EM345-0

OPENNET CONTROLLER
USER'S MANUAL

idec

SAFETY PRECAUTIONS

- Read this user's manual to make sure of correct operation before starting installation, wiring, operation, maintenance, and inspection of the OpenNet Controller.
- All OpenNet Controller modules are manufactured under IDEC's rigorous quality control system, but users must add a backup or failsafe provision to the control system using the OpenNet Controller in applications where heavy damage or personal injury may be caused in case the OpenNet Controller should fail.
- In this user's manual, safety precautions are categorized in order of importance to Warning and Caution:

⚠ Warning **Warning notices are used to emphasize that improper operation may cause severe personal injury or death.**

- Turn off the power to the OpenNet Controller before starting installation, removal, wiring, maintenance, and inspection of the OpenNet Controller. Failure to turn power off may cause electrical shocks or fire hazard.
- Special expertise is required to install, wire, program, and operate the OpenNet Controller. People without such expertise must not use the OpenNet Controller.
- Emergency stop and interlocking circuits must be configured outside the OpenNet Controller. If such a circuit is configured inside the OpenNet Controller, failure of the OpenNet Controller may cause disorder of the control system, damage, or accidents.

⚠ Caution **Caution notices are used where inattention might cause personal injury or damage to equipment.**

- Install the OpenNet Controller according to instructions described in this user's manual. Improper installation will result in falling, failure, or malfunction of the OpenNet Controller.
- The OpenNet Controller is designed for installation in a cabinet. Do not install the OpenNet Controller outside a cabinet.
- Install the OpenNet Controller in environments described in this user's manual. If the OpenNet Controller is used in places where the OpenNet Controller is subjected to high-temperature, high-humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks, then electrical shocks, fire hazard, or malfunction will result.
- The environment for using the OpenNet Controller is "Pollution degree 2." Use the OpenNet Controller in environments of pollution degree 2 (according to IEC 60664-1).
- The DC power applicable to the OpenNet Controller is "PS2" type (according to EN 61131).
- Prevent the OpenNet Controller from falling while moving or transporting the OpenNet Controller, otherwise damage or malfunction of the OpenNet Controller will result.
- Prevent metal fragments and pieces of wire from dropping inside the OpenNet Controller housing. Put a cover on the OpenNet Controller modules during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage, or malfunction.
- Use a power supply of the rated value. Use of a wrong power supply may cause fire hazard.
- Use wires of a proper size to meet voltage and current requirements. Tighten terminal screws to a proper tightening torque of 0.5 to 0.6 N·m.
- Use an IEC 60127-approved fuse on the power line outside the OpenNet Controller. This is required when equipment containing the OpenNet Controller is destined for Europe.
- Use an IEC 60127-approved fuse on the output circuit. This is required when equipment containing the OpenNet Controller is destined for Europe.
- Use an EU-approved circuit breaker. This is required when equipment containing the OpenNet Controller is destined for Europe.
- Make sure of safety before starting and stopping the OpenNet Controller or when operating the OpenNet Controller to force outputs on or off. Incorrect operation on the OpenNet Controller may cause machine damage or accidents.
- If relays or transistors in the OpenNet Controller output modules should fail, outputs may remain on or off. For output signals which may cause heavy accidents, provide a monitor circuit outside the OpenNet Controller.
- Do not connect to the ground directly from the OpenNet Controller. Connect a protective ground to the cabinet containing OpenNet Controller using an M4 or larger screw. This is required when equipment containing the OpenNet Controller is destined for Europe.
- Do not disassemble, repair, or modify the OpenNet Controller modules.
- Dispose of the battery in the OpenNet Controller modules when the battery is dead in accordance with pertaining regulations. When storing or disposing of the battery, use a proper container prepared for this purpose. This is required when equipment containing the OpenNet Controller is destined for Europe.
- When disposing of the OpenNet Controller, do so as an industrial waste.

About This Manual

This user's manual primarily describes entire functions of the OpenNet Controller CPU modules, digital I/O modules, analog I/O modules. Also included are powerful communications of the OpenNet Controller.

CHAPTER 1: GENERAL INFORMATION

General information about the OpenNet Controller, features, brief description on special functions, and various system setup configurations for communication.

CHAPTER 2: MODULE SPECIFICATIONS

Specifications of CPU, digital and analog I/O, expansion power supply, remote I/O master, OpenNet interface modules.

CHAPTER 3: INSTALLATION AND WIRING

Methods and precautions for installing and wiring OpenNet Controller modules.

CHAPTER 4: OPERATION BASICS

General information about setting up the basic OpenNet Controller system for programming, starting and stopping OpenNet Controller operation, and simple operating procedures from creating a user program using WindLDR on a PC to monitoring the OpenNet Controller operation.

CHAPTER 5: SPECIAL FUNCTIONS

Stop/reset inputs, run/stop selection at memory backup error, keep designation for internal relays, shift registers, counters, and data registers. Also included are module ID selection and run/stop operation upon disparity, input filter, catch input, high-speed counter, key matrix input, and user program read/write protection.

CHAPTER 6: ALLOCATION NUMBERS

Allocation numbers available for the OpenNet Controller CPU module to program basic and advanced instructions. Special internal relays and special data registers are also described.

CHAPTER 7: BASIC INSTRUCTIONS

Programming of the basic instructions, available operands, and sample programs.

CHAPTER 8: ADVANCED INSTRUCTIONS

General rules of using advanced instructions, terms, data types, and formats used for advanced instructions.

CHAPTER 9 THROUGH CHAPTER 20:

Detailed descriptions on advanced instructions grouped into 12 chapters.

CHAPTER 21 THROUGH CHAPTER 26:

Various communication functions such as data link, computer link, modem mode, remote I/O system, Devicenet slave module, and LONWORKS interface module.

CHAPTER 27: TROUBLESHOOTING

Procedures to determine the cause of trouble and actions to be taken when any trouble occurs while operating the OpenNet Controller.

APPENDIX

Additional information about execution times for instructions, I/O delay time, and OpenNet Controller type list.

INDEX

Alphabetical listing of key words.

IMPORTANT INFORMATION

Under no circumstances shall IDEC Corporation be held liable or responsible for indirect or consequential damages resulting from the use of or the application of IDEC PLC components, individually or in combination with other equipment.

All persons using these components must be willing to accept responsibility for choosing the correct component to suit their application and for choosing an application appropriate for the component, individually or in combination with other equipment.

All diagrams and examples in this manual are for illustrative purposes only. In no way does including these diagrams and examples in this manual constitute a guarantee as to their suitability for any specific application. To test and approve all programs, prior to installation, is the responsibility of the end user.

TABLE OF CONTENTS

CHAPTER 6: ALLOCATION NUMBERS

CHAPTER 7: BASIC INSTRUCTIONS

CHAPTER 8: ADVANCED INSTRUCTIONS

CHAPTER 9: MOVE INSTRUCTIONS

CHAPTER 10: DATA COMPARISON INSTRUCTIONS

CHAPTER 11: BINARY ARITHMETIC INSTRUCTIONS

CHAPTER 12: BOOLEAN COMPUTATION INSTRUCTIONS

CHAPTER 13: BIT SHIFT / ROTATE INSTRUCTIONS

CHAPTER 14: DATA CONVERSION INSTRUCTIONS

CHAPTER 15: WEEK PROGRAMMER INSTRUCTIONS

CHAPTER 23: MODEM MODE

CHAPTER 24: REMOTE I/O SYSTEM

CHAPTER 25: DEVICENET SLAVE MODULE

CHAPTER 26: LONWORKS INTERFACE MODULE

CHAPTER 27: TROUBLESHOOTING

APPENDIX

INDEX

1: GENERAL INFORMATION

Introduction

This chapter describes general information for understanding the OpenNet Controller and system setups for using the OpenNet Controller in various ways of communication.

About the OpenNet Controller

IDEC's OpenNet Controller is a programmable logic controller with enhanced communication capabilities. The OpenNet Controller is compatible with world's three major open networks; INTERBUS, DeviceNet, and LONWORKS. Since application of these networks are expanding at a fast pace, the OpenNet Controller is ideal for use in multi-vendor control systems.

In addition, the OpenNet Controller has user communication functions to communicate with various communication equipment. Modem communication is also very easy using the built-in modem communication functions to communicate with remote devices through telephone lines. For these communication applications, the OpenNet Controller CPU module features two RS232C ports and one RS485 port.

User programs for the OpenNet Controller can be edited using WindLDR on a Windows PC. Since WindLDR can load existing user programs made for IDEC's preceding PLCs such as all FA series, MICRO-1, MICRO^3, and MICRO^{3}C, your software assets can be used in the new control system.

Digital I/O points can be 480 total at the maximum when using an expansion power supply module.

Program capacity is 16K words (8K steps).

Features

Connect to Open Networks

The OpenNet Controller can be connected to the three major open networks; INTERBUS, DeviceNet, and LONWORKS. The versatile communication capabilities reduce the time and cost needed when constructing, expanding, or modifying production lines. Maintenance for communication lines will also become even easier.

Master Station (Remote I/O)	INTERBUS
Slave Station	DeviceNet, LONWORKS

High-performance CPU Module

The OpenNet Controller CPU module has multiple functions to work as a brain of the control system connected to the open networks. Optimum control systems can be made possible using the OpenNet Controller.

Powerful Communication Functions

In addition to connection to the open networks, the OpenNet Controller features three more communication functions.

User Communication	The OpenNet Controller can be linked to external RS232C devices such as computers, modems, printers, and barcode readers, using the user communication function.
Data Link	One OpenNet Controller at the master station can communicate with 31 slave stations through the RS485 line to exchange data and perform distributed control effectively.
Computer Link	When the OpenNet Controller is connected to a computer, operating status and I/O status can be monitored on the computer, data in the CPU can be monitored or updated, and user programs can be downloaded and uploaded. A maximum of 32 OpenNet Controller CPUs can be connected to one computer in the 1:N computer link system.

International Safety Standards and Approvals

The OpenNet Controller is certified by UL and CSA.

Special Functions

The OpenNet Controller features various special functions packed in the small housing as described below. For details about these functions, see the following chapters.

"Keep" or "Clear" Designation of CPU Data

Internal relays, shift register bits, counter current values, and data register values can be designated to be kept or cleared when the CPU is powered down. All of these data or a specified range of these operands can be designated as keep or clear types.

Catch Input Function

The catch input function makes sure to receive short input pulses (rising pulse of 40 µsec or falling pulse of 150 µsec minimum) from sensors without regard to the scan time.

Input Filter Function

The input filter can be adjusted for the pulse widths to accept or reject input signals. This function is useful for eliminating input noises and chatter in limit switches.

High-speed Counter Function

The OpenNet Controller has a built-in high-speed counter to make it possible to count up to 65,535 (FFFFh) high-speed pulses which cannot be counted by the normal user program processing. The maximum count input frequency is 10 kHz. This function can be used for simple positioning control and simple motor control.

Key Matrix Function

A matrix configuration consisting of 16 inputs and 16 outputs enables to read a maximum of 256 input signals.

User Program Read / Write Protection

The user program in the CPU module can be protected against reading and/or writing by including a password in the user program. This function is effective for security of user programs.

Week Programmer Function

Week programmer instructions can be programmed to compare the preset date and time with the internal realtime calendar/clock. When the preset values are reached, designated outputs can be turned on and off as programmed for the week.

RUN / STOP Selection at Startup when "Keep" Data is Broken

When data to be kept such as "keep" designated counter values are broken while the CPU is powered down, the user can select whether the CPU starts to run or not to prevent undesirable operation at the next startup.

Module ID Registration

Another protection method to run or stop operation is the module ID registration. When disparity is found between the module ID registration and actual modules in the system setup, the CPU can be made to start to run or not.

User Memory Download from Memory Card

A user program can be transferred using WindLDR from a computer to a miniature memory card. The handy miniature card can be inserted into the CPU module to download the user program. User programs can be replaced without the need for connecting to a computer. This feature is available on CPU modules FC3A-CP2KM and FC3A-CP2SM.

Constant Scan Time

The scan time may vary whether basic and advanced instructions are executed or not depending on input conditions to these instructions. When performing repetitive control, the scan time can be made constant by entering a required scan time value into a special data register reserved for constant scan time.

Keep Output Status during User Program Download

Outputs can be designated to maintain the current statuses when downloading a user program from WindLDR to the CPU. This function can be used when the output status change does not occur frequently.

Stop and Reset Inputs

Any input number can be designated as a stop or reset input to control the OpenNet Controller operation.

System Setup

This section describes various system setup configurations for using powerful communication functions of the OpenNet Controller.

