MECHATROLINK-Ⅲ

Installation Guide

MECHATROLINK

MECHATROLINK Members Association

MANUAL NO. MMA TDEP 018A

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1 About this Manual

1.1 Introduction

MECHATROLINK-III is a field network used for controlling several FA units such as servo amplifier, inverters, and input and output devices by a single FA controller.

This manual describes how to install the system by using MECHATROLINK-III.

1.2 Using this Manual

This manual is intended for the following users.

- Those considering using the MECHATROLINK-III
- Those designing a system using the MECHATROLINK-III
- Those designing the installation of MECHATROLINK-III on control devices

2 MECHATROLINK-III

2.1 General

MECHATROLINK-III is a field network used to control several Factory Automation (FA) units such as servo amplifiers, inverters, and I/O devices, with a single FA controller.

- High-speed transmission (100 Mbps)
- Synchronous transmission
- Optimal Cycle time for the number of stations and the amount of data being transmitted. (Transmission cycle time: 31.25 μs to 64 ms.)
- A maximum of 62 slave stations can be connected. (The exact number of connectable stations varies depending on the product specifications of the master module.)
- Reduced wiring.
- The communication ASIC features error detection and retry functions, enabling highly reliable communications.
- FA-tool can be connected (C2 master station).

2.2 System Configuration (Topology)

A MECHATROLINK-III system is configured as a network system in which one C1 master station[1] and up to 62 slave stations[2] are connected. There are two types of configuration: cascade connection, and star connection, which uses hubs. The number of connectable slave stations for each transmission cycle time differs for these two types (see section 2.3).

One C2 master station[3] can also be connected if necessary.

Figures 2-1 and 2-2 show the system configuration.

Terms Definition

[1] C1 master station
A network control station such as an FA controller.
Each network must have one C1 master station.

[2] Slave station
Slave stations are FA devices (servo amplifiers, various I/O devices) that are controlled by the C1 master.
A maximum of 62 slave stations can be connected in one network.

[3] C2 master station
This is the FA support tool. It executes message communication only.
Only one C2 master station can be connected in each network.

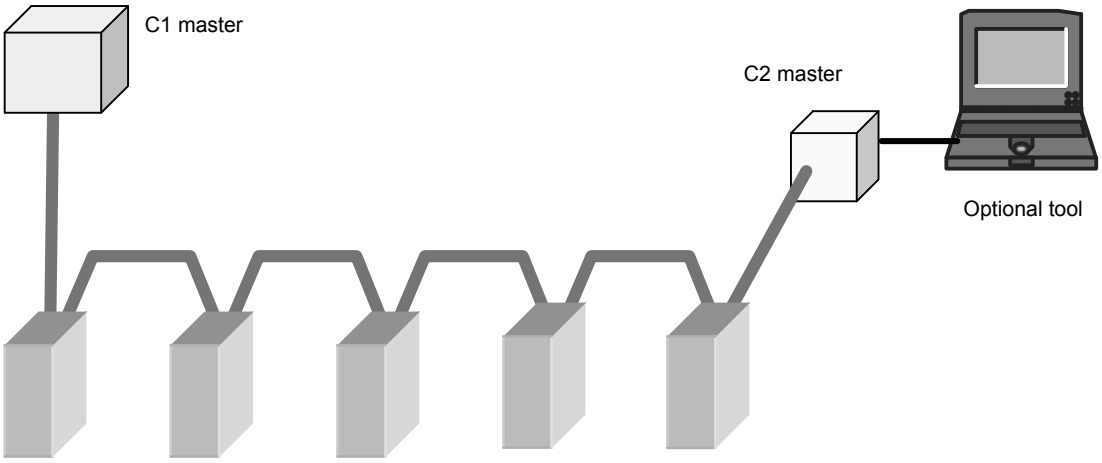


Fig. 2-1 MECHATROLINK-III System Configuration (Cascade Connection)

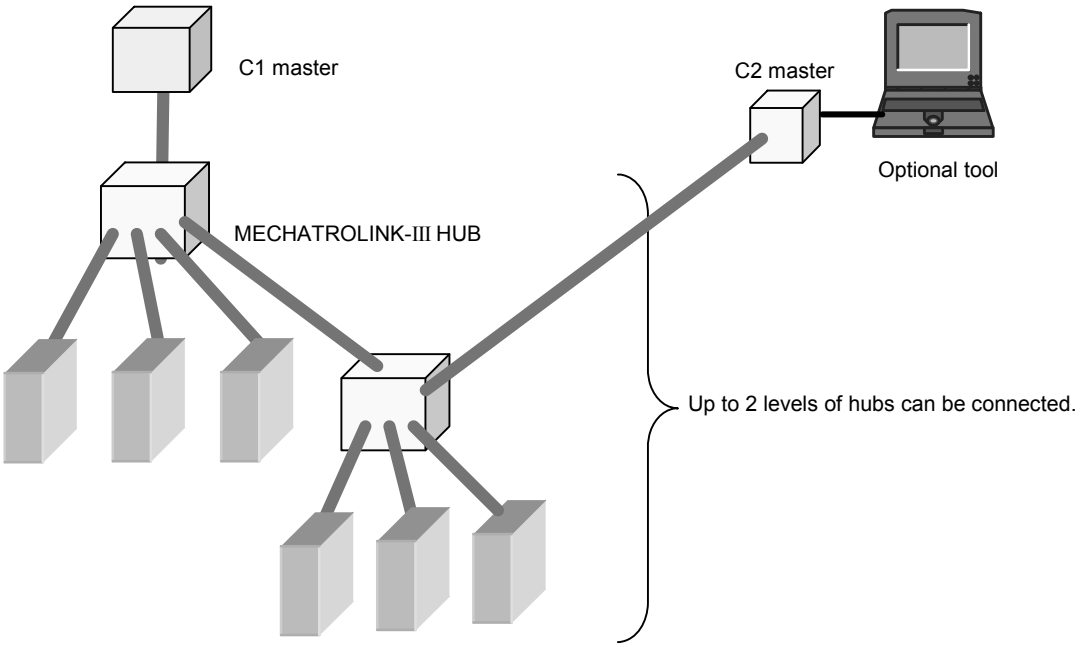


Fig. 2-2 MECHATROLINK-III System Configuration (Star Connection)

Up to two levels of hubs can be connected in one network.

2.3 Maximum Number of Slave Stations

The maximum number of slave stations that can be connected with MECHATROLINK-III is determined by the communication conditions, such as the transmission cycle, the number of transmission bytes, the topology, and cable lengths).

The transmission cycle time for a particular system configuration can easily be calculated by using the "MECHATROLINK-III Utility Software" (free transmission cycle calculation software) available at the MECHATROLINK Members Association's website.

