HITACHI

S10mini

S10mini
HARDWARE MANUAL

D.Station

SME-1-119 (A)

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BI-NR-HS (FL-MW20, AI8.0)

SAFETY PRECAUTIONS

Be sure to read this manual and all other attached documents carefully before installing, operating inspecting or conducting maintenance on this unit. Always use this unit properly. Be sure to carefully read the information about the device, the safety information and precautions before using this unit. Be sure that the person(s) responsible for maintenance receives and understands this manual completely.

This manual divides the safety precautions into DANGERs and CAUTIONs.

DANGER : Failure to observe these warnings may result in death or serious injury.

CAUTION : Failure to observe these cautions may result in injury or property damage.

Failure to observe any **CAUTION** may lead to serious consequences.

All of these DANGERs and CAUTIONs provide very important precautions and should always be observed.
Additional safety symbols representing a prohibition or a requirement are as follows:

: Prohibition. For example, “Do not disassemble” is represented by:

: Requirement. For example, if a ground is required, the following will be shown:

DANGER

- Devise an emergency stop circuit, interlock circuit, and other similar circuits outside the programmable controller. Disregarding this rule may result in damage to the equipment or cause an accident if the programmable controller fails.
- Keep it in mind that this hardware unit operates on a high voltage. If the user touches a high-voltage terminal inadvertently during connection or disconnection of this hardware unit or its cable, he or she may suffer from an electric shock. Also, this hardware unit may be damaged due to a short circuit or noise. Be sure to switch off the hardware unit before connecting or disconnecting it or its cable.

CAUTION

- This hardware unit may fail if the ambient temperature is too high. The hardware unit may also malfunction due to interference by electromagnetic waves from adjacent hardware. To dissipate heat and reduce electromagnetic interference, provide the specified mount of space between the cubicle and this hardware unit and between the hardware unit and other ones.
- After installing this hardware unit, measure temperatures near the in-cubicle controller and the mount base during operation, and check whether the measurements are within the limits. If the specified amount of space cannot be provided or the measured temperature is too high, use a cooling fan.
- At an extremely high temperature, this hardware unit may fail. Secure the mount base to a vertical surface. If the mount base is secured horizontally, heat does not dissipate efficiently, resulting in an extremely high temperature. This may further cause the hardware unit to fail or its parts to deteriorate.
- This hardware unit may be damaged due to static electricity. Ground yourself before setting switches or connecting or disconnecting cables or connectors with the hardware unit.
- This hardware unit may be damaged during its installation or removal unless the following rules are observed:
  - Check that the connector pins are not damaged (bent or broken), are aligned straight and are free from dust.
  - Move the hardware unit along an imaginary vertical surface to the face of the mount base. If the product is inserted or removed slantwise from the connector on the mount base, connector pins may be bent.

REQUIREMENT

- An electric shock may lead to a death or burn. Noise may cause the system to malfunction. Ground the line ground (LG), frame ground (FG), and shield (SHD) terminals, as described below.
  - Electrically insulate the mount base from the cubicle. To assure this, do not remove the insulating sheet from the mount base.
  - Ground the LG and FG terminals separately to prevent mutual interference. The LG terminal is grounded to prevent intrusion of power line noise, while FG and SHD terminals are grounded to suppress intrusion of line noise into external interfaces for remote I/O modules, interface modules, and other modules.
  - Connect the FG terminal on each module to the FG terminal on the mount base. Note, however, that the FG terminal for each remote I/O line or JPCN-1 line must be connected separately to a single place on the terminating side.

REQUIREMENT

- Excessive accumulation of heat in the cubicle may cause a fire or hardware failure. When the temperature in the cubicle reaches 48°C or higher, the maximum output current of the power supply module is limited. At 55°C, for instance, it is limited to 5.85 A. Where this is very likely, install a cooling fan in the cubicle or reduce the number of modules installed therein.

PROHIBITION

- If a part in a module is damaged, do not replace the part, but replace the faulty module in its entirety, except when the part is the battery for the CPU.

WARRANTY AND SERVICING

Unless a special warranty contract has been arranged, the following warranty is applicable to this product.

1. Warranty period and scope
   Warranty period
   The warranty period for this product is for one year after the product has been delivered to the specified delivery site.

   Scope
   If a malfunction should occur during the above warranty period while using this product under normal product specification conditions as described in this manual, please deliver the malfunctioning part of the product to the dealer or Hitachi Engineering Service Co., Ltd. The malfunctioning part will be replaced or repaired free of charge. If the malfunctioning is shipped, however, the shipment charge and packaging expenses must be paid for by the customer.

   This warranty is not applicable if any of the following are true.

   - The malfunction was caused by handling or use of the product in a manner not specified in the product specifications.
   - The malfunction was caused by a unit other than that which was delivered.
   - The malfunction was caused by modifications or repairs made by a vendor other than the vendor that delivered the unit.
   - The malfunction was caused by a disaster, natural or otherwise, for which the vendor is not responsible.

   The warranty mentioned here means the warranty for the individual product that is delivered. Therefore, we cannot be held responsible for any losses or lost profits that result from the operation of this product or from malfunctions of this product. This warranty is valid only in Japan and is not transferable.

2. Range of services
   The price of the delivered product does not include on-site servicing fees by engineers. Extra fees will be charged for the following:

   - Instruction for installation and adjustments, and witnessing trial operations.
   - Inspections, maintenance and adjustments.
   - Technical instruction, technical training and training schools.
   - Examinations and repairs after the warranty period is concluded.
   - Even if the warranty is valid, examination of malfunctions that are caused by reasons outside the above warranty scope.

PREFACE

Thank you for purchasing the Hitachi Programmable Controller (S10mini).
This manual describes how to handle the S10mini D.Station module. For details on the CPU modules, I/O modules, and optional modules, refer to each respective manuals.
Read this manual thoroughly to properly use this module.

CONTENTS

FIGURES

TABLES

1 BEFORE USE

■ Installation

The Programmable Controller is not fireproof, dustproof, or dripproof. When you install, mount the controller in a dust and dripproof iron cubicle as shown below:

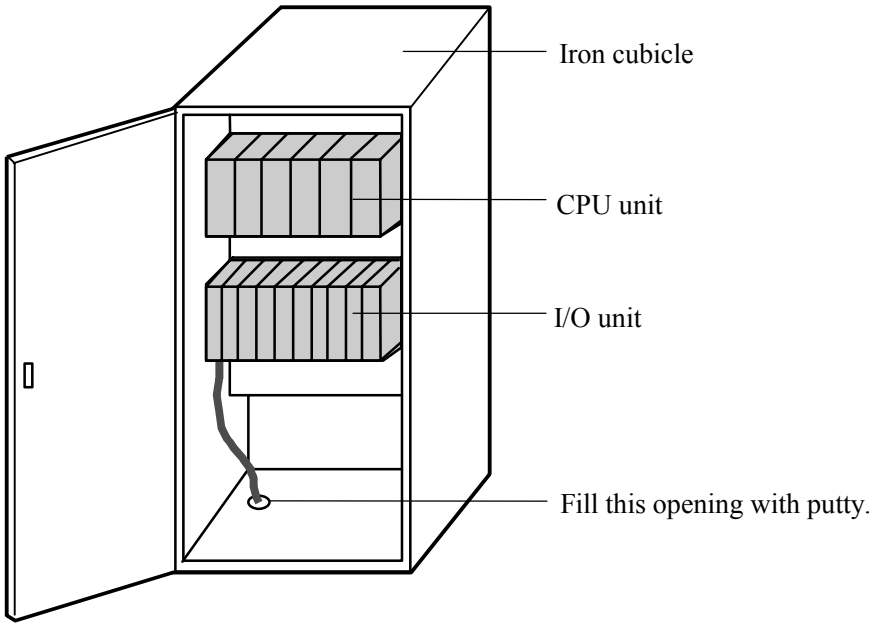


Figure 1-1 Installation Example

■ Environment

Operate the Programmable Controller in the following environment:

Table 1-1 Operating Environment

Supply voltage	100 to 120 VAC, single-phase, 50/60 Hz±4%	24 VDC	100 to 110 VDC
Amplitude range	85 to 132 VAC	20.4 to 28.8 VDC	85 to 132 VDC
Temperature	At operation: 0 to 55°C; storage: -20 to 75°C		
Relative humidity	At operation: 30 to 90% RH; storage: 10 to 90% RH		
Vibration resistance	5.8m/s^2 (1000 rpm)		
Shock resistance	98m/s^2		
Ambient air	Dust: 0.1 mg/m^3 or less (given that there is no corrosive gas)		

* The amplitude range varies depending on the employed power supply module.

■ Output module

Furnish the output module load power supply with a fuse for the protection of load short-circuits.

Ensure that the employed fuse is rated to match the load. If the employed fuse rating is higher than specified, the printed circuit boards, case, and other items may burnout when the load is shorted.

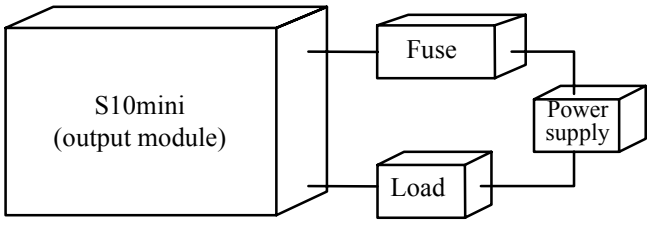


Figure 1-2 Output Module Specifications

■ Grounding point

Provide Class D* or better independent grounding. Do not use any other existing ground as a substitute. It is particularly important that the grounding point for the Programmable Controller be at least 15 m away from an AC panel grounding point.

* Class D grounding is defined in the Technical Standard for Electrical Facilities of Japan. This standard states that the grounding resistance must be 100 ohms or less for equipment operating on 300 VAC or less, and 500 ohms or less for devices that shut down automatically within 0.5 seconds when shorting occurs in low tension lines.
It is the best that the grounding wire be welded to the steel frame of a building. In case when the aforesaid is impossible, bury the grounding rod in earth.

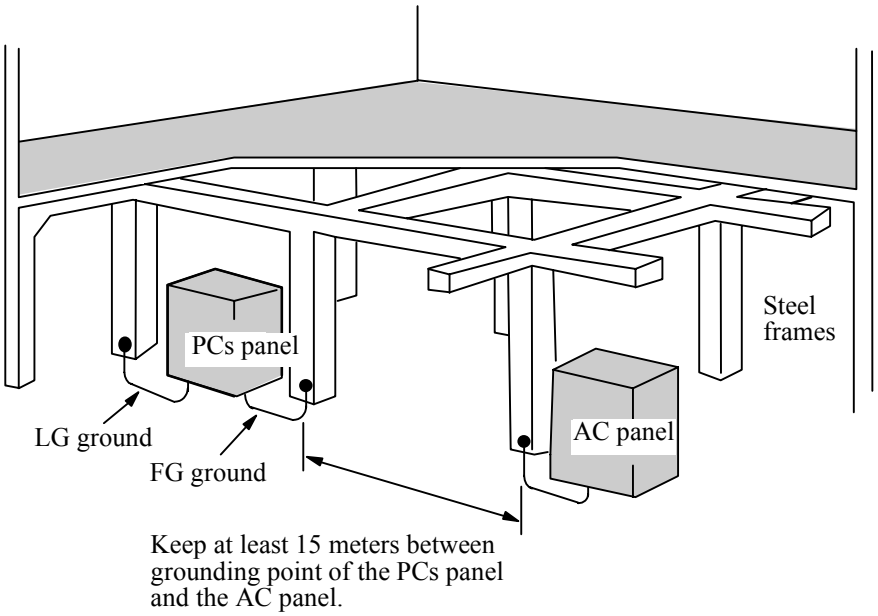


Figure 1-3 Grounding Specifications

■ Noise

Do not install the Programmable Controller inside or near a panel on which a high-voltage device such as inverter is mounted. Make a shielding plate to protect the CPU or I/O unit main frames and cables from electromagnetic or electrostatic induction.

■ External circuitry

Partial damage may affect the entire circuitry of the Programmable Controller. Ensure that the emergency stop circuit incorporated in the Programmable Controller consists of an external relay circuit.

■ Internal parts replacement

User must not replace internal parts of the Programmable Controller with anything other than the parts specified in the manual. Replace the entire module in which a defective part is included. For details on parts replacement, contact your Hitachi maintenance personnel.

■ Module insertion/removal

Power must be turned off while a module is inserted or removed. Insertion or removal of a module when power is ON may cause damage to the module or electric shock.

■ Equipment addition

If the peripheral equipment is added or altered, conduct an inspection as directed in Section 8.1, "Preventive Maintenance" to confirm whether the Programmable Controller is properly functioning.

Special attention must be paid to the following regarding power supply and grounding.

- Power supply
  - * Inspection of the supply voltage and waveform
    - Check for a voltage reduction.
    - Check for a significance in the amount of noise in the power supply line.
    - Check if the waveform resembles a sine wave.

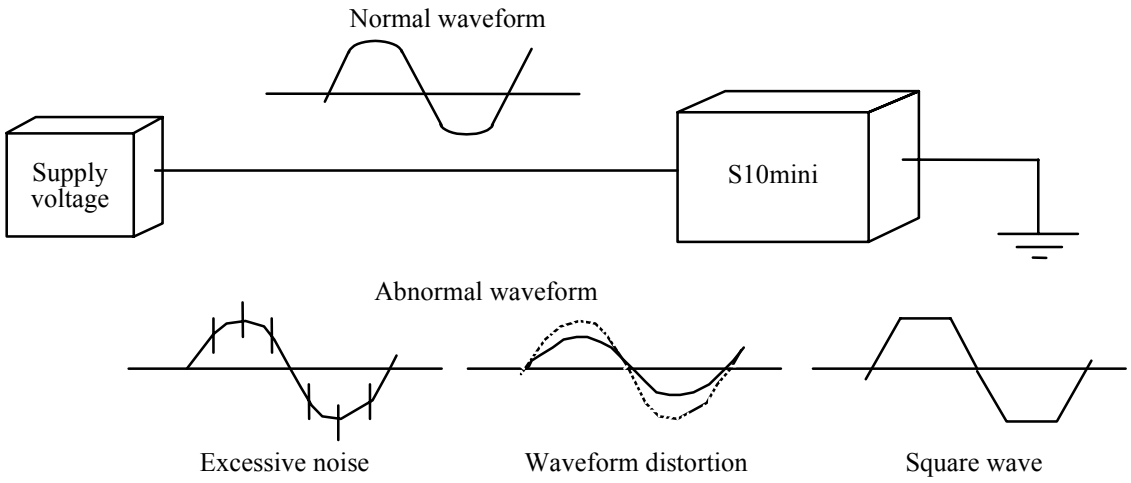
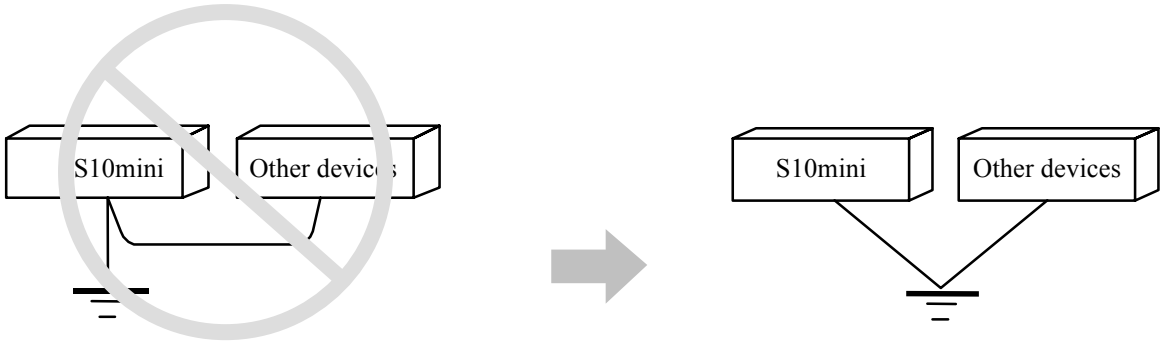


Figure 1-4 Power Supply Input Waveform

- Grounding
  * Inspection of the ground wiring
    – Check if a ground wire is shared with another ground wire.
    – Check if the grounding point is at least 15 m away from the grounding point of the AC panel.

  * Check if any power supplies or power cables are located adjacent to the signal cables such as DeviceNet line.



Share of grounding wires

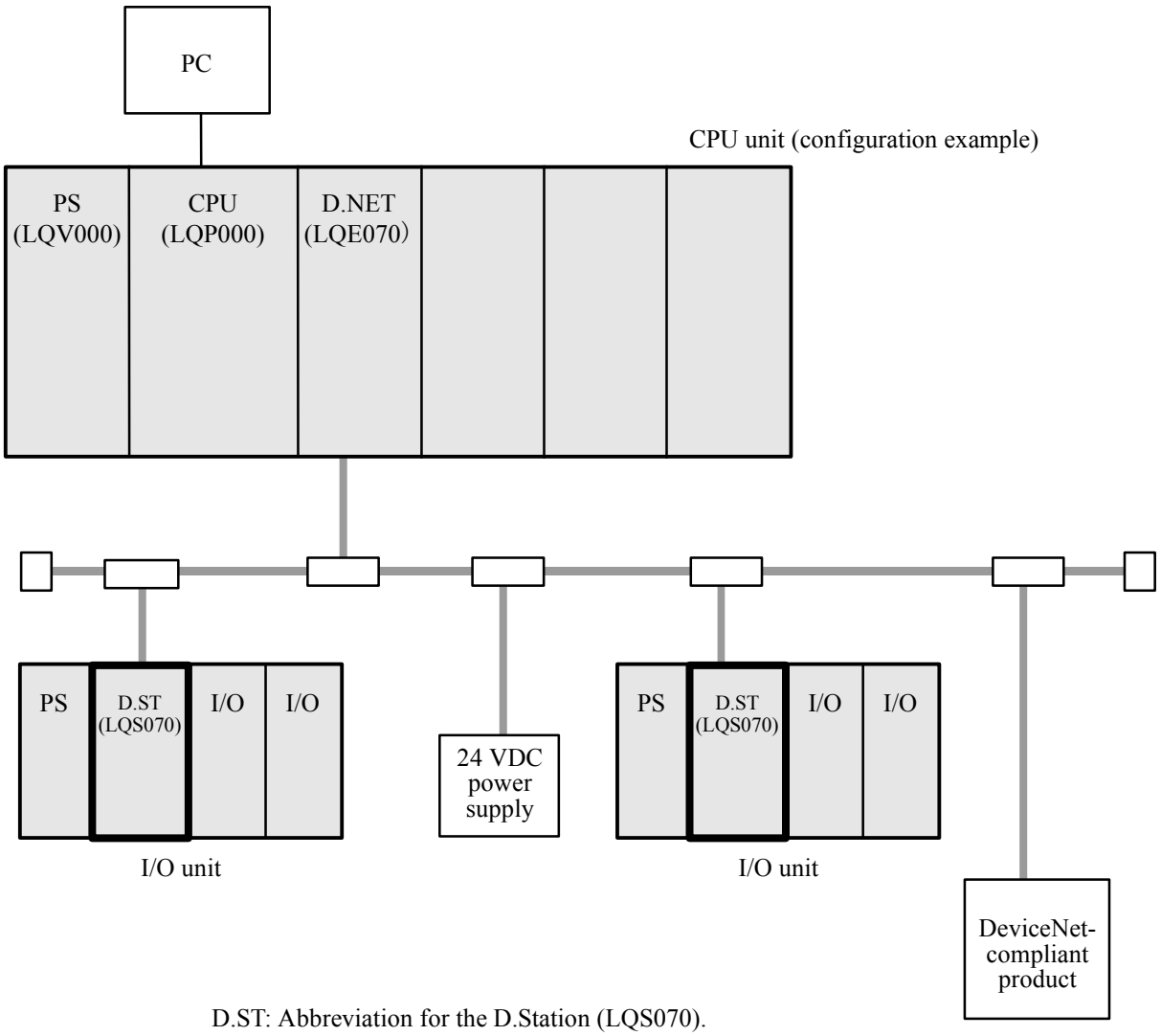
Isolation of grounding wires

Figure 1-5 Grounding Examples

2 GENERAL INFORMATION

2.1 System Overview

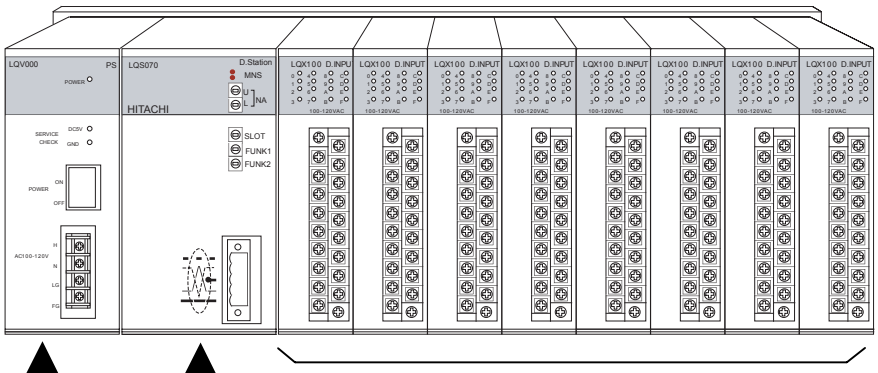
System configuration of the D.Station is shown below. The D.Station module (Model LQS070) connects to a network that meets the standard and communicates data between master stations (D.NET module, etc.).



D.ST: Abbreviation for the D.Station (LQS070).

