Category, and others. For details, refer to Section 4.3.3 "Connector connection precautions".

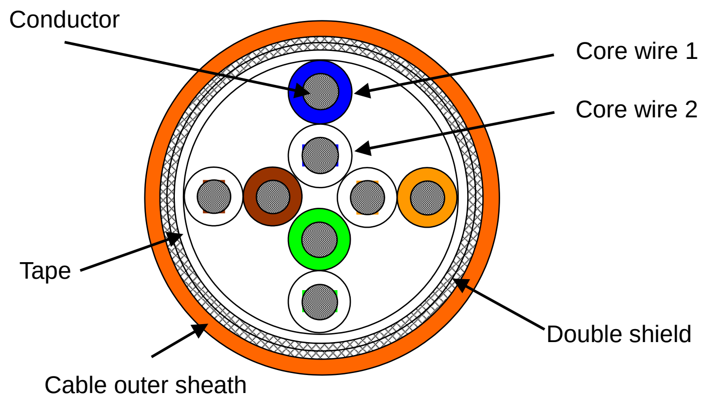
3.1 Cables

Use ANSI/TIA/EIA compliant Ethernet cables (Category 5e or higher) in CC-Link IE Field Network.

Table 3 CC-Link IE Field Network Recommended Cable Specifications

Item	Specifications
Cable type	4-pair balanced type shielded cable, double-shield type
Compliant standard	ANSI/TIA/EIA-568B (Category 5e)
Number of core wires	8 (4 twisted pairs)
Double shield	Aluminum tape
	Annealed copper braided wire

Cross-sectional view example



Core wire identification (color of insulating material)	
Core wire 1	Core wire 2
Blue	White/Blue
Orange	White/Orange
Green	White/Green
Brown	White/Brown

Note) • When wiring cables across a long distance, use solid-wire cables of 24 AWG or higher. For details, refer to Chapter 4.

• When wiring cables across a short distance, it is advisable to use stranded-wire cables and movable cables that are more flexible and easy to handle, to avoid stress on the connection area of the connectors. Refer to Section 5.1 and Appendix A1. "Structure of FA Cable Conductors".

• Select environment-friendly components if the wiring run is to be built in a special environment (for example, heatproof, oilproof, and movable parts) within a factory. For details on the environmental resistance of each component, refer to the specifications from each manufacturer.

3.2 Connectors

Use ANSI/TIA/EIA-568-B (Category 5e) compliant RJ45 connectors with shields.

For M12 connectors, use IEC 61076-2-109 compliant X-coding 8-pin connectors.

3.3 Relay Connectors

Use relay connectors compliant with the ANSI/TIA/EIA-568-B (Category 5e) RJ45 jack specifications.

For M12 connectors, use IEC 61076-2-109 compliant relay connectors.

Use relay connectors with shields.

3.4 Layer 2 Switch

Use a layer 2 switch that satisfies the conditions below in CC-Link IE Field Network.

A repeater hub cannot be used.

(1) IEEE 802.3 1000BASE-T compliant

(2) Auto MDI/MDI-X function supported

(3) Auto negotiation function supported

3.4.1 Number of layer 2 switches

Number of layer 2 switches = A

Latency (μsec) of layer 2 switch i = Bi

Number of slave stations = C

Latency (μsec) of slave station j = Dj (target: 1.5 μsec)

Value (μsec) of the token monitoring time (NetWatchTimer) in master station = E (target: 1500 μsec)

Install layer 2 switches within the number that satisfies the formula below.

(Total latency of all layer 2 switches + Total latency of all slave stations + Network delay) × 2 + Token hold time

$$= \left(\sum_{i=1}^{A} B_i + \sum_{j=1}^{C} D_j + 0.555\ \mu\text{sec} \times (A + C)\right) \times 2 + 300\ \mu\text{sec (maximum value)} \le E$$

[Calculation example]

Where,

Number of layer 2 switches = A = 20

Latency of layer 2 switch i = Bi = 8.0 μsec

Number of slave stations = 120

Latency of slave station j = Dj = 1.5 μsec

Value (μsec) of the token monitoring time (NetWatchTimer) in master station = E = 1500 μsec

Then,

$$= \left(\sum_{i=1}^{20} 8.0\ \mu\text{sec} + \sum_{j=1}^{120} 1.5\ \mu\text{sec} + 0.555\ \mu\text{sec} \times (20 + 120)\right) \times 2 + 300\ \mu\text{sec}$$

$$= 1135.4\ \mu\text{sec} \le 1500\ \mu\text{sec}\ (= E)$$

Therefore, the number of installable layer 2 switches is 20.

Note
The latency of layer 2 switch varies depending on the system configuration and presence of error stations as well as each layer 2 switch type. It is advisable to test the system in an environment close to the production environment before actual operation.

Chapter 4 CHECKING THE WIRING

The wiring between CC-Link IE Field Network devices (or between a CC-Link IE Field Network device and a layer 2 switch when a layer 2 switch is used) must comply with the ANSI/TIA/EIA-568-B Category 5e standard. When installing cables, check the following:

1) Wiring length
2) Number of connectors
3) Connector (plug/jack) and cable connection
4) Transmission characteristics

4.1 Wiring Length

The maximum physical wiring length between devices is 100 m in CC-Link IE Field Network.

(The term "device" refers to a CC-Link IE Field Network device, layer 2 switch, and others. Passive components that connect cables, such as connectors, do not fall under the category of device, and are regarded as a part of the wiring.)

The ANSI/TIA/EIA-568-B standard, which defines wiring specifications, refers to wiring between these two devices as a channel, and specifies channel transmission characteristics as well as the transmission characteristics of cables and connectors themselves, assuming a combined use of the cables and connectors.

In the example of Figure 4, there are five channels. The required wiring length of each channel is 100 m or less, and each channel must satisfy specified transmission characteristics.