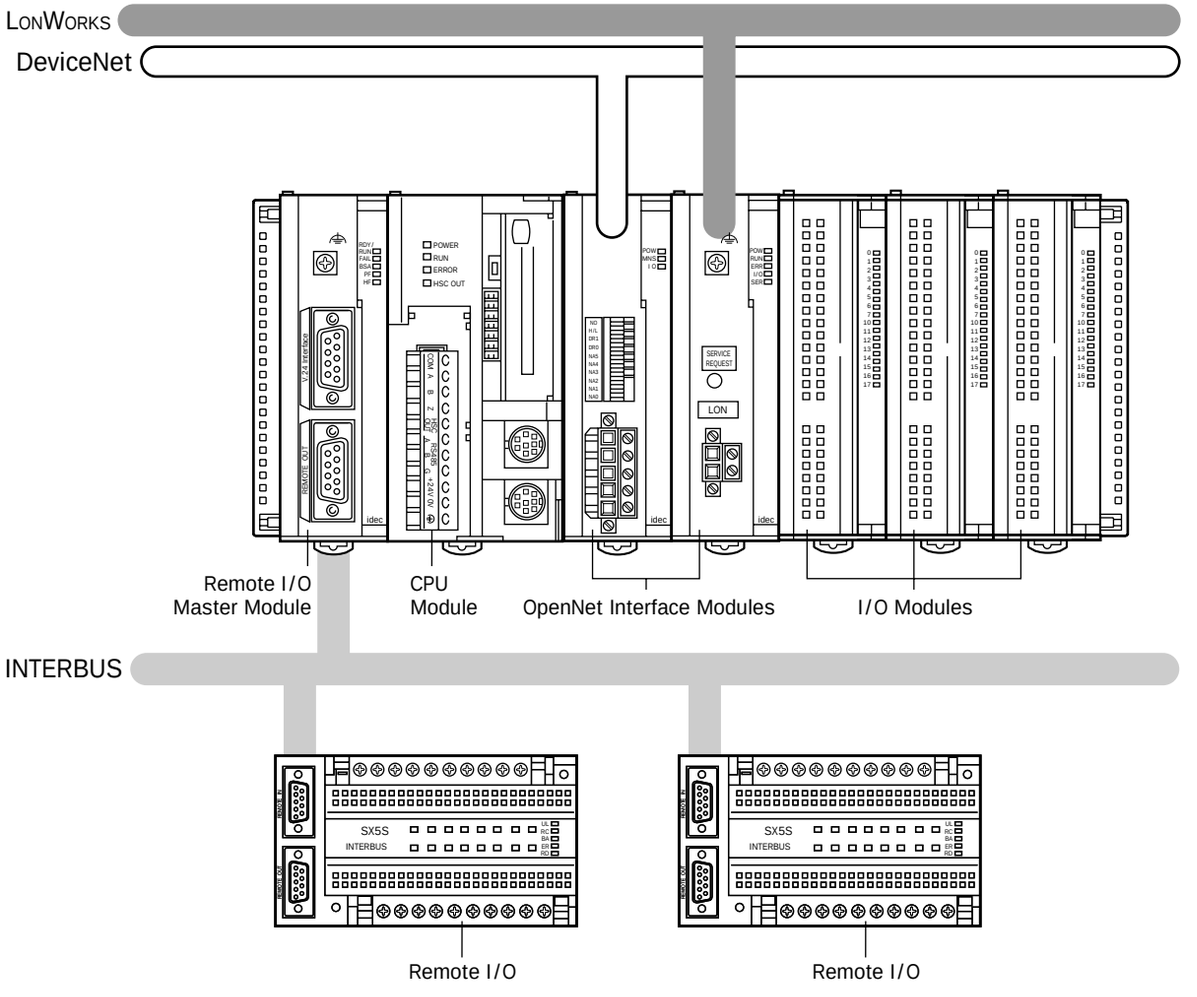
Open Network Communication System

The OpenNet Controller can be connected to three open network communication lines — DeviceNet, LONWORKS, and INTERBUS.

OpenNet interface modules are available for communication through DeviceNet and LONWORKS networks. The OpenNet interface modules, such as DeviceNet slave modules and LONWORKS interface modules, serve as a slave station or node in the network.

A remote I/O system can be set up using a remote I/O master module mounted next to the CPU module and SX5S communication I/O terminals at remote I/O slave stations. When using 32 SX5S modules with 16 input or output points, a total of 512 I/O points can be distributed to 32 remote s lave stations at the maximum. The remote I/O network uses the INTERBUS protocol for communication. The total cable length can be 12.8 km (7.95 miles) maximum.

One remote I/O master module can be mounted with the OpenNet Controller CPU module. In addition, a maximum of seven functional modules including OpenNet interface modules and analog I/O modules can be mounted with one OpenNet Controller CPU module.



SX5S Communication I/O Terminals

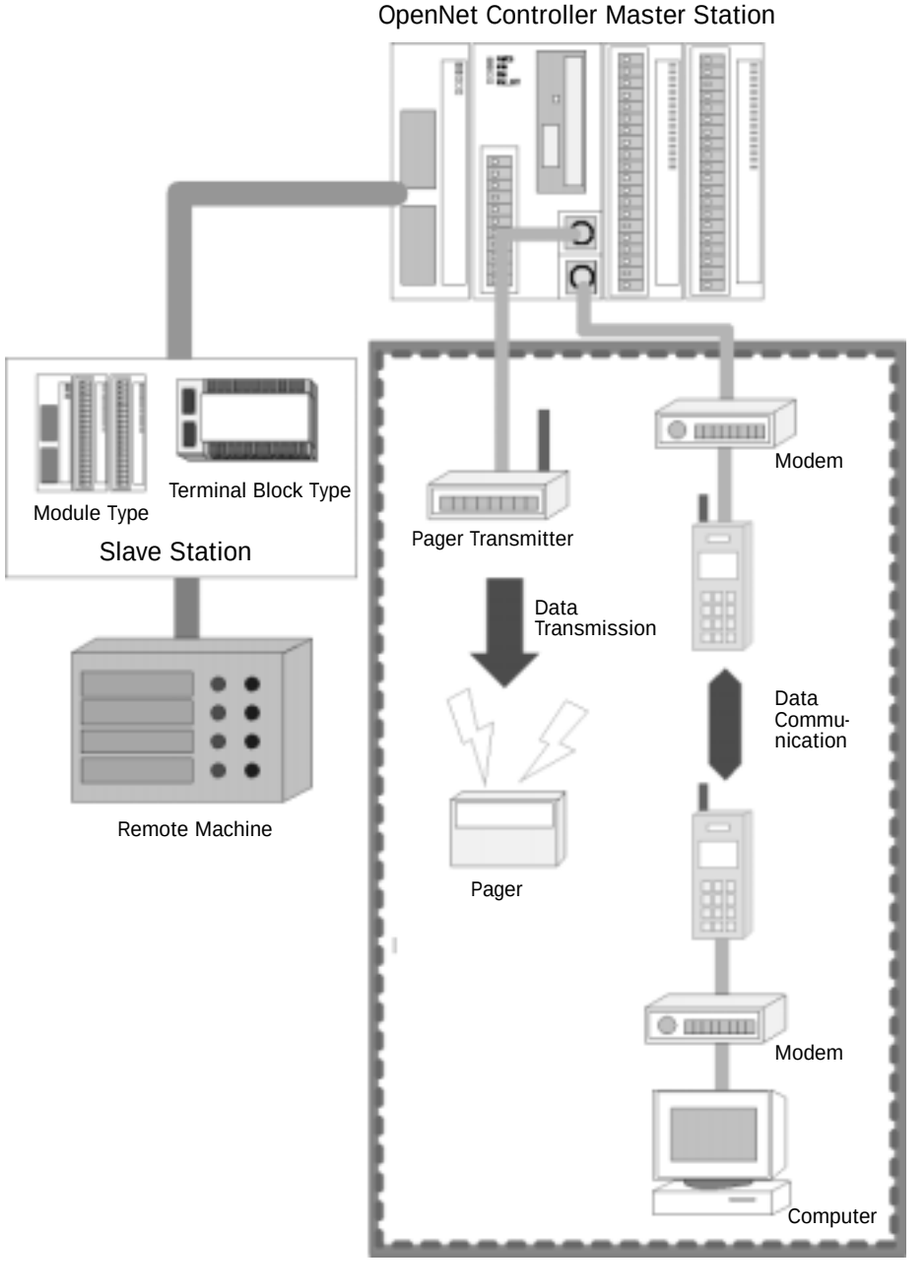
User Communication System

The OpenNet Controller CPU module has two RS232C ports and one RS485 port to control two RS232C devices and one RS485 device such as IDEC's HG series operator interface at the same time.

The figure below illustrates a system setup of remote I/O and user communication. In this example, the I/O statuses of a remote machine are transferred through the remote I/O line to the CPU. The data received through modems is monitored on a computer and also sent to a pager transmitter.

For details about the remote I/O system, see page 24-1.

For details about the modem mode, see page 23-1.

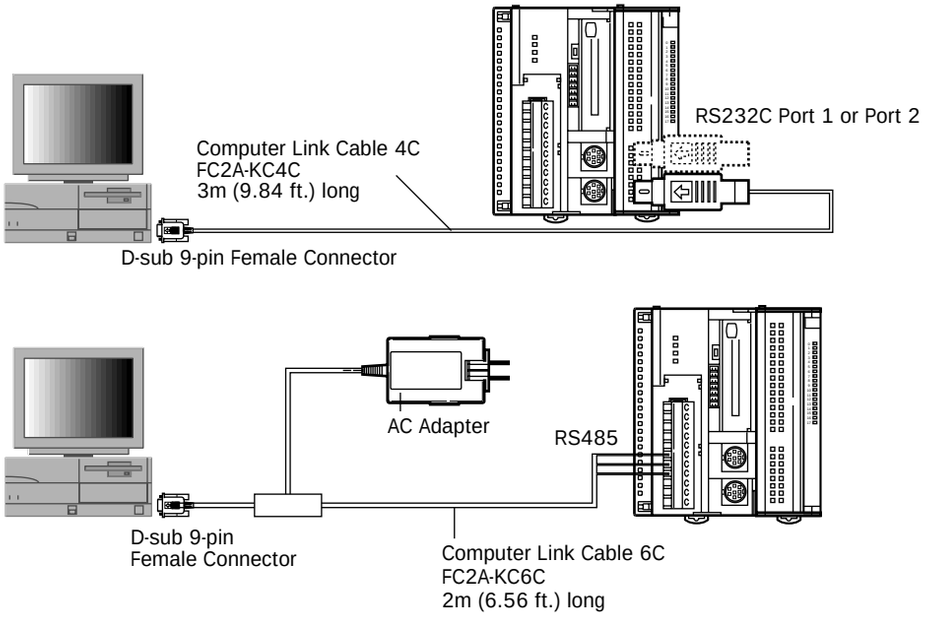


Computer Link System

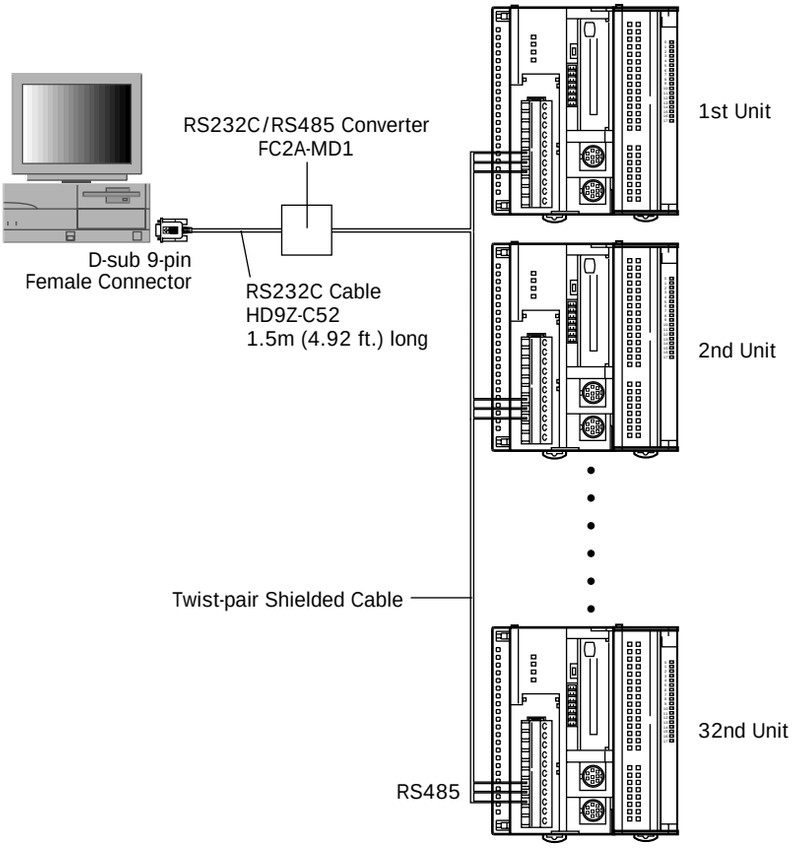
When the OpenNet Controller is connected to a computer, operating status and I/O status can be monitored on the computer, data in the CPU module can be monitored or updated, and user programs can be downloaded and uploaded. A maximum of 32 OpenNet Controller CPU modules can be connected to one computer in the 1:N computer link system.

For details about the computer link communication, see page 22-1.

Computer Link 1:1 Communication



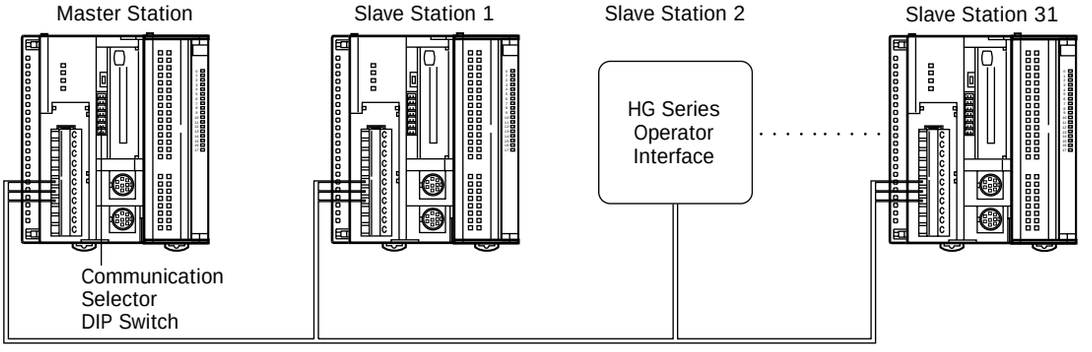
Computer Link 1:N Communication



Data Link System

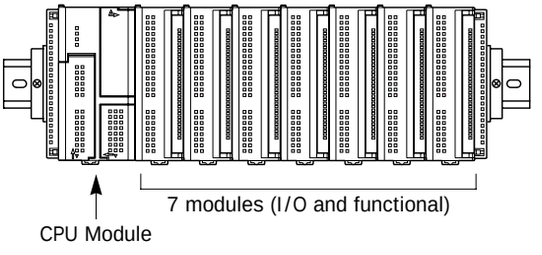
One OpenNet Controller at the master station can communicate with 31 slave stations through the RS485 line to exchange data and perform distributed control effectively. The RS485 terminals are connected with each other using a 2-core twisted pair cable.

For details about the data link communication, see page 21-1.