Figure 2-1 System Configuration

2.2 I/O Unit Modules



Power supply module

I/O modules

Model	Input
LQV000	100 VAC input
LQV020	24 VDC input
LQV100	100 VAC/100 VDC input

D.Station module (LQS070)

Mount base

Model	Name
HSC-1021	2-slot mount base
HSC-1041	4-slot mount base
HSC-1081	8-slot mount base
HSC-1281	8-slot I/O mount base for scanning analog input module

Model	Name	Remarks
LQX100	16-point AC input	
LQX110	16-point AC input (latch attached)	
LQS200	16-point DC input	
LQX201	16-point DC input	
LQX210	16-point DC input (latch attached)	
LQX211	16-point DC input (latch attached)	
LQX240	16-point DC input	
LQX250	16-point DC input	
LQX300	32-point DC input	
LQX350	64-point DC input	
LQY100	16-point contact output	
LQY140	8-point contact output	
LQY160	6-point contact output	
LQY200	16-point transistor output	
LQY300	32-point transistor output	
LQY350	64-point transistor output	
LQZ300	32-point input/output	
LQA000	Analog input (voltage)	Set the MODE selector switch to "1".
LQA100	Analog input (current)	
LQA200	Analog input (resistance)	
LQA300	ADC	Used in conjunction with HSC1281.
LQA310	Scanning analog input (individually insulated)	
LQA500	Analog output (voltage)	Set the MODE selector switch to "1".
LQA600	Analog output (current)	
LQA610	Analog output (current)	
LQC000	Pulse counter	

Figure 2-2 Unit Configuration

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3 SPECIFICATIONS

3.1 Specifications

3.1.1 D.Station module specifications

Table 3-1 Module Specifications

Item	Specifications
Model	LQS070
Module size	130 × 69 × 100mm
Current consumption	5V: 330mA
Weight	200g

3.1.2 Communication specifications

Table 3-2 Communication Specifications

Item			Specifications
MAC layer	Transmission path access method		CSMA/NBA (Carrier Sense Multiple Access with Non-destructive Bitwise Arbitration)
	Protocol		CAN (Control Area Network) protocol Master/slave communication supported (only the slave functions supported)
Physical layer	Transmission rate		Variable (Select from 125 kbps, 250 kbps, or 500 kbps)
	Communication type		Master/slave communication (poll)
	Word counter		Max 128 bytes.
	Encoding system/insulation		NRZ (Non Return to Zero) / photo coupler 500volts
	Communication power supply specifications		24 VDC (Ripple voltage: 250 mVp-p; Inrush current: Less than 65 A)
	Communication power supply		Supplied on an individual basis (self-feeding)
	Transmission media	Connectors	Open-plug connector and shield connector used
		TAP	Open-type TAP and shielded TAP used
		Cables	Main line Total extended distance → 125 kbps. up to 500 m / 250 kbps. up to 250 m / 500 kbps. up to 100 m (variable with the transmission rate) 5-conductor thick cable Drop line: Max. 6 m/drop line → Length of the total drop line: 125 kbps. up to 156 m / 250 kbps. up to 78 m / 500 kbps. up to 39 m 5-conductor thin cable Power supply line: Max. 3 m
		Terminator (terminating resistor)	Connector with terminating resistor or 121 Ω±1% (1/4 W or more) metal film resistor

3.1.3 D.Station module support function

Table 3-3 List of Support Functions

Feature of the DeviceNet			
Device type: Communication Adapter		Master/Scanner	Not supported
Explicit Peer to Peer messaging	Not supported	I/O Slave Messaging	
I/O peer-to-peer messaging	Not supported	Bit Strobe	Not supported
Configuration Consistency Value	Not supported	Polling	Supported
Faulted node recovery	Not supported	Cyclic	Not supported
Baud rates (125 k, 250 k, 500 k)	Supported	Change of State (COS)	Not supported

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4 NAMES AND FUNCTIONS OF EACH PART

4.1 D.Station Module

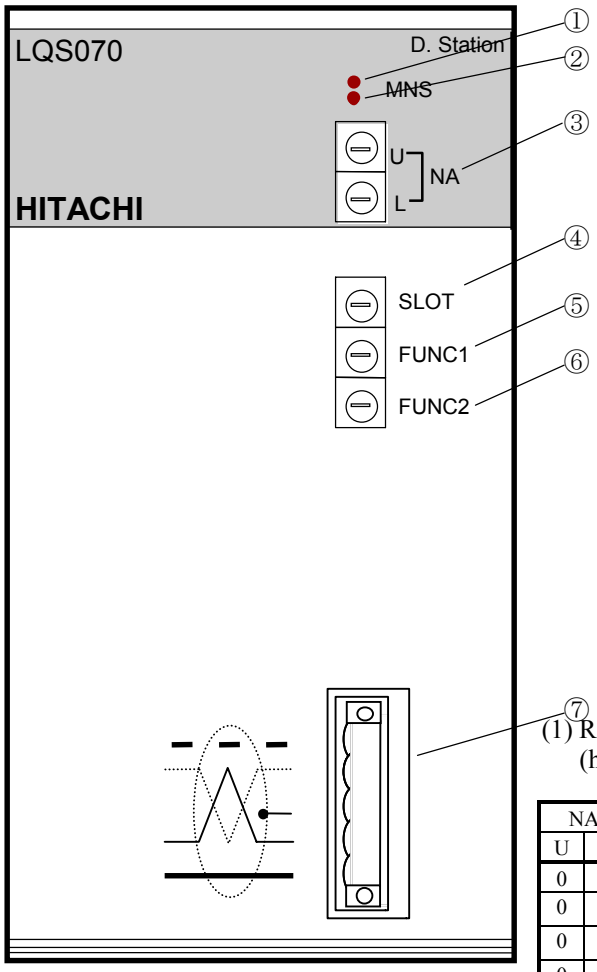


Figure 4-1 Module Front View

No.	Name	Function
①	Module/Network Status LED indicator (green)	Combination of two LED indicators is employed to indicate the module and network status (See (2) for the various LED status and descriptions).
②	Module/Network Status LED indicator (red)	
③	Node address setting switch	MAC ID configuration switch (/0 to /3F) Settings of /40 to /FF is prohibited (See (1)).
④	Slot setting switch	Configuration switch for the I/O points and data transfer mode (See (3) for detail of the setting).
⑤	FUNC1 setting switch	Communication rate (baud rate) setting switch (See (4) for detail of the setting).
⑥	FUNC2 setting switch	Setting switch to specify the I/O module controlling method (See (5) for detail of the setting).
⑦	DeviceNet interface connector	Connector for the DeviceNet interface connection

(1) Relationship between NA (Node Address) setting switch (hexadecimal) and MAC IDs (decimal)

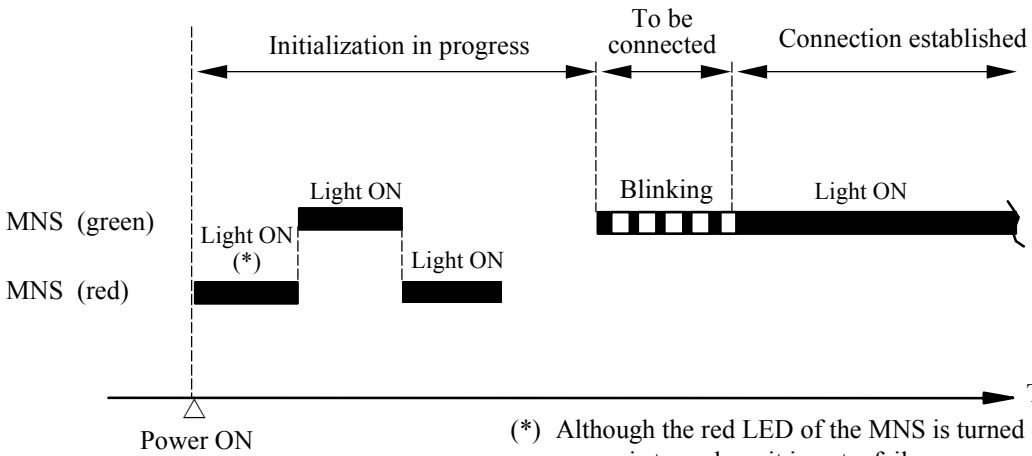
NA		MAC ID	NA		MAC ID	NA		MAC ID	NA		MAC ID
U	L	(decimal)	U	L	(decimal)	U	L	(decimal)	U	L	(decimal)
0	0	0	1	0	16	2	0	32	3	0	48
0	1	1	1	1	17	2	1	33	3	1	49
0	2	2	1	2	18	2	2	34	3	2	50
0	3	3	1	3	19	2	3	35	3	3	51
0	4	4	1	4	20	2	4	36	3	4	52
0	5	5	1	5	21	2	5	37	3	5	53
0	6	6	1	6	22	2	6	38	3	6	54
0	7	7	1	7	23	2	7	39	3	7	55
0	8	8	1	8	24	2	8	40	3	8	56
0	9	9	1	9	25	2	9	41	3	9	57
0	A	10	1	A	26	2	A	42	3	A	58
0	B	11	1	B	27	2	B	43	3	B	59
0	C	12	1	C	28	2	C	44	3	C	60
0	D	13	1	D	29	2	D	45	3	D	61
0	E	14	1	E	30	2	E	46	3	E	62
0	F	15	1	F	31	2	F	47	3	F	63

Note: If errors other than above mentioned is set, the MNS LED indicator (red) lights up and it terminates the operation. Set the NA setting switch within the range shown above and restart the module.

(2) Status and description of the MNS LED indicator is listed below:

MNS (green)	MNS (red)	Description	Remarks
OFF	OFF	The power is OFF.	–
OFF	OFF	• Initialization is in progress. • Duplicate checking the MAC ID.	This condition occur when communication cannot be established after starting up D.Station. Check that the MAC ID setting is not duplicated.
Blinking	OFF	The connection from the master awaited.	Blinks when the D.Station starts up before the master and it waits connection from the master. In addition, in a case when bass-off and recovery are repeatedly executed during communication, the MNS (green) may blinks.
ON	OFF	The connection with the master is established (communicating).	This is a condition occurs when a connection is being established with no data communication taking place.
OFF	ON	• Duplicate searching of the MAC ID • Heavy fault occurred (hard fault) • Rotary switch setting error.	• Check that the MAC ID setting is not duplicated. • Check that the NA switch is not set to 40 to FF. • Check that the FUNC1 switch is not set to 8 to F.
OFF	Blinking	• A bus OFF condition is occurring. • A connection timeout is occurring.	Because the LED blinking period is 0.5 sec., the LED may look like turned-on even if buss-off occurs, depending on the recovery time from buss-off. Check the connection and termination of the cables and the looseness of the connectors.

[Supplement] When power has just been supplied, the red and green MNS LED indicators operate in a manner as shown below:



(*) Although the red LED of the MNS is turned on immediately after the power is turned on, it is not a failure.
The red LED of the MNS is turned on when the hardware of the module is being reset.

Figure 4-2 MNS LED Indicator Operating Sequence

(3) The table below explains the settings of the SLOT switch:

Setting Value	Description of the settings		Setting Value	Description of the settings
	Points selected	Data transfer mode		
0	16 points	Normal transfer mode	8	Do not use these settings as these values are used for maintenance purposes only.
1	32 points		9	
2	64 points		A	
3	128 points		B	
4	16 points	Analog 4-bit shift mode	C	
5	32 points		D	
6	64 points		E	
7	128 points		F	

See Section 7.6, "Data Transfer Modes" for details on how data transfer mode operates.

Note: Do not use these settings. These values are used for maintenance purposes only. If these values need to be used, thoroughly read Section 8.2, "T/M (Test/Maintenance Program)," and try them off-line.

(4) The table below explains the settings of the FUNC1 switch:

Setting Value	Description of the settings		Setting Value	Description of the settings
	Baud rate	Module information control		
0	125kbps	Without module information	8	Do not use these settings as these values are used for future use.
1	250kbps		9	
2	500kbps		A	
3	Do not use this setting because it is reserved for future use.		B	
4	125kbps	Module information provided	C	
5	250kbps		D	
6	500kbps		E	
7	Do not use this setting because it is reserved for future use.		F	

Module information: The module information (module implementation/, digital/analog, and fuse blowout detection) is embedded in cyclic communication data and reported to higher levels.
For details, see Section 7.10, "I/O Error Information (Fuse Blowout)/Mounting Information Addition Function".

Note: Do not use switch settings 8 through F. The red MNS LED indicator will light up and the module stops its operation.

(5) The table below shows the FUNC2 switch settings:

Value	Description			Value	Description		
	Data swap	HOLD/RESET	FIX/FREE		Data swap	HOLD/RESET	FIX/FREE
0	Byte swapping	RESET	FREE	8	Byte swapping	RESET	FIX
1	No swapping			9	No swapping		
2	Bit/byte swapping			A	Bit/byte swapping		
3	Bit swapping			B	Bit swapping		
4	Byte swapping	HOLD		C	Byte swapping	HOLD	
5	No swapping			D	No swapping		
6	Bit/byte swapping			E	Bit/byte swapping		
7	Bit swapping			F	Bit swapping		

Data swap: Set up transmission/reception of data swapping.
For details, see Section 7.9, "Data Swap Modes".

HOLD/RESET: Specifies the output module status that prevails when DeviceNet communication is disrupted by consecutive abnormalities or halted (cable breakage, D. NET error, etc.).
The RESET option zeroes the output. The HOLD option retains the output that prevailed immediately before an abnormality occurrence.
For details, see Section 7.12, "Digital Output (DO) HOLD/RESET Function".

FIX/FREE: Specifies the partition of the mount base.
The FREE option should normally be selected. If the number of I/O points of I/O modules exceeds 2048, select the FIX option.
When the FIX option is selected, the maximum and minimum I/O points can be expanded to 2048 points.
For details, see Section 7.5, "FREE/FIX Setup".

4.2 Power Supply Module

The CPU unit and I/O unit use the same power supply module model.

Example: LQV000

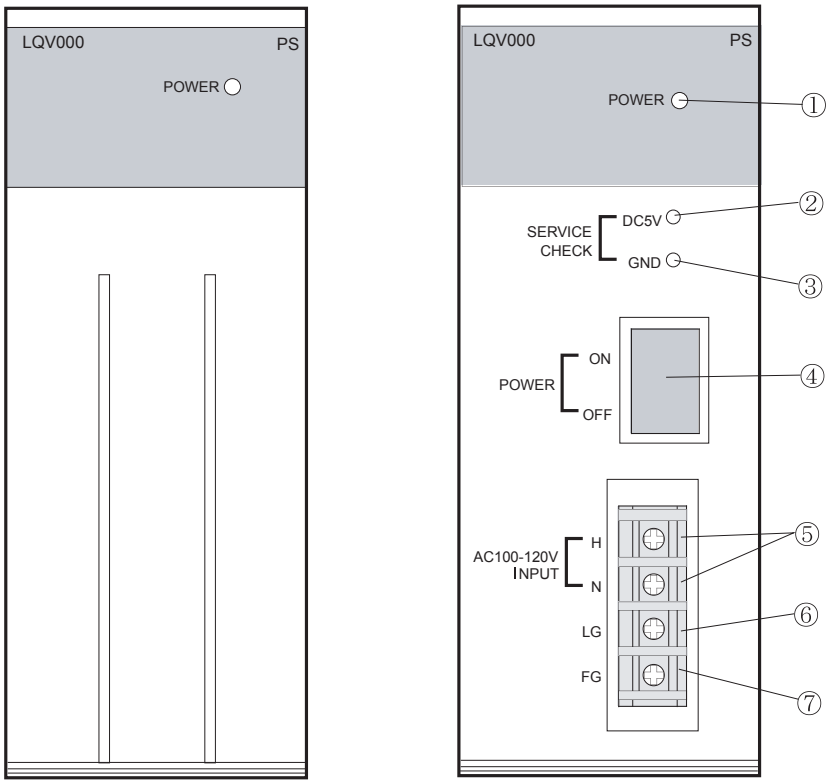


Figure 4-3 Front View: Power Supply Module

Table 4-1 List of the Power Supply Module

Name	Model	Remarks
AC input power supply	LQV000	100 VAC input power supply
DC input power supply	LQV020	24 VDC input power supply
AC/DC input power supply	LQV100	100 VAC/100 VDC input power supply

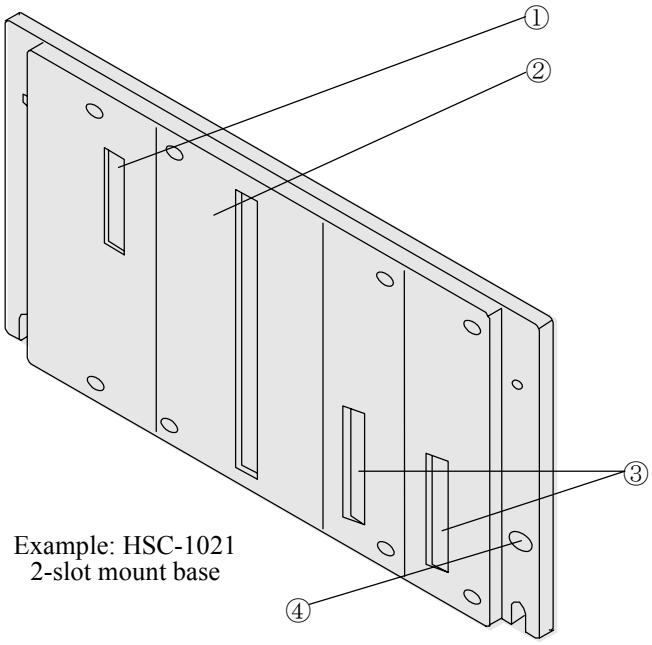
Names and Functions

No.	Name	Function	
①	Power indicator (POWER)	Lights on while the power switch is ON.	
②	Voltage check terminal (5 VDC)	Voltage check terminal for 5 V output. (Do not use this terminal for purposes other than voltage checkout.)	
③	Voltage check terminal (GND)	0 V reference terminal for voltage checkout. (Do not use this terminal for purposes other than voltage checkout.)	
④	Power switch (POWER)	Issue or cut off the input power supply of the module.	
⑤	Power supply terminal block (H, N)	LQV000	Connects the 100 VAC input power supply to the power supply module.
		LQV020	Connects the 24 VDC input power supply to the power supply module.
		LQV100	Connects the 100 VAC or 100 VDC input power supply to the power supply module.
⑥	Line filter ground terminal block (LG)	Ground terminals for the power supply line filter. Earth the unit at the power supply side.	
⑦	Frame ground terminal block (FG)	This terminal is to be connected to the frame ground (FG) of the I/O unit or ground assembly plate.	

4.3 Mount Base

The mount base secures the D.Station module, power supply module, and I/O module.

Use I/O unit type for mount base.



Example: HSC-1021
2-slot mount base

Table 4-2 List of Mount Base

Mounted Unit	Name	Model	Remarks
I/O unit	2-slot mount base	HSC-1021	Power supply + station + 2 slots (I/O type)
	4-slot mount base	HSC-1041	Power supply + station + 4 slots (I/O type)
	8-slot mount base	HSC-1081	Power supply + station + 8 slots (I/O type)
	8-slot I/O mount base for scanning analog input module	HSC-1281	Power supply + station + 8 slots (I/O type)

Names and Functions

No.	Name	Function
①	PS slot	Use to mount the power supply module.
②	ST slot	Use to mount the D.Station module.
③	I/O slot	Use to mount the I/O module.
④	FG terminal	Use to connect frame ground of each module

5 INSTALLATION

5.1 Mounting Clearances

For proper operation of this product, make air aperture at the top and bottom of the cubicle. This cubicle and each unit should be installed with certain spaces as indicated below.

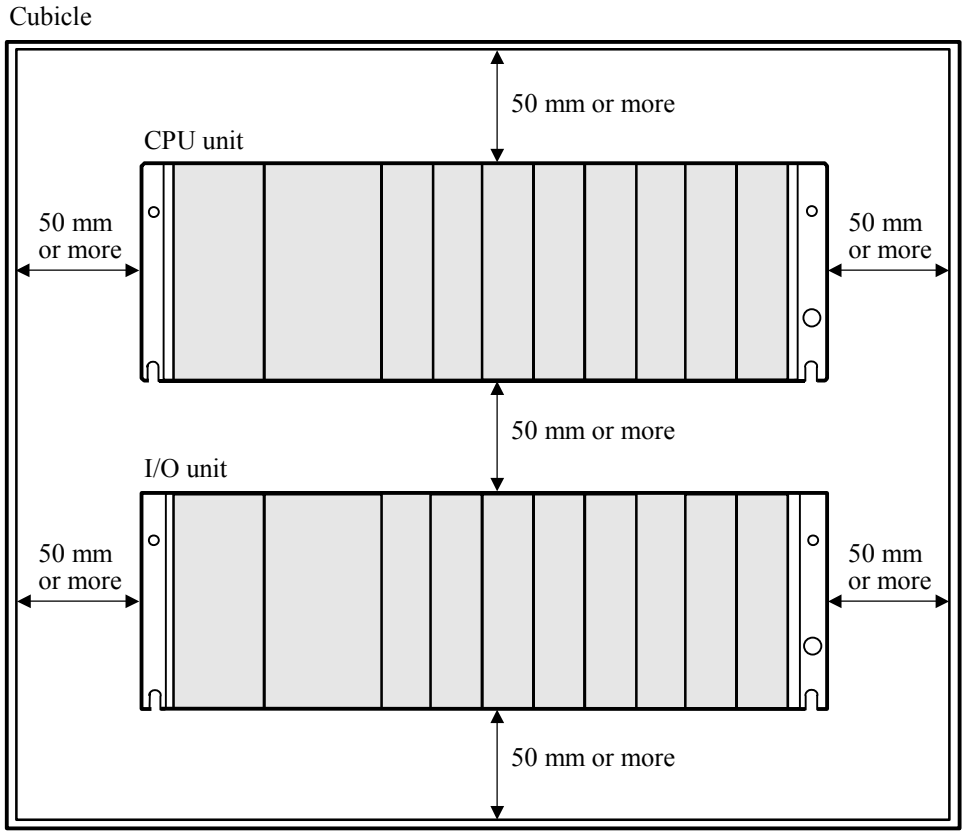


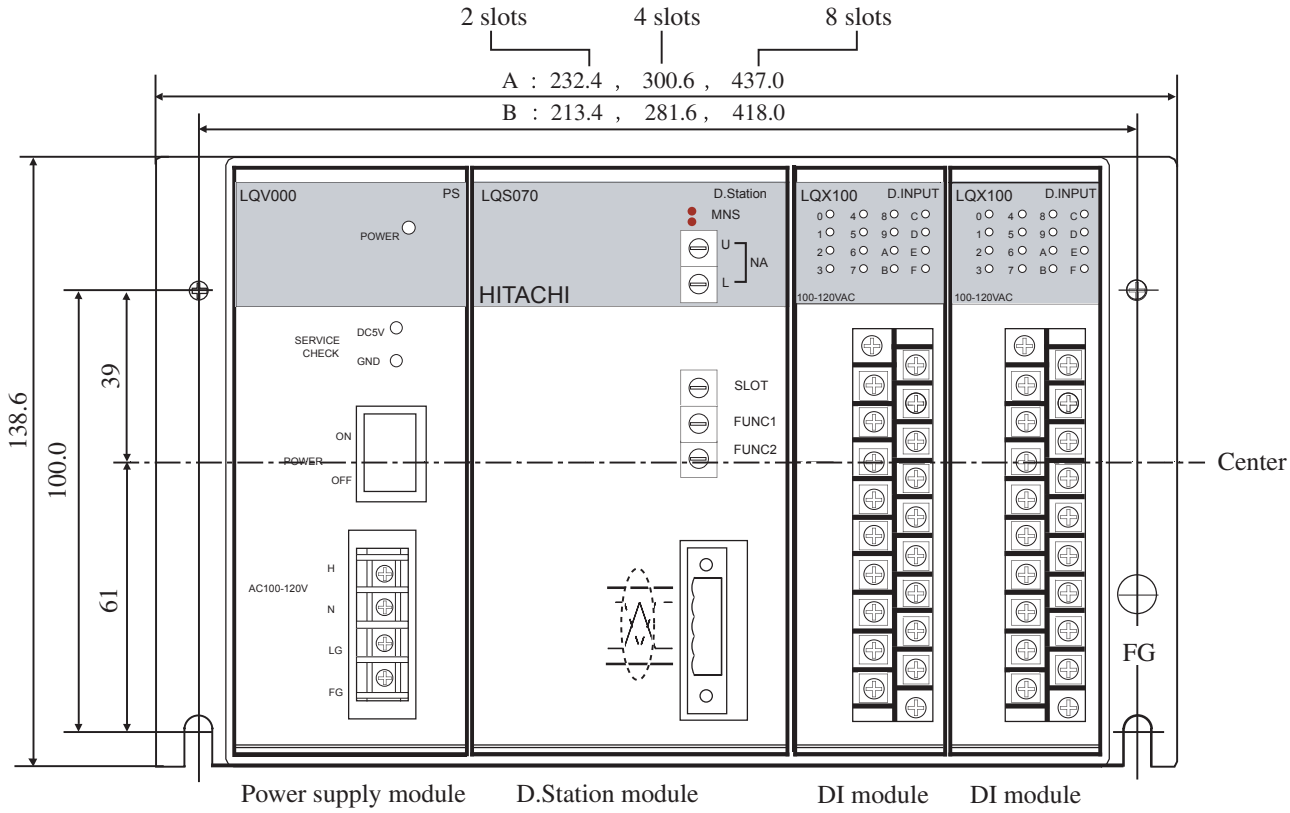
Figure 5-1 Mounting the Units

CAUTION

A high temperature inside of the cubicle may cause malfunction o f the units. The units may also make a false operation due to electromagnetic interference that is emitted by nearby devices. To decrease heat and electromagnetic radiation, provide the specified spaces between units, its cubicle and neighboring devices.
After the installation, check the temperature inside the cubicle nearby the module while test running it to see if the level of heat is within the limit specified. When a specified space cannot be secured or the temperature is our of the specified range (55°C or more of CPU suction air between the CPU unit and I/O unit), equip a cooling fan to forcibly cool the unit.