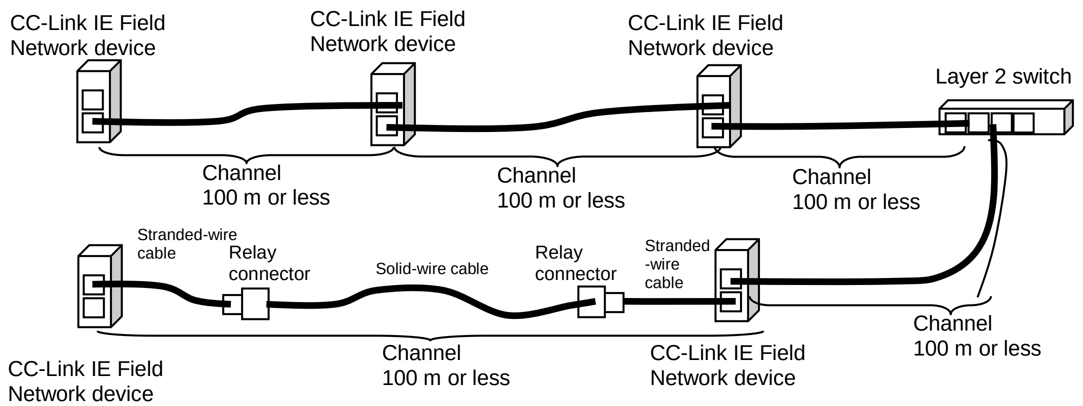


Figure 4 Wiring Length

The transmission characteristics of the wiring between devices, that is, each channel, needs to satisfy the specified channel value. It depends on the cable type and ambient temperature, and may not extend up to 100 m in certain cases. Especially, the total insertion loss and propagation delay of wiring components (cables and connectors) used need to be equal to or less than the specified channel value. For details, refer to Section 4.4.

Particularly, be careful with the cases below.

・ When a stranded-wire cable is used

A stranded-wire cable generally causes significant insertion loss, resulting in failure to meet the specified channel insertion loss value at a length of 100 m.

* ANSI/TIA/EIA-568-B Category 5e defines standard channel values assuming a combination of 90 m solid-wire cable and 10 m stranded-wire cable. Stranded-wire cables cause greater insertion loss than solid-wire cables, thus resulting in a shorter transmittable distance. For details, contact the cable manufacturer. When wiring cables across a long distance, use a solid-wire cable.

・ When a conductor is slender

When the conductor is slender by more than 24 AWG (0.5 mm), insertion loss increases, resulting in a shorter transmittable distance.

・ When a cable has a special specification, such as a movable cable

Before using a cable, check the transmission characteristics (particularly, insertion loss and propagation delay) and transmittable distance presented by the cable manufacturer.

・ When multiple cables are connected in combination

For example, when a device is installed inside a control panel and connected with a short cable, the length, insertion loss, and propagation delay of the cable must also be considered. When a relay connector (jack-jack) or another connector is used to connect multiple cables, the insertion loss and propagation delay of all cables and connectors between the devices must be considered.

・ When the ambient temperature is high

As the temperature rises, the insertion loss of a cable increases, which shortens the transmittable distance. As an example of a general cable with shields, insertion loss increases by about 0.2% per 1˚C. The insertion loss specifications of the cable are normally set as the value at 20˚C. If the temperature of the cable increases even partly, the cable must satisfy the specified insertion loss at its increased temperature. If there is no margin with respect to the specified channel value at 20˚C, the insertion loss of the cable may exceed the specified value when the ambient temperature is changed.

Calculate the insertion loss of the cable at high temperatures based on the temperature coefficient specifications set by the cable manufacturer.

4.2 Number of Connectors

A single channel must have four connectors or less. Note the following conditions.

・ The plugs that connect to the devices at both ends of each channel are not counted. A set of plug and jack for cable connection is counted as one connector. The number of connectors must be four or less.

When a relay connector (jack-jack) is used, calculate one relay connector as two connectors.

4.3 Connector and Cable Connection and Precautions

A poorly processed connection may deteriorate waterproof performance of the M12 connector or cause miscommunications due to contact failure between a cable and a connector. Follow the processing procedure specified by the connector manufacturer with care when processing connectors and cables.

4.3.1 RJ45 connector

When connecting a cable and a connector (plug/jack), follow the connection method defined in the ANSI/TIA/EIA-568 standard and the connection method and work procedure specified by the connector manufacturer.

The ANSI/TIA/EIA-568 standard specifies two connection methods, T568A and T568B, which are shown below. Any other connection method results in the risk of miswiring, increasing the possibility that the predetermined transmission characteristics will not be achieved and communications will fail.

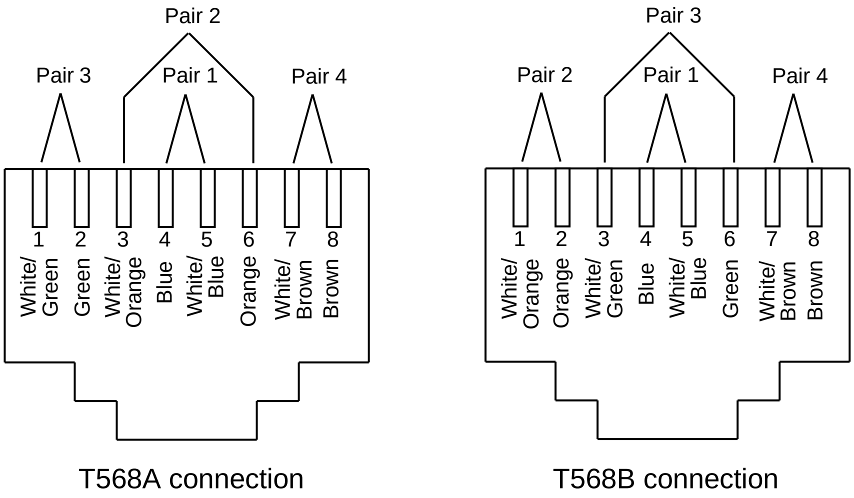


Figure 5 Connection Method with the RJ45 Connector (Plug)

Unless otherwise specified, it is advisable to use the same connection method (through a straight cable) at both ends of the cable.

4.3.2 M12 connector

For the connection method with the M12 connector that is compliant with the IEC 61076-2-109 standard, refer to the figure and table below.

Note that the connection pin layout of the M12 connector is slightly different from that of the RJ45 connector.