Basic System

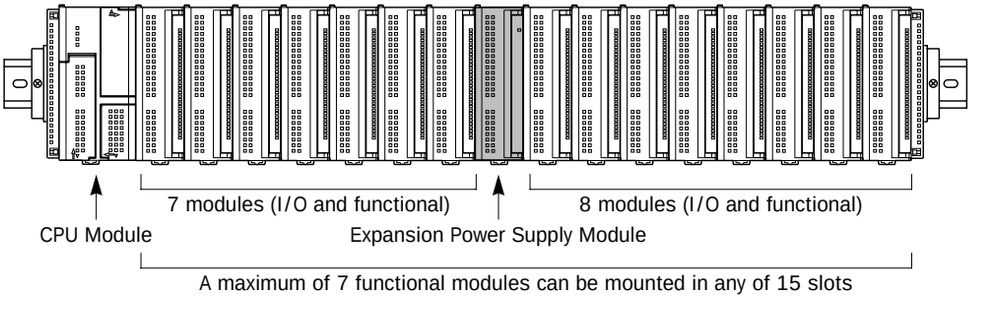
The OpenNet Controller CPU module can be mounted with seven modules including digital I/O and functional modules such as analog I/O, DeviceNet slave, and LONWORKS interface modules to set up a stand alone system. When using seven digital I/O modules, the I/O points can be 224 points at the maximum.



Expansion System

The FC3A-EA1 expansion power supply module is used to mount more than seven I/O and functional modules. When a maximum of 15 I/O modules are mounted, the number of I/O points is expanded from 224 to 480 maximum.

Whether an expansion power supply module is used or not, seven functional modules such as analog I/O, DeviceNet slave, and LONWORKS interface modules can be mounted at the maximum in either the normal or expansion slots.



2: MODULE SPECIFICATIONS

Introduction

This chapter describes OpenNet Controller modules, parts names and specifications of each module.

Available modules include CPU modules, digital I/O modules, analog I/O modules, expansion power supply module, remote I/O master module, and OpenNet interface modules such as DeviceNet slave and LONWORKS interface modules.

Analog I/O modules and OpenNet interface modules are also called functional modules. A maximum of seven functional modules can be mounted with one CPU module.

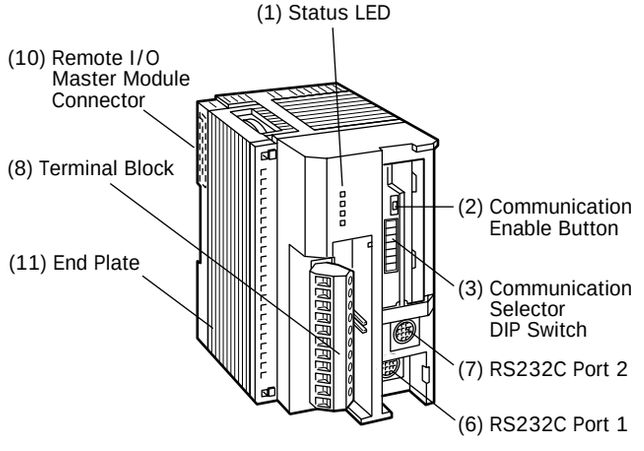
CPU Module

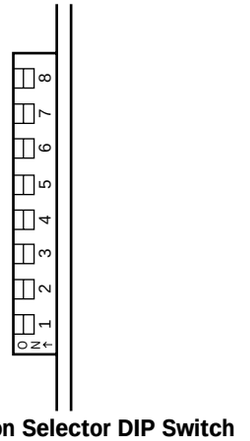
The CPU modules are available in sink and source output types which have a transistor sink or source output of the high-speed counter, respectively. Either type is available with or without a memory card connector. All CPU modules have two RS232C ports and one RS485 port.

CPU Module Type Numbers

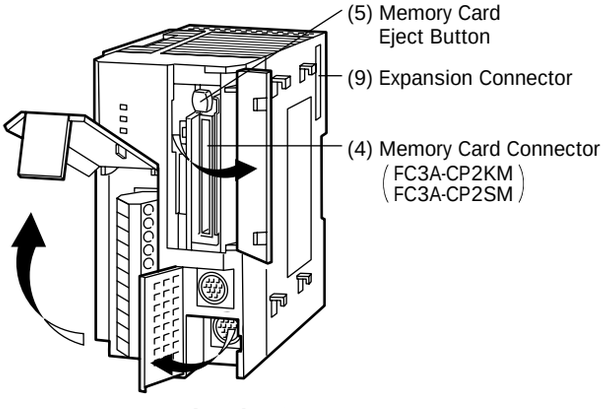
CPU Module Types	Without Memory Card Connector	With Memory Card Connector
High-speed Counter Sink Output Type	FC3A-CP2K	FC3A-CP2KM
High-speed Counter Source Output Type	FC3A-CP2S	FC3A-CP2SM

Parts Description





Communication Selector DIP Switch



Opening the Covers

Functions of each part are described on the following pages.

(1) Status LED

POWER	Turns on when power is supplied to the CPU
RUN	Turns on when the CPU is running
ERROR	Turns on or flashes when an error occurs
HSC OUT	Turns on when the high-speed counter comparison output is on

(2) Communication Enable Button

Enables the communication mode selected with the communication selector DIP switch. When the communication selector DIP switch setting is changed while the CPU is powered up, press this button to enable the new communication mode for the RS485 and RS232C ports.

(3) Communication Selector DIP Switch

Selects the communication mode for the RS485 and RS232C ports, and also selects the device number for the CPU in the computer link or data link communication network.

DIP Switch No.	Function	Setting	
1	RS485 port communication mode	ON: Data link mode	OFF: Maintenance mode
2	RS232C port 1 communication mode	ON: User communication mode	OFF: Maintenance mode
3	RS232C port 2 communication mode	ON: User communication mode	OFF: Maintenance mode
4 to 8	Device number selection	Device numbers 0 through 31 for the CPU in the computer link or data link communication network	

Data link mode: Used for data link communication

User communication mode: Used for user communication or modem communication

Maintenance mode: Used for computer link communication between the CPU and WindLDR on computer

After changing the settings of the communication selector DIP switch while the CPU is powered up, press the communication enable button for more than 4 seconds until the ERROR LED blinks once; then the new communication mode for the RS485 or RS232C port takes effect. When the CPU is powered up, the CPU checks the settings of the communication selector DIP switch and enables the selected communication mode and device number automatically. You have to press the communication enable button only when you change the DIP switch settings while the CPU is powered up.

Do not power up the CPU while the communication enable button is depressed and do not press the button unless it is necessary.

(4) Memory Card Connector

Plug a miniature memory card into the memory card connector. When a memory card is inserted, the CPU runs the user program contained in the memory card instead of the user program stored in the CPU memory.

The memory card connector is provided on CPU modules FC3A-CP2KM and FC3A-CP2SM.

(5) Memory Card Eject Button

Press this button to eject the memory card from the CPU module.

(6) RS232C Port 1

Communication port used for the maintenance and user communication modes. User communication instructions TXD1 and RXD1 send and receive data through this port.

(7) RS232C Port 2

Communication port used for the maintenance and user communication modes. User communication instructions TXD2 and RXD2 send and receive data through this port.

(8) Terminal Block

Function	Terminal No.	Symbol	Assignment
High-speed Counter Terminals	1	COM	High-speed counter COM
	2	A	High-speed counter phase A
	3	B	High-speed counter phase B
	4	Z	High-speed counter phase Z
	5	HSC OUT	High-speed counter comparison output
RS485 Port	6	RS485 A	RS485 line A
	7	RS485 B	RS485 line B
	8	RS485 G	RS485 line SG
Power Supply Terminals	9	+24V	Power supply +24V DC
	10	0V	Power supply 0V DC
	11	⏚	Frame ground

(9) Expansion Connector

For connecting a digital I/O module or functional module.

(10) Remote I/O Master Module Connector

For connecting a remote I/O master module compatible with INTERBUS. This connector is located on the left side of the CPU module and usually covered with an end plate. When connecting a remote I/O master module, remove the end plate from the CPU module and attach the remote I/O master module.

(11) End Plate

A pair of end plates are supplied with the CPU module. Remove the end plate from the CPU module before connecting digital I/O and functional modules, then attach the end plates on both sides of the assembly. For removing the end plates, see page 3-3.

General Specifications

Normal Operating Conditions

Operating Temperature	0 to 55°C (operating ambient temperature)
Storage Temperature	–25 to +70°C
Relative Humidity	Level RH1, 30 to 95% (non-condensing)
Pollution Degree	2 (IEC 60664-1)
Corrosion Immunity	Free from corrosive gases
Altitude	Operation: 0 to 2,000m (0 to 6,565 feet) Transport: 0 to 3,000m (0 to 9,840 feet)
Vibration Resistance	10 to 57 Hz amplitude 0.075 mm, 57 to 150 Hz acceleration 9.8 m/sec^2 (1G) 10 sweep cycles per axis on each of three mutually perpendicular axes (total 80 minutes each) (IEC1131)
Shock Resistance	147 m/sec^2 (15G), 11 msec duration, 3 shocks per axis, on three mutually perpendicular axes (IEC1131)
Weight (approx.)	FC3A-CP2K/CP2S (w/o memory card connector): 290g FC3A-CP2KM/CP2SM (w/memory card connector): 300g

Power Supply

Rated Power Voltage	24V DC
Allowable Voltage Range	19 to 30V DC (including ripple)
Dielectric Strength	Between power terminal and FG: 500V AC, 1 minute Between I/O terminal and FG: 1,500V AC, 1 minute
Maximum Input Current	1.5A at 24V DC
Power Consumption	8.4W (24V): CPU module + 48 I/Os (32-DC input module + 16-relay output module) 18W (24V): CPU module + 128 I/Os (32-DC input module × 2 + 16-DC input module + 16-relay output module × 3) 11.8W (24V): CPU module + remote I/O master module + 48 I/Os (32-DC input module + 16-relay output module) 21.4W (24V): CPU module + remote I/O master module + 128 I/Os (32-DC input module × 2 + 16-DC input module + 16-relay output module × 3)
Allowable Momentary Power Interruption	10 msec (24V DC), Level PS-2 (EN61131)
Insulation Resistance	Between power terminal and FG: 10 MΩ minimum (500V DC megger) Between I/O terminal and FG: 10 MΩ minimum (500V DC megger)
Inrush Current	40A maximum (24V DC)
Ground	Grounding resistance: 100Ω maximum
Grounding Wire	UL1015 AWG22, UL1007 AWG18
Power Supply Wire	UL1015 AWG22, UL1007 AWG18
Effect of Improper Power Supply Connection	Reverse polarity: No operation, no damage Improper voltage or frequency: Permanent damage may be caused Improper lead connection: Permanent damage may be caused

Function Specifications

CPU Module Specifications

Program Capacity		16K words (8K steps)
I/O	**Quantity of Slots**	7 slots maximum (without using expansion power supply module) 15 slots maximum (when using expansion power supply module)
	Maximum Digital I/O Points	224 points (without using expansion power supply module) 480 points (when using expansion power supply module) • 56 points when using 7 modules of 8-point I/O • 112 points when using 7 modules of 16-point I/O • 224 points when using 7 modules of 32-point I/O • 480 points when using 15 modules of 32-point I/O
User Program Memory		Flash ROM, RAM, memory card
RAM Backup	**Backup Duration**	Approx. 30 days (typical) at 25°C after backup battery fully charged
	Backup Data	Internal relay, shift register, counter, data register
	Battery	Lithium secondary battery
	Charging Speed	Approx. 2 hours from 0% to 90% of full charge
	Battery Life	Approx. 10 years using in cycles of 9-hour charging, 15-hour discharging
	Replaceability	Impossible
Control System		Stored program system (not in compliance with EN61131-3)
Instruction Words		37 basic instructions 65 advanced instructions
Processing Time		Basic/advanced instruction: See page A-1. END processing: See page A-2. Clock/calendar processing: One cycle in 100 msec (see page A-2) Data link master station processing: See pages page 21-1 and page 21-10.
Internal Relay		2,048 points
Data Register		8,000 points
Counter		256 points (adding, dual pulse reversible, up/down selection reversible)
Timer		256 points (1-sec, 100-msec, 10-msec, 1-msec)
Catch Input		First 8 channels of each input module can be designated as catch inputs Minimum turn on pulse width: 40 µsec maximum Minimum turn off pulse width: 150 µsec maximum
Calendar/Clock		Accuracy: ±30 sec/month at 25°C (typical) Backup duration: Approx. 30 days 25°C (typical)
Self-diagnostic Function		Keep data sum check, WDT check, user program RAM sum check, user program ROM sum check, user program write check, power failure check, timer/counter preset value sum check, calendar/clock error check, user program syntax check, data link connection check, I/O bus check, I/O bus initialization check, user program execution check
Start/Stop Method		Turning power on and off Start/stop command in WindLDR Turning start control special internal relay M8000 on and off Turning designated stop or reset input off and on

System Statuses at Stop, Reset, and Restart

Mode	Outputs	Internal Relays, Shift Registers, Counters, Data Registers		Timer Current Value	Link Register (Note)
		Keep Type	Clear Type		
Run	Operating	Operating	Operating	Operating	Operating
Reset (Reset input ON)	OFF	OFF/Reset to zero	OFF/Reset to zero	Reset to zero	Reset to zero
Stop (Stop input ON)	OFF	Unchanged	Unchanged	Unchanged	Unchanged
Restart	Unchanged	Unchanged	OFF/Reset to zero	Reset to preset	Unchanged

Note: Link registers used as outputs are turned off like outputs.

Communication Function

Communication Port	RS232C Port 1	RS232C Port 2	RS485 Port
Standards	EIA RS232C	EIA RS232C	EIA RS485
Baud Rate	19,200 bps	19,200 bps	Computer link: 19,200 bps Data link: 38,400 bps
Maintenance Communication	Possible	Possible	Possible
User Communication	Possible	Possible	Impossible
Data Link Communication	Impossible	Impossible	Possible
Quantity of Slave Stations	—	—	31
Maximum Cable Length	Special cable	Special cable	200m *
Isolation between Power Supply and Communication Port	Not isolated	Not isolated	Not isolated

* Recommended cable for data link: Twisted-pair shielded cable with a minimum core wire diameter of 0.9 mm. Conductor resistance 85 Ω/km maximum, shield resistance 20 Ω/km maximum.