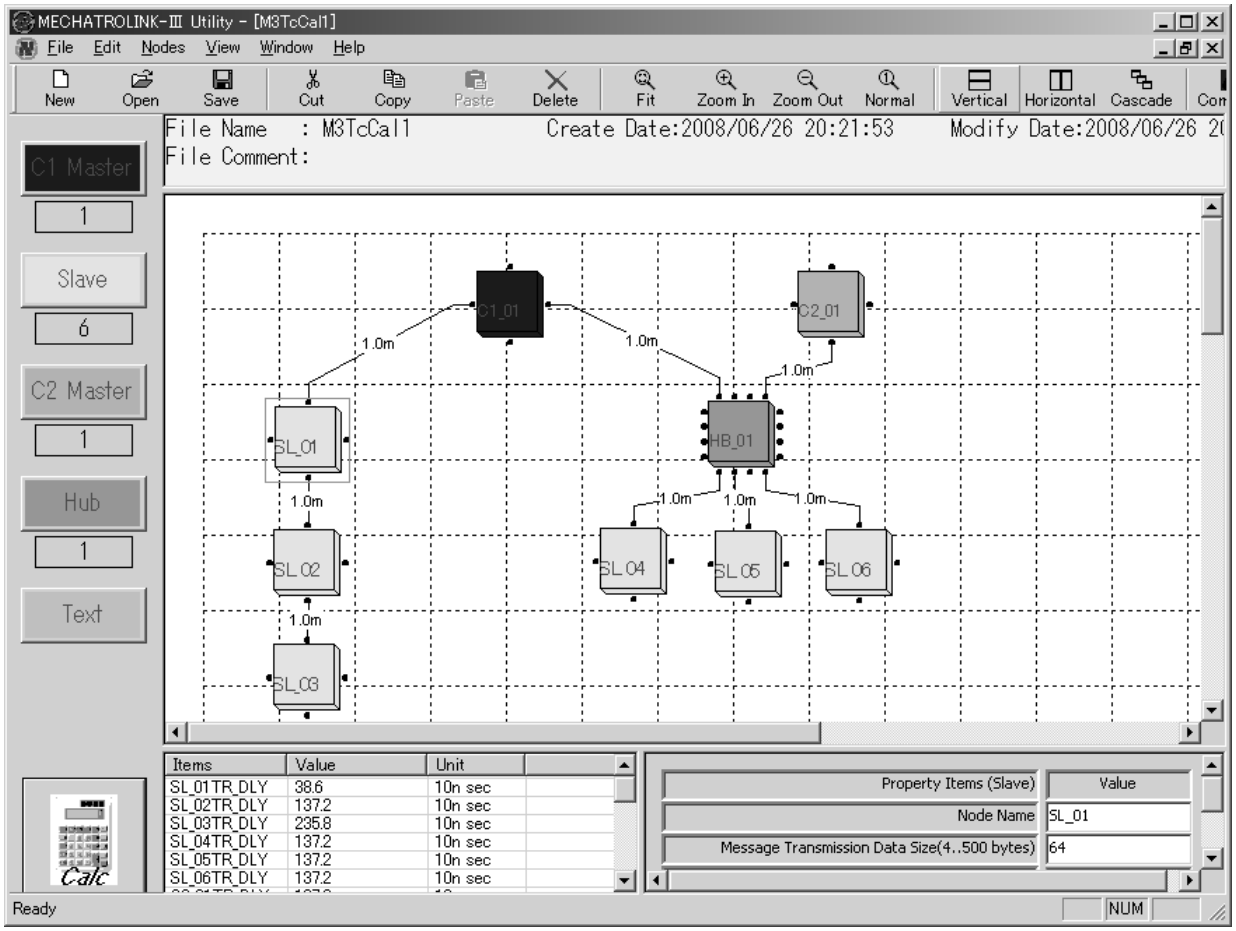


Fig. 2-3 Example Utility Software Screen

INFO

■ What is utility software?

The utility software enables definition of a system configuration by arranging the C1 master, the C2 master, slaves, and hubs as required and connecting them to construct a MECHATROLINK-III system.

The transmission cycle required for the system is calculated by setting parameters such as the communication data length, cable length, and number of retries.

Shown below as examples are the numbers of connectable stations for each transmission cycle and number of transmission bytes in a cascade connection and in a star connection with a single hub.

Table 2-1 Cascade Connection (C1 Master: 1 Port, Length of Each Cable: 0.2 m)

Transmission Cycle	No. of Transmission Bytes			
	16	32	48	64
31.25 µs	1	1	0	0
62.5 µs	2	2	2	2
125 µs	5	5	4	4
250 µs	9	9	8	8
500 µs	15	15	15	14
1 ms	24	24	23	22
2 ms	37	37	36	35
4 ms	56	56	55	53
8 ms	62	62	62	62

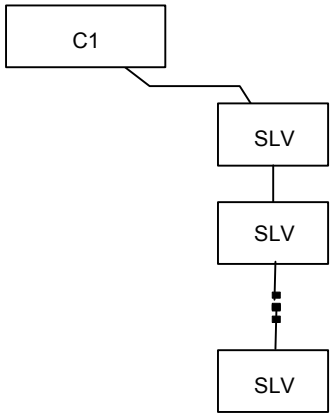
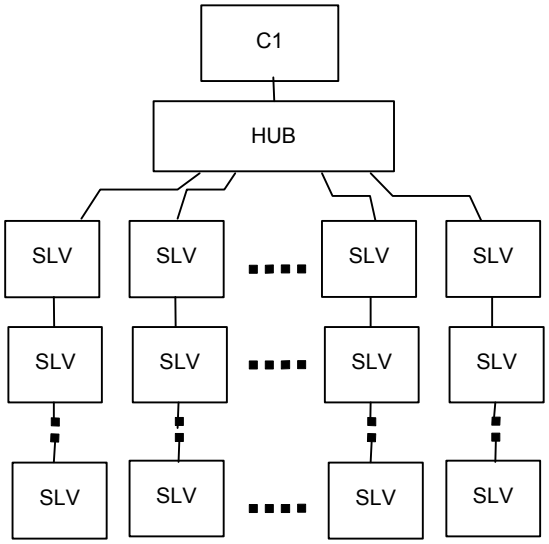


Table 2-2 Star Connection (Hub: 1 Level, Length of Each Cable: 0.2 m)

Transmission Cycle	No. of Transmission Bytes			
	16	32	48	64
31.25 µs	0	0	0	0
62.5 µs	2	2	2	2
125 µs	6	6	5	4
250 µs	12	12	11	10
500 µs	24	24	21	19
1 ms	42	42	39	36
2 ms	62	62	62	62
4 ms	62	62	62	62
8 ms	62	62	62	62



Note: 1. These tables show a situation where there are no retries and no C2 master. In cases where there are retries and there is a C2 master, the number of connectable stations might differ from that shown here.

2. If the device to be connected (particularly a master device) has some limitations (due for example to software processing), conform to the limitations outlined in the specifications for that device.

2.4 Wiring Specifications

Wire the MECHATROLINK-III network according to the following specifications for the length of wiring between stations and the total length of the network.