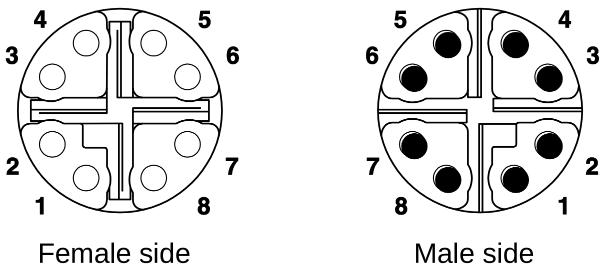


Figure 6 M12 (X-coding) Connector

Table 4 Comparison of the Connection Methods with the M12 Connector (RJ45/M12)

Cable color (T568A)	Cable color (T568B)	RJ45 connection pin number	M12 (X-coding) connection pin number
White/Green	White/Orange	1	1
Green	Orange	2	2
White/Orange	White/Green	3	3
Blue	Blue	4	8
White/Blue	White/Blue	5	7
Orange	Green	6	4
White/Brown	White/Brown	7	5
Brown	Brown	8	6

4.3.3 Connector connection precautions

A poorly processed connection may deteriorate waterproof performance of the M12 connector or cause miscommunications due to contact failure between a cable and a connector. Follow the processing procedure specified by the connector manufacturer with the notes below in mind when connecting cables and connectors.

In addition, check that the combination of a cable and a connector is appropriate in terms of the wire conductor size (AWG), the structure of conductor (solid wire or stranded wire), the outside diameter of the insulator, the outside diameter of the cable, shield, Category, and others.

● Structure of cable conductors

Cables are categorized into solid-wire type and stranded-wire type, and connectors are also grouped into the ones for solid wires, stranded wires, and both wires. Check that the combination of a cable and a connector is appropriate.

Some combinations are not allowed, such as a solid-wire cable and a connector for stranded wires.

Refer to Appendix A1. "Structure of FA Cable Conductors".

● Cable outside diameter

Check that the combination of a cable outside diameter and a connector used is appropriate.

If not, the connector may be damaged or the cable strength may decrease.

● Shield and shield wire processing

Follow the processing procedure specified by the connector manufacturer, and securely connect the shield wire of a cable to the shield of a connector.

● Crimp height

For the RJ45 connector (plug) with crimp-type contacts, it is important that the crimp height is even and within the specified value.

The height outside the specified value may cause miscommunications.

Refer to Appendix A2. "Crimp Height".

● Dedicated tools

Use a dedicated tool specified by the connector manufacturer, if any.

Otherwise, a proper wiring connection may not be achieved.

A proper wiring connection may also not be achieved when the dedicated tool is deteriorated or damaged. Inspect the tool regularly.

● Reprocessing of a connector

Reprocessing a connector is not recommended.

If a connector is reprocessed, a communication error may occur due to deformation or damage of the connector.

4.4 Transmission Characteristics

The wiring between devices must satisfy the channel transmission characteristics requirements of ANSI/TIA/EIA-568-B Category 5e. However, if the installation technique is inappropriate, the channel transmission characteristics requirements may not be satisfied even if wiring components (cables and connectors) that satisfy the Category 5e standard are used. Once wiring is complete, it is advisable to measure the characteristics with a field tester to verify whether the specified value is satisfied.

The main transmission characteristics specified in the Category 5e standard include the items below. For details on the specified values, refer to the ANSI/TIA/EIA-568-B Category 5e standard.

- Insertion loss, IL
- Near end crosstalk loss, NEXT
- Power sum near end crosstalk loss, PSNEXT
- Equal level far end crosstalk, ELFEXT
- Power sum equal level far end crosstalk, PSELFEXT
- Return loss, RL
- Propagation delay
- Delay skew

Of the above, insertion loss and propagation delay can be calculated approximately from the specification values of the cables and connectors used in the wiring. In particular, when a cable having a length near the 100 m (standard upper limit), a movable cable, or a special cable with a small conductor size is used, or when a cable is used in a particularly high ambient temperature environment, whether the cable satisfies the specified channel value in the actual configuration and at the actual operating ambient temperature or not needs to be checked in advance.

If the calculated value does not satisfy the specified channel value, satisfy the specified channel value by either shortening the total cable length by reviewing the layout, shortening the length of movable cables or cables with a small conductor size as much as possible, or using cables with a smaller insertion loss and propagation delay. If none of these is possible, consider using a layer 2 switch and so on in the system.
All items other than the insertion loss and propagation delay require measurement using a measuring device such as a field tester since values cannot be simply calculated from the cable and connector specification values.

● Approximate calculation of propagation delay

When two types of cables and multiple connectors (plug + jack) are used

Cable 1 propagation delay at 10 MHz per 100 m: $Delay_{cable1}$ (ns/100 m) (Normally 545 ns/100 m or less)
Cable 2 propagation delay at 10 MHz per 100 m: $Delay_{cable2}$ (ns/100 m)
Total lengths of cable 1 and cable 2: L_{cable1}, L_{cable2} (m)
Propagation delay of connector (plug + jack): $Delay_{conn}$ (ns) (Normally 2.5 ns or less. Use 2.5 ns for calculation.)
Number of connectors: n
Propagation delay of channel (wiring between devices): $Delay_{channel}$ (ns)

$$Delay_{channel} = Delay_{cable1} \times L_{cable1} / 100 + Delay_{cable2} \times L_{cable2} / 100 + Delay_{conn} \times n \text{ (Formula A)}$$

Check that the channel propegation delay calculated above is equal to or less than the specified channel value (555 ns).
The following is a calculation example where a solid-wire cable (cable 1) and a special cable having a long propagation delay (cable 2) are used together.