Communication Selector DIP Switch Settings

DIP Switch No.	Function	Setting	
1	RS485 port communication mode	ON: Data link mode	OFF: Maintenance mode
2	RS232C port 1 communication mode	ON: User communication mode	OFF: Maintenance mode
3	RS232C port 2 communication mode	ON: User communication mode	OFF: Maintenance mode
4 to 8	Device number selection	Device numbers 0 through 31 for the CPU	

Memory Card

Card Type	Miniature memory card
Accessible Memory Capacity	2MB, 5V type
Download Destination	CPU module (FC3A-CP2KM and -CP2SM)
Software for Writing Card	WindLDR
Quantity of Stored Programs	One user program stored on one memory card
Program Execution Priority	When a memory card is inserted, user program on the memory card is executed.

High-speed Counter

Maximum Counting Frequency	10 kHz
Counting Range	0 to 65535 (16 bits)
Operation Mode	Rotary encoder mode Dual-pulse reversible counter mode
Comparison Output	Transistor sink or source output 1 point (500mA) Output delay: 20 µsec

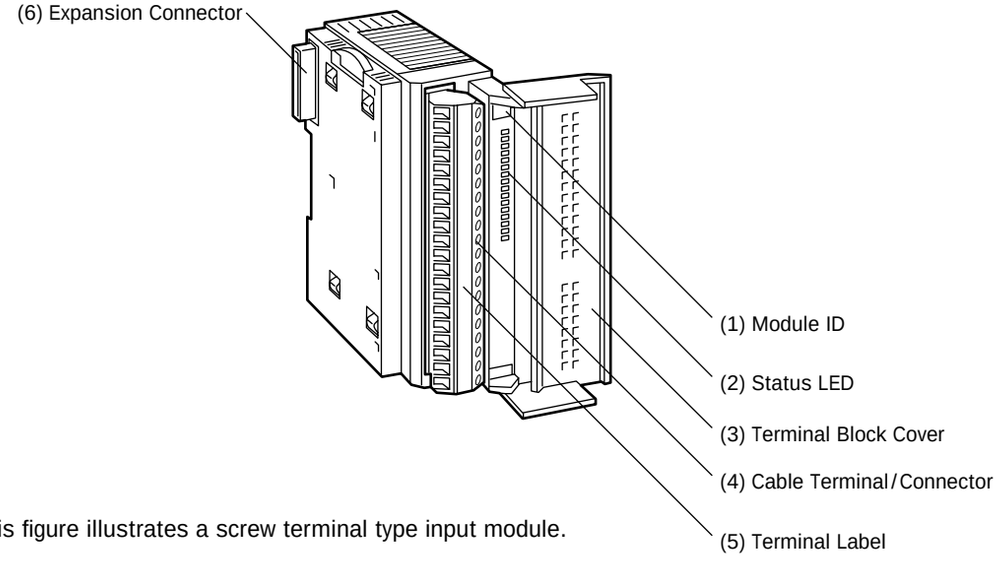
Input Module

Digital input modules are available in 16- and 32-point DC input modules and 8-point AC input modules. Four different connector/terminal styles are available.

Input Module Type Numbers

Module Name	16-point DC Input	32-point DC Input	8-point AC Input
Screw Terminal	FC3A-N16B1	—	FC3A-N08A11
Nylon Connector	FC3A-N16B3	—	—
	—	FC3A-N32B4	—
Fujitsu Connector	—	FC3A-N32B5	—

Parts Description



This figure illustrates a screw terminal type input module.

(1) Module ID — Indicates the input module ID.

DC IN: 24V DC sink/source input, 16 or 32 points
AC IN: 100V AC input, 8 points

(2) Status LED — Turns on when input is on.

(3) Terminal Block Cover — The terminal block cover flips open to the right.
When using long ferrules for wiring, the terminal block cover may be removed.

(4) Cable Terminal / Connector — Five different terminal/connector styles are available for wiring.

(5) Terminal Label — Indicates terminal numbers 1 through 20 on the terminal block.

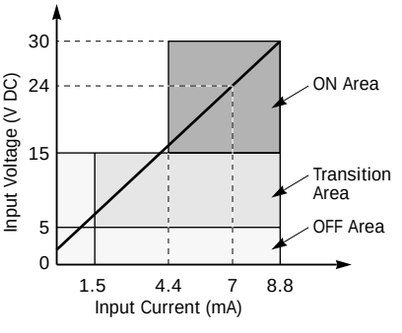
(6) Expansion Connector — Connects to CPU and other modules.

16-point DC Input Module Specifications

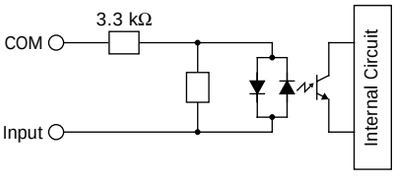
Type No.	FC3A-N16B1	FC3A-N16B3
Rated Input Voltage	24V DC sink/source input signal	
Input Voltage Range	19 to 30V DC	
Rated Input Current	7 mA/point (24V DC)	
Terminal Arrangement	See Terminal Arrangement charts on pages 2-11 and 2-12.	
Input Impedance	3.4 kΩ	
Turn ON Time (24V DC)	20 µsec + filter preset	
Turn OFF Time (24V DC)	120 µsec + filter preset	
Input Filter	0 msec, 0.5 msec, 1 msec, 2 msec, 4 msec, 8 msec, 16 msec, 32 msec	
Isolation	Between input terminals: Not isolated Internal circuit: Photocoupler isolated	
External Load for I/O Interconnection	Not needed	
Signal Determination Method	Static	
Effect of Improper Input Connection	Both sinking and sourcing input signals can be connected. If any input exceeding the rated value is applied, permanent damage may be caused.	
Cable Length	3m (9.84 ft.) in compliance with electromagnetic immunity	
Connector on Mother Board	Screw Terminal Block MSTBA2.5/20-G5.08 (Phoenix Contact)	Nylon Connector B10PS-VH × 2 (J.S.T. Mfg.)
Connector Insertion/Removal Durability	100 times minimum	50 times minimum
Internal Current Draw	All inputs ON: 40 mA (24V DC) All inputs OFF: 10 mA (24V DC)	
Weight (approx.)	210g	180g

Input Operating Range

The input operating range of the Type 1 (EN61131) input module is shown below:



Input Internal Circuit

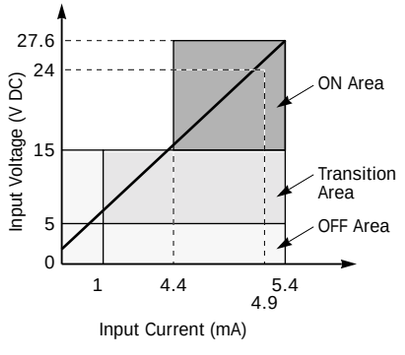


32-point DC Input Module Specifications

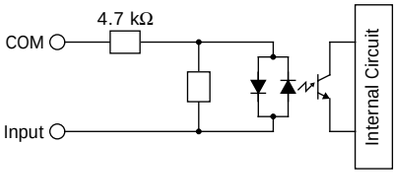
Type No.	FC3A-N32B4	FC3A-N32B5
Rated Input Voltage	24V DC sink/source input signal	
Input Voltage Range	20.4 to 27.6V DC	
Rated Input Current	4.9 mA/point (24V DC)	
Terminal Arrangement	See Terminal Arrangement charts on pages 2-13 and 2-14.	
Input Impedance	4.7 kΩ	
Turn ON Time (24V DC)	20 µsec + filter preset	
Turn OFF Time (24V DC)	120 µsec + filter preset	
Input Filter	0 msec, 0.5 msec, 1 msec, 2 msec, 4 msec, 8 msec, 16 msec, 32 msec	
Isolation	Between input terminals: Not isolated Internal circuit: Photocoupler isolated	
External Load for I/O Interconnection	Not needed	
Signal Determination Method	Static	
Effect of Improper Input Connection	Both sinking and sourcing input signals can be connected. If any input exceeding the rated value is applied, permanent damage may be caused.	
Cable Length	3m (9.84 ft.) in compliance with electromagnetic immunity	
Connector on Mother Board	Nylon Connector BS18P-SHF-1AA × 2 (J.S.T. Mfg.)	Fujitsu Connector FCN-365P040-AU (Fujitsu)
Connector Insertion/Removal Durability	50 times minimum	500 times minimum
Internal Current Draw	All inputs ON: 50 mA (24V DC) All inputs OFF: 10 mA (24V DC)	
Allowable Simultaneous ON Inputs	70% maximum	
Weight (approx.)	230g	240g

Input Operating Range

The input operating range of the Type 1 (EN61131) input module is shown below:



Input Internal Circuit

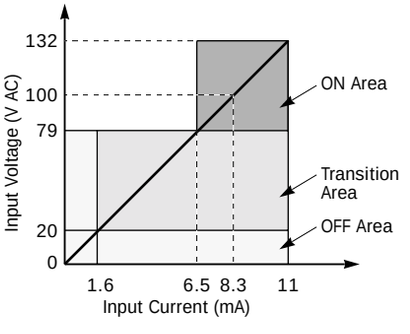


8-point AC Input Module Specifications

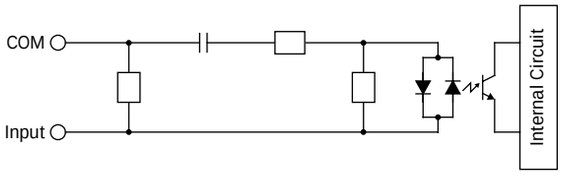
Type No.	FC3A-N08A11
Rated Input Voltage	100 to 120V AC
Input Voltage Range	85 to 132V AC
Rated Input Current	8.3 mA/point (100V AC, 60 Hz)
Terminal Arrangement	See Terminal Arrangement chart on page 2-15.
Input Impedance	12 kΩ (60 Hz)
Turn ON Time (100V AC)	20 msec maximum
Turn OFF Time (100V AC)	20 msec maximum
Isolation	Between input terminals: Not isolated Internal circuit: Photocoupler isolated
External Load for I/O Interconnection	Not needed
Signal Determination Method	Static
Effect of Improper Input Connection	If any input exceeding the rated value is applied, permanent damage may be caused.
Cable Length	3m (9.84 ft.) in compliance with electromagnetic immunity
Connector on Mother Board	Screw Terminal Block MSTBA2.5/20-G5.08 (Phoenix Contact)
Connector Insertion/Removal Durability	100 times minimum
Internal Current Draw	All inputs ON: 30 mA (24V DC) All inputs OFF: 20 mA (24V DC)
Weight (approx.)	220g

Input Operating Range

The input operating range of the Type 1 (EN61131) input module is shown below:



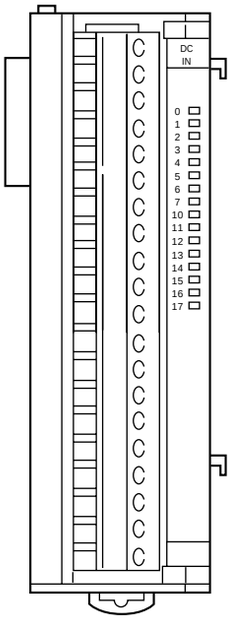
Input Internal Circuit



Input Module Terminal Arrangement

FC3A-N16B1 (16-point DC Input Module) — Screw Terminal Type

Applicable Connector: SMSTB2.5/20-ST-5.08 (Phoenix Contact)

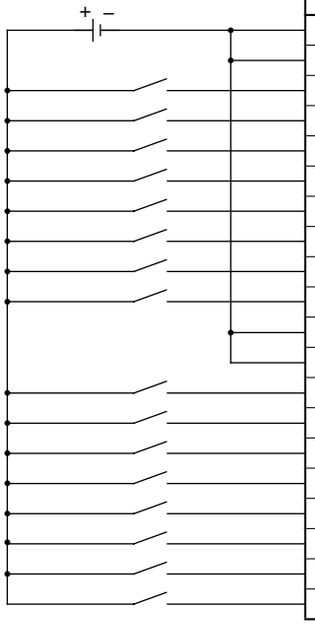


Terminal No.	Name
1	COM
2	COM
3	I0
4	I1
5	I2
6	I3
7	I4
8	I5
9	I6
10	I7
11	COM
12	COM
13	I10
14	I11
15	I12
16	I13
17	I14
18	I15
19	I16
20	I17

Wiring Schematic

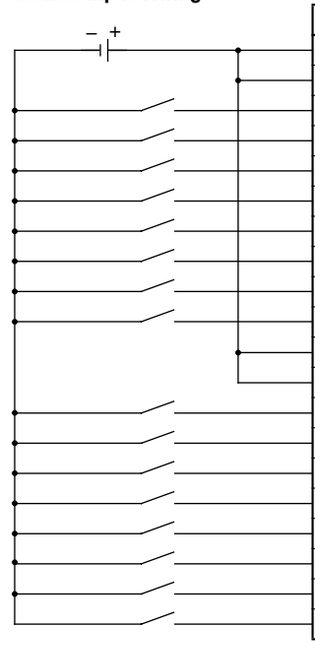
- COM terminals are connected together internally.
- Terminal numbers are marked on the terminal block label on the input module.
- For wiring precautions, see page 3-5.

Sink Input Wiring



Terminal No.	Name
1	COM
2	COM
3	I0
4	I1
5	I2
6	I3
7	I4
8	I5
9	I6
10	I7
11	COM
12	COM
13	I10
14	I11
15	I12
16	I13
17	I14
18	I15
19	I16
20	I17

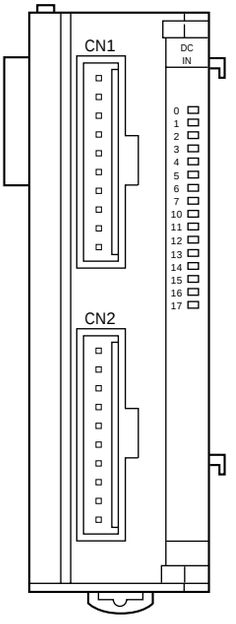
Source Input Wiring



Terminal No.	Name
1	COM
2	COM
3	I0
4	I1
5	I2
6	I3
7	I4
8	I5
9	I6
10	I7
11	COM
12	COM
13	I10
14	I11
15	I12
16	I13
17	I14
18	I15
19	I16
20	I17

FC3A-N16B3 (16-point DC Input Module) — Nylon Connector Type

Applicable Connectors: **VHR-10N (J.S.T. Mfg.)**
SVH-21T-P1.1 (J.S.T. Mfg.)