■ Cable Length between Nodes

Maximum: 100 m

Minimum: 0.2 m

■ Total Length for System

Maximum: Taking the cable length between nodes to be 100 m,
Total length = 100 m × number of connected nodes

Note: The values above are for MECHATROLINK-III communications specifications. If there are limitations in the product specifications of the module used, conform to these limitations.

3 About the Devices Used

3.1 Cables

For MECHATROLINK-III network systems, use either MECHATROLINK-III dedicated cables or STP (shielded twisted pair) cables that conform to Ethernet CAT5e.

3.1.1 Cable Assembly

The models of MECHATROLINK-III dedicated assembled cables for standard applications and moving application are shown below.

■ Standard Cables (Cables for Fixed Applications)

Table3-1 Standard Cable Models and their Applications

Cable Model	Application
JEPMC-W6012-□□-E	Used to connect MECHATROLINK-III modules.
JEPMC-W6013-□□-E	Used to connect MECHATROLINK-III modules. This is a JEPMC-W6012 cable with a ferrite core. Used in environments where noise is a problem.
JEPMC-W6014-□□-E	Used to connect MECHATROLINK-II modules. This is a JEPMC-W6012 cable with loose wires at one end. The user can assemble a cable with the length that suits the target system. This cable is also used when an RJ-45 connector needs to be fitted at one end.

■ Flexible Cables (Cables for Moving Applications)

Table3-2 Cable Models for Moving Applications and their Applications

Cable Model	Application
JEPMC-W6015-□□-E	Used to connect modules subjected to relative movement.
JEPMC-W6016-□□-E	Used to connect modules subjected to relative movement. This is a JEPMC-W6015 cable with a ferrite core.

Model: JEPMC-W6012-□□-E (manufactured Yaskawa Controls Co., Ltd.)

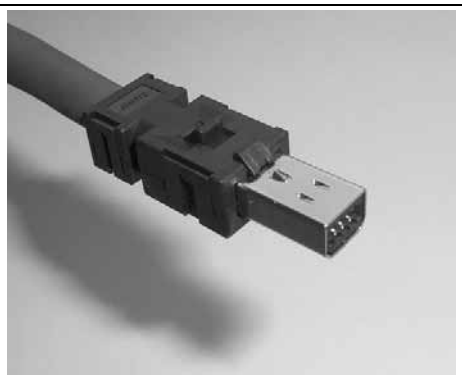


Fig. 3-1 Appearance of a Cable Assembly

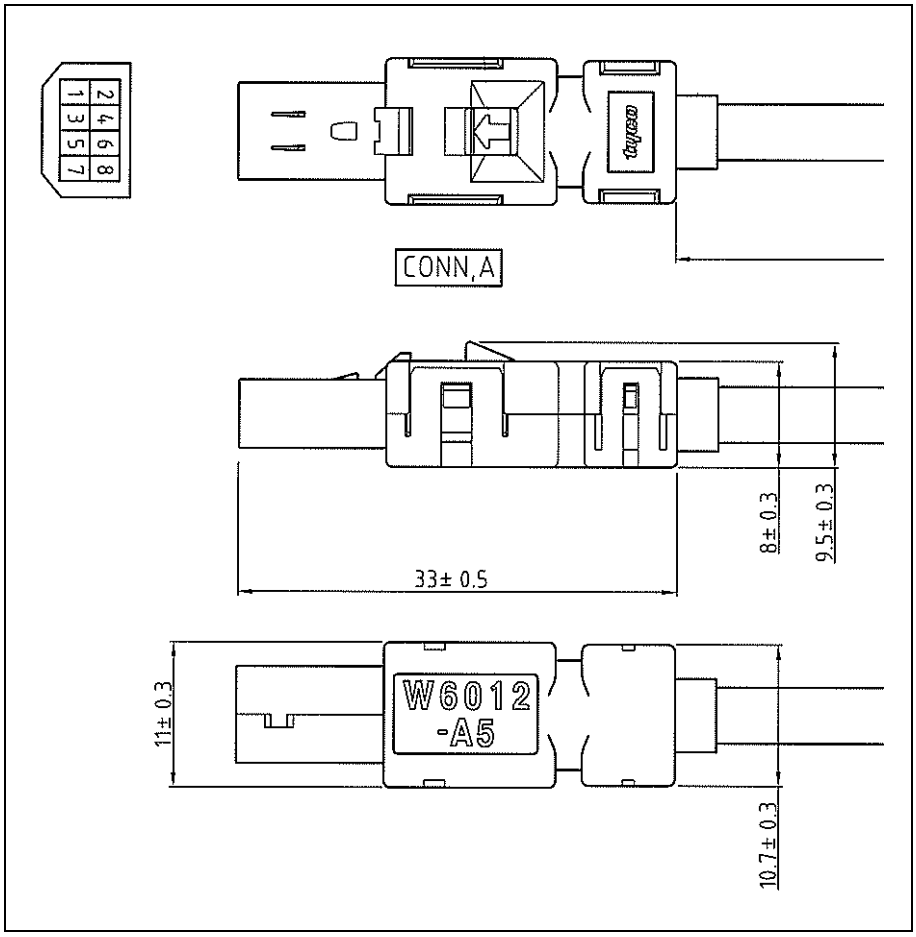


Fig. 3-2 External Dimensions of Cable Connectors

■ Cable Wire

The manufacturer and the model numbers of the wire used in the cable assembly are listed here. If planning to use such a cable and assemble it yourself, use a connector kit for industrial mini I/O connectors (IMI connectors) or RJ-45 connectors (for details, see section 3.2).

Standard cable wire: RS-M III (20276)

Manufacturer: DYDEN CORPORATION

Cable wire for moving applications: RM-M III (20276)

Manufacturer: DYDEN CORPORATION

Standard cable wire: RS-M III (20276)

Fig. 3-3 Appearance of Standard Cable Wire

3.2 Cable Connectors

Both general-purpose RJ-45 connectors and IMI connectors (industrial mini I/O connectors) are recommended for MECHATROLINK-III.

3.2.1 IMI Connectors (Industrial Mini I/O Connectors)

■ Cable Connectors

Connector kit model: 2040008-2

Hand press with die kit for shielding, model: 1891800-2

Manufacturer: Tyco Electronics Japan G.K.

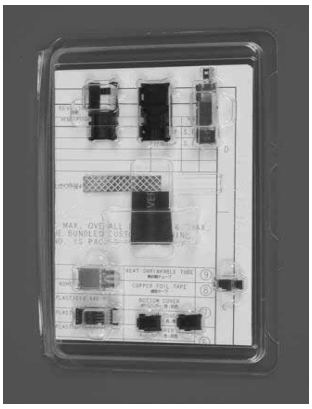
Connector kit: 2040008-2	Hand press with die kit for shielding: 1891800-2
	

Fig. 3-4 Appearance of Connector Kit Fig. 3-5 Appearance of Hand Press with Die Kit for Shielding

For details on the method of assembly by the user, refer to the following website of Tyco Electronics Japan G.K.