5.2 Outside Dimensions

The overall width (A) and diameter of screw holes (B) varies depending on the number of I/O module installed on a mount base.



Front view (example of 2-slot mount base use)

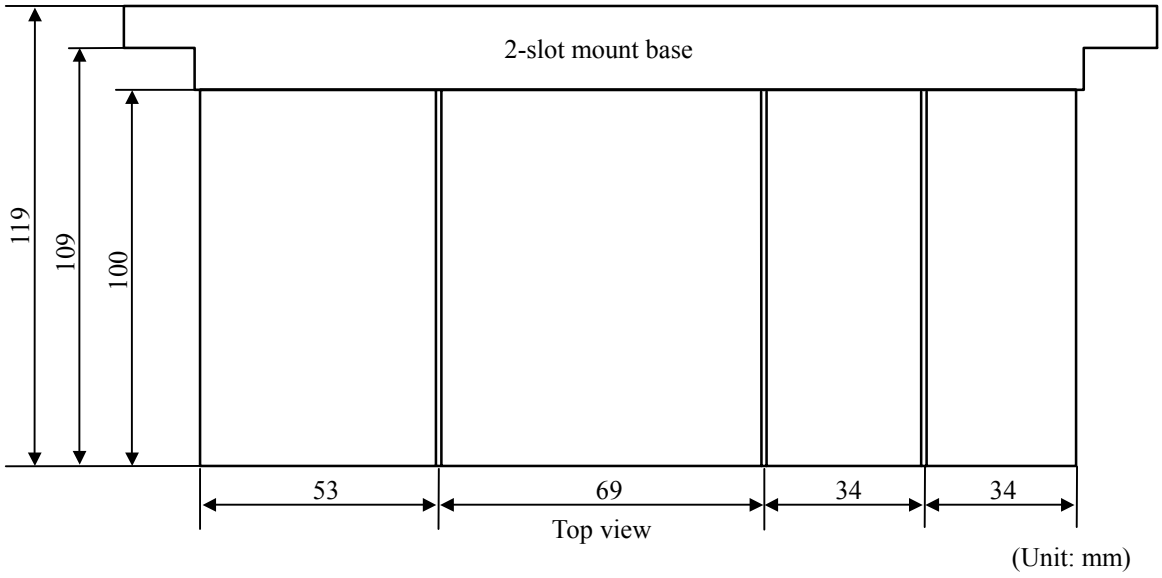


Figure 5-2 Unit Dimensions

5.3 Securing the Mount Base

Fasten the mount base to a vertical surface of the enclosure. Do not install mount base upward, downward, or sideways. The modules are designed to produce optimum heat dissipation effects when they are fastened to a vertical plane of the cubicle.

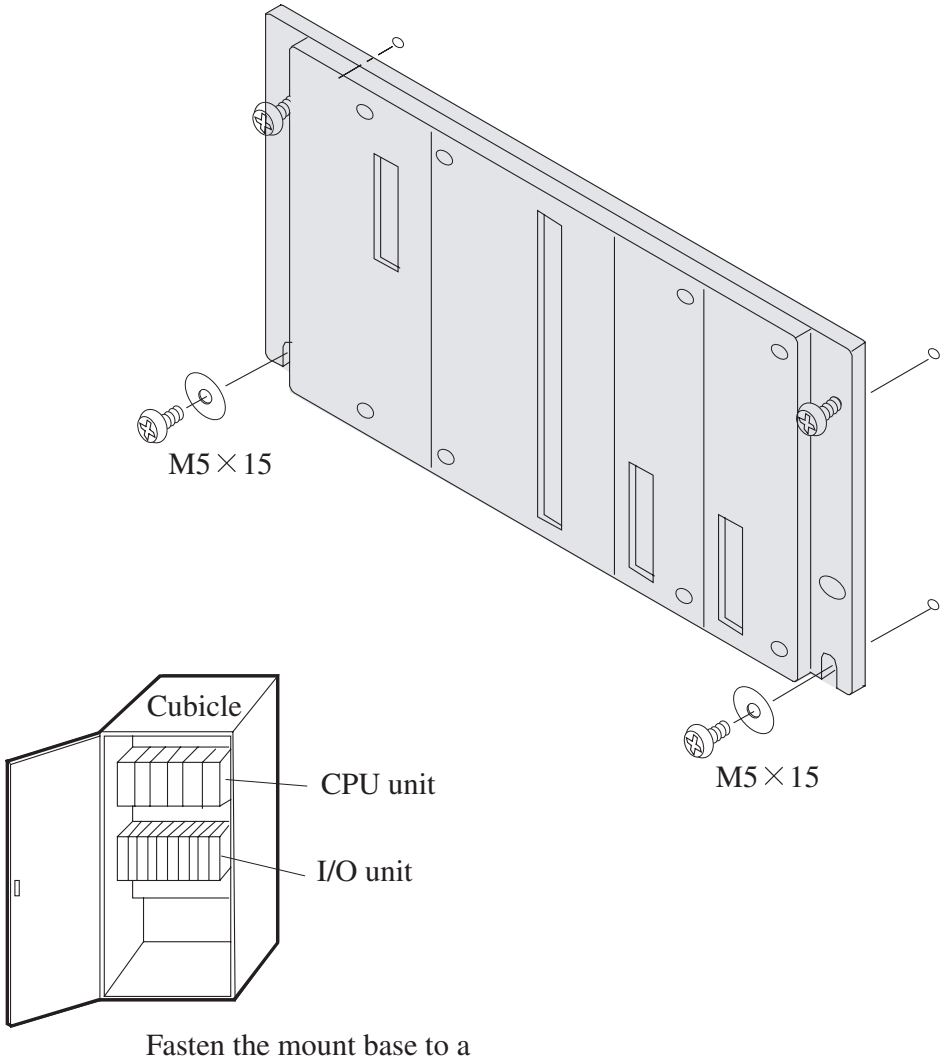


Figure 5-3 Securing the Mount Base

⚠ CAUTION

Fasten the mount base to a vertical plane of the cubicle. If mount base is fastened to a horizontal plane, the heat dissipation effects lowers thereby it may cause a defection and incur deterioration in component parts.

5.4 Securing the Module

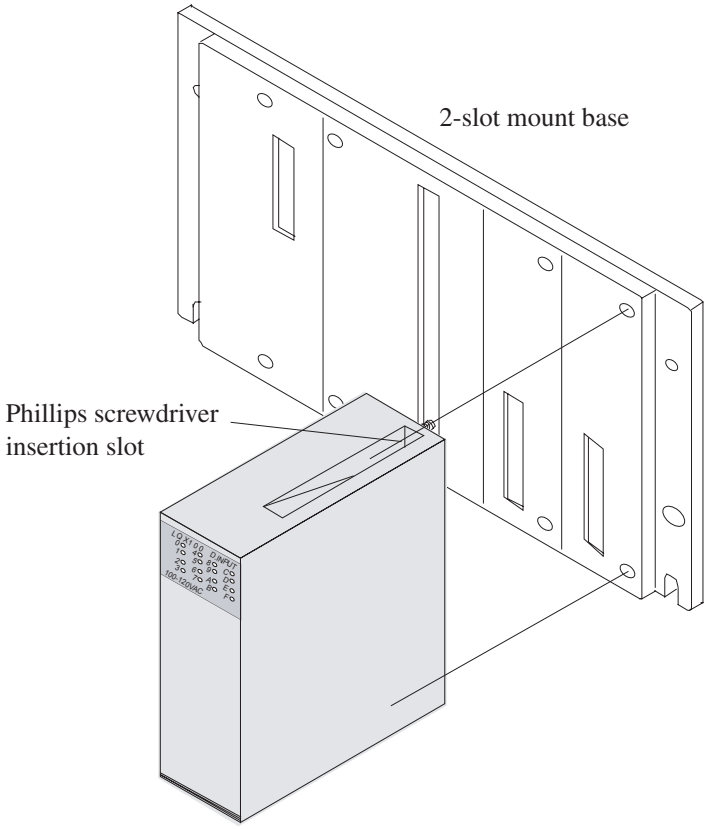


Figure 5-4 Mounting the Module

Insert a screwdriver from an insertion groove to tighten the screws to fix the module.

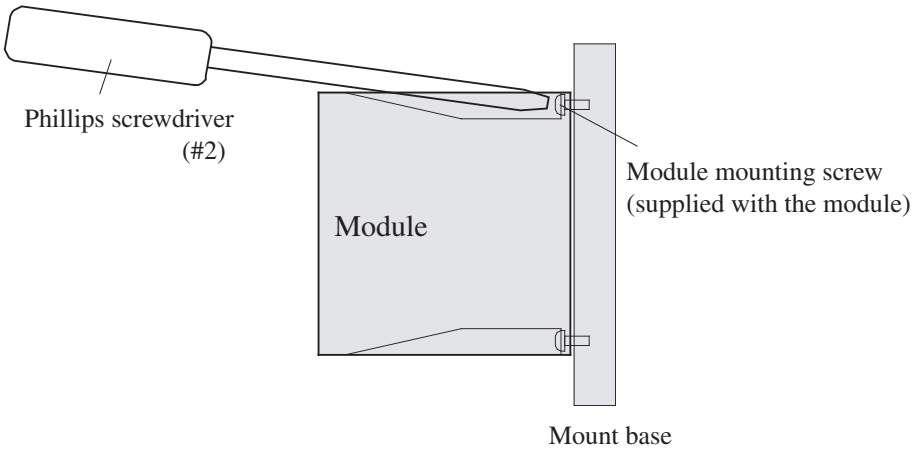


Figure 5-5 Securing the Module

⚠ DANGER

You may be electrified if you install/remove a module or connect/disconnect a cable when power is ON by inadvertently touching a power supply terminal due to the presence of a high voltage. Also, note that a short circuit or noise may render the machine defective. To avoid these problems, make sure to turn OFF the power before install/removing a module or connect/disconnecting a cable.

⚠ CAUTION

- Static electricity may damage the modules. Remove static electricity from your body before setting various switches, connecting or disconnecting cables or connectors.
- When insert or remove a module, observe the following precautions to prevent the module from being damaged:
  - Before connecting a module to the mount base connector, check for dirt or other foreign matters adhered on the terminals.
  - When insert/remove a module, ensure that it is vertical to the mount base as shown below. If you insert/remove a module while it is tilted, the connector may be damaged.

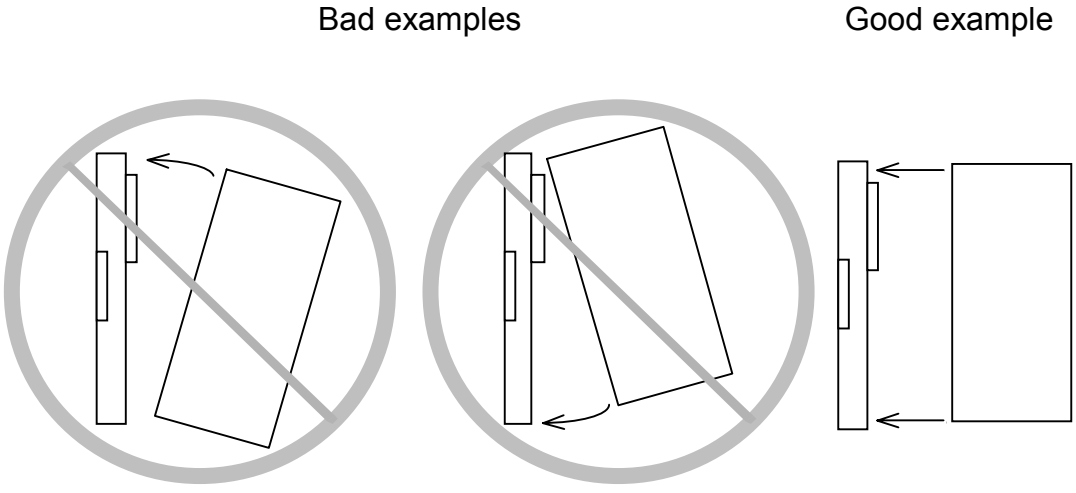


Figure 5-6 Module Mounting Examples

6 CABLING

6.1 Cabling

6.1.1 Interface signals and cabling

Module silk	Signal	
	Symbol	Name
	V-	Power supply line (GND)
	CAN-L	Signal line (L side)
	SHD	Shield (Drain)
	CAN-H	Signal line (H side)
	V+	Power supply line (+24V)

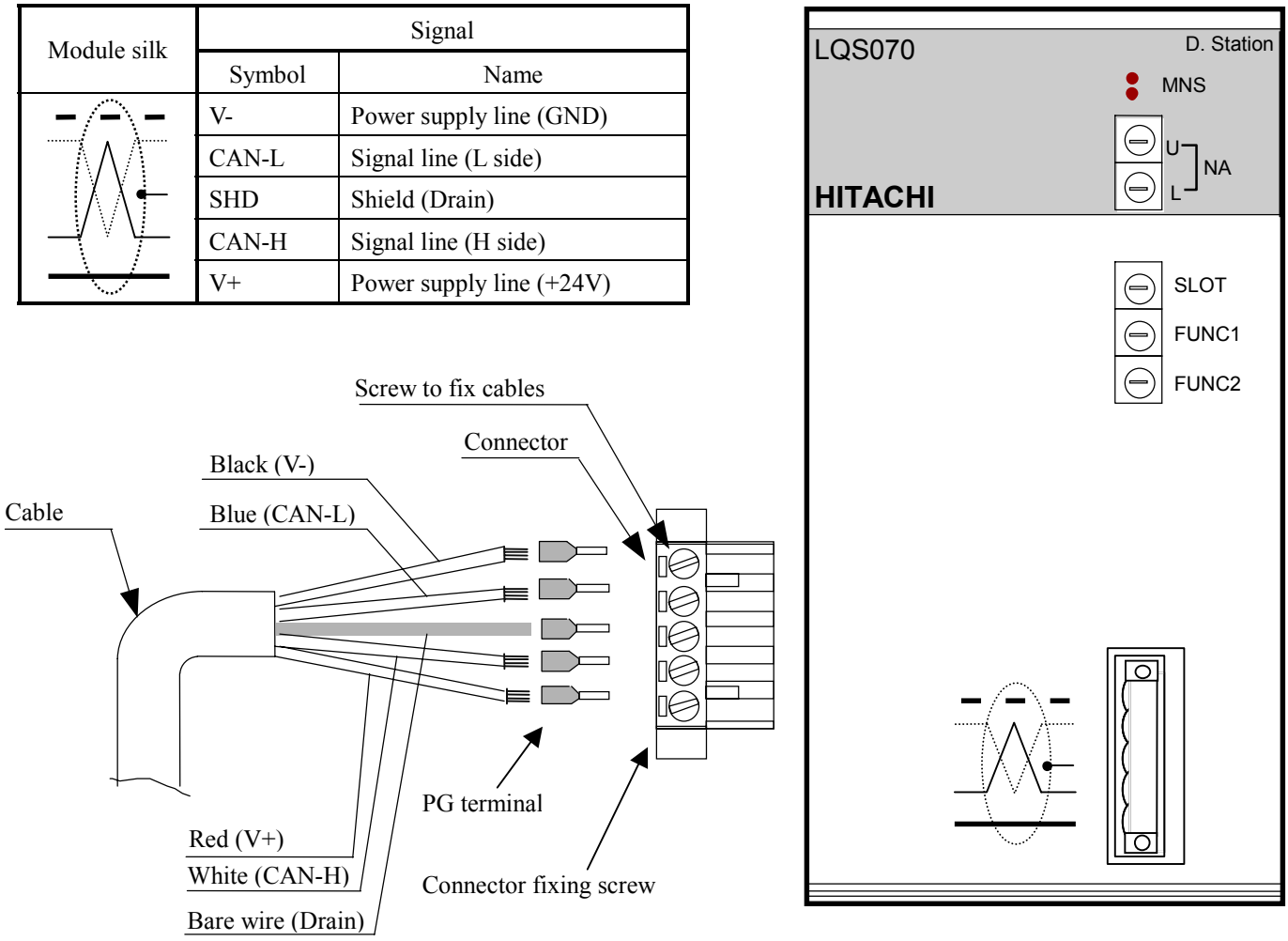


Figure 6-1 Module Wiring

As shown in the diagram above, press and attach the PG terminals to the cable wires (See Section 6.1.4, "Restrictions on Cable Lengths."). Insert the power supply lines, signal lines, and drain into the corresponding holes of the connector, and firmly tighten with each terminal screw (with a tightening torque of 5±1 kg·cm). After connecting the cable to the connector, insert the connector into the D.Station module so that the direction of the connector matches that of the module, and then tighten the connector fixing screw.

CAUTION

- Power off power supply of the S10mini, all associated DeviceNet devices and connected communication power supplies when working with cables.
- D.Station module does not require external power supply since it separately feeds necessary power (self-feeding). In addition, the power lines can be connected like a diagram shown above.
- Check if the connector fixing screw is not loosened periodically (every 3 to 6 months) and tighten it if required.

6.1.2 Hardware configuration

An example of a DeviceNet hardware configuration is shown below. In the DeviceNet, a control device connected to the network is called a "node" and the D.Station module is one of the nodes. Nodes can be classified into two types: a slave which transfers information to and from the outside and a master which collectively controls and manages slaves in the network.

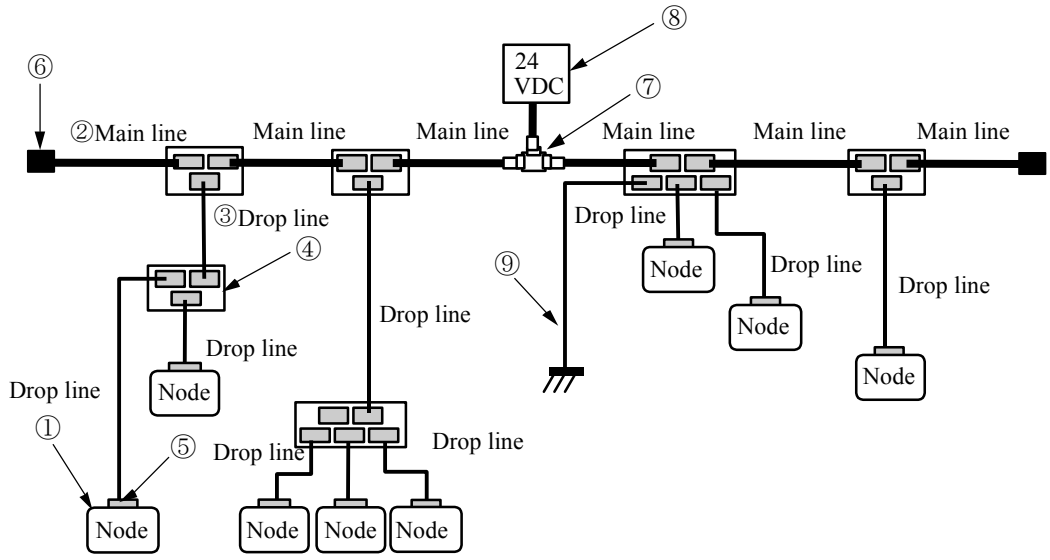


Figure 6-2 Network Structure

Following components are included in the DeviceNet:

① Nodes

Nodes can be classified into two types: a slave which transfers information to and from the outside and a master which collectively controls and manages slaves in the network. In the network, the master and slave nodes can be placed anywhere regardless of their roles.

②③ Main line and drop line

Communication cables connected to the network can be classified into two types. A main line is a bundle of cable having terminating resistor attached at both ends. A cable splitting out from the main lines as well as cables splitting from the drop line is also a drop line. Each node is connected to a drop line. Dedicated 5-wire cables (thick cabled and thin cables) are used as communication lines.

④ T-branch device tap

Main lines and drop lines are connected by T-branch device taps in the DeviceNet. Besides, TB (terminal block) can also be used to connect drop lines.

⑤ Connector

There are two types of connectors that connect communication cables to a node and to a T-branch tap. The open-type connector is preferably used to connect a communication cable to a D.Station module and to a T-branch tap.

⑥ Terminating resistor

In the DeviceNet network, terminating resistors (121 Ω±1%)must be attached to both ends of the main lines. Out of many methods, the use of terminal blocks (TBs) and their terminating resistors are recommended.

⑦⑧ Power taps and communication power supply

To communicate using the DeviceNet, supply power (24 VDC) to each node connected to the network through power taps. T-branch taps and terminal blocks (TBs) can be used to connect to the network.

⑨ Network grounding

Ground the shield of the network cable only at one point near by the center of the network to avoid grounding looping. There are many ways of grounding: grounding at D.Station module, grounding from a tap, and grounding from a terminal block (TB). A grounding method using T-branch device tap in the sampler below.

Other recommended components of a DeviceNet control mechanism (than the nodes) are listed below. “No.” column corresponds to the components No.
When a terminal block (TB) is used, a terminal block, screws for the terminal block, and solderless terminals for the communication cables are also required in addition to the components listed below.