CN1

Terminal No.	Name
1	COM
2	COM
3	I0
4	I1
5	I2
6	I3
7	I4
8	I5
9	I6
10	I7

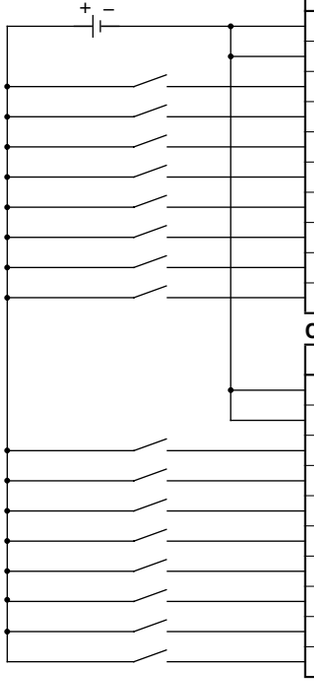
CN2

Terminal No.	Name
1	COM
2	COM
3	I10
4	I11
5	I12
6	I13
7	I14
8	I15
9	I16
10	I17

Wiring Schematic

- COM terminals are connected together internally.
- Terminal numbers are marked on the female connector on the cable.
- For wiring precautions, see page 3-5.

Sink Input Wiring



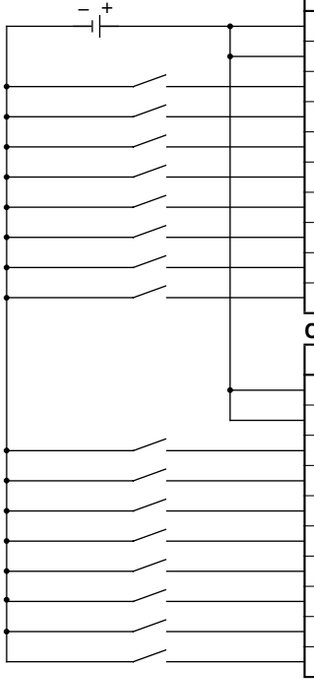
CN1

Terminal No.	Name
1	COM
2	COM
3	I0
4	I1
5	I2
6	I3
7	I4
8	I5
9	I6
10	I7

CN2

Terminal No.	Name
1	COM
2	COM
3	I10
4	I11
5	I12
6	I13
7	I14
8	I15
9	I16
10	I17

Source Input Wiring



CN1

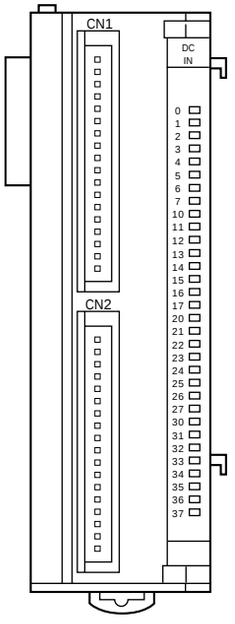
Terminal No.	Name
1	COM
2	COM
3	I0
4	I1
5	I2
6	I3
7	I4
8	I5
9	I6
10	I7

CN2

Terminal No.	Name
1	COM
2	COM
3	I10
4	I11
5	I12
6	I13
7	I14
8	I15
9	I16
10	I17

FC3A-N32B4 (32-point DC Input Module) — Nylon Connector Type

Applicable Connector: **H18-SHF-AA (J.S.T. Mfg.)**
SHF-001T-0.8BS (J.S.T. Mfg.)



CN1

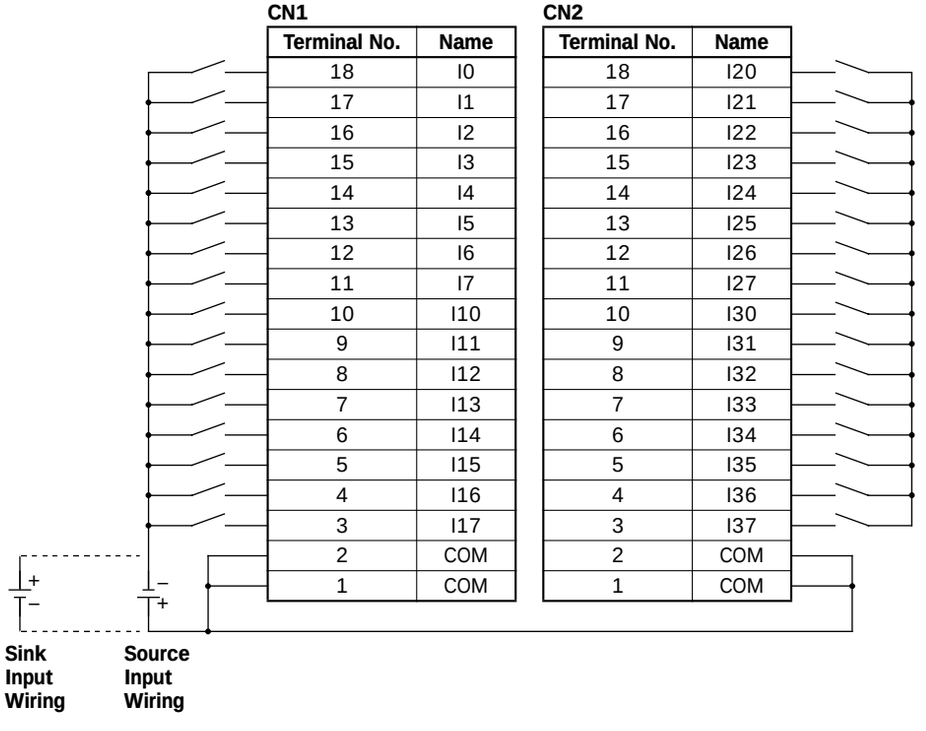
Terminal No.	Name
18	I0
17	I1
16	I2
15	I3
14	I4
13	I5
12	I6
11	I7
10	I10
9	I11
8	I12
7	I13
6	I14
5	I15
4	I16
3	I17
2	COM
1	COM

CN2

Terminal No.	Name
18	I20
17	I21
16	I22
15	I23
14	I24
13	I25
12	I26
11	I27
10	I30
9	I31
8	I32
7	I33
6	I34
5	I35
4	I36
3	I37
2	COM
1	COM

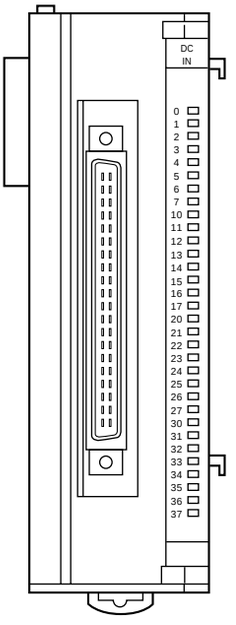
Wiring Schematic

- COM terminals are connected together internally.
- Terminal numbers are marked on the female connector on the cable.
- For wiring precautions, see page 3-5.



FC3A-N32B5 (32-point DC Input Module) — Fujitsu Connector Type

Applicable Connector: FCN-367J040-AU (Fujitsu)

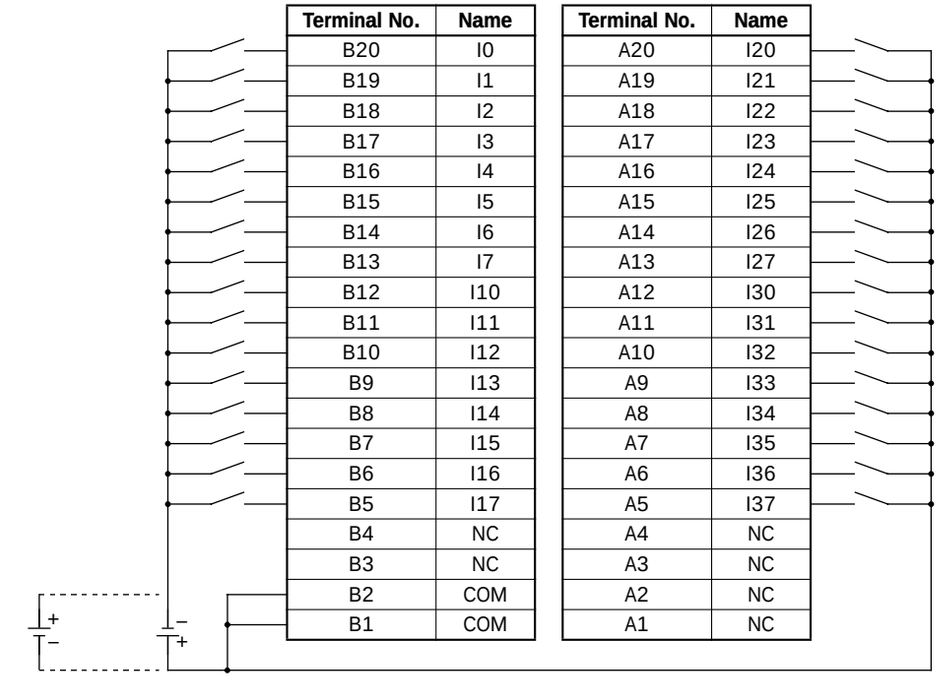


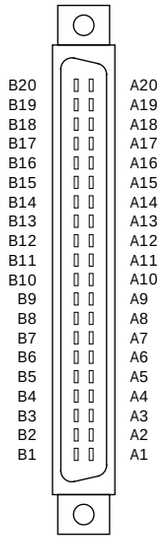
Terminal No.	Name
B20	I0
B19	I1
B18	I2
B17	I3
B16	I4
B15	I5
B14	I6
B13	I7
B12	I10
B11	I11
B10	I12
B9	I13
B8	I14
B7	I15
B6	I16
B5	I17
B4	NC
B3	NC
B2	COM
B1	COM

Terminal No.	Name
A20	I20
A19	I21
A18	I22
A17	I23
A16	I24
A15	I25
A14	I26
A13	I27
A12	I30
A11	I31
A10	I32
A9	I33
A8	I34
A7	I35
A6	I36
A5	I37
A4	NC
A3	NC
A2	NC
A1	NC

Wiring Schematic

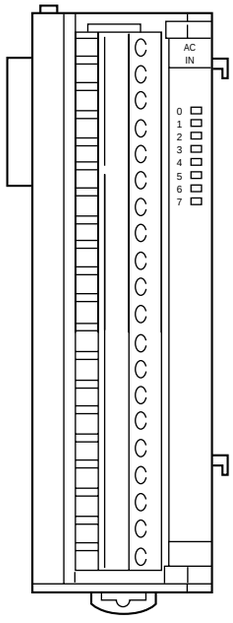
- COM terminals are connected together internally.
- Terminal numbers are the front view of the male connector on the input module.
- For wiring precautions, see page 3-5.





FC3A-N08A11 (8-point AC Input Module) — Screw Terminal Type

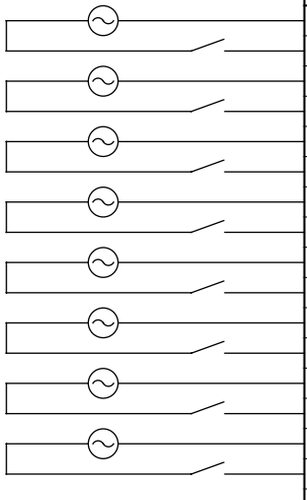
Applicable Connector: SMSTB2.5/20-ST-5.08 (Phoenix Contact)



Terminal No.	Name
1	COM0
2	I0
3	COM1
4	I1
5	COM2
6	I2
7	COM3
8	I3
9	COM4
10	I4
11	COM5
12	I5
13	COM6
14	I6
15	COM7
16	I7
17	NC
18	NC
19	NC
20	NC

Wiring Schematic

- COM terminals are *not* connected together internally.
- Terminal numbers are marked on the terminal block label on the input module.
- For wiring precautions, see page 3-5.



Terminal No.	Name
1	COM0
2	I0
3	COM1
4	I1
5	COM2
6	I2
7	COM3
8	I3
9	COM4
10	I4
11	COM5
12	I5
13	COM6
14	I6
15	COM7
16	I7
17	NC
18	NC
19	NC
20	NC

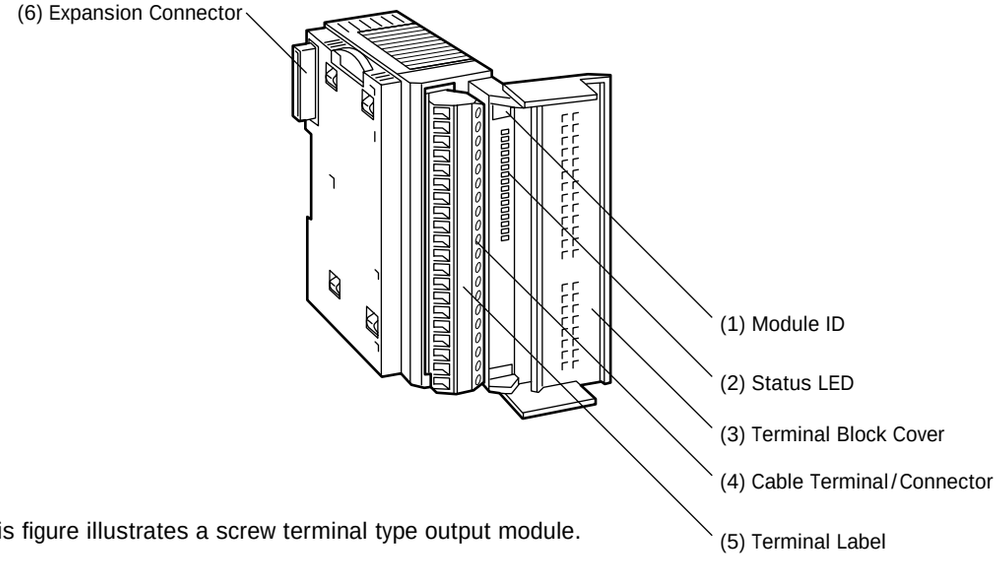
Output Module

Digital output modules are available in 16-point relay output modules, 16- and 32-point transistor sink output modules, and 16-point transistor protect source output modules. Five different connector/terminal styles are available.