Cable 1 propagation delay at 10 MHz per 100 m: $Delay_{cable1}$ = 545 (ns/100 m)
Cable 2 propagation delay at 10 MHz per 100 m: $Delay_{cable2}$ = 600 (ns/100 m)
Propagation delay of connector (plug + jack): $Delay_{conn}$ = 2.5 (ns)
Number of connectors: n = 4
Propagation delay of channel (wiring between devices): $Delay_{channel}$ (ns)

$$Delay_{channel} = 545 \times L_{cable1} / 100 + 600 \times L_{cable2} / 100 + 2.5 \times 4$$

Example 1: When the total length of cable 1 is 80 m, and the total length of cable 2 is 3 m
$Delay_{channel}$ = 545 × 80 / 100 + 600 × 3 / 100 + 10 = 464 (ns)
The value satisfies the specified channel propagation delay value, 555 ns or less. The cable can be used.

Example 2: When the total length of cable 1 is 40 m, and the total length of cable 2 is 60 m
$Delay_{channel}$ = 545 × 40 / 100 + 600 × 60 / 100 + 10 = 588 (ns)
The value does not satisfy the specified channel propagation delay value, 555 ns or less. The cable cannot be used.

When a total of 100 m length of cable with the propagation delay (545 ns/100 m) specified in the ANSI/TIA/EIA-568-B Category 5e standard and four connectors (propagation delay: 2.5 ns) are used, the propagation delay becomes 555 ns (a value exactly equivalent to the specified channel value). In this case, the propagation delay does not need to be calculated as long as a special cable with a long propagation delay is not employed.

- Approximate calculation of insertion loss

When two types of cables and multiple connectors (plug + jack) are used

Cable 1 insertion loss per 100 m: IL_{cable1} (dB/100 m)

Cable 2 insertion loss per 100 m: IL_{cable2} (dB/100 m)

Total lengths of cable 1 and cable 2: L_{cable1}, L_{cable2} (m)

Insertion loss of connector (plug + jack): IL_{conn} (dB)

Number of connectors: n

Insertion loss of channel (wiring between devices): $IL_{channel}$ (dB)

$$IL_{channel} = IL_{cable1} \times L_{cable1} / 100 + IL_{cable2} \times L_{cable2} / 100 + IL_{conn} \times n \quad \text{(Formula B)}$$

Temperature conversion formula for cable insertion loss

Cable 1 insertion loss per 100 m at 20˚C: $IL_{cable1,20^\circ C}$ (dB/100 m)

Temperature coefficient of cable 1 insertion loss: k_{cable1} (%)

Cable temperature: t (˚C)

Cable 1 insertion loss per 100 m at t (˚C): $IL_{cable1,t^\circ C}$ (dB/100 m)

$$IL_{cable1,t^\circ C} = IL_{cable1,20^\circ C} \times (1 + (t - 20) \times k / 100) \quad \text{(Formula C)}$$

To calculate the insertion loss of a channel at t˚C, use the values of $IL_{cable1,t^\circ C}$ and $IL_{cable2,t^\circ C}$ calculated by (Formula C) in place of IL_{cable1} and IL_{cable2} of (Formula B).

Check that the channel insertion loss calculated above is equal to or less than the specified channel value. While the value must satisfy the specified channel value across the entire bandwidth of 1 MHz to 100 MHz, normally a general assessment can be made with the insertion loss at 100 MHz.
The following is a calculation example where a solid-wire cable (cable 1) and a stranded-wire cable (cable 2) are used together with a rise in ambient temperature to 60˚C.

Cable 1 insertion loss per 100 m at 100 MHz and 20˚C: $IL_{cable1,20^\circ C}$ = 22.0 (dB/100 m)

Cable 1 insertion loss temperature coefficient: k_{cable1} = 0.2 (%)

Cable 2 insertion loss per 100 m at 100 MHz and 20˚C: $IL_{cable2,20^\circ C}$ = 26.4 (dB/100 m)

Cable 2 insertion loss temperature coefficient: k_{cable2} = 0.2 (%)

Cable temperature: t = 60 (˚C)

Insertion loss of connector (plug + jack) at 100 MHz: IL_{conn} = 0.4 (dB)

Number of connectors: n = 4

Insertion loss of channel (wiring between devices) at 100 MHz: $IL_{channel}$ (dB)

$$\begin{aligned} IL_{channel} &= (22.0 \times (1 + (60 - 20) \times 0.2 / 100)) \times L_{cable1} / 100 + \\ &\quad (26.4 \times (1 + (60 - 20) \times 0.2 / 100)) \times L_{cable2} / 100 + 0.4 \times 4 \\ &= 23.76 \times L_{cable1} / 100 + 28.51 \times L_{cable2} / 100 + 1.6 \end{aligned}$$

Example 1: When the total length of cable 1 is 80 m, and the total length of cable 2 is 3 m

$IL_{channel}$ = 23.76 × 80 / 100 + 28.51 × 3 / 100 + 1.6 = 21.46 (dB)

The value satisfies the specified channel insertion loss value, at 100 MHz of 24 dB. The cable can be used.

Example 2: When the total length of cable 1 is 50 m, and the total length of cable 2 is 40 m

$IL_{channel}$ = 23.76 × 50 / 100 + 28.51 × 40 / 100 + 1.6 = 24.88 (dB)

The value does not satisfy the specified channel insertion loss value, at 100 MHz of 24 dB. The cable cannot be used.

Note that the above is only approximate calculation, and the result may not always match the actual measurement of the channel insertion loss value for various reasons. Set the cable length so that a margin exists with respect to the insertion loss standard. After wiring, it is advisable to measure the value using a measuring device such as a field tester under actual operating conditions to check that the margin exists.

Chapter 5 INSTALLATION AND WIRING

5.1 Wiring Precautions

- Wiring run

  On the wiring run, use ducts or cable racks as many as possible. When conduit tubes are used, select a tube diameter considering dimensions of connectors and boots. When pull boxes are installed, select a box that satisfies the allowable bending radius of the cable. Use the wiring run as a dedicated run as much as possible. In addition, build the wiring run that is not infiltrated with liquid, such as water and oil, and does not reach high or low temperature outside of the specified ambient temperature range. Select environment-friendly components if the wiring run is to be built in a special environment within a factory.
  Example: Heatproof, oilproof, and movable parts
  For details on the environmental resistance of each component, refer to the specifications from each manufacturer.