Table 6-1 Components

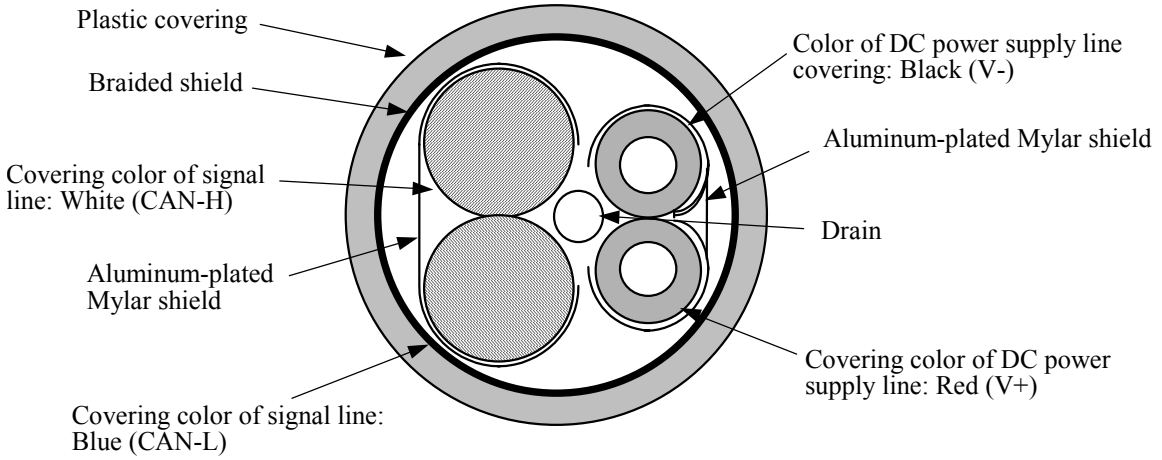
No.	Part name	Specifications	Recommended product	
			Model	Manufacturer
②	Thick cable	5-wire communication cable	UL20276-PSX (*1) IP × 18AWG + 1P × 14AWG	Hitachi Cable, Ltd.
③	Thin cable	5-wire communication cable	UL20276-PSX (*1) IP × 24AWG + 1P × 22AWG	Hitachi Cable, Ltd.
④	T-branch tap	Open-type T-branch tap	DCN1-1C	OMRON Corporation
		Open-type 3-branch tap	DCN1-3C	
⑤	Connector	Open type	MSTBT2.5/5-STF-5.08-AU (*2)	Phoenix Contact GmbH & Co.
	PG terminal	For connecting a thick cable (signal) to a connector	A1-6	
	PG terminal	For connecting a thick cable (power) to a connector	A2.5-7	
	PG terminal	For connecting a thin cable to a connector	VPC-0.5-F8	JST Mfg. Co., Ltd.
⑥	Terminating resistor	For a terminal block	MFB120ΩCT1	Tama Electric Co., Ltd.
⑦	Power tap	Equipped with a reverse current stopper and a grounding terminal	1485T-P2T5-T5	Allen-Bradley
⑧	Communication power supply	24 VDC	S82J-5524	OMRON Corporation

(*1) The cable length is specified separately.
(*2) We recommend this connector with a connector stop screw and hook even though the connector (MSTB2.5/5-ST-5.08-AU) recommended by D.NET (LQE070) can be used. ("AU" of the model name of the connector here stands for gold coating.)

6.1.3 Components

(1) Communication cables

There are two types of dedicated 5-wire communication cable conforming to the DeviceNet standard: thick and thin. Their physical structures of those types are identical as shown below.



Cable type	Outer diameter (mm)
Thick cable	11.2 to 12.1
Thin cable	6.9

Figure 6-3 Sectional Drawing of the Cable

The thick cable is usually used for communications over a comparatively longer distance as it is strong against bending and produces less signal attenuation. The thick cables are often used as main lines which requires longer lines.

The thin cables are not compatible for long distance communication because it is soft, easy to be bent and attenuates signals. Therefore, the thin cables are typically used as drop lines. However, it is used as short distance main lines when a small network is being constructed.

As shown below, provide a stub length of 5 cm or more at the end of the communication cable connected to the D.Station module. The bending radius (R) of the cable must be at least 25 cm (for a thick cable) or 15 cm (for a thin cable).

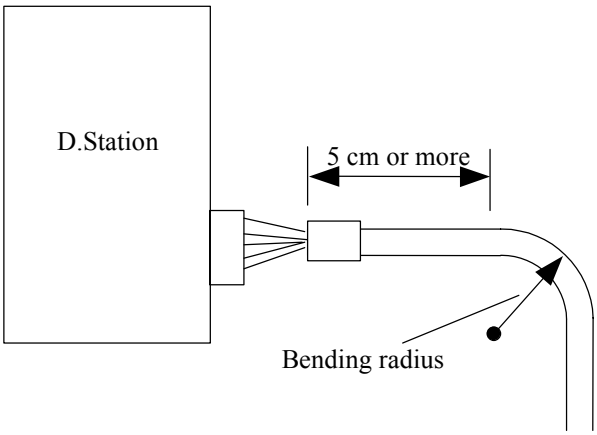


Figure 6-4 Bending Radius of the Cable

CAUTION

- Cables of the same kind (e.g. communication cables) must not be mixed up with cables of other types (e.g., network power cables and high-power cables). Particularly, communication lines must be isolated at least 300 mm from power lines for inverters, motors, and power regulators. Do not put both the communication cables and the power cables in the same pipe or conduit.
- Always use the dedicated 5-wire communication cables conforming to the DeviceNet standard. Do not use any other cables.
- Provide enough allowances in cable connections for future re-cabling for moving, re-connecting and for when any problem occur.
- Do not clamp or tie cables tightly in a bundle. Tying them firmly may apply an excessive force to the bundle when moving and it may result in damaging the cables. Clamp or tie the cables loosely so that you can move the cables later for adjustment.
- Do not forcefully pull the communication cable. Exerting an excessive force on such a cable may cause disconnection or break of the cable.
- Do not put heavy objects on the communication cable to prevent disconnection or breaking the cables.

(2) Connector

Removable connectors are used to connect communication cables to nodes and to branch taps. There are two types of connectors: open and closed. The open-type connectors, particularly plug-type screw connectors, are recommended to connect cables to the D.Station modules and T-branch taps.

The plug-type screw connector enables removal of a node without parting the network. The external view and pin-out of an open-type connector is shown below.

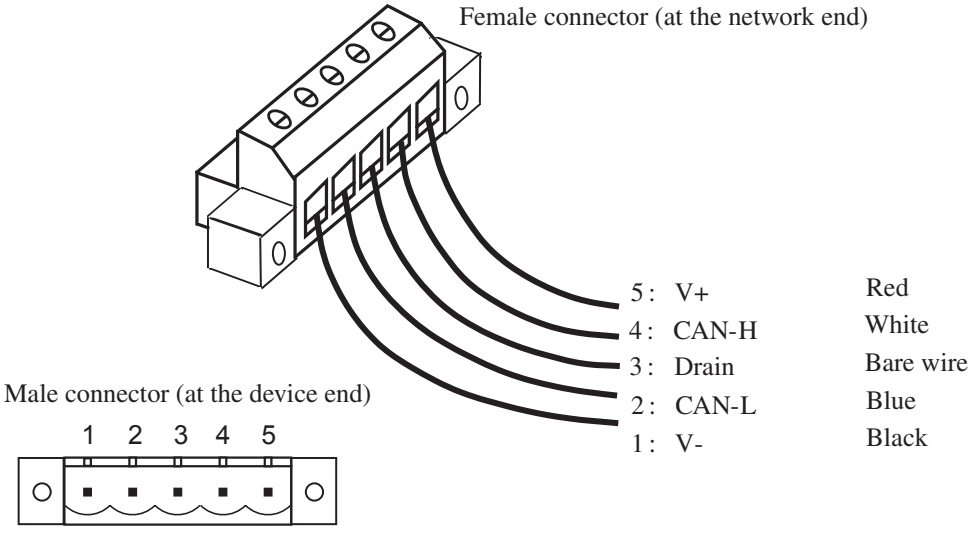


Figure 6-5 Connector Wiring

⚠ CAUTION

- Always use PG terminals to connect wires of the communication cable to the plug-type screw connector. If PG terminals is not used, the cable may disconnect or fall out.
- Provide enough length of cables to connect devices not to apply tensile force upon the connectors. Failure to observe this precaution may result in disconnection or fall out of the cables during communication.
- The type of connector is not specified to open type for connecting nodes other than D.Station. Connect the cables according to attached user's manual that comes with the node.
- Connect the signal wires, power wires, and the drain correctly to the appropriate connectors. Note that the power wires of the thick cable require different PG terminals than the other wires of the same cable.

(3) T-branch taps

T-branch taps are used to branch a cable from main line and to split drop lines. Two types of T-branch taps are available for the DeviceNet network. The open-type tap is preferably used. In addition, the T-branch taps can be classified into two types: 1-branch and 3-branches. Their connection methods are identical. Structures and connections of the 1-branch type and 3-branch type T-branch taps are shown below.

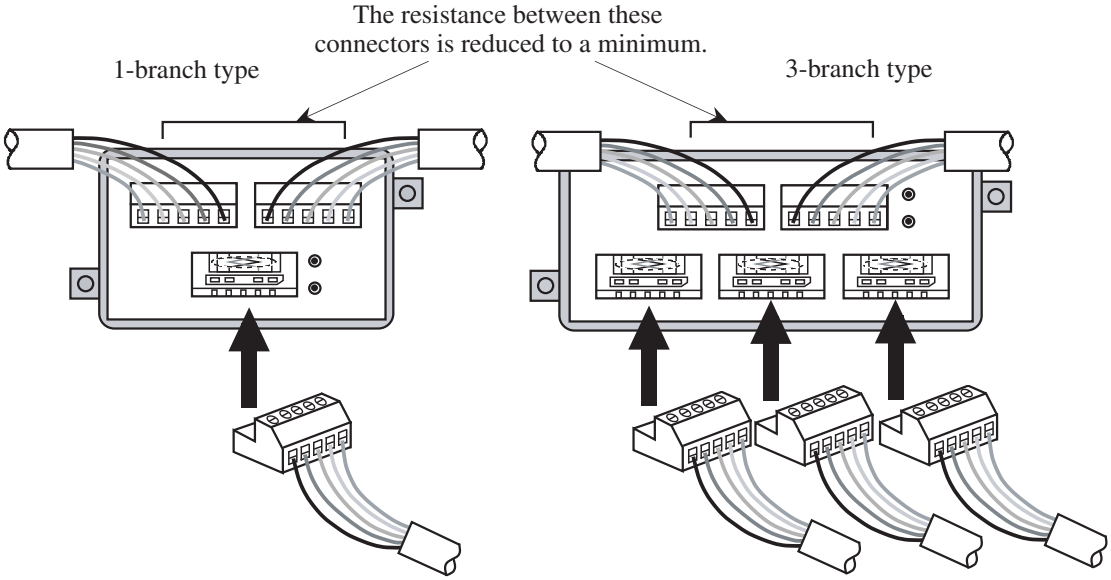


Figure 6-6 Branch with Branch Taps

There is resistance between each taps. It is recommended to connect the longest drop line to this connector since the top two connectors of the T-branch tap has the smallest resistance.

CAUTION

Each T-branch tap has holes for fixing the tap. After communication the communication cables to the tap, secure the tap firmly with screws.

The communication cables can also be branched by terminal blocks (TBs). Connect each cable wire to the terminal block with an appropriate solderless terminal. See the TB connection example below.

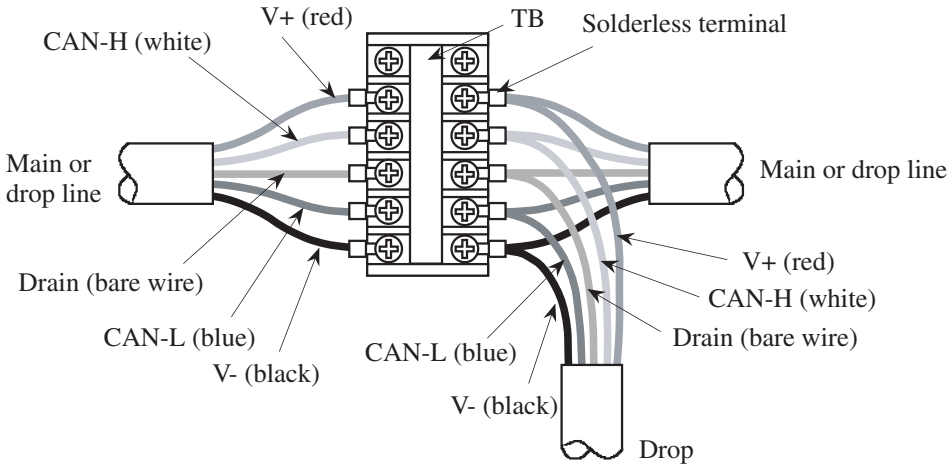


Figure 6-7 Branch with TB

CAUTION

Two wires must be connected to a single terminal if TB is used to split. In such case, attach two solderless terminals back to back. There may be a problem in communication due to incomplete contact of the terminals if they are attached front to front and back to back.

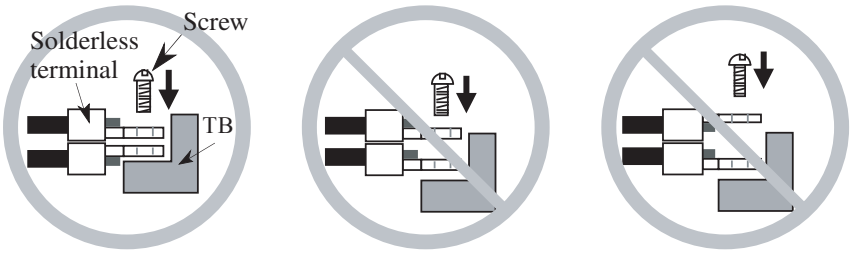


Figure 6-8 Screw Cramp of Solderless Terminal

(4) Terminal resistor

Both ends of the main lines must always be terminated with a terminating resistor.
The physical characteristics of the terminating resistor are as follows:

Physical characteristics
Resistance: 121 Ω
Tolerance: ±1%
Permissible loss: 1/4 W
Type: Metal film

There are many ways to connect terminating resistors but it is recommended to use a terminal block to connect a terminating resistor. Connect the terminal resistor to TB only after soldering the appropriate solderless terminals to each end then cover with Teflon tube. The terminating resistor need not be oriented but always connect it between corresponding signal wires (CAN-H and CAN-L).
See the connection example of a terminating resistor below.

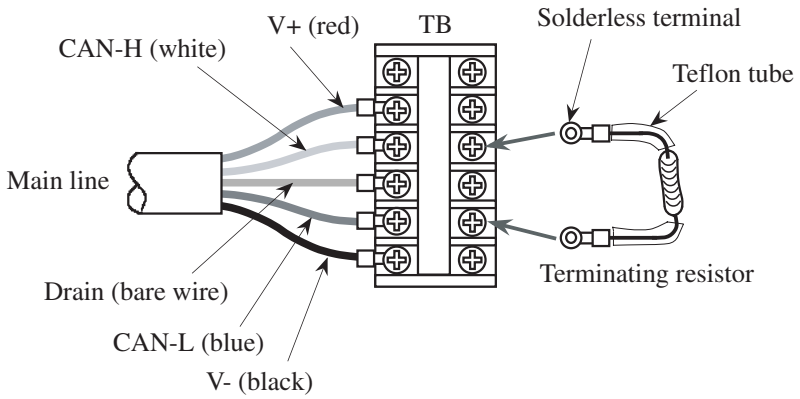


Figure 6-9 Connection of Terminating Resistor

⚠ CAUTION

When connecting a terminating resistor to a terminal block (TB), always connect it between corresponding signal wires (CAN-H and CAN-L). When the terminating resistor is connected to different terminals, the communication may be disabled.

(5) Power supply tap and communication power supply

The DiviceNet does not require communication power supply for each nodes because it feeds power directly from cables. Instead, connect a communication power supply rated at 24 V to the main line. LQS070, however, does not use power supply from the network because it has a internal communication power supply except when another node without power supply is connected to it.

There are two ways of connecting power lines to the main line: by a dedicated power tap and by a terminal block (TB). T-branch taps can be used if the current consumption is 3 A or less.

Basically, DeviceNet uses a single power supply per network. If two or more power supplies are required (as the result of discussion in Section 6.1.5), they must be separated. Power supply line V+ can be isolated by a power tap or a terminal block (TB).

These separation methods are shown below.

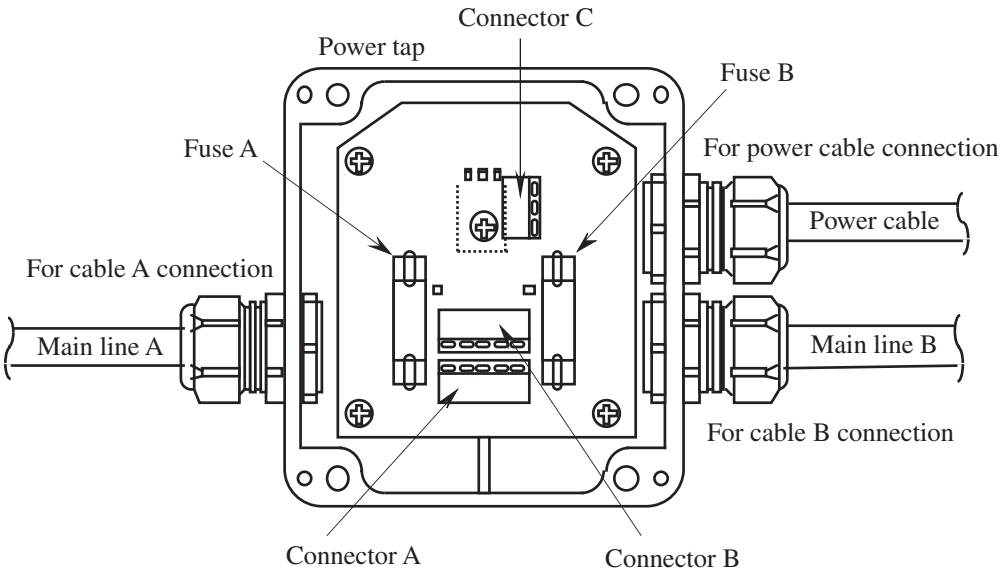


Figure 6-10 Connection by a Power Tap

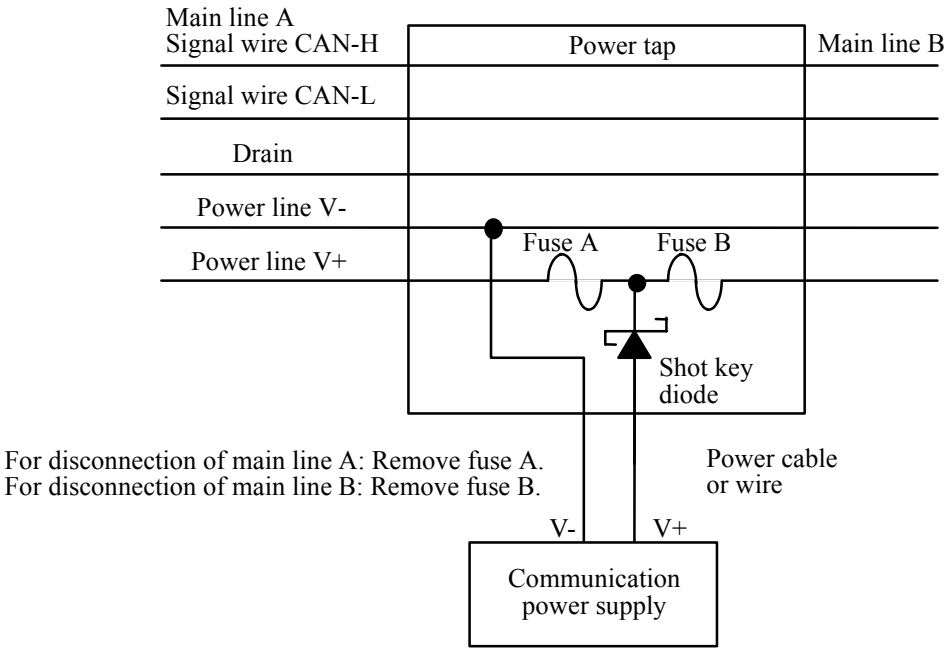


Figure 6-11 Disconnecting a Power Line by a Power Tap

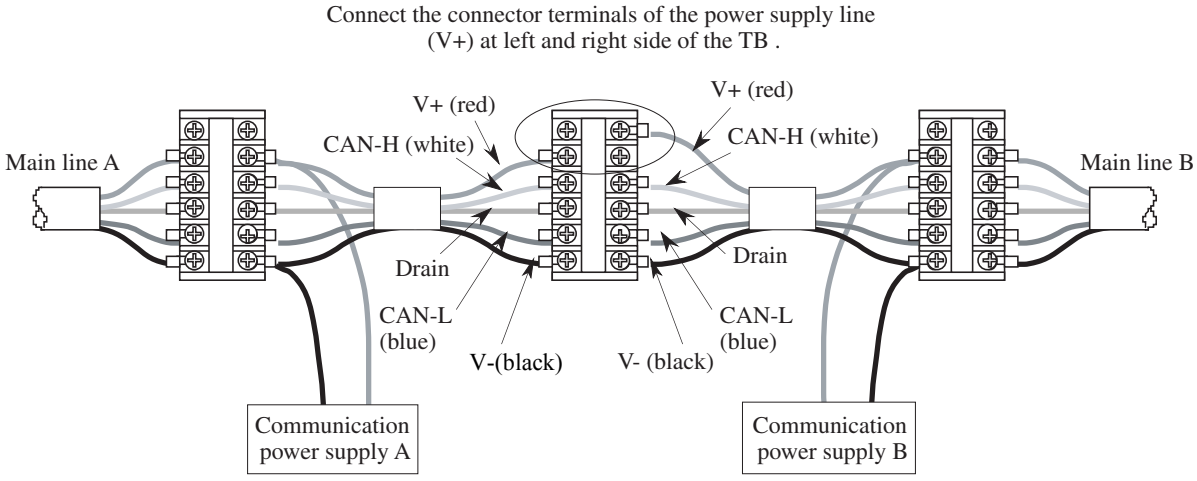


Figure 6-12 Connecting and Disconnecting Power Lines by a Terminal Block

Specification of communication power supplies conforming to the DeviceNet standard is listed in the table below.