URL: http://www.tycoelectronics.com/commerce/DocumentDelivery/DDEController

Document title: INDUSTRIAL MINI I/O PLUG CONNECTOR KIT

Document type: Application specification

Document ID: 114-5431

3.2.2 RJ-45 Connectors

The recommended RJ-45 connectors are the connectors for industrial use offered by each connector manufacturer (with excellent environmental resistance covering vibration, impact and noise resistance).

Recommended RJ-45 connector for FA applications: 1903526-1 (manufactured by Tyco Electronics Japan G.K.)


Fig. 3-6 Appearance of RJ Connector

3.3 Hubs for MECHATROLINK-III

If a MECHATROLINK-III system is configured with a star connection, dedicated hub modules are required.

MECHATROLINK-III uses a dedicated protocol, so the hubs for Ethernet applications that are available on the market cannot be used.

Model: JEPMC-MT2000-E (manufactured by Yaskawa Electric Corporation)


Fig. 3-7 Model and Appearance of Dedicated Hub for MECHATROLINK-III

A hub module has one port for connection to the master and eight ports for connection to slaves. Unused slave ports can be left unconnected with no problems.

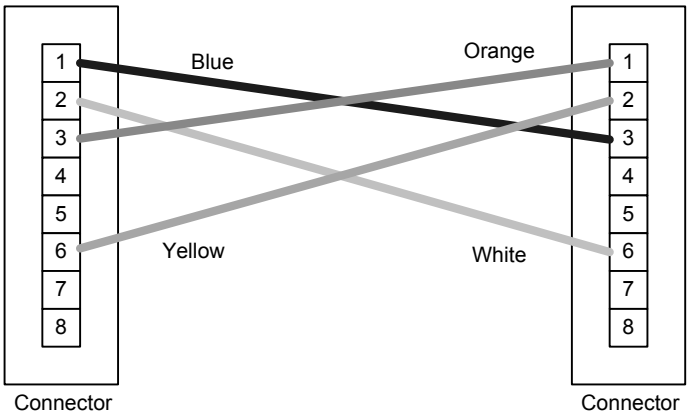
4 Network Wiring and Connection

After the MECHATROLINK devices have been installed, connect the wiring between devices.
For modules that are equipped with two connector ports for MECHATROLINK-III, no distinction is made between the ports on the master side and the subordinate side.

Modules installed at a terminal position in a network can have the cable connected to either port. In such cases, the port that was not connected can be left open (no terminating resistor is required).

4.1 Connector Pin Assignment

All of the cables used in MECHATROLINK-III networks are cross cables. The cables are connected as shown below (same for both IMI connectors and RJ-45 connectors).



Pin No.	Signal Name
1	TXD_P
2	TXD_N
3	RXD_P
4	N.C
5	N.C
6	RXD_N
7	N.C
8	N.C

Fig. 4-1 MECHATROLINK-III Connector Pin Assignment

When the cable cores are colored as shown in the figure, blue is paired with white, and orange is paired with yellow. Take note of this if making the cable by user.

4.2 Wiring

For the cables at each station, use JEPMC-W601□-XX-E or general-purpose STP cable.

A single network can be configured with mixed use of JEPMC-W601□-XX-E and general-use STP cables.

Cables for fixed applications and cables for moving applications can also be used in combination. However, some restrictions apply to the maximum length of flexible cables, so care is required when using them.

5 Notice

5.1 Vibration and Shock

Be sure to firmly insert the MECHATROLINK cable connector.

The MECHATROLINK cable connectors (both IMI connectors and RJ-45 connectors) are locking type connector. Be sure to insert the connector until a clicking sound is heard.

Confirm that the other devices in the system or nearby do not cause any vibrations or shock.

If vibration or shock is observed, take protective measures such as providing an enclosure for the system. Vibration or shock will also affect other equipment as well as the system itself.

If any stress is applied to the bundled cable, remove the stress.

Extreme stress may cause the cable to disconnect.

5.2 Anti-Noise Measures

Make sure that the device has been correctly installed and wired.

The same anti-noise measures that are used for general factory-automation (FA) devices can also be applied to devices in a MECHATROLINK network.

Observe the following precautions regarding noise.

■ Noise Sources

Possible causes are as follows:

- Variation in voltage caused by turning the power switch or the circuit breaker of the power distribution panel on and off.
- Spark noise during opening and closing of the relay contact points when the power switch or contactor is turned on or off. (As in Nearby machinery, air conditioners, blinking lights, etc.)
- Switching noise from motor-driven equipment such as general lighting dimmers, air conditioners and cranes
- Electrical discharge and noise from electronic equipment and lights. (As in Electric welding equipment, neon lights, and fluorescent lights)
- Variation in ground level when large-capacity equipment is turned on and off.

Noise from instruments or equipment may be transferred to other instruments or equipment through power circuit cables, and may cause problems.

■ Anti-noise Measures

Power

A noise filter or noise-cut transformer should be provided to isolate each power circuit and to prevent noise from flowing to other instruments or equipment. Observe the following precautions when installing the dedicated power circuit.

- Do not share the power circuit with any other system.
- Use cables with a low voltage loss for wiring from the power-distribution panel in the system. Keep the length of the power cables as short as possible.
- Route the cables in a separate conduit so they will be isolated from the wiring for other systems.
- Connect the ground wire on the secondary side of the dedicated transformer to a ground terminal that is used for grounding only the MECHATROLINK system.
- Consider the power capacity of the power distribution panel's circuit breaker and the sub-circuit breaker that branches out from the power distribution panel.

Wiring

- Wire the communication cables separately from the power cables to prevent inductive noise. Keep them at least 30 cm apart.
- Enclose the power cables inside a grounded conduit.
- Communication cables should never be bundled together with power cables, nor should they be run parallel to power cables.

Grounding

Grounding can be used to reduce or eliminate noise, but the methods will vary in accordance with the kind of noise.
An example of grounding is shown below.

- Prepare a ground with a resistance of 100 Ω or less to be used exclusively for the MECHATROLINK system.
- To eliminate common impedance, ground each device in the system to the framing ground or protective earth (PE) so that the entire system is connected in a star pattern.