- Minimum bending radius

  Check the specifications from each cable manufacturer to keep the minimum bending radius of cables. A minimum bending radius is the radius within which the characteristics can be ensured over long periods of time after a cable is installed.
  Use of cables below the specified minimum bending radius may decrease transmission performance or cause a disconnection of cables.

- Allowable tension

  Do not apply tension to a cable as much as possible.
  Failure to do so may cause a disconnection of connectors and cables, or impair transmission performance.

  Upon installation: If tension is unavoidable, use the cable within the allowable tension range. (For the allowable tension range, contact the cable manufacturer.)
  After installation: Pay attention to the cable length and the installation method so that tension is not applied to the cable.

- Measures to reduce noise

  Install signal lines as far away from power cables as possible to prevent induced noise.
  Do not install cables in a control panel where high-voltage devices are installed.
  Attach a surge suppressor on devices that tend to generate noise.

- Cable lateral pressure

  Do not apply lateral pressure to cables by, for example, tucking excessive cables into cable protective materials (such as wire protectors and pipes), inserting cables between them, or excessively tightening cable bundling bands.
  Doing so may impair the transmission performance.

- Connector handling

  Do not apply external forces, such as lateral pressure and shock, to the connector before it is connected.
  Especially, pins of an RJ45 connector (plug), both the metal part and the plastic resin part, are easily deformable. A connection through a deformed connector may cause malfunction due to poor contact or damage to the connection area of the device.
  If there is a possibility that external forces are applied to a connector, check the connector for deformation before using it.
  Refer to Appendix A3. "Deformation of Connectors".

● Stress on connector connection areas
Do not apply any stress to the connector connection areas.
If stress is applied due to some reasons, such as the weight, bending of the neck part, twisting, swinging, moving, and inattentive pulling of the cable, it may cause damage to the module or the connector, malfunction due to poor contact, and miscommunications that occurs with age.
Solid-wire cables have a hard conductor, and therefore stress may be applied easily to the connector connection areas.
Stress may also be applied easily to the connector connection areas when the wiring distance is short.
In such cases, it is preferable to use stranded-wire cables or movable cables that are more flexible and easy to handle.

● Waterproof performance of the M12 connector
Check the manual of the module used.

● Wiring to movable parts
When wiring cables to a movable part, use a dedicated cable.
Also, observe the following at wiring to prevent cable disconnection in the early stages.
- Check the bending characteristics of the cable, such as the minimum bending radius, with the manufacturer.
- Do not bend, kink, or twist the cable.
- Do not scratch or damage the cable sheath.
- Minimize the locations where the cable is secured.
- Do not forcibly secure the cable at a location where the cable moves.
- Wire the cable with the optimal length.

● Other precautions
Shut off all the power supply for the connected devices and for communications before connecting cables.

5.2 Grounding Method

- Provide independent grounding or shared grounding.
- Ground the FG terminal of each module to the protective ground conductor dedicated to the programmable controller. (Ground resistance: 100 Ω or less)

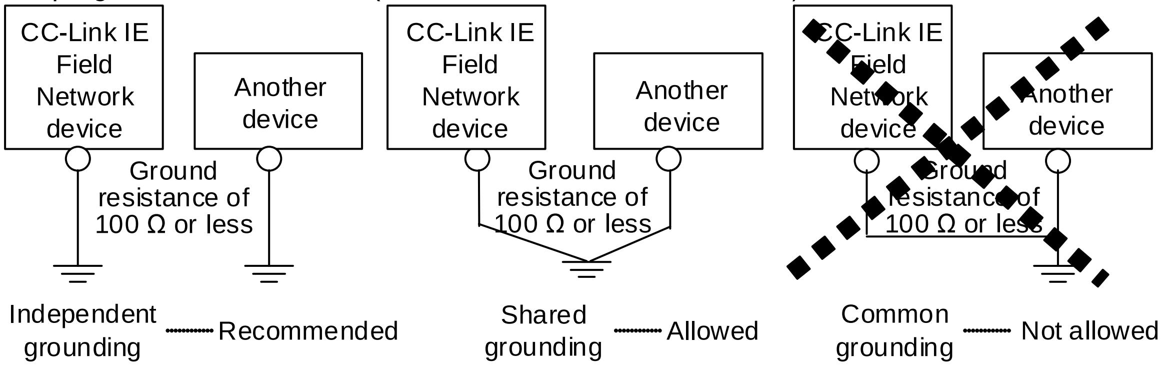


Figure 7 Figure 8 Figure 9

- Use the thickest cable possible (2 mm^2 or more). Bring the grounding point close to the programmable controller as much as possible so that the ground cable can be shortened.

5.2.1 Supplementary explanation on grounding

(1) Grounding types

The grounding of products (devices) supporting CC-Link IE Field Network can be broadly divided into the following two types in accordance with their purposes:

1. Protective ground aimed to protect human bodies from electric shock and ground faults
2. Functional ground to ensure communication reliability

The grounding of shield wires of CC-Link IE Field Network cables is functional ground to ensure communication reliability.

(2) Supplementary explanation to the grounding method

Provide independent grounding (Figure 7) for protective ground and functional ground. Or, employ shared grounding (Figure 8) where cables are connected individually up to the ground point. If common grounding (Figure 9) is provided, noise may enter the functional ground from the protective ground, making CC-Link IE Field Network communications unstable. Especially, when common grounding is employed for the protective grounding and functional grounding (shield wire of the CC-Link IE Field Network cable) of driving devices such as inverters and servos, the possibility of unstable communications will increase.

1) For the ground wire for functional ground, use a copper wire whose diameter is 1.6 mm or more or 2 mm^2 or more.
   (It is advisable to use the thickest copper wire possible (preferably 14 mm^2 or more) to the grounding point and bring the point close to the programmable controller.)

2) Do not install the ground wire of the functional ground together with the protective ground wire or power cables. (Noise may enter the ground wire, making communications unstable.)