Table 6-2 Specification of Communication Power Supply

Item	Specifications
Initial power setting	24 VDC ± 1% (23.76 to 24.24 V)
Voltage fluctuation	Output current of 16 A or less
Maximum rating	0.3% max.
Load fluctuation	0.3% max.
Influence by ambient temperature	0.03%/°C max.
Input voltage range	120 V ± 10%
	230 V ± 10% (if necessary) or automatically selected in the range of 95 V to 250 V.
Input frequency range	48 to 62 Hz
Output ripple	250 m Vp-p
Electrostatic capacitance of load	7,000 μF max.
Ambient temperature	Operating: 0 to 60°C
	Non-operating: -40 to 85°C
Restriction of a rush current from power supply	Restricted to less than 65 A
Protection against overvoltage	Provided (no specified value)
Protection against overcurrent	Provided (Maximum current: 125%)
Time required for power activation	250 ms to reach 5% of the final output voltage
Overshoot at startup	0.2% max.
Insulation	Between output and AC power supply and between output and frame ground
Standards	Required: UL
	Recommended: FCC Class B, CSA, TUV, and VDE
Ambient relative humidity	5 to 95% (Non-condensing)
Surge current withstand	Reserve a capacity of 10%

CAUTION

Always use a communication power supply equipped with the overvoltage and overcurrent protection.

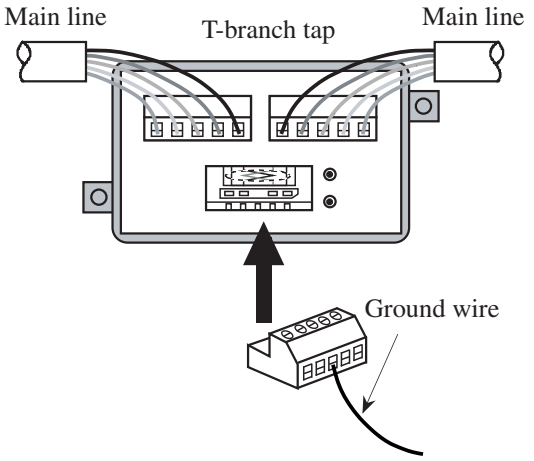
REQUIREMENT

- Make sure the cables are correctly connected before turning on the power supply.
- Add a line filter to the primary side of the communication power supply.

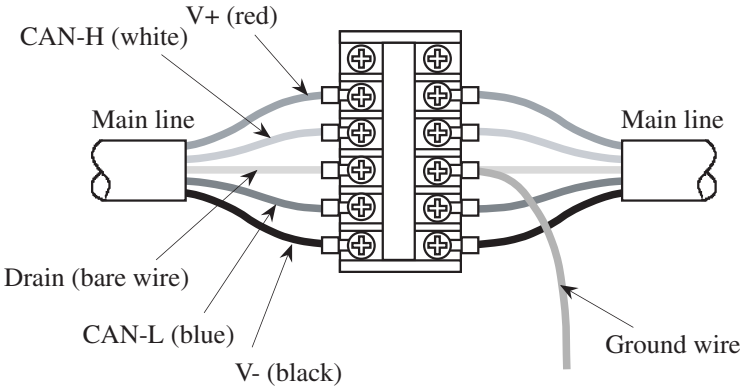
(6) Network grounding

If not grounded, the network may be affected by emission of static electricity and external power noise, resulting in malfunction or, in the worst case, failure of the device. To prevent this, DeviceNet is grounded at a single point. If DeviceNet is grounded at more than one point, a grounding loop may occur. In addition, the network must be grounded as close to the center of the network as possible. The grounding must be Class D grounding.

Connect the drain from the shield of the main line to a T-branch tap or a terminal block (TB) and lead a single wire, standard wire or braided copper wire from that point to a complete grounding rod or grounding part of the building. Below are shown how the drain wire is connected for grounding from a T-branch tap or terminal block.



Insert a ground wire into the "drain" hole of the connector, secure it firmly, and then plug it into one of the connectors of the T-branch tap.



Connect the ground wire to a solderless terminal and connect the solderless terminal to the "drain" terminal of the terminal block.

Figure 6-13 Network Grounding

Another way of grounding is from the D.Station module connected near the center of the network. As the drain terminal of the D.Station module is not grounded, this grounding is done as follows: (1) uncover the braided shield of the communication cable, (2) solder a ground wire to it, (3) attach an M3 solderless terminal to the free end of the ground wire, and (4) connect the solderless terminal to the cable shield connection terminal on the mount base of the D.Station module.

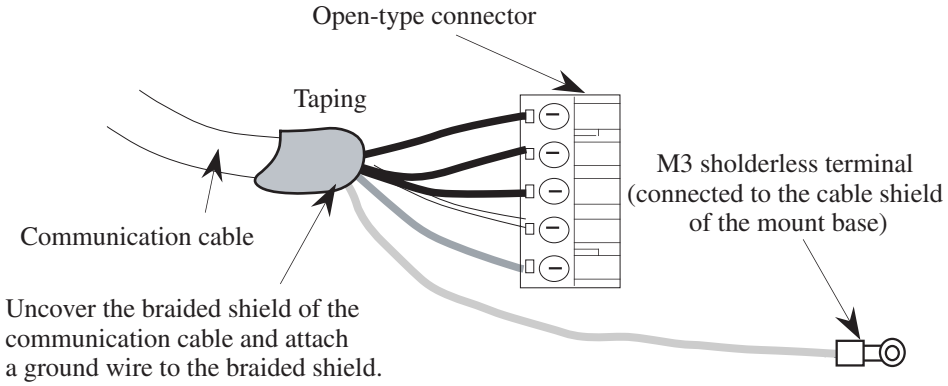


Figure 6-14 Uncovering of Braided Shield

PROHIBITION

- Do not connect the ground wire to the drain terminal of the open connector which already has a drain wire connected as shown below.

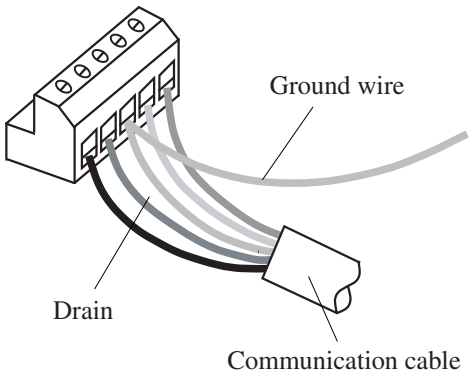


Figure 6-15 Prohibited Uncovering Method of Braided Shield

- Do not ground the communication and power cable together. If grounded together, power noise may be induced into the communication cable through the ground wire.

6.1.4 Restriction of cable lengths

The lengths of cables in DeviceNet are restricted. Satisfy the following restrictions when cunstrucing a DeviceNet.

(1) Maximum network length

The maximum network length means a distance between two nodes or terminating resistors which are located furthest from each other. It is dependent of the type of the main line cable and the transfer rate of the network, See the figure below.

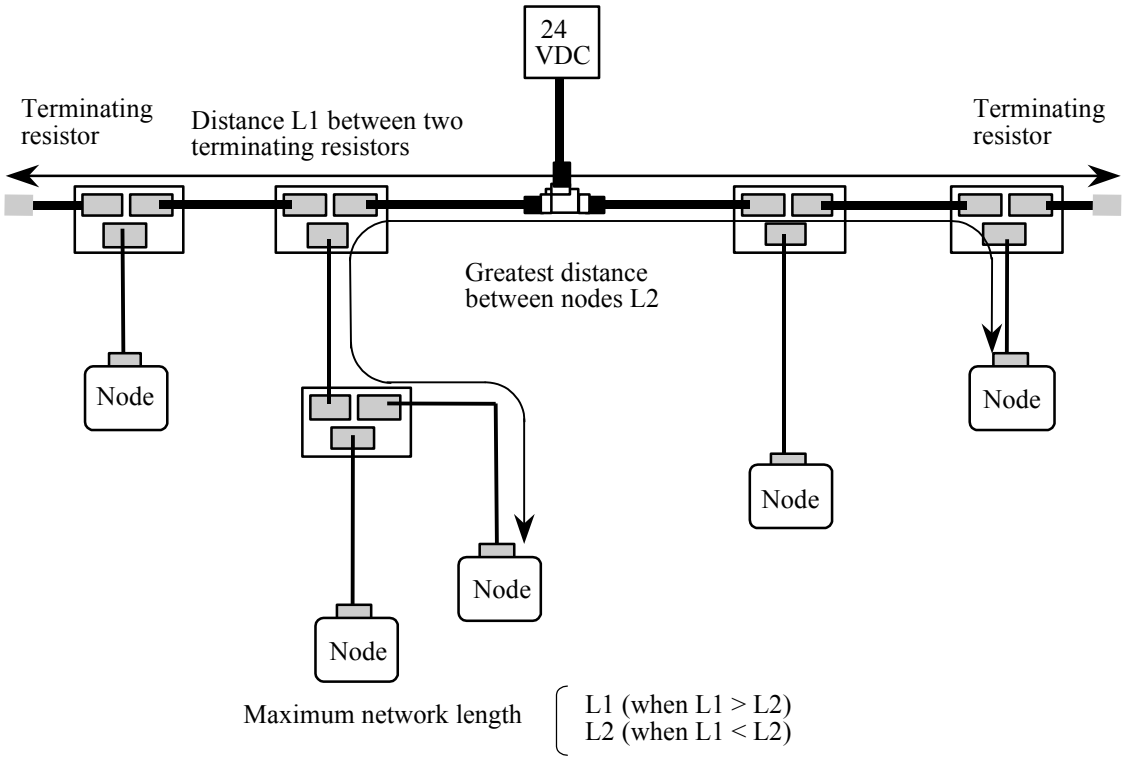


Figure 6-16 Maximum Network Length

Table 6-3 Cable Length and Line Type

Transfer rate	Main line cable		
	Thick cable only	Thin cable only	Thick and thin cables
500kbps	100 m or shorter	100 m or shorter	L THICK + L THIN ≦ 100 m
250kbps	250 m or shorter		L THICK + 2.5 × L THIN ≦ 250 m
125kbps	500 m or shorter		L THICK + 5 × L THIN ≦ 500 m

"L THICK" represents the length of a thick cable and "L THIN" represents the length of a thin cable.

(2) Branch length

The branch length means a distance between a point at which a drop line branches out from the main line to a point at which the end of a drop line. The maximum branch length is 6 meters. The maximum length of a power cable from the main line is 3 meters.

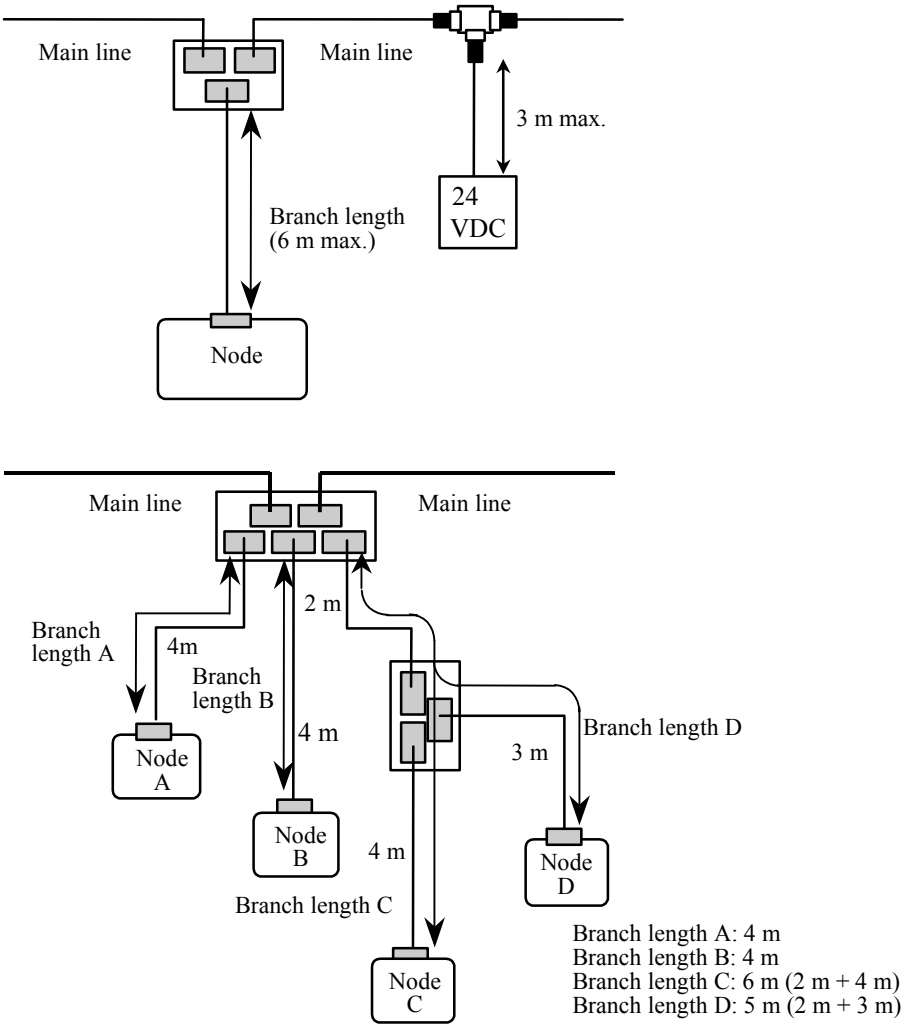


Figure 6-17 Example of Branch Length

(3) Total branch length

The total branch length represents the sum of lengths of all branch cables in the network. It does not represent total lengths between each node and the branch tap of the main line. Maximum likelihood of total branch length differs depending on transfer rate of the network. For example, in the network below, when the total branch length is 40 meters then the possible transfer rate is either 125 kbps or 250 kbps.

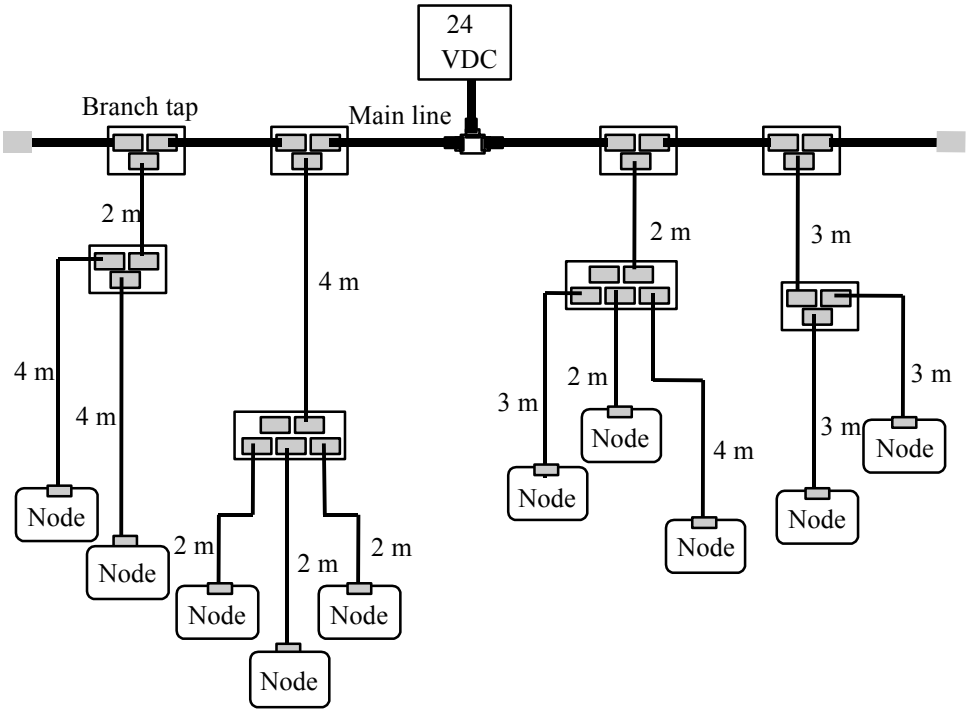


Figure 6-18 Example of Total Branch Length

Transfer rate	Total branch length
500 kbps	39 m or shorter
250 kbps	78 m or shorter
125 kbps	156 m or shorter

Table 6-4 Communication Cable Specifications

Item		Main line cable (Thick cable)	Drop line cable (Thin cable)
Signal line	Cross section of conductor	18 AWG	24 AWG
	Outer diameter of insulator	3.81 mm	1.96 mm
	Color	Blue and white	Blue and white
	Impedance	120Ω ± 10%	120Ω ± 10%
	Propagation delay	4.46ns/m	4.46ns/m
	Attenuation factor	500 kHz: 0.820dB/100 m 125 kHz: 0.426dB/100 m	500 kHz: 1.640dB/100 m 125 kHz: 0.951dB/100 m
	Conductor resistance	22.6Ω/1000 m	91.9Ω/1000 m
Power line	Cross section of conductor	15 AWG	22 AWG
	Outer diameter of insulator	2.49 mm	1.40 mm
	Color	Red and black	Red and black
	Conductor resistance	8.9Ω/1000 m	57.4Ω/1000 m
	Maximum current	8 A	3 A
Outer diameter of cable product		10.41 to 12.45 mm	6.10 to 7.11 mm

Recommended cables:

- Manufacturer: Hitachi Cable, Ltd.
- Models

Main line cable (Thick cable)	Drop line cable (Thin cable)	Length	Color
UL20276-PSX 1P×18 AWG+1P×14 AWG	UL20276-PSX 1P×24 AWG+1P×22 AWG	100 m	Gray
		300 m	
		500 m	

- Manufacturer: SHOWA ELECTRIC WIRE & CABLE CO., LTD.
- Models

Main line cable (Thick cable)	Drop line cable (Thin cable)	Length	Color
TDN18-100G	TDN24-100G	100 m	Light gray
TDN18-300G	TDN24-300G	300 m	
TDN18-500G	TDN24-500G	500 m	
TDN18-100B	TDN24-100B	100 m	Light blue
TDN18-300B	TDN24-300B	300 m	
TDN18-500B	TDN24-500B	500 m	

6.1.5 Consideration on disposition of a communication power supply

In the DeviceNet network, each node is supplied power from a 5-wire communication cable through a communication connector. Therefore, check whether each node can be supplied power from a planned power supply disposition independently of the cable length restriction (see Section 6.1.4) when constructing the network.

Calculate the following in advance before consideration:

- Current consumption (the amount of required current) of each node
- Type (Thick or Thin) and length of each communication cable determined in Section 6.1.4.

First of all, confirm the total required amount of current of all the nodes is within the capacity of the communication power supply. If it exceeds the capacity, either replace the power supply with one that has a larger current capacity or separate the system into two or more parts and supply power from multiple power sources .

Secondly, check the maximum current capacity of cables. The maximum current capacity if the main line cable is 8A (for a thick cable) or 3A (for a thin cable). Therefore, a single communication power supply can feed a current up to 16 A (for a thick main line) or 6 A (for a thin main line) as shown below.

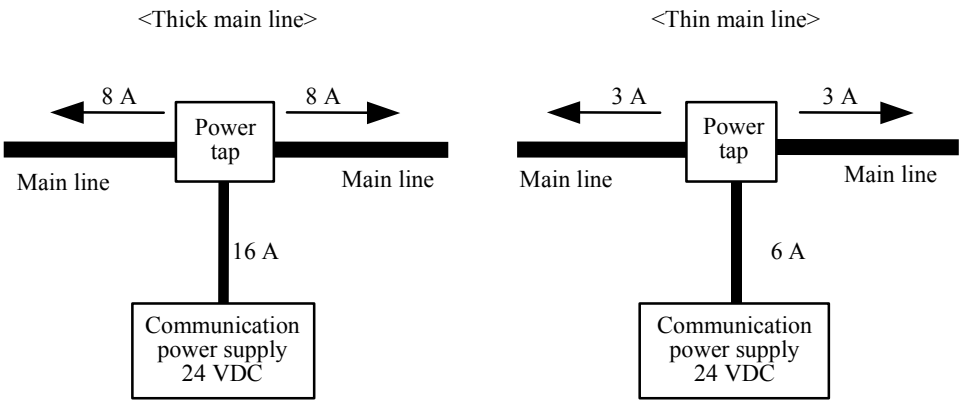


Figure 6-19 Current Capacity by Main Line Thickness

If the total amount currents required by all the nodes exceeds the maximum capacity of 6A, thin cable would not work no matter where it is connected. Consider using thick cables instead of the thin ones.

Furthermore, the maximum current capacity of a drop line becomes smaller as the drop line becomes longer, which is true to both thick and thin cables. The maximum current capacity I (a total amount of currents consumed in the branch) of a branch can be calculated by equation below.

I = 4.75/L (less than 8 A for the thick cable or less than 3 A for the thin cable)

Given,

I: Current capacity of a branch (A)

L: Branch length (m)

If the maximum current capacity of branch is less than the total amount of currents consumed by nodes connected to the branch, take the following measures:

- Shorten the branch.
- If the drop line has a plurality of nodes, branch some of the nodes to the other drop line.

After making sure the total amount of currents consumed by nodes is less than the maximum current capacity of branch, determines the disposition of the power supply considering decrease in a voltage running in the main line. There are two ways of determined a power supply disposition.

- simple calculation using a graph
- formula that figure out the voltage drop from a resistance and a consumed current of a communication cable

If the method the former method is satisfactory, the power supply can be placed at the assumed disposition. The former method assumes the worst disposition in terms of power supply. Even when the requirements are not met, the expression may show as valid. In this case the power supply can be located on the calculated point.

(1) Simple calculation using a graph

Disposition of the power supply can be determined by fast and easy method by using this method. Note that the graphs to be referred are different according to the type of the main line cables (thick cable or thin cable).

Refer to the table in the next page to find the maximum current capacity of the cables against lengths of all the main lines.

If total current consumption of all nodes does not exceed the maximum current capacity the power supply can be placed anywhere.

If the total current consumption of all nodes exceeds the maximum current capacity, try the list below. If any of these measures does not work, reduce the amount of voltage using formula in section (2) in which the actual disposition of the nodes are considered.

- Replace the thin cable (when it is used) with a thick cable and achieve the higher maximum current capacity of the cable.
- Move communication power supply towards the center of the main line so that the nodes are located at both sides of the power supply. Calculate the maximum current capacity of each node at both sides corresponding to the main line
- If the total current consumption of all nodes connected to one side of the main line is greater while nodes are located both sides of the power supply, move the power supply in the direction to which current consumption is greater.

⚠ CAUTION

Current consumption of the D.Station module is not included in the calculation of the total current consumption because the D.Station module contains a communication power supply (for individual self-power feeding). The network power lines can be connected to the D.Station module because the power lines are connected anywhere in D.Station module.