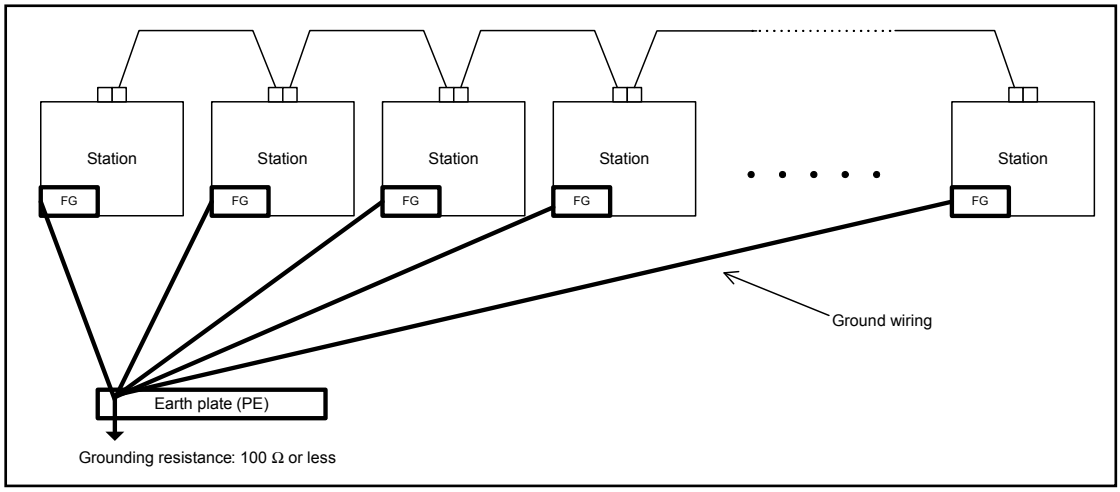


Fig. 5-1 Example of grounding

6 Troubleshooting

For MECHATROLINK-III communications, general-purpose Ethernet 100Base-TX is adopted for the physical layer. If signal reliability is affected by noise from external sources or deterioration in cable characteristics, communication errors will occur. Each MECHATROLINK-III module is mounted with specific LEDs so that when this kind of problems occurs in cause can be roughly classified according to the lighting status of the LEDs. When the above problems occur, first check the LEDs and take action according to their status. The troubleshooting by checking the LEDs is described below.

6.1 Checking Status with the LEDs

With MECHATROLINK-III specifications, the LEDs (link, connect, error) mounted to indicate the communication status are standardized. The rough cause of problems can be identified from the lighting status of the LEDs.

6.1.1 LED Specifications

The LED mounting specifications for master and slave devices and details on each LED are given below.

LED Name	Master Product		Slave Product	
	Mandatory/Optional	Number Mounted	Mandatory/Optional	Number Mounted
Link LED	Mandatory	Same as number of ports mounted	Mandatory	Same as number of ports mounted
Connect LED	Optional	–	Mandatory	One
Error LED	Mandatory	Depends on product specifications	Mandatory	Depends on product specifications

■ Link LED

This LED lights when a physical connection is established with the neighboring module connected by cable when the power is turned on. Because it lights regardless of the operating status of the communication ASIC and the host CPU, this LED makes it possible to easily find disconnected cables by providing confirmation of the physical connections of the network.

■ Connect LED (Slaves Only)

This LED lights at the host CPU after the CONNECT command has been received normally from the master device. This LED makes it possible to check if all data, including that used in applications has been successfully transmitted or received.

However, after the CONNECT command has once been received normally, the Connect LED does not turn off unless the DISCONNECT command is received normally from the master device (even if communication with the master device is interrupted by a disconnected cable, for example, the Connect LED will remain lit).

■ Error LED

If some kind of communication-related error detected by the communication ASIC has occurred, this LED lights at the host CPU (on some models the status is indicated by a 7-segment LED display).

Table 6-1 Status Classification According to LED Lighting States

Status / LED Name	Normal	Error Status 1 (See 6.2.1)	Error Status 2 (See 6.2.2)	Error Status 3 (See 6.2.3)	Error Status 4 (See 6.2.4)
Link LED	Lit	Not lit	Not lit/Flashing	Lit	Lit
Connect LED	Lit	Not lit	Lit	Not lit	Lit
Error LED	Not lit	Not lit/Lit	Not lit/Lit	Not lit/Lit	Lit

The following pages describe the flow of the analysis of each error status.

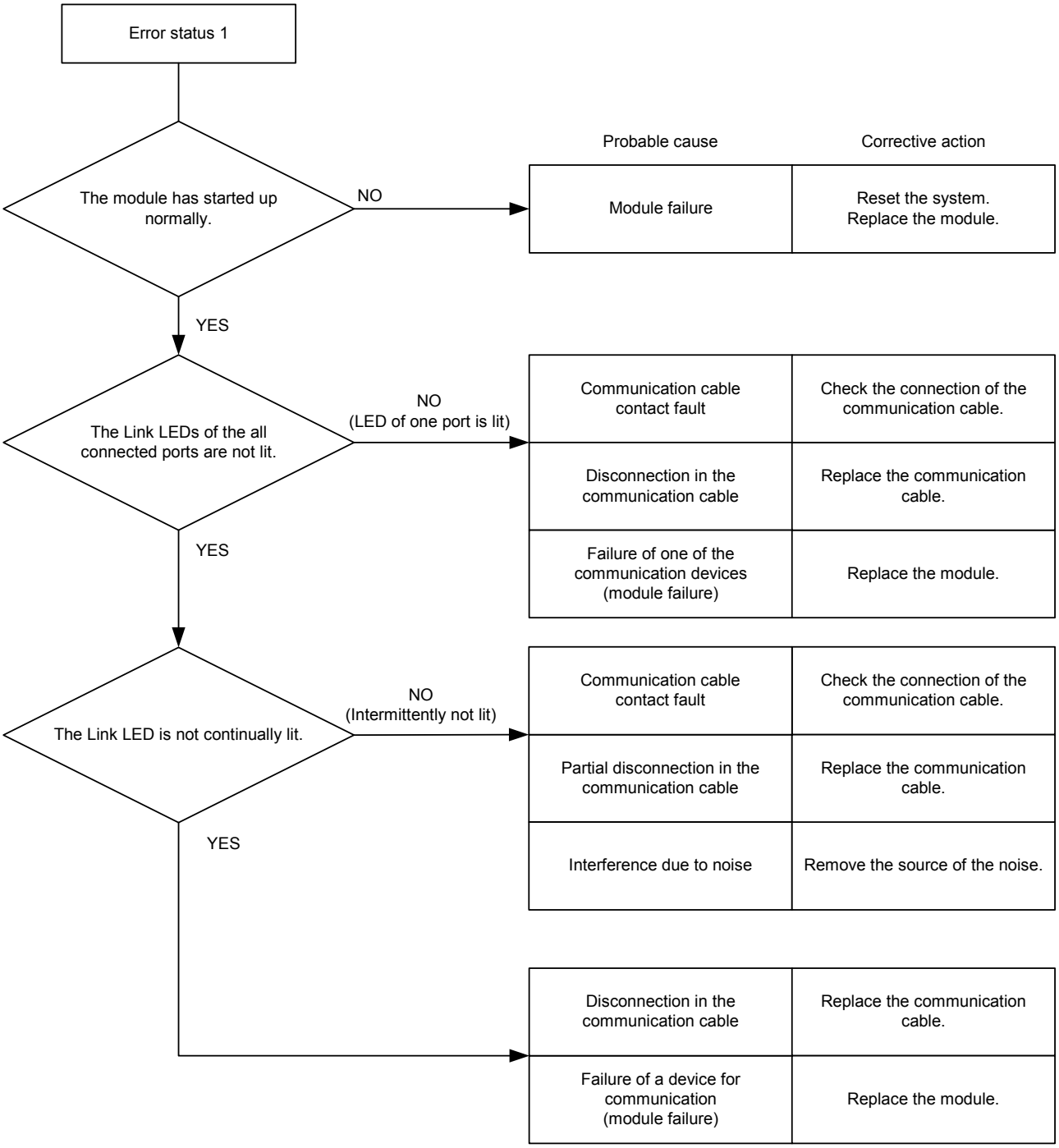
6.2 Analysis of Trouble in Each Error Status

6.2.1 Analysis of Error Status 1

Link LED	Not lit (including intermittently not lit time.)
Connect LED	Not lit
Error LED	Not lit (no error)/Lit (error detected)

The most likely cause in this status is a disconnected cable.