Output Module Type Numbers

Module Name	16-point Relay Output	16-point Transistor Sink Output	16-point Transistor Protect Source Output	32-point Transistor Sink Output
Screw Terminal	FC3A-R161	FC3A-T16K1	FC3A-T16P1	—
Nylon Connector	FC3A-R162	—	—	—
	—	FC3A-T16K3	—	—
	—	—	—	FC3A-T32K4
Fujitsu Connector	—	—	—	FC3A-T32K5

Parts Description



This figure illustrates a screw terminal type output module.

(1) Module ID Indicates the output module ID.

Ry OUT: Relay output, 16 points
Tr OUT: Transistor output, 16 or 32 points

(2) Status LED Turns on when output is on.

(3) Terminal Block Cover The terminal block cover flips open to the right.
When using long ferrules for wiring, the terminal block cover may be removed.

(4) Cable Terminal / Connector Six different connector/terminal styles are available

(5) Terminal Label Indicates terminal numbers 1 through 20 on the terminal block.

(6) Expansion Connector Connects to CPU and other modules.

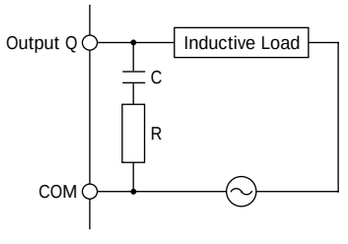
16-point Relay Output Module Specifications

Type No.	FC3A-R161	FC3A-R162
Terminal Arrangement	See Terminal Arrangement charts on pages 2-22 and 2-23.	
Output Points and Common Lines	16 NO contacts in 4 common lines (COM terminals not connected together)	
Maximum Load Current	2A per point	
	8A per common line	7A per common line
Minimum Switching Load	0.1 mA/0.1V DC (reference value)	
Initial Contact Resistance	30 mΩ maximum	
Electrical Life	100,000 operations minimum (rated load 1,800 operations/hour)	
Mechanical Life	20,000,000 operations minimum (no load 18,000 operations/hour)	
Rated Load Voltage (resistive/inductive)	240V AC/2A, 30V DC/2A	
Dielectric Strength	Between output terminal and FG: 1,500V AC, 1 minute Between output terminal and internal circuit: 1,500V AC, 1 minute Between output terminals (COMs): 1,500V AC, 1 minute	
Connector on Mother Board	Screw Terminal Block MSTBA2.5/20-G5.08 (Phoenix Contact)	Nylon Connector B5PS-VH × 4 (J.S.T. Mfg.)
Connector Insertion/Removal Durability	100 times minimum	50 times minimum
Internal Current Draw	All outputs ON: 170 mA (24V DC) All outputs OFF: 20 mA (24V DC)	
Output Delay	Turn ON time: 6 msec maximum Chatter: 6 msec maximum Turn OFF time: 10 msec maximum	
Weight (approx.)	260g	230g

Contact Protection Circuit for Relay Output

Depending on the load, a protection circuit may be needed for the relay output of the OpenNet Controller. Choose a protection circuit from A through D shown below according to the power supply and connect the protection circuit to the outside of the relay output module.

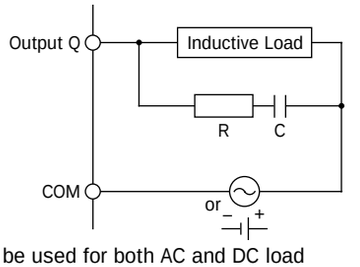
Protection Circuit A



Protection circuit A can be used when the load impedance is smaller than the RC impedance in an AC load power circuit.

C: 0.1 to 1 µF
R: Resistor of about the same resistance value as the load

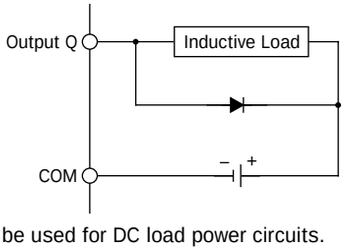
Protection Circuit B



Protection circuit B can be used for both AC and DC load power circuits.

C: 0.1 to 1 µF
R: Resistor of about the same resistance value as the load

Protection Circuit C

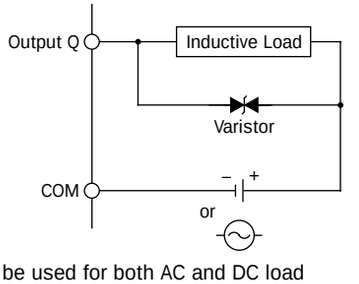


Protection circuit C can be used for DC load power circuits.

Use a diode with the following ratings.

Reverse withstand voltage: Power voltage of the load circuit × 10
Forward current: More than the load current

Protection Circuit D

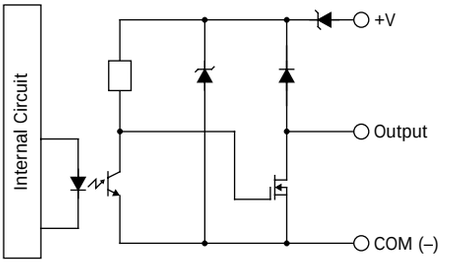


Protection circuit D can be used for both AC and DC load power circuits.

16-point Transistor Sink Output Module Specifications

Type No.	FC3A-T16K1	FC3A-T16K3
Terminal Arrangement	See Terminal Arrangement charts on pages 2-24 and 2-25.	
Rated Load Voltage	24V DC	
Operating Load Voltage Range	19 to 30V DC	
Rated Load Current	0.5A per output point	
Maximum Load Current	0.625A per output point (at 30V DC) 5A per common line (at 30V DC)	
Voltage Drop (ON Voltage)	1V maximum (voltage between COM and output terminals when output is on)	
Inrush Current	5A maximum	
Leakage Current	0.1 mA maximum	
Clamping Voltage	39V±1V	
Maximum Lamp Load	10W	
Inductive Load	L/R = 10 msec (30V DC, 0.5 Hz)	
External Current Draw	100 mA maximum, 24V DC (power voltage at the +V terminal)	
Isolation	Between output terminal and internal circuit: Photocoupler isolated Between output terminals: Not isolated	
Connector on Mother Board	Screw Terminal Block MSTBA2.5/20-G5.08 (Phoenix Contact)	Nylon Connector B10PS-VH × 2 (J.S.T. Mfg.)
Connector Insertion/Removal Durability	100 times minimum	50 times minimum
Internal Current Draw	All outputs ON: 60 mA (24V DC) All outputs OFF: 20 mA (24V DC)	
Output Delay	Turn ON time: 500 µsec maximum Turn OFF time: 500 µsec maximum	
Weight (approx.)	220g	190g

Output Internal Circuit

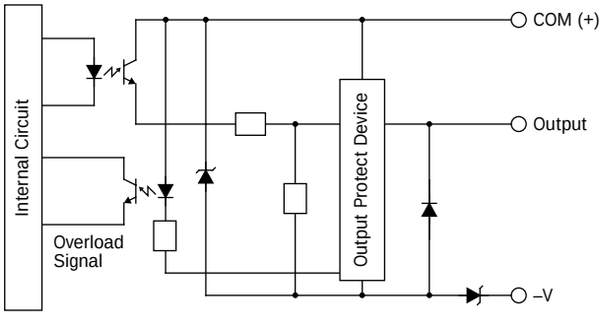


COM terminals are connected together internally.

16-point Transistor Protect Source Output Module Specifications

Type No.	FC3A-T16P1
Terminal Arrangement	See Terminal Arrangement chart on page 2-24.
Rated Load Voltage	24V DC
Operating Load Voltage Range	19 to 30V DC
Rated Load Current	0.5A per output point
Maximum Load Current	0.625A per output point (at 30V DC) 5A per common line (at 30V DC)
Voltage Drop (ON Voltage)	1V maximum (voltage between COM and output terminals when output is on)
Inrush Current	5A maximum
Leakage Current	0.1 mA maximum
Clamping Voltage	39V±1V
Maximum Lamp Load	10W
Inductive Load	L/R = 10 msec (30V DC, 0.5 Hz)
External Current Draw	100 mA maximum, 24V DC (power voltage at the –V terminal)
Isolation	Between output terminal and internal circuit: Photocoupler isolated Between output terminals: Not isolated
Connector on Mother Board	Screw Terminal Block MSTBA2.5/20-G5.08 (Phoenix Contact)
Connector Insertion/Removal Durability	100 times minimum
Internal Current Draw	All outputs ON: 70 mA (24V DC) All outputs OFF: 40 mA (24V DC)
Output Delay	Turn ON time: 500 µsec maximum Turn OFF time: 500 µsec maximum
Protecting Operation	Protection is activated by element heating when a short circuit occurs. Only the overloaded output is forced off. Not in compliance with IEC1131 “Protected outputs” and “Short-circuit proof outputs”
Restarting Method	Remove the cause of overload, then the output protection is reset automatically. Reset time: 10 msec maximum
Short-circuit Current	2.5A maximum at power voltage 24V DC, load resistance 10 mΩ maximum
Allowable Short-circuit Current	60 sec at power voltage 24V DC, load resistance 10 mΩ maximum
Maximum Modules	7 transistor protect source output modules can be mounted at the maximum
CPU Module Operation	Special data register D8030 to D8036, assigned to 1st through 7th module, stores 1 to indicate the slot where an overload occurred. The ERROR LED also turns on.
Weight (approx.)	220g

Output Internal Circuit



COM terminals are connected together internally.

Special Data Registers D8030 through D8036 (Protect Transistor Output Error)

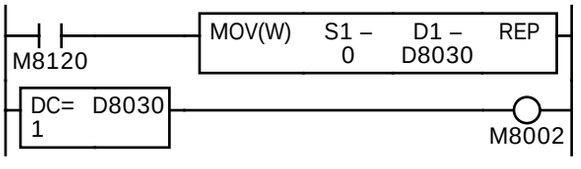
> **⚠ Caution**
> • A prolonged overload or short circuit may damage the output circuit elements of the transistor protect source output module. Include a protection program in the user program to protect the output module from damage caused by overheating.

A maximum of seven transistor protect source output modules can be mounted with one CPU module. The protect output modules are numbered from one through seven in the order of increasing distance from the CPU module. When an overload or short circuit occurs, special data registers D8030 through D8036 store 1 to indicate the output module where the overload occurred. D8030 through D8036 correspond to the first through seventh protect transistor modules, respectively.

When an overload or short circuit occurs, the transistor protect source output module detects the overload and shuts down the output immediately to protect the external load and output circuit elements from permanent damage. Since the overload detection is based on the heating of the output element, the output circuit is turned on again when the output elements have cooled down. Consequently, a continued overloaded status causes the output to turn on and off repeatedly, and eventually leads to deterioration of the output module.

When the cause of the short circuit is removed, the output module restores normal operation. However, once an overload or short circuit occurs, the condition tends to continue for a long period of time. When the transistor protect source output module is used, use of a protection program is recommended to turn off all outputs within 60 seconds as described below.

Sample Program 1: Turning All Outputs Off (when using one transistor protect source output module)



M8120 is the initialize pulse special internal relay.

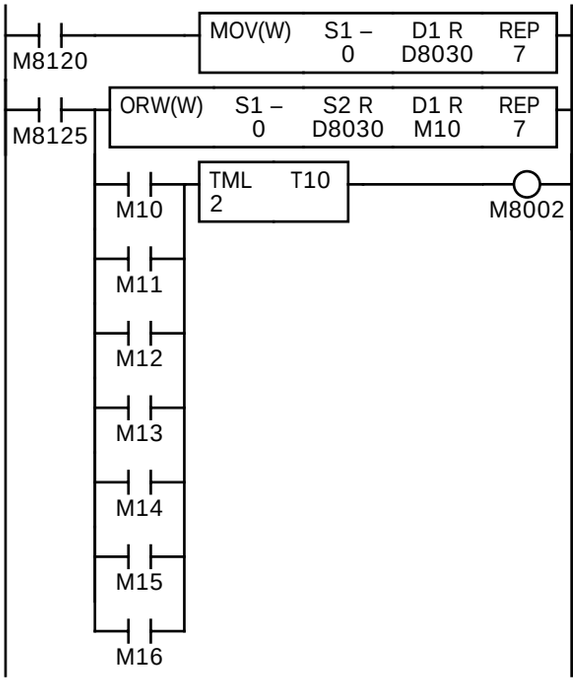
MOV stores 0 to data register D8030.

Special data register D8030 stores protect transistor output error data when an overload or short-circuit occurs in the first protect output modules.

When an overload occurs, D8030 stores 1.

When the D8030 data is 1, M8002 (all outputs off special internal relay) is turned on to turn off all outputs.

Sample Program 2: Turning All Outputs Off (when using seven transistor protect source output modules)



M8120 is the initialize pulse special internal relay.

MOV stores 0 to seven data registers D8030 through D8036.

Special data registers D8030 through D8036 store protect transistor output error data when an overload or short-circuit occurs in the first to seventh protect output modules, respectively.

When an overload occurs, D8030 through D8036 store 1.

M8125 is the in-operation output special internal relay.

ORW turns on M10 through M16 when D8030 through D8036 store 1, respectively.

When any of M10 through M16 turns on, 1-sec timer TML starts to timedown.

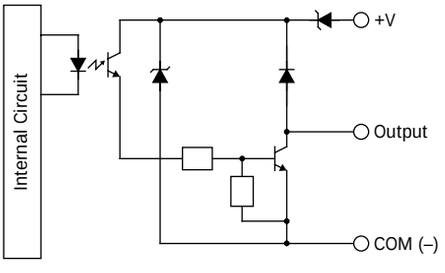
When the preset value of 2 seconds is reached, M8002 is turned on to turn off all outputs.

M8002 is the all outputs off special internal relay.