Table 6-5 Maximum Length of Main Line (Thick) and Maximum Current

Main length (m)	0	25	50	100	150	200	250	300	350	400	450	500
Max. current (A)	8.00	8.00	5.42	2.93	2.01	1.53	1.23	1.03	0.89	0.78	0.69	0.63

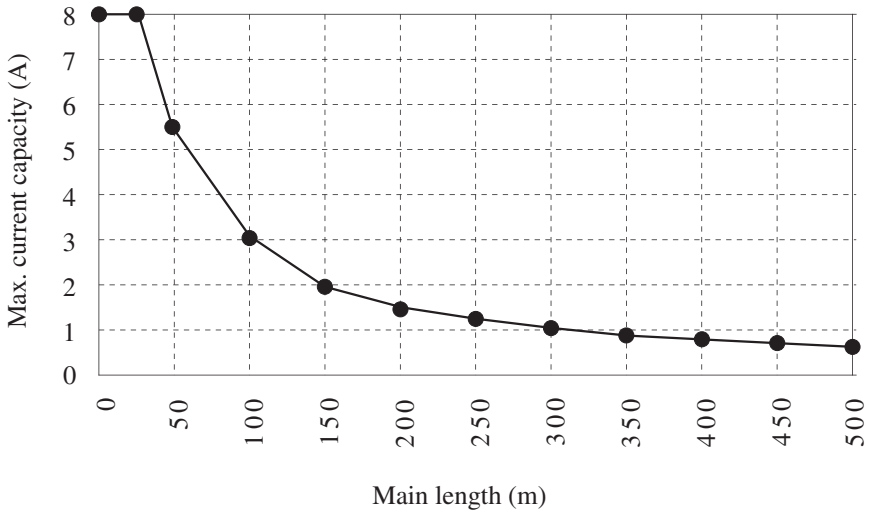
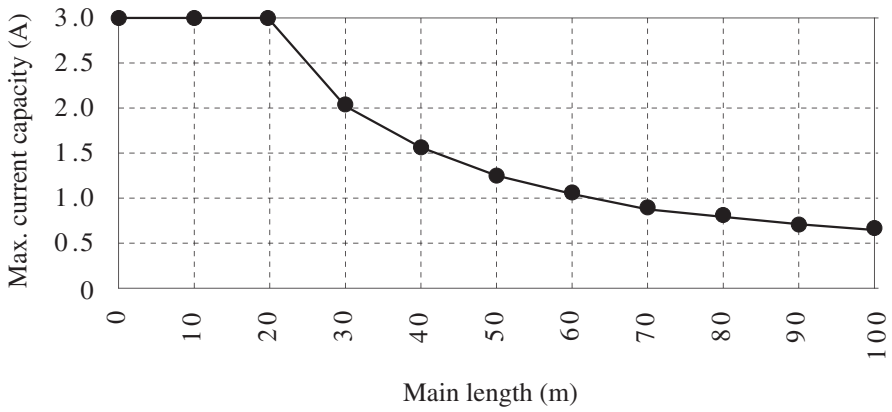


Table 6-6 Maximum Length of Main Line (Thin) and Maximum Current

Main length (m)	0	10	20	30	40	50	60	70	80	90	100
Max. current (A)	3.00	3.00	3.00	2.06	1.57	1.26	1.06	0.91	0.80	0.71	0.64



<Example of simple calculation using a graph>

This example assumes that a single power supply is connected to one end of a main line of 300 m long and that nodes in this network have current consumptions as shown below.

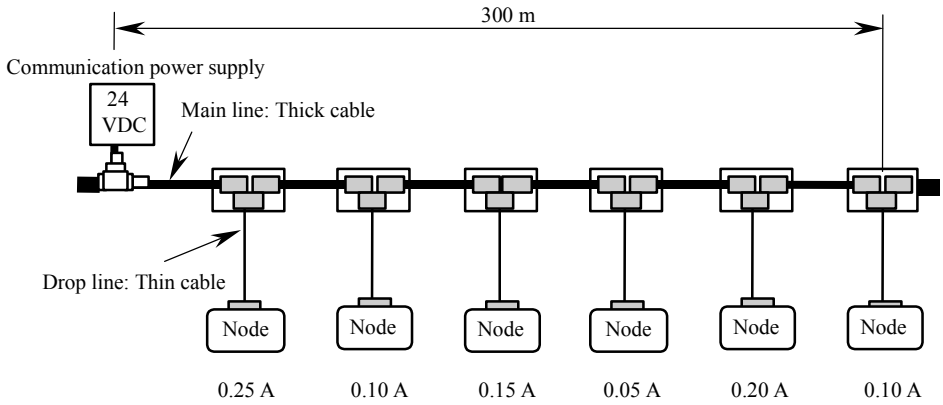


Figure 6-20 Example of Consumed Current Calculation

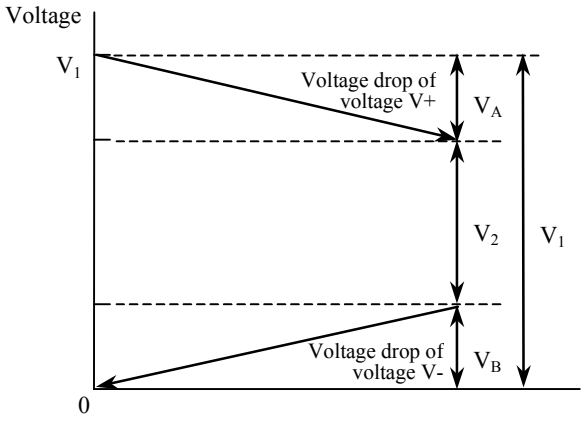
Total of consumed currents of all nodes: 0.25 + 0.10 + 0.05 + 0.20 + 0.10 = 0.85 A
Total length of power cables: 300 meters
From "Table 6-5 Thick Main Cable Lengths and Maximum Currents," maximum current of the thick cable (300 m) = 1.03 A
In this example, as the total current consumption of all nodes does not exceed the maximum current capacity read from the graph, it is apparent that the power supply can feed power to all nodes.

(2) Calculating a voltage drop from a resistance and a consumed current of a communication cable by a preset expression

In case the above method (1) is not available, this method (2) is used. This method calculates a voltage effect from a resistance and a consumed current of a communication cable. In other words, this method calculates a voltage drop from actual node locations and a power supply location.

Verification by an expression

In the DeviceNet system, it is prescribed that the maximum voltage drop of each of the power lines (V+ and V-) in pair is 5 V judging from the voltage specification (24 VDC) of the communication power supply and the input voltage specification (11 VDC to 25 VDC) of the communication power supply for devices. See the figure below for voltage drops.



V_1: Supply voltage of the communication power supply
V_2: Voltage supplied to each node
V_A: Voltage drop of the power cable (V+)
V_B: Voltage drop of the power cable (V-)
Wherein V_A and V_B are 5 V or less.

Figure 6-21 Voltage Drop

As DeviceNet prescribes that the supply voltage of the communication power supply is 24 VDC and its tolerance is 4.0%, we use "V1 = 23 V" including a margin. Further, the voltage drops of the power cables V+ and V- are prescribed to be 5 V or less, the voltage V2 supplies to each node is equal to or greater than 13 V. This voltage contains a more margin than the minimum supply voltage (11) supplied to each node.

The permissible voltage drop (5 V) of the power cables are divided for the main line and the drop line as follows:

- Calculation of a permissible voltage drop of the drop line
  When the maximum branch length is 6 m, the current I flowing through the drop line is calculated from the maximum current capacity by
  $I = 4.57/6 = 0.761$ (A)
  The resistance R of the maximum drop line is calculated (as the maximum resistance of the thin cable is 0.069 Ω/m) by
  $R = 0.069 \times 6 = 0.414$ (Ω)
  Therefore, the permissible voltage drop for the maximum branch length is
  $IR = 0.761 \times 0.414 = 0.315$ (V)
  The final voltage drop for the branch is 0.33 V including a margin.
- Calculation of a permissible voltage drop of the main line
  As the permissible voltage drop of each of the power lines (V+ and V-) in the DeviceNet system is prescribed to be 5 V, the permissible voltage drop of the main line is calculated by
  5.0 - 0.33 = 4.67 (V)
  The method of calculating a voltage drop from a preset expression uses the above permissible voltage drop of the main line (4.67 V) and the above permissible voltage drop of the drop line (0.33 V) for verification.
- Conditional expression for a voltage drop of the main line
  $\Sigma\ (L(n) \times R(c) + N(t) \times 0.005) \times I(n) \leqq 4.67$
  - L (n): Distance between the power supply and a node (excluding a branch length)
  - R (c): Maximum cable resistance
    (thick cable:0.015 Ω/m ; thin cable:0.069 Ω/m)
  - N (t): Number of branch taps between each node and the communication power supply
  - I (n): Current required by the transmission section of each node
  - 0.005Ω: Contact resistance of a branch tap

As far as the above conditional expression is satisfied, the power supply at an estimated position can supply power to every node. However, the total current of the nodes must not exceed the maximum current capacity of the main cable (8 A for a thick cable or 3 A for a thin cable). If the above conditional expression is not satisfied, take the following measures:

- Replace the thin cable (when it is used) by a thick cable and calculate the conditional expression again.

- Move the communication power supply toward the center of the main line so that the power supply may be in the center of the node, and calculates the conditional expression on each of the left and right main cables (relative to the power supply position) again.
- If the total current consumption of all nodes connected to the left main line is greater, move the power supply leftward. Contrarily, if the total current consumption of all nodes connected to the right main line is greater, move the power supply rightward, and calculates the conditional expression on each of the left and right main cables (relative to the power supply position) again.
- Reposition a node which consumes a great current closer to the communication power supply and calculate the conditional expression again.

If the conditional expression cannot be satisfied after all of the above measures are carried out, divide the system into two or more parts and provide a power supply for each of the parts.

<Example of calculating a voltage drop by an expression>

This example assumes that a single power supply is connected to the center of a main line of 240 m long (120 m from each end) and that nodes in this network have current consumptions as shown below.

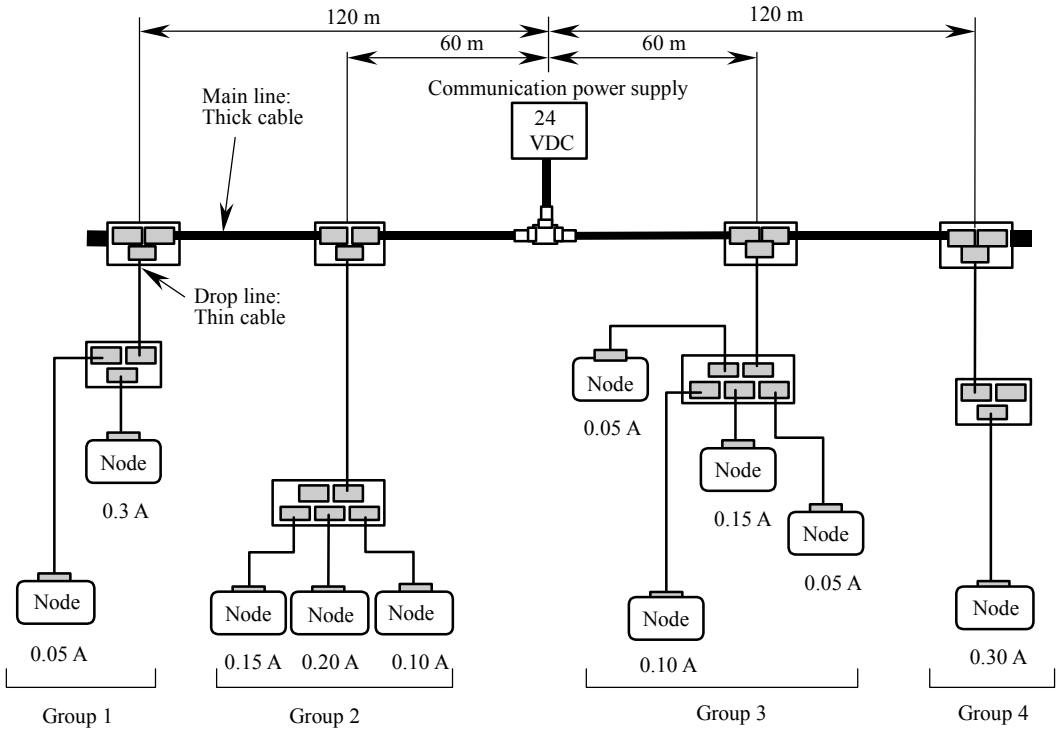


Figure 6-22 Example of Voltage Drop Calculation

To calculate the left side of the conditional expression, a voltage drop of each group is calculated.

Left side of the main line

Voltage drop of group 1 $(120 \times 0.015 + 2 \times 0.005) \times 0.35 = 0.634$ V

Voltage drop of group 2 $(60 \times 0.015 + 1 \times 0.005) \times 0.45 = 0.407$ V

Total of voltage drops in the left main line = 0.634 + 0.407 = 1.041 V

Right side of the main line

Voltage drop of group 3 $(60 \times 0.015 + 1 \times 0.005) \times 0.35 = 0.317$ V

Voltage drop of group 4 $(120 \times 0.015 + 2 \times 0.005) \times 0.30 = 0.543$ V

Total of voltage drops in the right main line = 0.317 + 0.543 = 0.860 V

The voltage drop of the left main line and the voltage drop of the right main line respectively satisfy the conditional expression. Therefore, it is apparent that the power supply can supply power to all nodes in the network.

⚠ CAUTION

When the system is divided into two or more parts and changed to provide a power supply for each of the parts, repeat the above on each power supply and make sure that the power supply can feed power to all nodes.

6.1.6 Grounding specifications

The transmission path must be grounded at a single point. Therefore, always insulate the communication section of a node which is connected to the transmission path and ground the node at one point only. When two or more power supplies (individual power supply or network power supply) are used, select one of the power supplies in the network, and ground the drain and the V-power line of the transmission line through it as shown below.

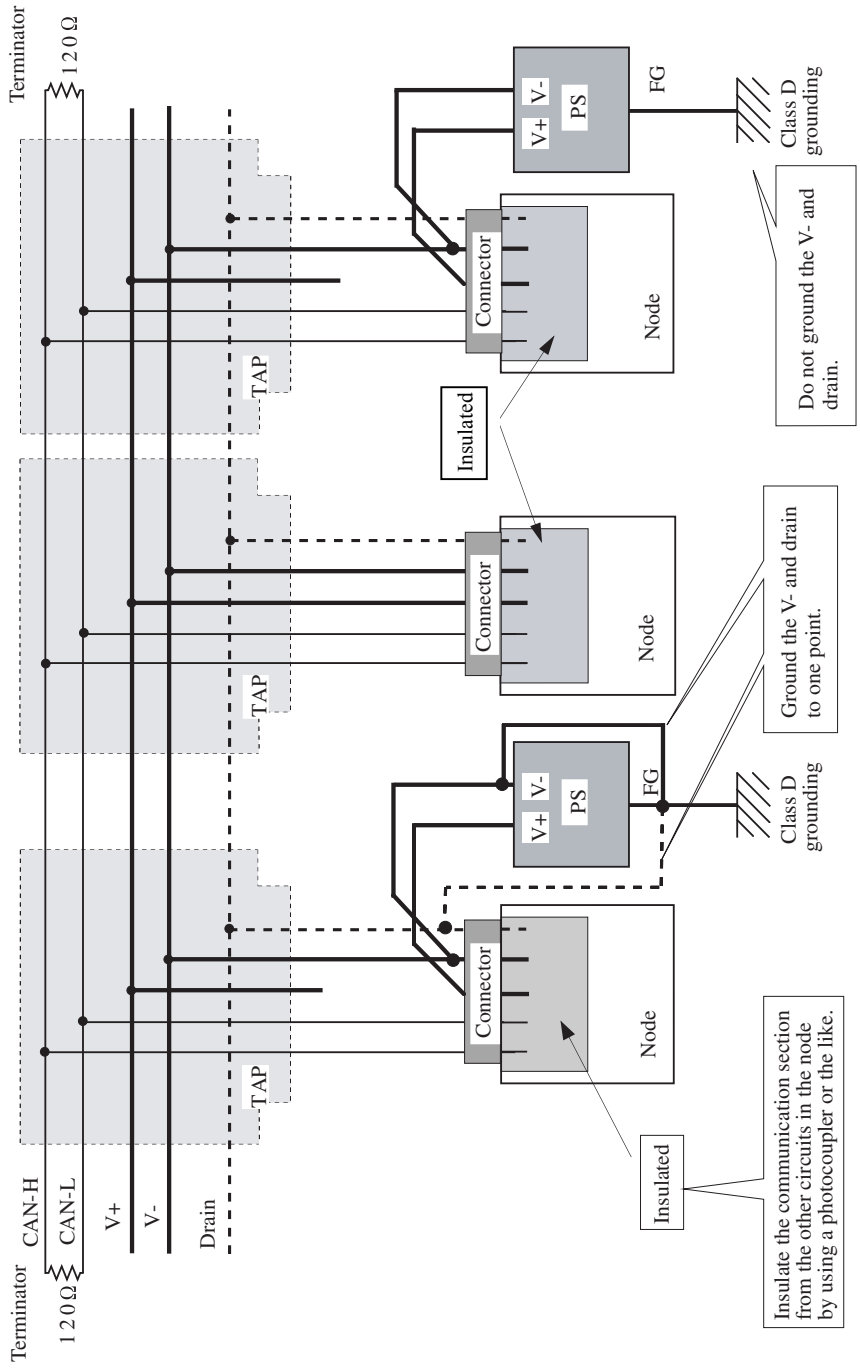


Figure 6-23 Example of Grounding Specifications

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7 COMMUNICATION FUNCTION

7.1 Function Overview

As a process communication (I/O communication) function, the D.Station supports slave-style polling communication only. It does not support bit-strobe/change-of-state/cyclic communication or peer communication. The term "process communication" refers to a communication method for transmitting/receiving control data. Table 7-1 shows the polling communication specifications.

Table 7-1 Polling Communication Specifications

No.	Item	Polling communication specifications
1	Communication style	One-to-one communication
2	User data length	Maximum transmission data length: 128 bytes (1024 points) + 4 bytes of additional information (optional) Maximum reception data length: 128 bytes (1024 points)
3	Available ID	No consideration need be given to the available ID.
4	Data synchronicity assurance	2 bytes max. (The S10's I/O is basically in 2-byte units.)
5	Number of master units	One unit (MAC IDs of 0 through 63 are available).

<Polling operation overview>

The master node polls a slave node (D.Station) at fixed intervals. In this polling request sequence, I/O data is transmitted to the slave, and the slave outputs the data to an output module. The slave node transmits the data received from an input module to the master by making a polling response to it. This operation is repeated at fixed intervals.

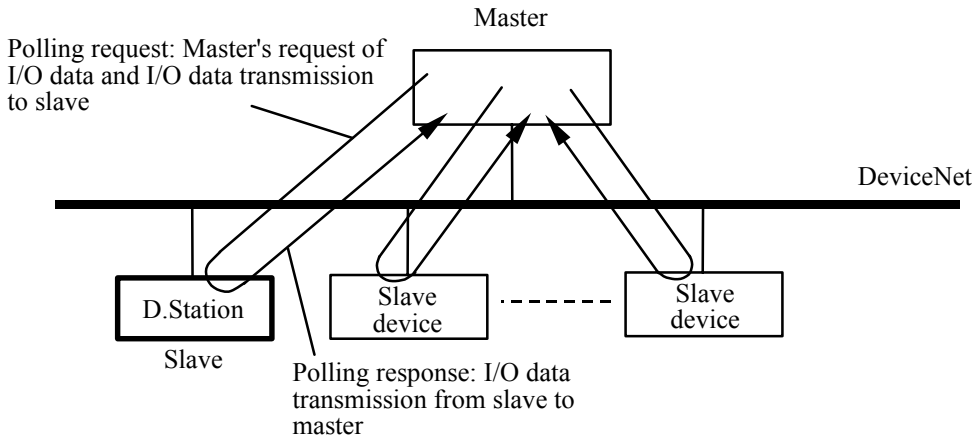


Figure 7-1 Polling Operation Overview

7.2 Service Communication Function

The D.Station use explicit communications to receive service requests from another node. When a requested service is addressed to an object within the D.Station, the it executes the service and transmits a response.

Other nodes (master) are able to receive the results by requesting required services using this explicit communication.

The D.Station supports the following services:

- Transmits the D.Station's communication information such as transmission/reception ID and data length to a specific node.
- Transmits the D.Station's maintenance information such as manufacturer name, device type, status information to a specific node.

7.2.1 Communication specifications

Table 7-2 shows the service (explicit) communication specifications.

Table 7-2 Service (Explicit) Communication Specifications

No.	Item	Specifications	Remarks
		Server	
1	Requested maximum data length	70 bytes	
	Responded maximum data length	70 bytes	
2	Message group used	3 or 2	Fixed
3	Message ID	Fixed at 4	
4	Data synchronicity assurance	70 bytes	Same size as No. 1
5	Multiple-instance startup prevention unit	In the unit of a node	Fixed

The number of service requests that can be simultaneously issued from a client (master) to the D.Station is one per a node. If next request is made while the previous request is being processed, the latter request will be rejected.

7.2.2 List of supported services

The D.Station supports the services shown in Table 7-3.

Table 7-3 List of Supported Services

Service code	Service name	Service description	Use
0x0E	Get_Attribute_Single	Request transmission of one attribute data	For reading one attribute data about an object
0x10	Set_Attribute_Single	Request for a setup of one attribute data	For setting one attribute data about an object

7.3 System Management Function

D.Station supports the "Transmission/reception of the MAC ID duplication detection signal" function as a system management function. Transmission/reception of the detection signal is automatically done by the D.Station. The MAC ID duplication detection signal is a frame that the D.Station or the DeviceNet communication control program of a specific device broadcasts upon startup or bus OFF recovery. This signal secede either or both of the nodes having a duplicate MAC ID from the network, thereby leaving the line unaffected.