If the Error LED is lit, the status varies in accordance with the application, but modular failure is a strong possibility if this status occurs after normal communications were established in a MECHATROLINK module.

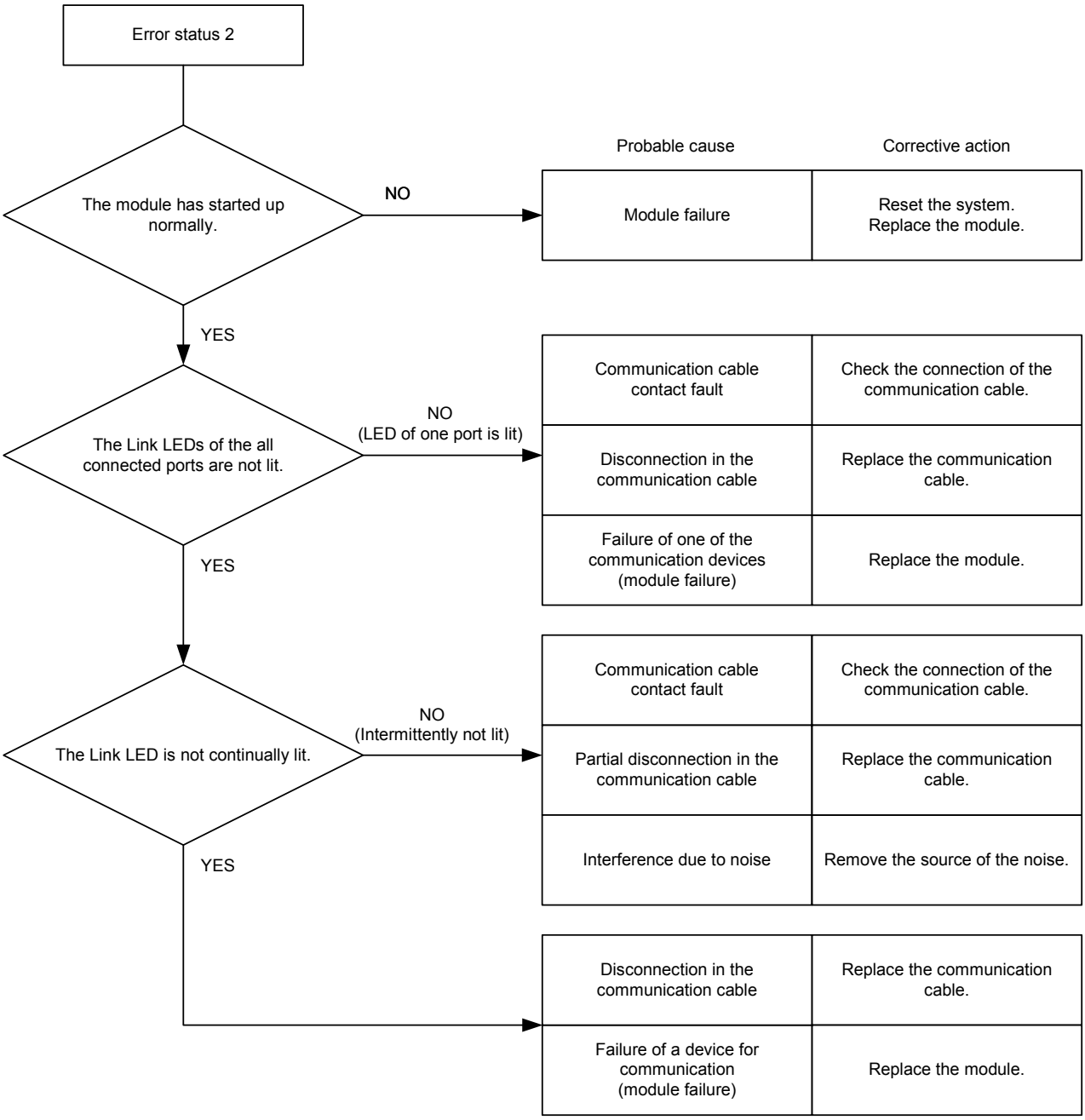


Probable cause	Corrective action
Module failure	Reset the system. Replace the module.
Communication cable contact fault	Check the connection of the communication cable.
Disconnection in the communication cable	Replace the communication cable.
Failure of one of the communication devices (module failure)	Replace the module.
Communication cable contact fault	Check the connection of the communication cable.
Partial disconnection in the communication cable	Replace the communication cable.
Interference due to noise	Remove the source of the noise.
Disconnection in the communication cable	Replace the communication cable.
Failure of a device for communication (module failure)	Replace the module.

6.2.2 Analysis of Error Status 2

Link LED	Not lit (including intermittently not lit time.)
Connect LED	Lit
Error LED	Not lit/Lit

The analysis for this status is the same as for error status 1, but the lit Connect LED suggests that this status might have occurred after normal communications were established in a MECHATROLINK module. This status might have resulted as an effect of noise from external sources or as a result of modular failure caused by noise.