32-point Transistor Sink Output Module Specifications

Type No.	FC3A-T32K4	FC3A-T32K5
Terminal Arrangement	See Terminal Arrangement charts on pages 2-26 and 2-27.	
Rated Load Voltage	24V DC	
Operating Load Voltage Range	20.4 to 27.6V DC	
Rated Load Current	0.1A per output point	
Maximum Load Current	0.115A per output point (at 27.6V DC)	
Voltage Drop (ON Voltage)	1V maximum (voltage between COM and output terminals when output is on)	
Inrush Current	3A maximum	
Leakage Current	0.1 mA maximum	
Clamping Voltage	39V±1V	
Inductive Load	L/R = 20 msec (27.6V DC, 1 Hz)	
External Current Draw	100 mA maximum, 24V DC (power voltage at the +V terminal)	
Isolation	Between output terminal and internal circuit: Photocoupler isolated Between output terminals: Not isolated	
Connector on Mother Board	Nylon Connector BS18P-SHF-1AA × 2 (J.S.T. Mfg.)	Fujitsu Connector FCN-365P040-AU (Fujitsu)
Connector Insertion/Removal Durability	50 times minimum	500 times minimum
Internal Current Draw	All outputs ON: 90 mA (24V DC) All outputs OFF: 40 mA (24V DC)	
Output Delay	Turn ON time: 500 µsec maximum Turn OFF time: 500 µsec maximum	
Weight (approx.)	190g	200g

Output Internal Circuit

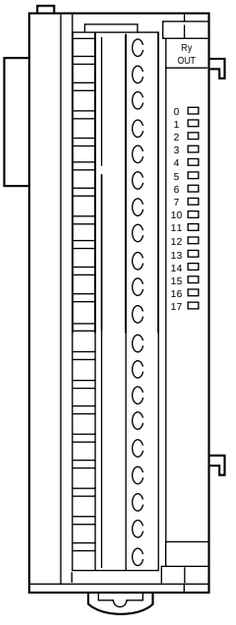


COM terminals are connected together internally.

Output Module Terminal Arrangement

FC3A-R161 (16-point Relay Output Module) — Screw Terminal Type

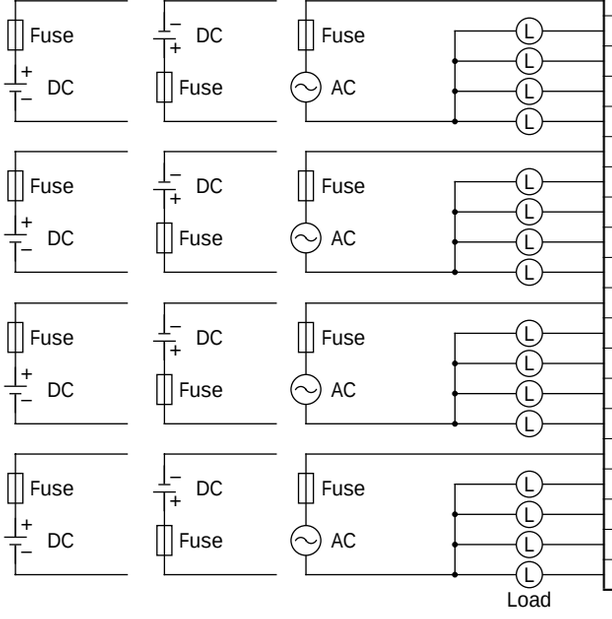
Applicable Connector: SMSTB2.5/20-ST-5.08 (Phoenix Contact)



Terminal No.	Name
1	COM0
2	Q0
3	Q1
4	Q2
5	Q3
6	COM1
7	Q4
8	Q5
9	Q6
10	Q7
11	COM2
12	Q10
13	Q11
14	Q12
15	Q13
16	COM3
17	Q14
18	Q15
19	Q16
20	Q17

Wiring Schematic

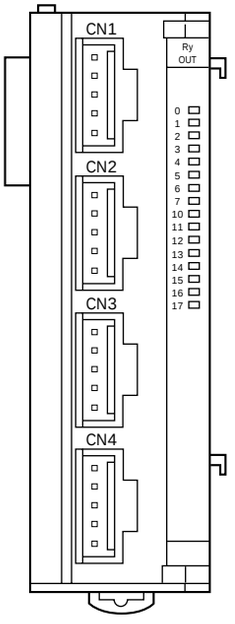
- COM terminals are *not* connected together internally.
- Terminal numbers are marked on the terminal block label on the output module.
- For wiring precautions, see page 3-6.



Terminal No.	Name
1	COM0
2	Q0
3	Q1
4	Q2
5	Q3
6	COM1
7	Q4
8	Q5
9	Q6
10	Q7
11	COM2
12	Q10
13	Q11
14	Q12
15	Q13
16	COM3
17	Q14
18	Q15
19	Q16
20	Q17

FC3A-R162 (16-point Relay Output Module) — Nylon Connector Type

Applicable Connectors: **VHR-5N (J.S.T. Mfg.)**
SVH-21T-P1.1 (J.S.T. Mfg.)



CN1

Terminal No.	Name
1	COM0
2	Q0
3	Q1
4	Q2
5	Q3

CN3

Terminal No.	Name
1	COM2
2	Q10
3	Q11
4	Q12
5	Q13

CN2

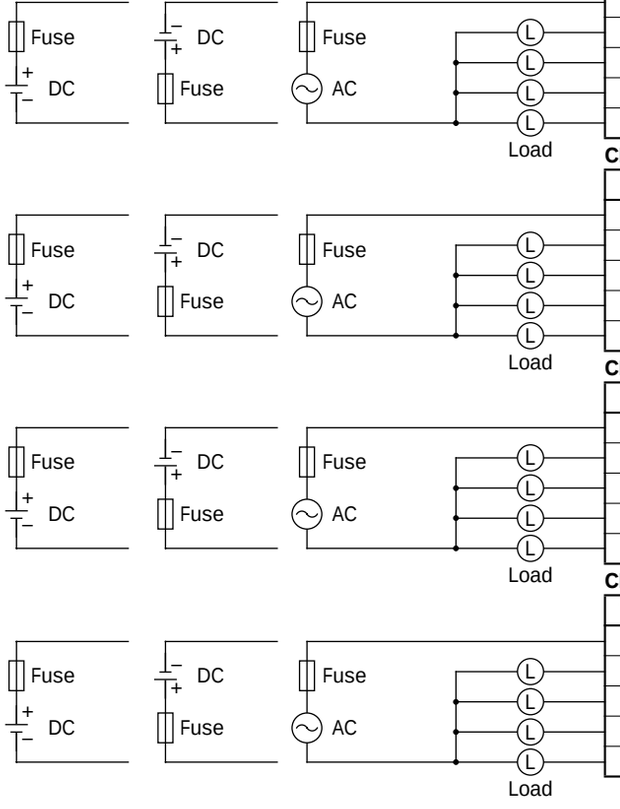
Terminal No.	Name
1	COM1
2	Q4
3	Q5
4	Q6
5	Q7

CN4

Terminal No.	Name
1	COM3
2	Q14
3	Q15
4	Q16
5	Q17

Wiring Schematic

- COM terminals are *not* connected together internally.
- Terminal numbers are marked on the female connector on the cable.
- For wiring precautions, see page 3-6.



CN1

Terminal No.	Name
1	COM0
2	Q0
3	Q1
4	Q2
5	Q3

CN2

Terminal No.	Name
1	COM1
2	Q4
3	Q5
4	Q6
5	Q7

CN3

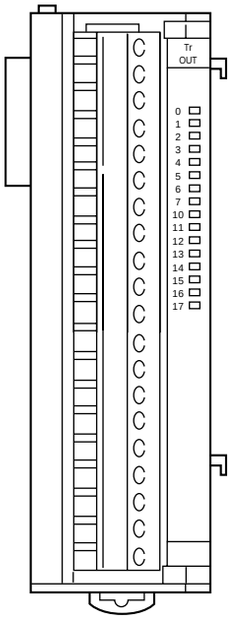
Terminal No.	Name
1	COM2
2	Q10
3	Q11
4	Q12
5	Q13

CN4

Terminal No.	Name
1	COM3
2	Q14
3	Q15
4	Q16
5	Q17

FC3A-T16K1/FC3A-T16P1 (16-point Transistor Sink and Protect Source Output Modules) — Screw Terminal Type

Applicable Connector: SMSTB2.5/20-ST-5.08 (Phoenix Contact)



FC3A-T16K1

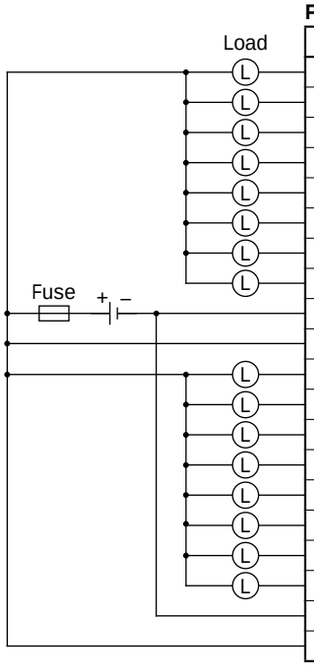
Terminal No.	Name
1	Q0
2	Q1
3	Q2
4	Q3
5	Q4
6	Q5
7	Q6
8	Q7
9	COM(–)
10	+V
11	Q10
12	Q11
13	Q12
14	Q13
15	Q14
16	Q15
17	Q16
18	Q17
19	COM(–)
20	+V

FC3A-T16P1

Terminal No.	Name
1	Q0
2	Q1
3	Q2
4	Q3
5	Q4
6	Q5
7	Q6
8	Q7
9	COM(+)
10	–V
11	Q10
12	Q11
13	Q12
14	Q13
15	Q14
16	Q15
17	Q16
18	Q17
19	COM(+)
20	–V

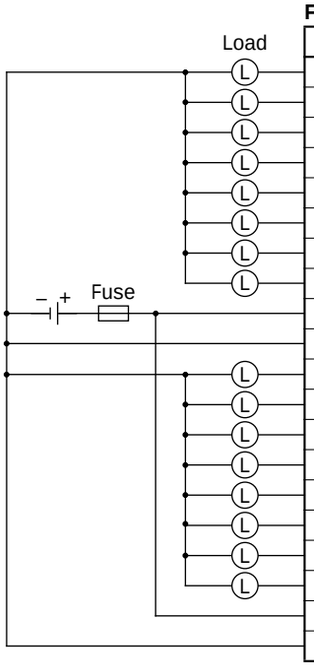
Wiring Schematic

- COM terminals are connected together internally.
- Terminal numbers are marked on the terminal block label on the output module.
- For wiring precautions, see page 3-6.



FC3A-T16K1

Terminal No.	Name
1	Q0
2	Q1
3	Q2
4	Q3
5	Q4
6	Q5
7	Q6
8	Q7
9	COM(–)
10	+V
11	Q10
12	Q11
13	Q12
14	Q13
15	Q14
16	Q15
17	Q16
18	Q17
19	COM(–)
20	+V

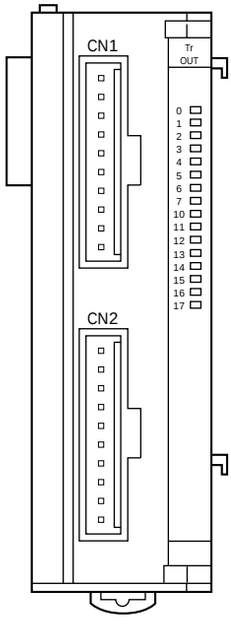


FC3A-T16P1

Terminal No.	Name
1	Q0
2	Q1
3	Q2
4	Q3
5	Q4
6	Q5
7	Q6
8	Q7
9	COM(+)
10	–V
11	Q10
12	Q11
13	Q12
14	Q13
15	Q14
16	Q15
17	Q16
18	Q17
19	COM(+)
20	–V

FC3A-T16K3 (16-point Transistor Sink Output Module) — Nylon Connector Type

Applicable Connector: **VHR-10N (J.S.T. Mfg.)**
SVH-21T-P1.1 (J.S.T. Mfg.)



CN1

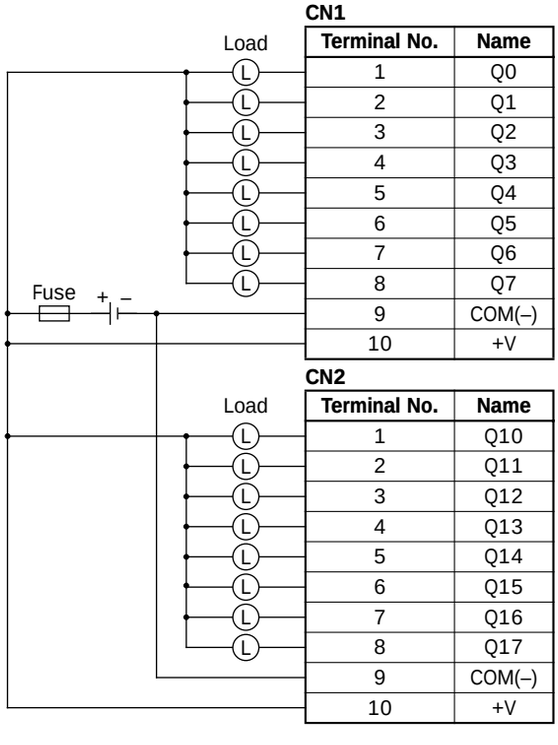
Terminal No.	Name
1	Q0
2	Q1
3	Q2
4	Q3
5	Q4
6	Q5
7	Q6
8	Q7
9	COM(–)
10	+V

CN2

Terminal No.	Name
1	Q10
2	Q11
3	Q12
4	Q13
5	Q14
6	Q15
7	Q16
8	Q17
9	COM(–)
10	+V

Wiring Schematic

- COM terminals are connected together internally.
- Terminal numbers are marked on the female connector on the cable.
- For wiring precautions, see page 3-6.