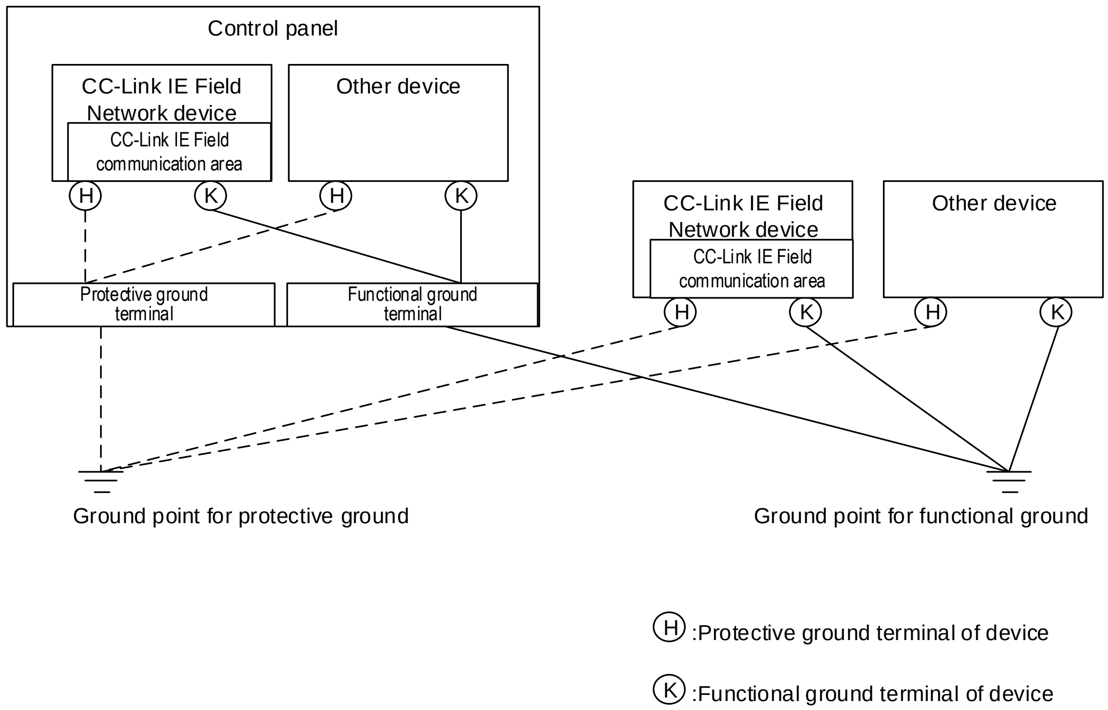


Figure 10 Example of Independent Grounding

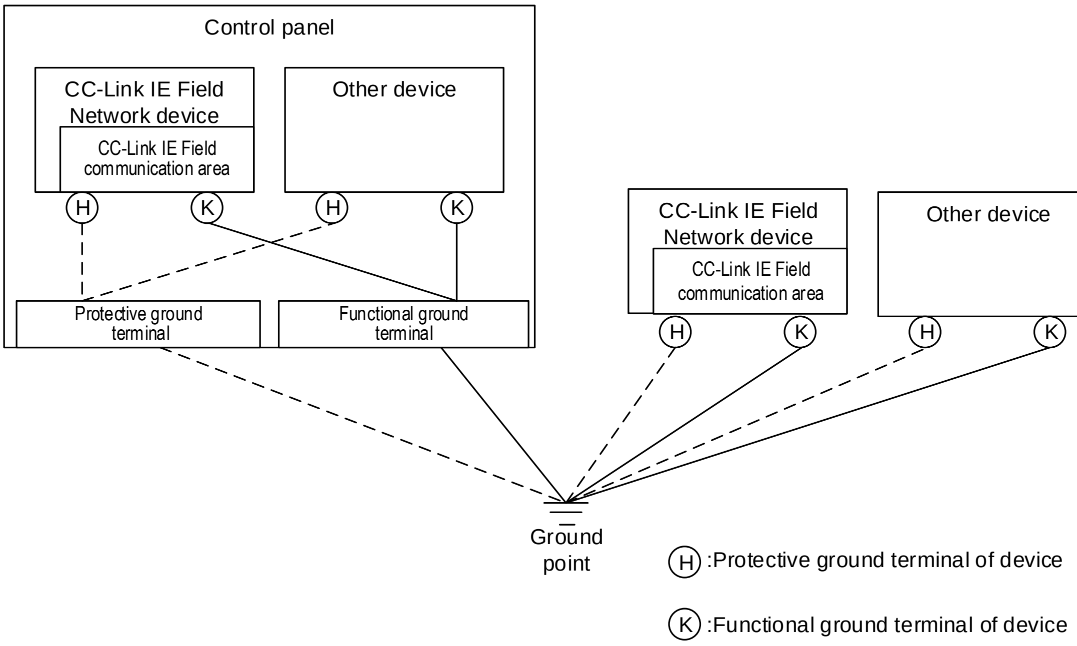


Figure 11 Example of Shared Grounding

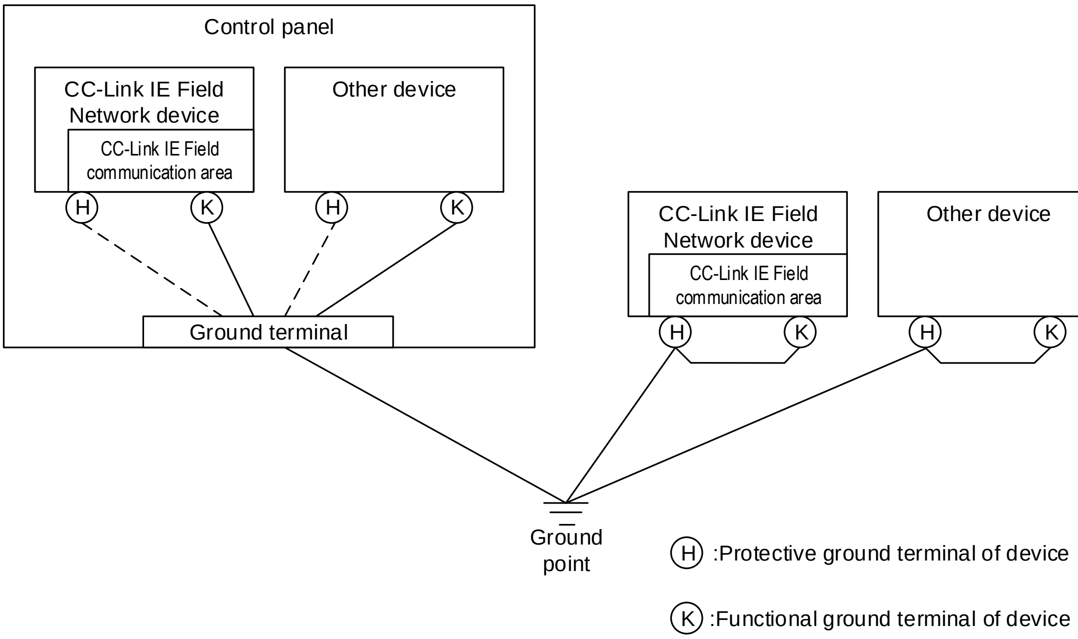


Figure 12 Example of Common Grounding

(3) Wiring example of shared grounding

The following figure shows the wiring example of shared grounding.

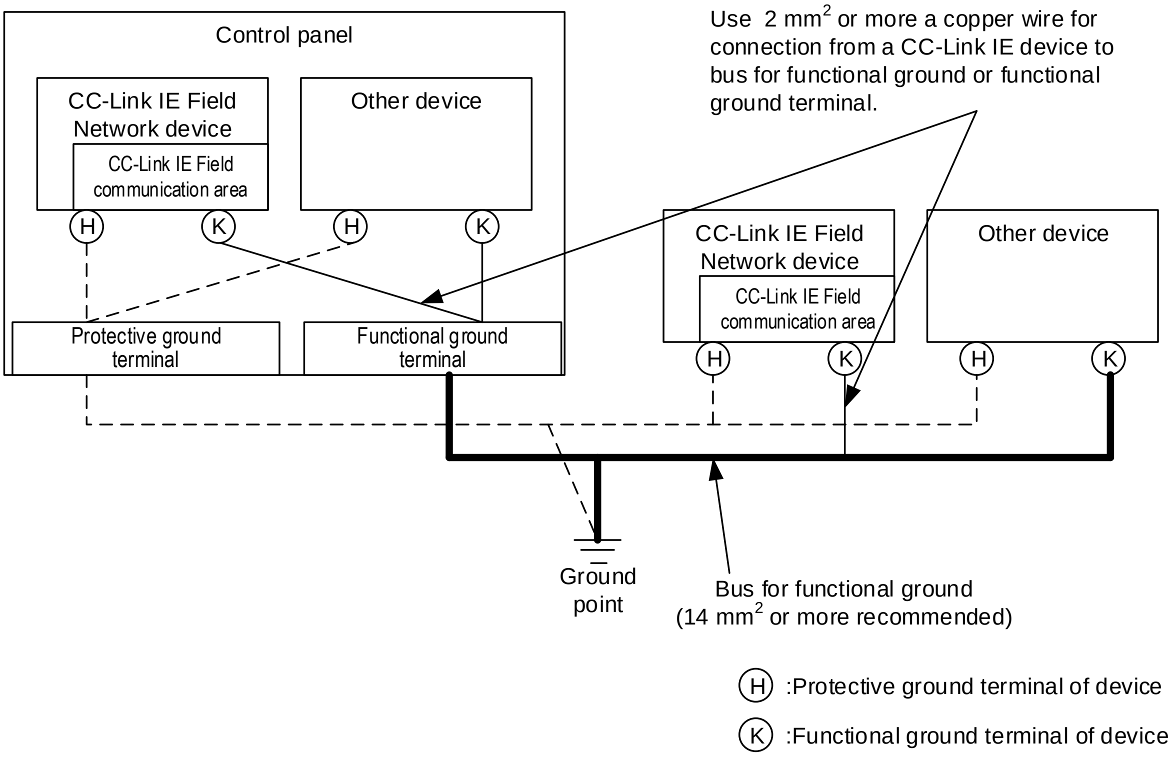


Figure 13 Wiring Example of Shared Grounding

APPENDICES

A1. Structure of FA Cable Conductors

The wire type differs depending on the application of a cable.

Accordingly, there are three types of RJ45 connector (plug): for solid wires, stranded wires, and both wires.

Some combinations are not allowed, such as a solid-wire cable and a connector for stranded wires.

Table 5 Cable Types

Wire type	Application
Solid wire	Used for fixed wiring.
Stranded wire (seven wires)	Used for fixed wiring. This type of cable has good flexibility, but a shorter communication distance.
Stranded wire (braided)	Used for movable parts. (Applications differ depending on the manufacturer specifications.)

The American Wire Gauge (AWG) standard is used for the diameters of wire. Increasing gauge numbers denote decreasing wire diameters. In Japan, the unit "sq" from the JIS standard may be used as well.

It is important to align the diameter and type of the wire and the external dimensions of the entire cable with the specifications of a cable applicable to the connector used.