6.2.3 Analysis of Error Status 3

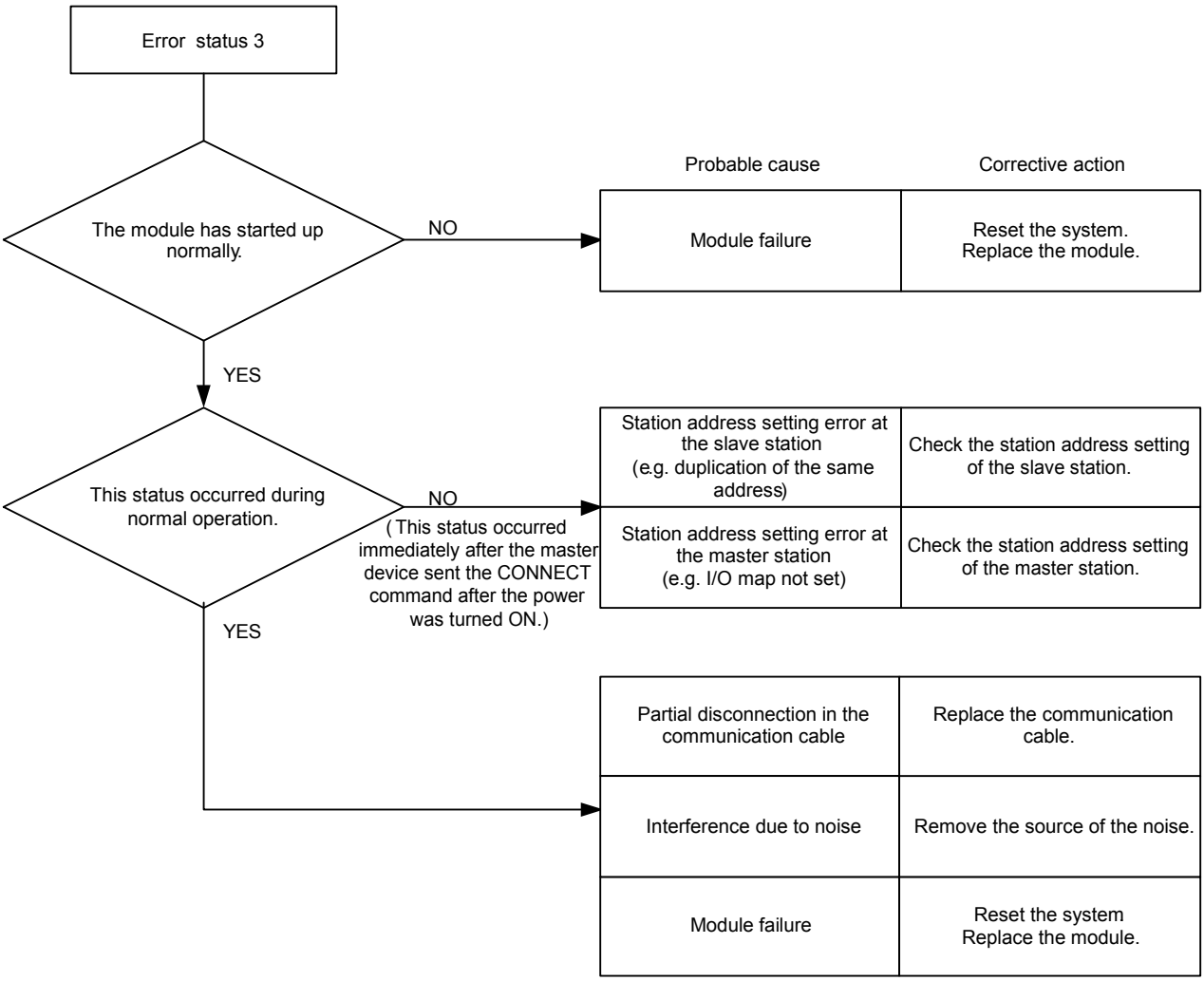
Link LED	Lit
Connect LED	Not lit
Error LED	Not lit /Lit

This status often occurs due to a setting error of master/slave address when the system is started up.

If this status occurs during normal operation, a MECHATROLINK module may be affected by noise from external sources.

If the Error LED is lit, the status varies in accordance with the application, but modular failure is a strong possibility if this status occurs after normal communications were established in a MECHATROLINK module.

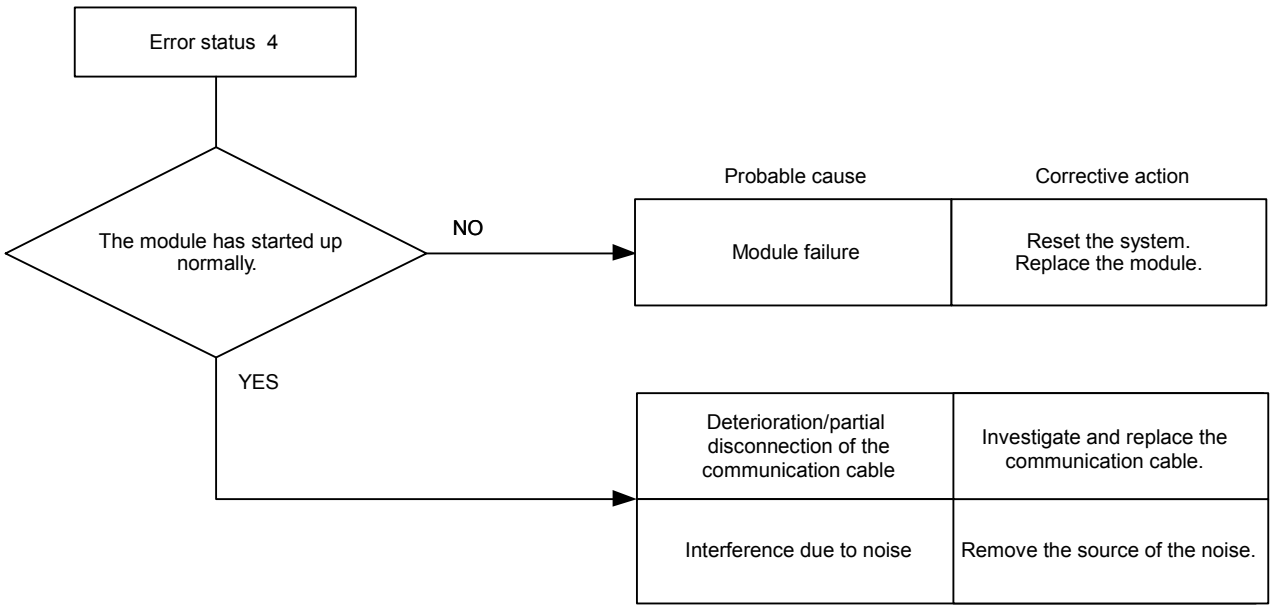
As described before, be careful that the Connect LED will not turn off after the CONNECT command has been successfully received and it has lit even if a disconnected cable or communication error occurs.



6.2.4 Analysis of Error Status 4

Link LED	Lit
Connect LED	Lit
Error LED	Lit

If this status occurs during normal operation, a MECHATROLINK module may be affected by noise from external sources.