7.4 List of Supported I/Os

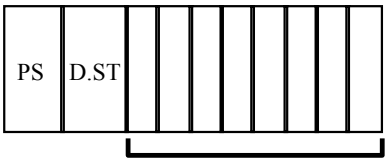
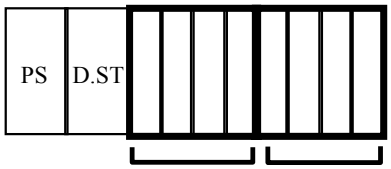
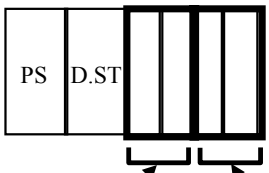
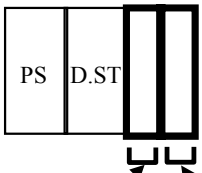
Table 7-4 List of Supported I/Os

No.	I/O type	Model	D.ST	Remarks
1	DI (16 to 64 points)	LQX***	√	DIs equipped with a signal latch function cannot be used when the FIX location is selected in the setup.
2	DO (16 to 64 points)	LQY***	√	–
3	DI/DO mix	LQZ300	√	Unusable when the FIX location setup is employed.
4	AI	LQA000 LQA100 LQA200	√ √ √	Only Mode 1 is supported. Mode 2 is not supported.
5	AO	LQA500 LQA600 LQA610	√ √ √	
6	Pulse counter	LQC000	√	• Control code and data are transferred together as one word. • Unusable when the FIX location is selected in the setup. • Unusable in the analog 4-bit shift mode.
7	Scanning analog input (individually insulated)	LQA300/310	√	–
8	Scanning analog input (individually insulated)	LQA301/310	ns	–

D.ST: D.Station (LQS070)
√: Supported
ns: Not supported

7.5 FREE/FIX Option

Table 7-5 FREE/FIX Option

FREE/FIX option	FREE	FIX
Slot allocation	Common to 2-, 4-, and 8-slot mount bases  Input/output modules can be optionally mounted in any slots.	8-slot mount base  Slots dedicated to input modules Slots dedicated to output modules 4-slot mount base  Slots dedicated to input modules Slots dedicated to output modules 2-slot mount base  Slots dedicated to input modules Slots dedicated to output modules
Merits	• I/O modules can be mounted freely in any slots. • A pulse counter, DI/DO mixed module, and modules equipped with input/output such as DI with latch can be used.	• The number of input/output data bytes is less in comparison when FREE option is selected. • The area occupied by the master is less in comparison when FREE option is selected.
Demerits	• The number of input/output data bytes is larger when the FIX option is selected. • The area occupied by the master is larger when the FIX option is selected.	• Slots to mount input/output module are predetermined. • A pulse counter, DI/DO mixed module, and modules equipped with input/output such as DI with latch cannot be used.

7.6 Data Transfer Modes

7.6.1 Normal transfer mode

Normal transfer mode is a mode in which data is transmitted/received in the same array as for remote I/O. The number-of-points setting determines the number of words transmittable/receivable for each slot.

The followings show samples of points setting and the data to be input/output in the D.Station when FREE option is selected and FIX option is selected respectively.

(1) When the FREE option is selected

<Configuration example>

<Input/output data array>

When a setting of 16 points is selected (4-word input/output)

Word offset	Slot number	Transmission from D.ST	Reception by D.ST
0	0	DI data	Invalid
1	1	AI (channel 0) data	Invalid
2	2	0x0000	AO (channel 0) data
3	3	Pulse counter (data and control code)	Pulse counter (data and control code)

When a setting of 32 points is selected (8-word input/output)

Word offset	Slot number	Transmission from D.ST	Reception by D.ST
0	0	DI data	Invalid
1		(Same data as for 0th word)	Invalid
2	1	AI (channel 0) data	Invalid
3		AI (channel 1) data	Invalid
4	2	0x0000	AO (channel 0) data
5		0x0000	AO (channel 1) data
6	3	Pulse counter (data and control code)	Pulse counter (data and control code)
7		(Same data as for the 6th word)	Invalid

The "Transmission from D.ST" and "Reception by D.ST" columns of the data format tables indicate ① or ② in Figure 7-2.

① Transmission from D.ST: Data that the D.Station transmits to the line after reading PI/O data.

② Reception by D.ST: Data that the D.Station receives from the line and writes into PI/O.

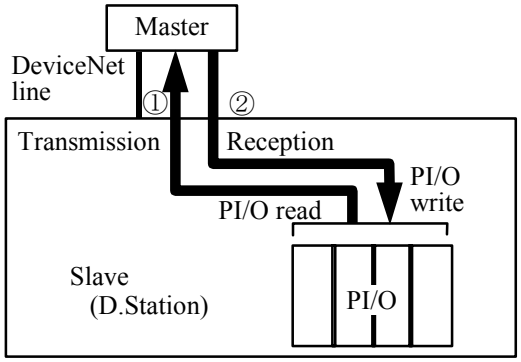
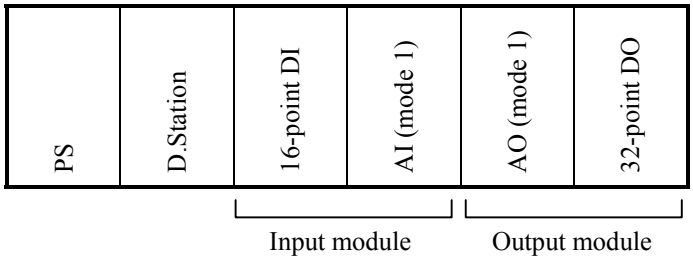


Figure 7-2 Transmission/Reception from D.Station

(2) When the FIX option is selected

<Configuration example>



<Input/output data array>

When a setting of 16 points is selected (2-word input/output)

Word offset	Slot number	Transmission from D.ST	Reception by D.ST
0	0, 2	DI data	AO (channel 0) data
1	1, 3	AI (channel 0) data	DO data

When a setting of 32 points is selected (4-word input/output)

Word offset	Slot number	Transmission from D.ST	Reception by D.ST
0	0, 2	DI data	AO (channel 0) data
1		(Same data as for 0th word)	AO (channel 1) data
2	1, 3	AI (channel 0) data	DO data
3		AI (channel 1) data	DO data

7.6.2 Analog 4-bit shift mode

Analog 4-bit shift mode is a mode in which analog data (in mode 1) is shifted 4 bits to the right when the D.Station transmits the data and shifted 4 bits to the left when the D.Station receives the data. Note, however, that digital data will not be shifted.

Note: In this mode, the pulse counter cannot be used because this mode also shifts data of the pulse counter.

(1) When the FREE setup is employed

<Configuration example>

<Input/output data array>

When a setting of 16 points is selected (4-word input/output)

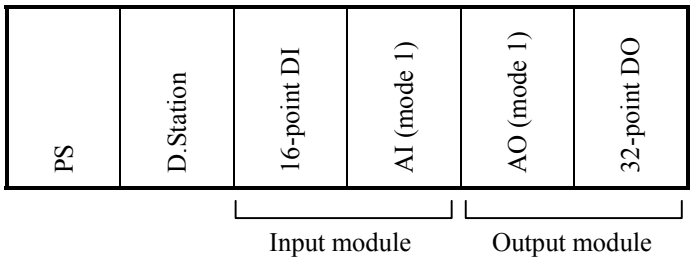
Word offset	Transmission from D.ST	Reception by D.ST
0	DI data	Invalid
1	AI (channel 0) data	Invalid
2	0x0000	AO (channel 0) data
3	0x0000	AO (channel 0) data

When a setting of 64 points is selected (16-word input/output)

Word offset	Transmission from D.ST	Reception by D.ST
0	DI data	Invalid
1	(Same data as for 0th word)	Invalid
2	(Same data as for 0th word)	Invalid
3	(Same data as for 0th word)	Invalid
4	AI (channel 0) data	Invalid
5	AI (channel 1) data	Invalid
6	AI (channel 2) data	Invalid
7	AI (channel 3) data	Invalid
8	0x0000	AO (channel 0) data
9	0x0000	AO (channel 1) data
10	0x0000	AO (channel 2) data
11	0x0000	AO (channel 3) data
12	0x0000	AO (channel 0) data
13	0x0000	AO (channel 1) data
14	0x0000	AO (channel 2) data
15	0x0000	AO (channel 3) data

(2) When the FIX option is selected

<Configuration example>



<Input/output data array>

When a setting of 16 points is selected (2-word input/output)

Word offset	Slot number	Transmission from D.ST	Reception by D.ST
0	0, 2	DI data	AO (channel 0) data
1	1, 3	AI (channel 0) data	DO data

When a setting of 32 points is selected (4-word input/output)

Word offset	Slot number	Transmission from D.ST	Reception by D.ST
0	0, 2	DI data	AO (channel 0) data
1		(Same data as for 0th word)	AO (channel 1) data
2	1, 3	AI (channel 0) data	DO data
3		AI (channel 1) data	DO data

7.7 Analog Data Formats

This section describes the data formats that prevail when the AI/AO module is used.

7.7.1 Analog input (LQA000/100/200) and output (LQA500/600/610)

Be sure to use the analog module in mode 1.

Table 7-6 Analog Data Format 1

<table>
<tr><th>Data transfer mode</th><th>Data format</th></tr>
<tr><td>Normal transfer mode</td><td>
MSB 2^{15} … 2^{0}
<table>
<tr><td>1st word</td><td>S</td><td>Channel 0 A/D conversion data</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2nd word</td><td>S</td><td>Channel 1 A/D conversion data</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>3rd word</td><td>S</td><td>Channel 2 A/D conversion data</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>4th word</td><td>S</td><td>Channel 3 A/D conversion data</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
Signal Data: -2048 to +2047

No sign applies and the data range is from 0 to 4095 when the LQA500 is used with a range setting of 2 selected or when the LQA600/610 is used.

Upon power ON (for a period of about 0.5 second), the data = /0000.
</td></tr>
<tr><td>Analog 4-bit shift mode</td><td>
MSB 2^{15} … 2^{0}
<table>
<tr><td>1st word</td><td>S</td><td>S</td><td>S</td><td>S</td><td>S</td><td>Channel 0 A/D conversion data</td></tr>
<tr><td>2nd word</td><td>S</td><td>S</td><td>S</td><td>S</td><td>S</td><td>Channel 1 A/D conversion data</td></tr>
<tr><td>3rd word</td><td>S</td><td>S</td><td>S</td><td>S</td><td>S</td><td>Channel 2 A/D conversion data</td></tr>
<tr><td>4th word</td><td>S</td><td>S</td><td>S</td><td>S</td><td>S</td><td>Channel 3 A/D conversion data</td></tr>
</table>
Signal Data: -2048 to +2047

Bits 12 to 15 are invalid and bit 11 serves as the data when the LQA500 is used with a range setting of 2 selected or when the LQA600/610 is used. The resulting data range is from 0 to 4095.

Upon power ON (for a period of about 0.5 second), the data = /0000.
</td></tr>
</table>

7.7.2 Scanning analog input (Individually insulated ; LQA300/310)

Table 7-7 Analog Data Format 2

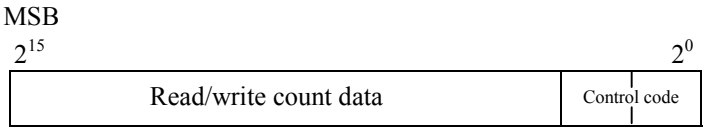
<table>
<tr><td>Data transfer mode</td><td>Data format</td></tr>
<tr><td>Normal transfer mode</td><td>
MSB 2^{15} ... 2^{0}
1st word: S S S S S | Channel 0 A/D conversion data
2nd word: S S S S S | Channel 1 A/D conversion data
3rd word: S S S S S | Channel 2 A/D conversion data
4th word: S S S S S | Channel 3 A/D conversion data
Signal Data: -2048 to +2047

Upon power ON (for a period of about 0.8 second), the data = /8000.
</td></tr>
<tr><td>Analog 4-bit shift mode</td><td>Unavailable</td></tr>
</table>

7.8 Pulse Counter Data Format

This section describes the data format that prevails when the pulse counter module is used.

Table 7-8 Pulse Counter Data Format

<table>
<tr><th>Data transfer mode</th><th>Data format</th></tr>
<tr><td>Normal transfer mode</td><td>


Status code when read
<table>
<tr><th>Control code</th><th>Mode 1</th><th>Mode 2</th></tr>
<tr><td>0 0 (0 in decimal notation)</td><td>Count stop</td><td>Count stop</td></tr>
<tr><td>0 1 (1)</td><td>Preset start</td><td>Preset start</td></tr>
<tr><td>1 0 (2)</td><td>Comparison value set</td><td>Comparison value set</td></tr>
<tr><td>1 1 (3)</td><td>Latch reset</td><td>Latch reset</td></tr>
</table>
<table>
<tr><th>Status code</th><th>Mode 1</th><th>Mode 2</th></tr>
<tr><td>0 0 (0 in decimal notation)</td><td>Count stop</td><td>Count stop</td></tr>
<tr><td>0 1 (1)</td><td>R>C</td><td>Preset start</td></tr>
<tr><td>1 0 (2)</td><td>R=C</td><td>Comparison value set</td></tr>
<tr><td>1 1 (3)</td><td>R<C</td><td>Latch reset</td></tr>
</table>
</td></tr>
<tr><td>Analog 4-bit shift mode</td><td>Unavailable</td></tr>
</table>

7.9 Data Swap Mode

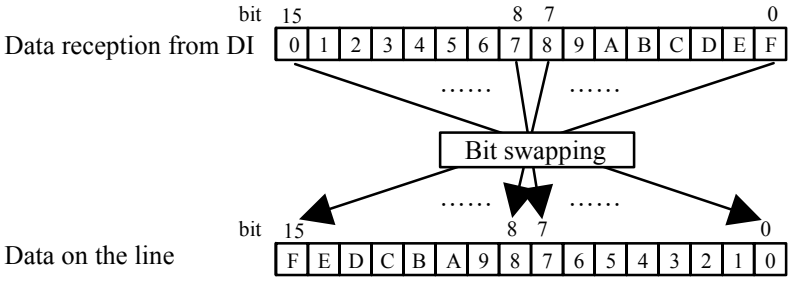
When the data received from the DeviceNet line is output to an I/O or the data entered from an I/O is transmitted to the DeviceNet line, data byte and bit arrangements can be specified with the "FUNC2" rotary switch.

ON and OFF of the bit and byte swapping can be combined to specify byte and bit arrangements.

7.9.1 Bit swap mode

The bit swap mode is operative for digital (DI/DO) data only. When the bit swap feature is ON, processing is performed at 16-points (words) as a unit as shown in Figure 7-3. When the bit swap feature is OFF, the data sent from the DI is transferred to the line and then output the data as it is to the DO.

<Transmission from D.Station>



<Reception by D.Station>

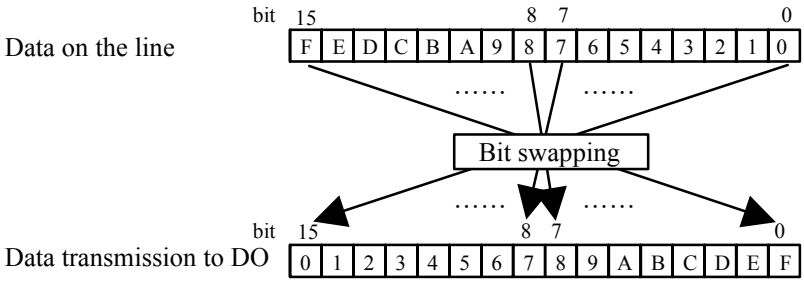
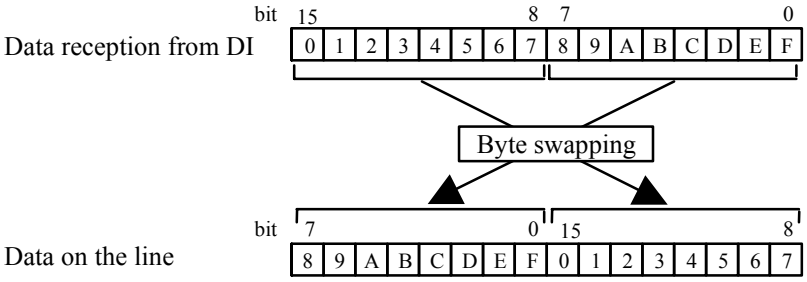


Figure 7-3 Bit Swap Mode

7.9.2 Byte swap mode

The byte swap mode is operative for both digital (DI/DO) and analog (AI/AO and pulse counter) data. When the byte swap feature is ON, processing is performed t 16-points (words) as a unit as shown in Figure 7-4. When the byte swap feature is OFF, the data sent from the DI, AI, and pulse counter is simply passed as is to the line and then output to the DO, AO, and pulse counter.

<Transmission from D.Station>



<Reception by D.Station>

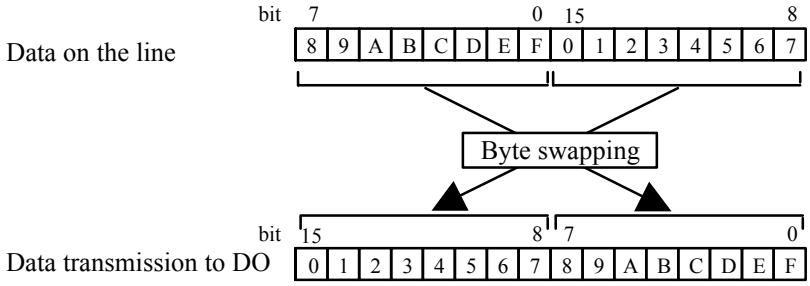


Figure 7-4 Byte Swap Mode

7.9.3 Recommended bit/byte swap settings

It is recommended that you perform bit/byte swap setup in accordance with the master device connected to the D.Station (see Table 7-9). The best settings may vary depending on how the application program handles data. You do not have to comply with the setup instructions stated in Table 7-9.

Table 7-9 Recommended Bit/Byte Swap Setting

No.	DeviceNet master device	D.Station setup		Remarks
		Bit swap	Byte swap	
1	S10mini D.NET	OFF	ON	Applies to situations where the bit inversion mode is OFF for D.NET. If the bit inversion mode is ON, the bit swap feature should be ON.
2	R600 RIF-D	OFF	ON	–
3	Other DeviceNet master devices	ON	ON	Applies to situations where the data from the D.Station is accessed word by word.

7.10 I/O Error Information (Fuse Blowout)/Addition Function with Implementation Information

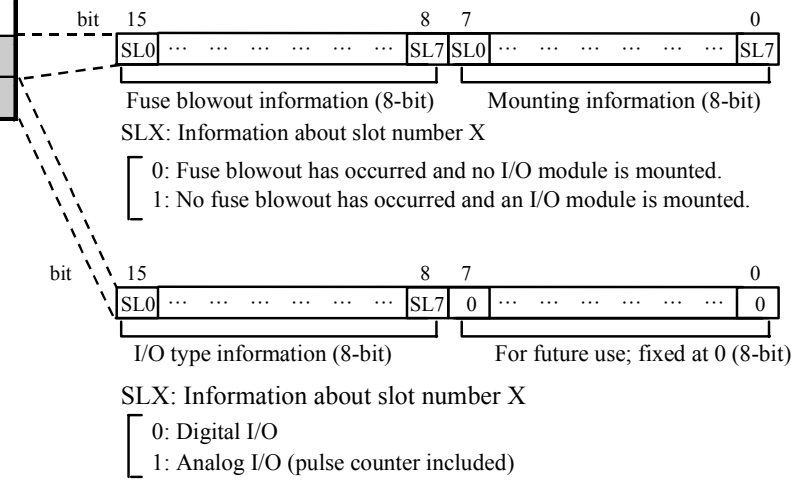
This function reports PI/O error information and whether I/O module is inserted in each slot by adding those information to the last word of the data.

Note: This function is adopted in consideration for future expansion. Presently, no existing PI/O modules are equipped with a fuse thus this function involves error information other than that of fuse blowout only.

This function transmits the information to the master with four bytes added to the last word, as shown below. Note that the information is affected when the byte swap mode is selected (remains unaffected in the bit swap mode).

4-word output from D.Station (no byte swapping)

Word offset	Output from D.ST
0	I/O data 1
1	I/O data 2
2	I/O data 3
3	I/O data 4
4	I/O additional information 1
5	I/O additional information 2



Further, this information can be collected from the Get_Attribute_Single service of explicit service communication stipulated in the DeviceNet standard.
D.Station returns the information to the master by issuing the Get_Attribute_sigle service addressed to the following class, instance, and attribute numbers.

- Class number = 105 (0x69): Configuration Agent Object (D.Station original class)
- Instance number = 1
- Attribute number = 100 (0x64): I/O status information (D.Station original attribute)

Examples of data formats seen on the DeviceNet lines are shown below:

Transmission from master (Get_Attribute_Single request)

Byte offset	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0	Flag [0]	XID[0]	Master MAC ID					
1	R/R[0]	Service code [0x0E] (Get_Attribute_Single)						
2	Class ID= 105 [0x69] (Configuration_Agent_Object)							
3	Instance ID= 1 [0x01]							
4	Attribute ID= 100 [0x64] (I/O status information)							

Response from D.Station (Get_Attribute_Single response)

Byte offset	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	
0	Flag [0]	XID[0]	Master MAC ID						
1	R/R[1]	Service code [0x0E] (Get_Attribute_Single)							
2	Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Fuse blowout information (8-bit)
3	Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Implementation information (8-bit)
4	Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	I/O type information (8-bit)
5	0	0	0	0	0	0	0	0	For future use; fixed at 0 (8-bit)

7.11 Number of Input/Output Bytes

7.11.1 Factors determining the number of input/output bytes

The number of input/output bytes for the D.Station is determined by the following factors:

- Number of mount base slots
- Number-of-points settings for each D.Station slot (SLOT rotary switch setting)
- I/O error information/Implementation information additional setting for the D.Station (FUNC1 rotary switch setting)
- Selection of the FIX/FREE options for the D.Station (FUNC2 rotary switch setting)

As indicated in Table 7-10, the number of input/output bytes varies with the number of mount base slots, number-of-points setting, selection of the FIX/FREE option, and additional error information setting.

Table 7-10 Number of Input/Output Bytes

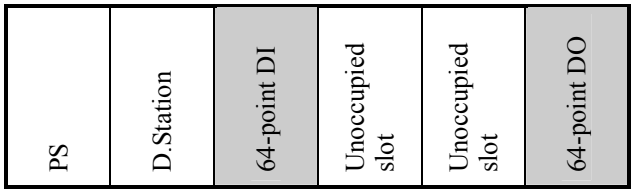
No.	Description		Number of input/output bytes	
	FIX/FREE option	Error information addition setting		
1	FREE	Do not add	Number of input bytes = Number of output bytes =	number of mount base slots × number-of-points setting/8 Number of input bytes
2		Add	Number of input bytes = Number of output bytes =	Same as for "Do not add" Number of input bytes + 4
3	FIX	Do not add	Number of input bytes = Number of output bytes =	number of mount base slots/2 × number-of-points setting/8 Number of input bytes
4		Add	Number of input bytes = Number of output bytes =	Same as for "Do not add" Number of input bytes + 4

7.11.2 Calculating number of input/output bytes as example

The calculation examples in this section indicate how the number of input/output bytes varies with the number of mount base slots and rotary switch settings.

(1) 4-slot mount base, 65 points, no error information addition to be applied, and FREE setup

<Configuration example>



<Settings>

- 64 points
- No error information addition to be applied
- FREE

The employed calculation formula corresponds to No. 1 in Table 7-10. Therefore, the number of bytes are as follows:

Number of input bytes = number of mount base slots × number-of-points setting/8
=4 × 64/8
=32 bytes (16 words)

Number of output bytes = same as the number of input bytes

(2) 8-slot mount base, 128 points, error information addition to be applied, and FREE setup

The example below shows the setting that maximizes the number of input/output bytes.