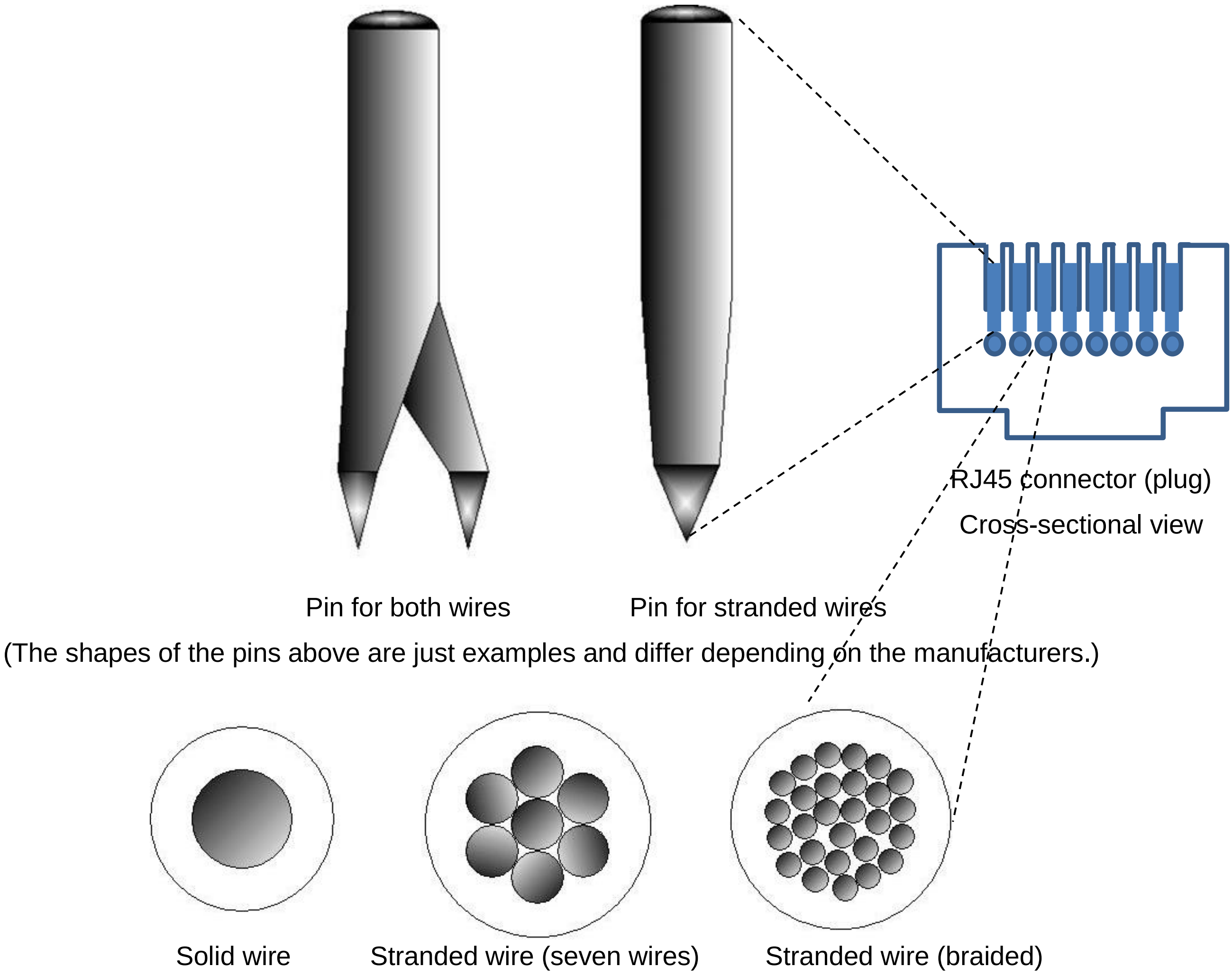


Figure 14 Pin Shape Examples of RJ45 Connector and Wire Types

A2. Crimp Height

Crimp height is the height of the part where the RJ45 connector plug pins secure the wire conductor. Measuring the crimp height is one of the important items to check the connection reliability.

Crimp height: Lower limit 5.89 mm, upper limit 6.15 mm

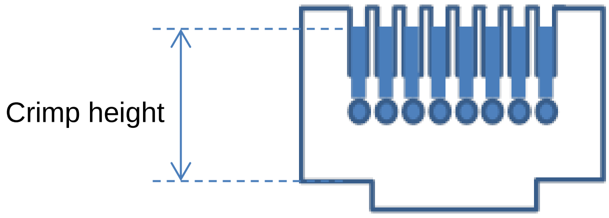


Figure 15 Crimp Height of RJ45 Connector (Plug)

If the crimp height is lower than the specified value, it means that the plug is excessively tightened and the contact with the pins in a jack will weaken when the connector is inserted into the jack.

If the crimp height is higher than the specified value, it means that the conductor is not fixed enough into the plug, possibly leading to poor electrical continuity, increased contact resistance, or unplugging of the wire conductor. In addition, the pins in the jack may be deformed when the connector is inserted into the jack.

Always use a dedicated tool specified by the connector manufacturer to achieve the same height.

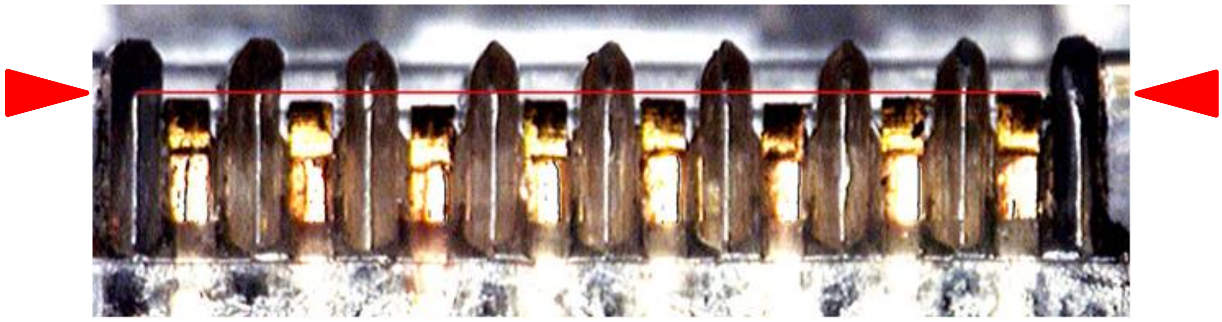


Figure 16 Uneven Crimp Height Example of RJ45 Connector (Plug) with Crimp-Type Contacts

A3. Deformation of Connectors

Do not apply external forces, such as lateral pressure and shock, to a connector before it is connected to a module.

A connection through a deformed connector may cause malfunction due to poor contact or damage to the connection area of the module.

Protecting a connector with a tube, cushion material, or other materials before the connection is useful as a means of preventing the connector from being damaged by external forces.

Deformed connector Normal connector

Figure 17 Example of a Deformed RJ45 Connector

MEMO

Access point:

CC-Link Partner Association
6F Ozone-front Building, 3-15-58, Ozone, Kita-ku, Nagoya 462-0825, Japan
TEL: +81-52-919-1588
FAX: +81-52-916-8655
URL: http://www.cc-link.org/
E-Mail: info@cc-link.org

CC1006-15-B

Prepared in March, 2019