INFO

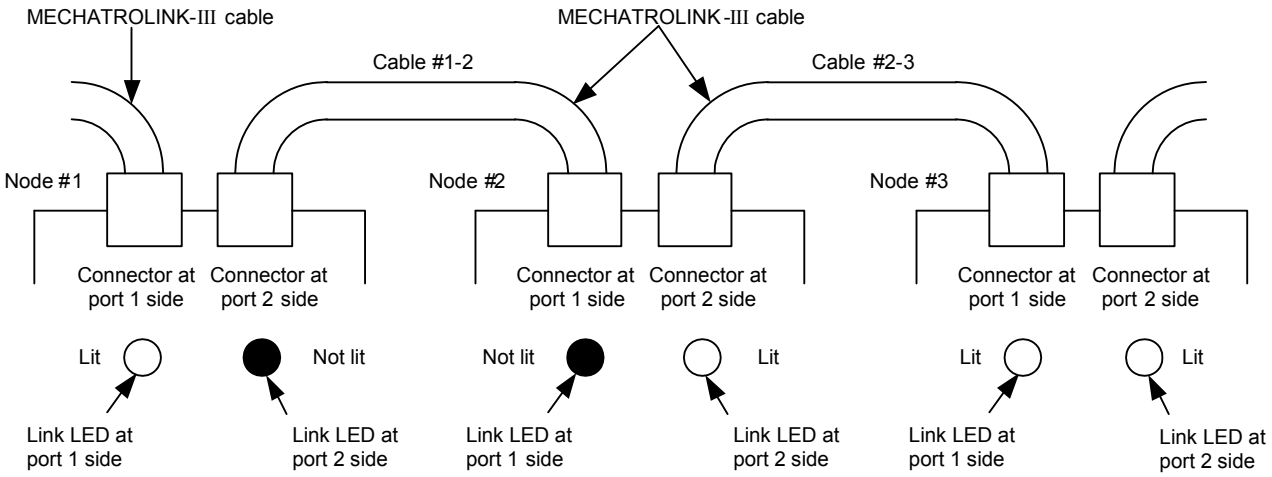
If the cause of the problems is determined to be cable related, the cable can be evaluated in isolation by using a cable tester of the kind readily available on the market. However, if the cables use IMI connectors, they need to be converted to RJ-45 connectors.

(Cable tester: E.g. the DTX CableAnalyzer™ Series manufactured by FLUKE Networks)

6.3 Inferring Error Locations by Checking the Link LED

Examples of determining the module or cable with an error in a multi-node system are shown below.

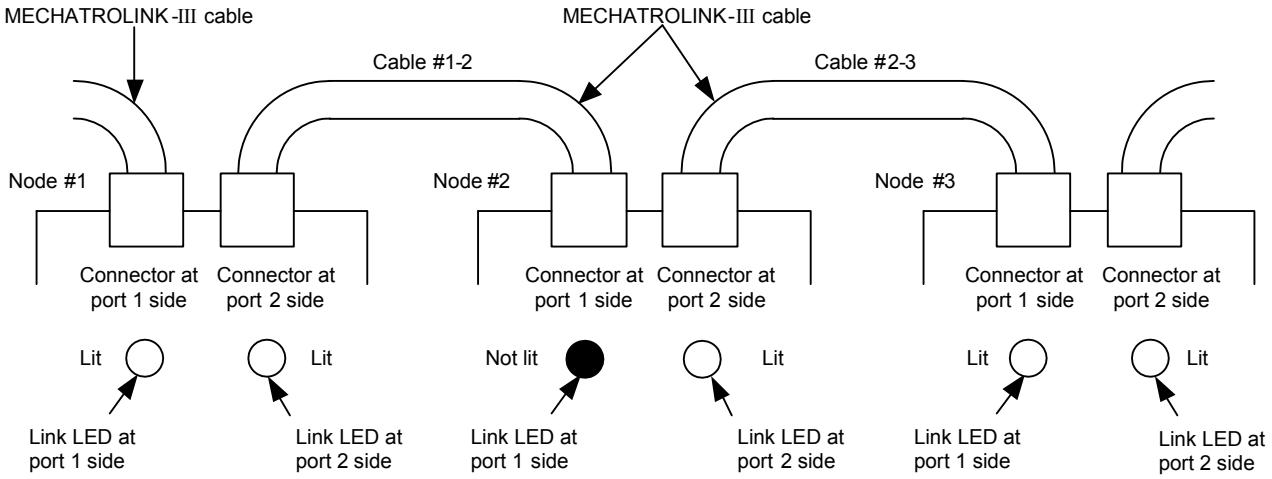
■ Link LED Pattern 1 when an Error Occurs



When the statuses of the Link LEDs at node #1 and node #2 are as shown in the figure above, the probable causes are:

- Disconnected cable #1-2
- Failure of the IC for transmission/reception at node #1 or node #2

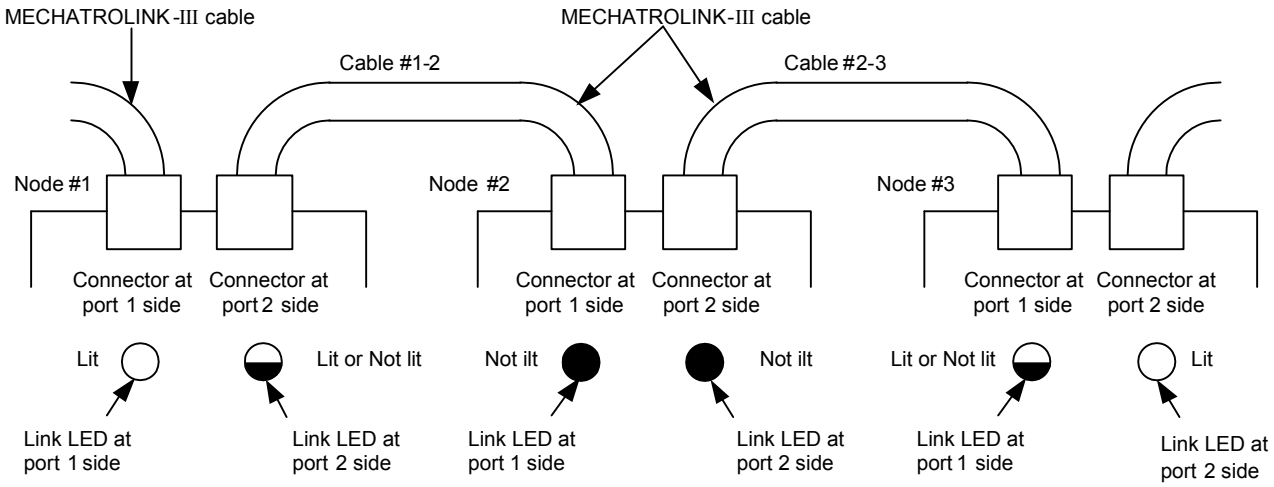
■ Link LED Pattern 2 when an Error Occurs



When the statuses of the Link LEDs at node #1 and node #2 are as shown in the figure above, the probable causes are:

- Failure of the IC for transmission/reception at node #1 or node #2

■ Link LED Pattern 3 when an Error Occurs

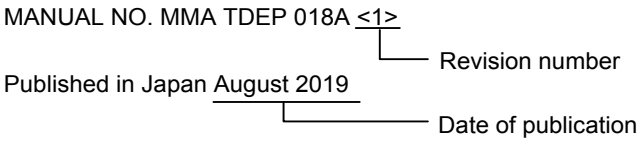


When the statuses of the Link LEDs at node #1 and node #2 are as shown in the figure above, the probable causes are:

- Module failure at node #2
- Failure of the IC for transmission/reception at node #2

Revision History

The revision dates and numbers of the revised manuals are given at the bottom of the back cover.



Date of Printing	Rev. No.	Section	Revised Contents
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