<Configuration example >

<Settings>

- 128 points
- Error information addition to be applied
- FREE

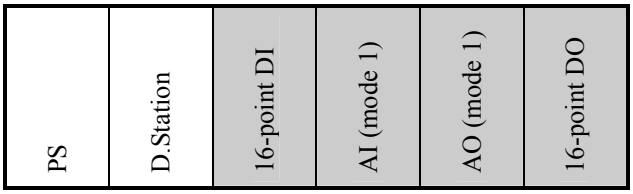
The employed calculation formula corresponds to No. 2 in Table 7-10. Therefore, the number of bytes is calculated as follows:

Number of input bytes = number of mount base slots × number-of-points setting/8
= 8 × 128/8
= 128 bytes (64 words)

Number of output bytes = number of input bytes + 4 = 132 bytes (66 words)

(3) 4-slot mount base, 16 points, no error information addition to be applied, and FIX setup

<Configuration example >



<Settings>

- 16 points
- No error information addition to be applied
- FIX

The employed calculation formula corresponds to No. 3 in Table 7-10. Therefore, the number of bytes is calculated as follows:

Number of input bytes = number of mount base slots/2 × number-of-points setting/8 = 4/2 × 16/8
= 4 bytes (2 words)

Number of output bytes = same as the number of input bytes

(4) 8-slot mount base, 128 points, error information addition to be applied, and FIX setup

<Configuration example >

<Settings>

- 128 points
- Error information addition to be applied
- FIX

The employed calculation formula corresponds to No. 4 in Table 7-10. Therefore, the number of bytes is calculated as follows:

Number of input bytes = number of mount base slots/2 × number-of-points setting/8
= 8/2 × 128/8
= 64 bytes (32 words)

Number of output bytes = number of input bytes + 4 = 68 bytes (34 words)

7.12 Digital Output (DO) HOLD/RESET Function

The HOLD/RESET function is a function to HOLD (retains the output signal) or RESET (turns OFF the output signal) the output of the digital output module when no request is received from the master for a certain period of time.

Table 7-11 shows the specifications for the HOLD/RESET function.

Table 7-11 HOLD/RESET Specifications

No.	Item	Description	Remarks
1	Applicable I/O module	Digital output (DO) module Pulse counter module (when mode 2 selected)	The analog output (AO) module is not applicable.
2	Setting method	"FUNC2" rotary switch	–
3	RESET timing	• When the connection to the master is closed • When a serious failure occurs	When the HOLD mode is selected, however, the prevailing status is retained.
4	Monitoring time	Depends on the setting defined by the master.	It is necessary that the setting be supported by the master.

The output resets when the connection to the master is cut off or when other serious failure such as hardware error occurs. The D.Station automatically cuts off the connection and resets the output after a certain time elapses (timeout). Timeout occurs when no request is received from the master for a period of time that is 4 times the timeout time selected by the master.

7.13 CAN Transmission Timeout Monitoring Time

The CAN transmission timeout time refers to the timeout monitoring time that takes to monitor errors that occurred in the CAN controller built in the D.Station and obtain right to transmit frames into a transmission path is not allowed.

The CAN transmission timeout monitoring feature starts a monitoring operation at the activation of a transmission to the CAN controller. If a transmission completed notice is not generated from the CAN controller for a predetermined period of time, this feature concludes that a timeout has occurred, and removes data from the transmission queue.

The monitoring time varies with the communication type and transfer rate, as shown in Table 7-12.

Table 7-12 CAN Transmission Timeout Monitoring Time

Transfer rate / Communication type	125 kbps	250 kbps	500 kbps
Process communication	200 ms	150 ms	100 ms
Process communication	400 ms	400 ms	400 ms

8 MAINTENANCE

8.1 Preventive Maintenance

For optimum use of the S10mini, it is essential that you carry out the following maintenance ever now and then (at least 2 times a year).

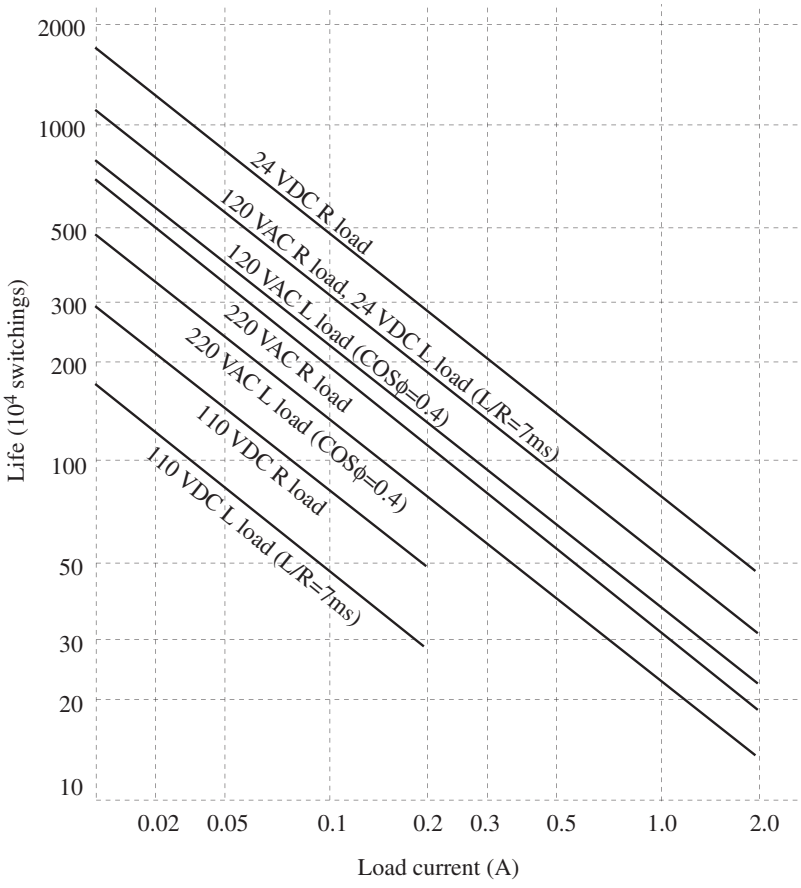
Preventive maintenance items
Module appearance check
Screw/terminal strip screw looseness check
Cable/wire coating check
Dust adhesion check
AC supply voltage check (85 to 132 V)
Indicator devices check
5 V supply voltage check

- Module appearance check
  Check to see whether the module case is cracked or otherwise broken. If the case is damaged, the internal circuit may also be damaged which may due in malfunction of the system.
- Condition of the indicators – lights and contents
  Check the indicators for abnormalities.
- Screw/terminal strip screw looseness check
  Check that the module mounting screws and terminal strip screws are loose.
  Any loose screws must be tightened because this may cause the system to malfunction or end up with the components to burn out due to generated heat.
- Module replacement
  If you replace the module while the power is ON, the hardware and software may be damaged. Before replacing the module, be sure to turn OFF the power.
- Cable coating check
  Check whether the cable coating is in good condition. If the cable coating is peeled or damaged, system malfunction, electric shock, or shorting-induced component burnout may result.

⚠ CAUTION

Static electricity may damage the module. Before starting the work, discharge all electrostatic charge from your body.

- Dust adhesion check
  Check if dust or other foreign matter adhered on the module. If any dust/foreign matter buildup is found, remove it with a vacuum cleaner. If you allow dust or other foreign matter to build up, the internal circuitry may be shorted or to cause a component burnout.
- Supply voltage check
  Check that the voltages of the module power supply and externally supplied power are within the specified ranges. If the supply voltage is out of the range, the system may malfunction. (For the modules' operating supply voltages and externally supplied voltage, refer to the respective manuals.)
- Life expectancy of the relay
  As regards the LQY100, LQY140, and other I/O modules having a built-in relay, you must pay attention to the life expectancy of the relay.
  If the relay opens/closes at frequent intervals or is incorporated in a system having a high output voltage or current, you should consider a module replacement.



The L load contains a rush current.

Figure 8-1 Life Expectancy of Relay

8.2 T/M (Test/Maintenance Program)

The test/maintenance program (abbreviated to T/M) is a test program that is used for D.Station module maintenance/inspection. Since the D.Station module is equipped with T/M, the user can execute the T/M by performing simple procedures. To start the T/M, set the node address, slot, FUNC1, and FUNC2 setup switches as specified, and restart.

NOTE
Before you use the T/M, be sure to remove the communication cable (which means "off-line").

8.2.1 Hardware diagnostic T/M

The hardware diagnostic T/M checks the processor functionality and its memory. Since it does not operate communication, you can run the hardware diagnostic check on the D.Station module itself.

(1) Hardware diagnostic T/M descriptions

- Contents of the tests

  The hardware diagnostic T/M tests the following functions:

  - Check write/read/compare functions of the processor inside register
  - Processor arithmetic operation function check
  - Memory (RAM) write/read/compare function check
    (There are three types of diagnostic data: random, fixed, and address.)
  - Flash memory read/read/compare check and checksum check
  - Processor internal timer check
  - Processor internal HCAN check

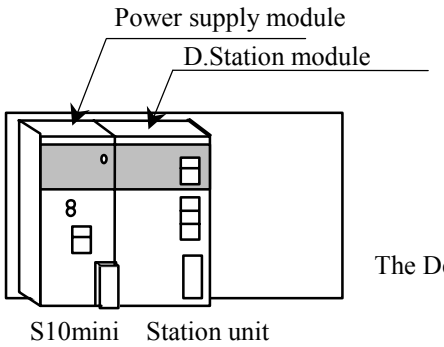
- Operation performed when the hardware is normal

  When you execute the T/M, the green and red MNS LED indicators on the module repeatedly blink in order.

- When the hardware anomaly is detected

  When you execute the T/M, the red MNS LED indicator on the module lights up and it stops the diagnostic check.

(2) Configuration for hardware diagnostic T/M operation



The DeviceNet communication cables not required.

Figure 8-2 Configuration for Hardware Diagnostic T/M Operation

(3) Executing the hardware diagnostic T/M

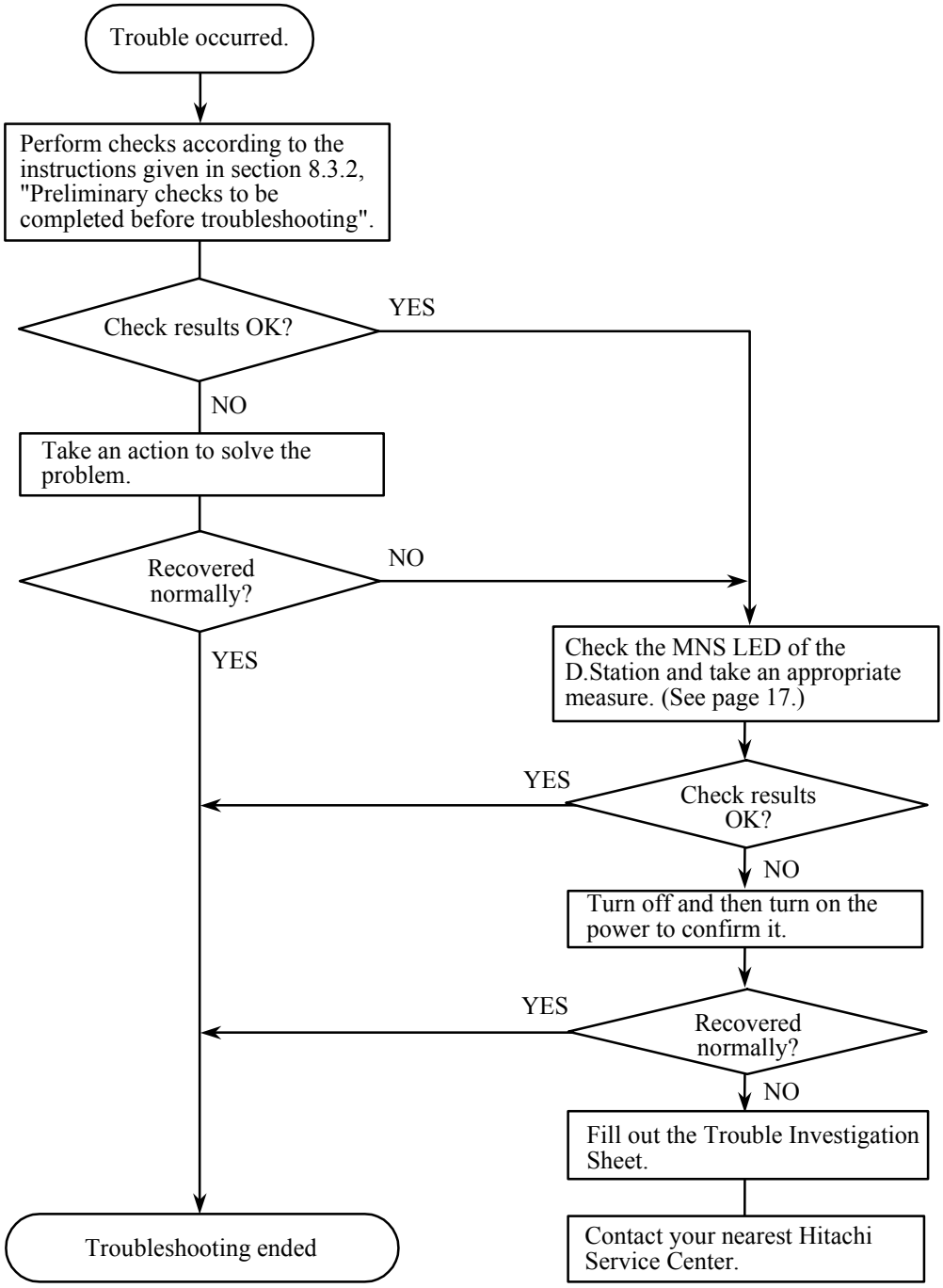
- Module mounting and cable wiring
  Mount the modules as explained in section "Figure 8-2 Configuration for hardware diagnostic T/M operation". The DeviceNet cables are not required to be connected.
- Switch setup
  To T/M startup, set the rotary switches on the module as specified in the following list:

Node address setting switch	(NA-U)	Select a setting of 0.
	(NA-L)	Select a setting of 0.
Slot setting switch (SLOT)		Select a setting of F.
FUNC1 setting switch (FUNC1)		Select a setting of 0.
FUNC2 setting switch (FUNC2)		Select a setting of 0.

- T/M execution
  The T/M starts running when you turn the power OFF and then back ON.

8.3 Troubleshooting

8.3.1 Procedure



* Use "Trouble Investigation Sheet" in Section 9.2.

8.3.2 Preliminary checks to be completed before troubleshooting

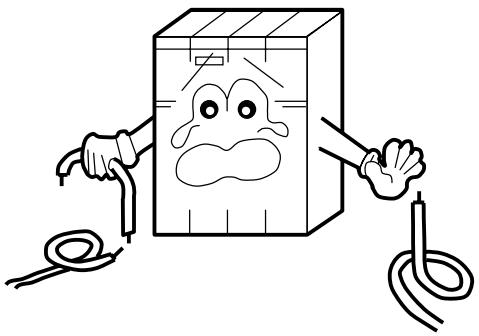
(1) Plausible causes of D.Station's communication failure

The table below shows the plausible causes of D.Station's communication failure. Note the contents of the table and take a suggested remedial action.

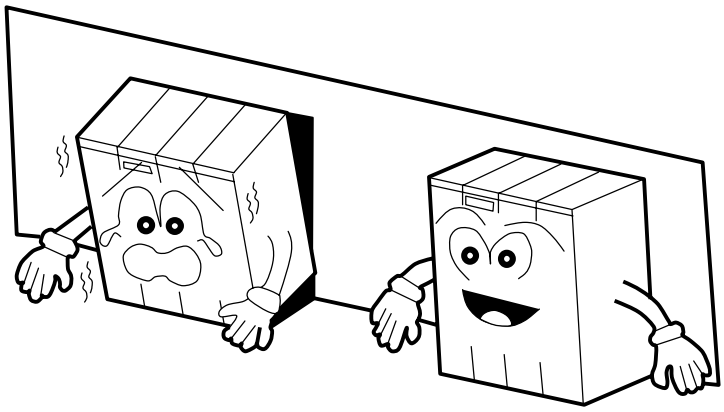
No.	Probable cause of communication failure	Solution
1	The D.Station does not agree with the master node in transmission rate.	Select the same transmission rate as for the master node.
2	The line is heavily loaded so that information cannot be transmitted over the network. (This problem may arise when the local node's MAC ID priority is lower than that of the other nodes. The smaller the MAC ID, the higher the priority.)	Increase the transmission intervals of each node, decrease the number of nodes, or take other measures to reduce the network load.
3	The network power is not supplied. The D.Station does not require power supply, however, supply power for DeviceNet of other brand.	Make the network power supply connection.
4	Although the network power is supplied, it is beyond the capacity.	See Section 6.1.5, "Investigations for communication power supply location".
5	The cable length is over the limit.	See Section 6.1.4, "Limitations on cable length", and correct the cable length.
6	The terminating resistor is not connected.	See under "(4) Terminating resistor" in Section 6.1.3, "Components", and connect the terminating resistor.
7	The connector connections to the D.Station are loosened.	Ensure that the connectors are properly connected.
8	The CAN-H or CAN-L cable is loosely connected to a connector.	Ensure that the cables are properly connected to the connectors.

(2) Is cabling normal?

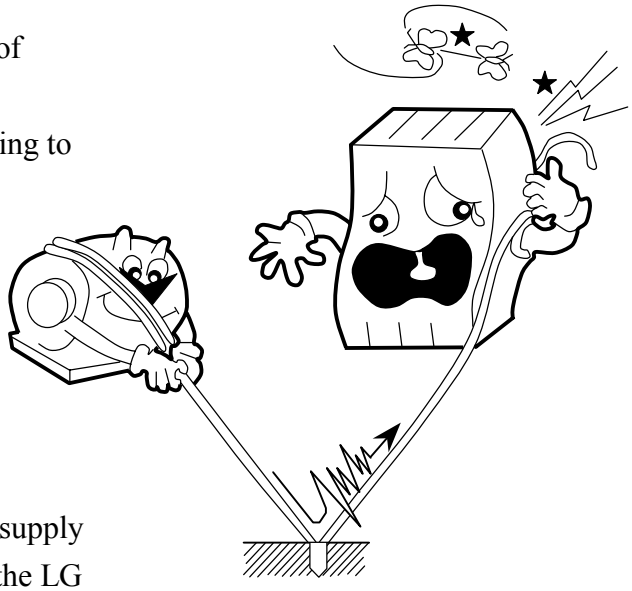
Check that there is disconnection or erroneous connection of cables.



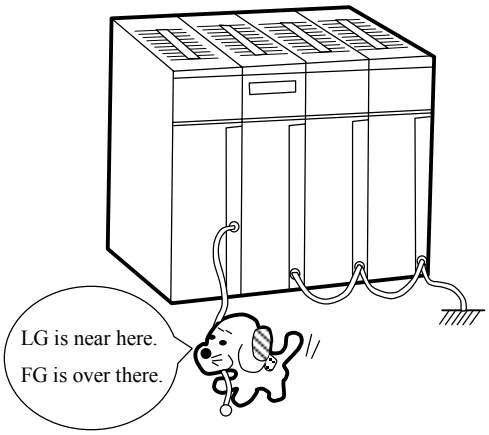
(3) Are the modules mounted correctly?
Check that no set screws loosen.



(4) Is ground made correctly?
- Separate the grounding from that of high-voltage equipment.
- Perform grounding work conforming to Class D grounding or higher.



(5) Are LG and FG separated?
- If electrical noise from the power supply enters the FG (frame ground) via the LG (line ground), a malfunction may result. To prevent this, LG and FG must be separated.
- Ground the LG at the power supply side.



9 APPENDIX

9.1 Installation Checklist

Table 9-1 Installation Checklist

No.	Component	Item	Description	Result
1	D.Station module	NA setting switch	Check that the MAC ID selected on the node address setup switch is not a duplicate of the MAC ID selection for any other connected device.	
2		SLOT setting switch	Check whether the correct number of I/O points is selected on the slot setup switch. Also, check that the setting agrees with the master's transmission/reception word count.	
3		FUNC1 setting switch	Check that the baud rate (transmission rate) selected on the FUNC1 setup switch agrees with the system's transfer rate.	
4		FUNC2 setting switch	Check that the data swap, mount base partition, and output module output status settings selected on the FUNC2 setup switch are correct.	
5	Cable	Cable length	Check that the overall cable length and drop line lengths of the network are within the specified ranges which vary with the communication speed (see Section 6.1, "Cabling").	
6		Cable laying environment	Check that the network cables are positioned away from motive power lines and other noise induction sources.	
7		Current capacity	Check that the current flowing in each cable is within the permissible value range (see Section 6.1, "Cabling").	
8		Cable specifications	Check that the employed cables comply with the specifications (see Section 6.1, "Cabling").	
9	Connector	Cable connection	Check that the color-identified cables are connected to the proper connectors (see Section 6.1, "Cabling").	
10		Shield-type connector	Check that the shield-type connector is firmly inserted and tightened with its retaining screws installed.	
11		Open-type connector	Check that the open-type connector cable connection is made by crimping a compression terminal onto the cable and fastening the cable to the connector with 5±1 kg·cm torque.	
12			You are not allowed to connect two cables to the open-type connector. Check that two cables are not connected to it.	
13	Terminating resistor	Arrangement	Check that the ends of the main line are connected to the CAN-H and CAN-L signals, respectively. Ensure that the signals are not connected to intermediate points of the main line.	
14		Resistance value error	Check that the resistance value of the terminating resistor is 121 Ω±1% (1/4 W or higher).	
15	Ground	Grounding location	Check that the communication cable shield is grounded only at one place near the center of the network. Also, check that the V- is grounded from one power supply within the network.	
16		Grounding environment	Check that Class D grounding is provided separately from motor and drive system grounding.	

9.2 Trouble Investigation Sheet

- Trouble Investigation Sheet

<table>
<tr><td>Your company name</td><td colspan="5"></td></tr>
<tr><td>Person in charge</td><td colspan="2"></td><td>Date and time of occurrence</td><td colspan="2"></td></tr>
<tr><td rowspan="3">Contact address and numbers</td><td>Address</td><td colspan="4"></td></tr>
<tr><td>Phone</td><td colspan="4"></td></tr>
<tr><td>Fax</td><td colspan="4"></td></tr>
<tr><td colspan="2">Module of defective module</td><td></td><td>CPU model</td><td colspan="2"></td></tr>
<tr><td>OS Ver. Rev.</td><td colspan="5">Program name: Ver. Rev.</td></tr>
<tr><td>Support program</td><td colspan="5">Program name: Ver. Rev.</td></tr>
<tr><td>Symptom of defect</td><td colspan="5"></td></tr>
<tr><td rowspan="3">Connection load</td><td>Type</td><td colspan="4"></td></tr>
<tr><td>Model</td><td colspan="4"></td></tr>
<tr><td>Cabling status</td><td colspan="4"></td></tr>
<tr><td colspan="6">System configuration and switch setting</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Space for correspondence</td><td colspan="5"></td></tr>
</table>