CN1

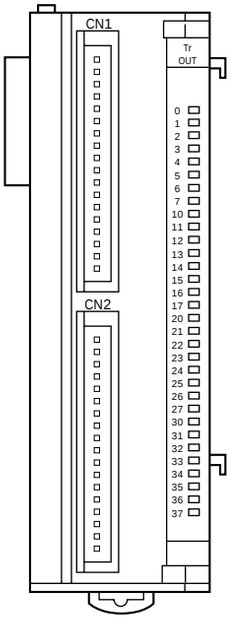
Terminal No.	Name
1	Q0
2	Q1
3	Q2
4	Q3
5	Q4
6	Q5
7	Q6
8	Q7
9	COM(–)
10	+V

CN2

Terminal No.	Name
1	Q10
2	Q11
3	Q12
4	Q13
5	Q14
6	Q15
7	Q16
8	Q17
9	COM(–)
10	+V

FC3A-T32K4 (32-point Transistor Sink Output Module) — Nylon Connector Type

Applicable Connector: **H18-SHF-AA (J.S.T. Mfg.)**
SHF-001T-0.8BS (J.S.T. Mfg.)



CN1

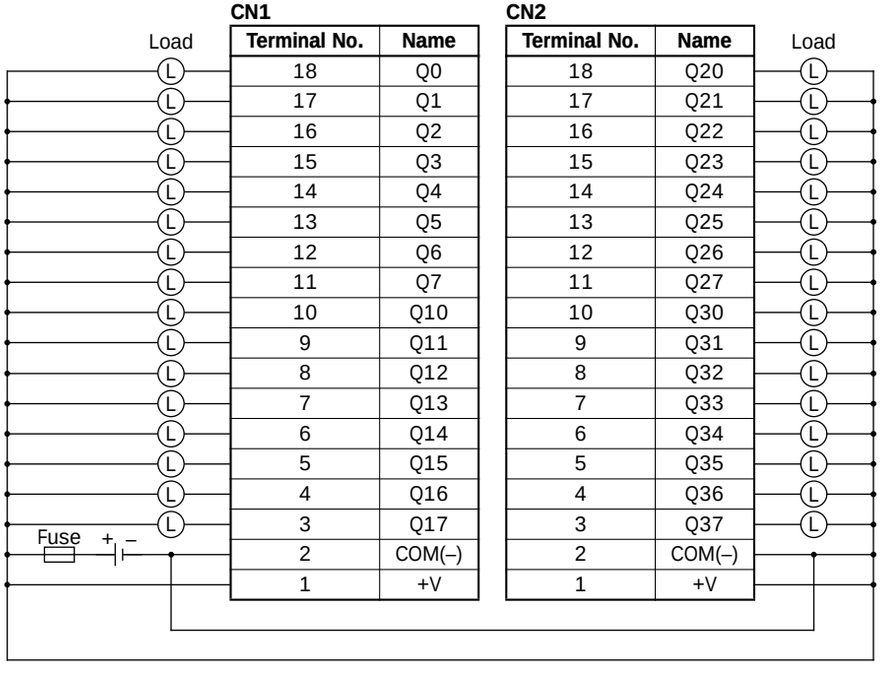
Terminal No.	Name
18	Q0
17	Q1
16	Q2
15	Q3
14	Q4
13	Q5
12	Q6
11	Q7
10	Q10
9	Q11
8	Q12
7	Q13
6	Q14
5	Q15
4	Q16
3	Q17
2	COM(–)
1	+V

CN2

Terminal No.	Name
18	Q20
17	Q21
16	Q22
15	Q23
14	Q24
13	Q25
12	Q26
11	Q27
10	Q30
9	Q31
8	Q32
7	Q33
6	Q34
5	Q35
4	Q36
3	Q37
2	COM(–)
1	+V

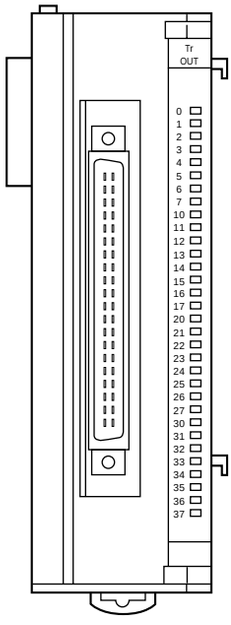
Wiring Schematic

- COM terminals are connected together internally.
- Terminal numbers are marked on the female connector on the cable.
- For wiring precautions, see page 3-6.



FC3A-T32K5 (32-point Transistor Sink Output Module) — Fujitsu Connector Type

Applicable Connector: FCN-367J040-AU (Fujitsu)

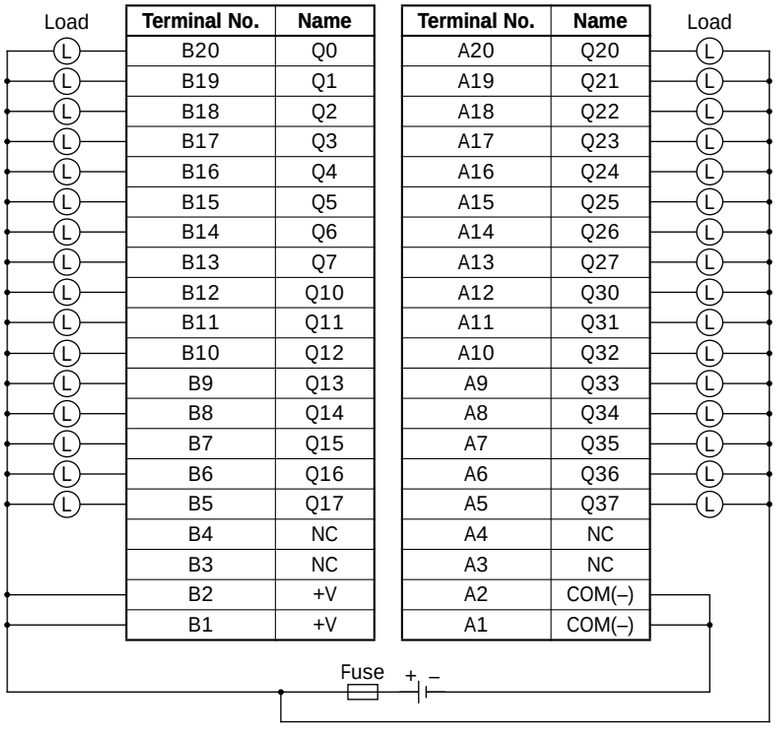


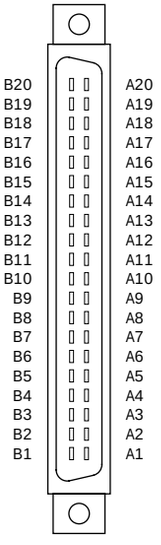
Terminal No.	Name
B20	Q0
B19	Q1
B18	Q2
B17	Q3
B16	Q4
B15	Q5
B14	Q6
B13	Q7
B12	Q10
B11	Q11
B10	Q12
B9	Q13
B8	Q14
B7	Q15
B6	Q16
B5	Q17
B4	NC
B3	NC
B2	+V
B1	+V

Terminal No.	Name
A20	Q20
A19	Q21
A18	Q22
A17	Q23
A16	Q24
A15	Q25
A14	Q26
A13	Q27
A12	Q30
A11	Q31
A10	Q32
A9	Q33
A8	Q34
A7	Q35
A6	Q36
A5	Q37
A4	NC
A3	NC
A2	COM(–)
A1	COM(–)

Wiring Schematic

- COM terminals are connected together internally.
- Terminal numbers are the front view of the male connector on the output module.
- For wiring precautions, see page 3-6.





Connect the two +V terminals together, and connect the two COM(–) terminals together because the current capacity of one terminal is exceeded when many outputs are on simultaneously.

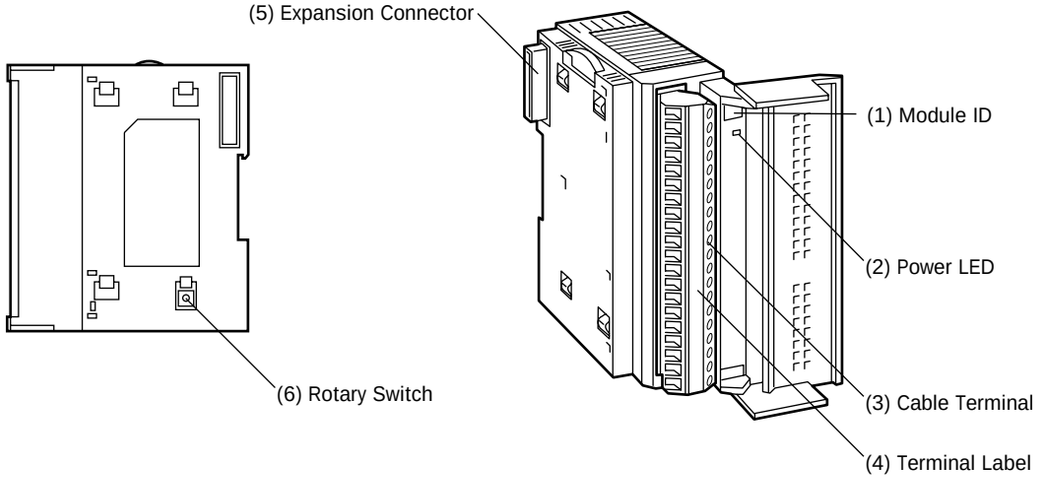
Analog Input Module (A/D Converter)

The 12-bit analog input module converts 6 channels of analog signals to digital data of 0 through 4000 which can be processed using advanced instructions such as the coordinate conversion instruction. The analog input module is a functional module and the converted digital data is stored to a link register, depending on the analog channel and the mounting slot number of the analog input module in the system setup. The input mode can be selected using the rotary switch to meet five different analog signal ranges; 0 to 10V, ±10V, 0 to 5V, ±5V, or 4 to 20 mA.

Analog Input Module Type Number

Module Name	6-channel Analog Input Module
Type No.	FC3A-AD1261

Parts Description



(1) Module ID A/D indicates the analog input module ID.

(2) Power LED Turns on when power is on.

(3) Cable Terminal Screw terminal block

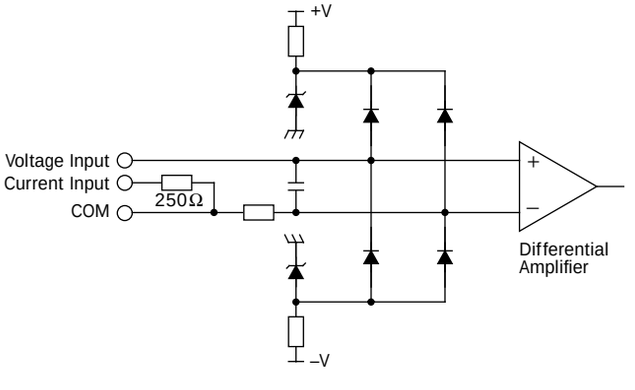
(4) Terminal Label Indicates terminal numbers on the terminal block.

(5) Expansion Connector Connects to CPU and other modules.

(6) Rotary Switch Selects the input mode from five different signal ranges

Rotary Switch Position	Input Signal Range	Resolution (Input value of LSB)
0	0 to 10V DC	2.5 mV
1	±10V DC	5 mV
2	0 to 5V DC	1.25 mV
3	±5V DC	2.5 mV
4	4 to 20 mA DC	4 µA

Type of Protection



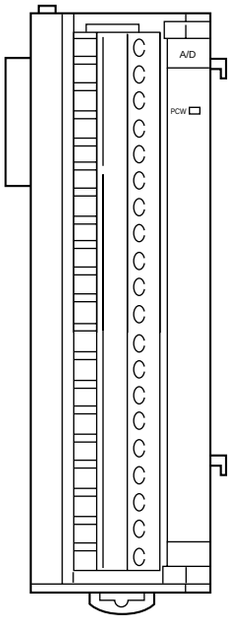
Analog Input Module Specifications

Type No.		FC3A-AD1261
Quantity of Input Channels		6 channels
Terminal Arrangement		See page 2-30.
Input Impedance within Signal Range		Voltage input: 1 MΩ minimum Current input: 250Ω
Input Error	Maximum Error at 25°C	±0.6% of full scale
	Temperature Coefficient	±0.013 %/°C (typical)
	Maximum Error over Full Temperature Range	±1% of full scale
Digital Resolution		4000 increments
Data Type in Application Program		0 to 4000
Digital Output Reading at Overload		4000
Input Mode Selection		Using a rotary switch (see page 2-28)
Type of Input		Differential input
Common Mode Characteristics		Common mode reject ratio (CMRR) –50 dB
Common Mode Voltage		16V DC
Total Input System Transfer Time		3 msec per channel + 1 scan time maximum
Conversion Time		3 msec per channel
Conversion Method		∑Δ type ADC
Maximum Temporary Deviation during Electrical Noise Tests and Test Conditions		3% maximum of full scale at 500V impulse test
Conversion Type		Successive approximation type
Operating Mode		Self-scan
Calibration or Verification to Maintain Rated Accuracy		Impossible
Monotonicity		Yes
Crosstalk		2 LSB maximum
Non-lineality		0.1% of full scale maximum
Repeatability after Stabilization Time		0.5% of full scale maximum (more than 30 minutes after powerup)
Sample Duration Time		0.1 msec
Sample Repetition Time		0.5 msec
Input Filter		0.2 msec
Dielectric Strength		500V AC between input channel and power supply under normal operating conditions
Cable		Shielded cable is recommended for improved noise immunity
Effect of Improper Input Connection		Permanent damage may be caused
Terminal Block Insertion/Removal Durability		100 times minimum
Internal Current Draw		120 mA (24V DC)
Weight (approx.)		230g

Analog Input Module Terminal Arrangement

FC3A-AD1261 (6-channel Analog Input Module) — Screw Terminal Type

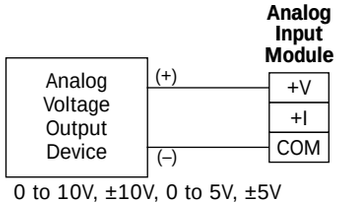
Applicable Connector: SMSTB2.5/20-ST-5.08 (Phoenix Contact)



Terminal No.	Channel	Name
1	Channel 0	+V (voltage)
2		+I (current)
3		COM (–V, –I)
4	Channel 1	+V (voltage)
5		+I (current)
6		COM (–V, –I)
7	Channel 2	+V (voltage)
8		+I (current)
9		COM (–V, –I)
10	Channel 3	+V (voltage)
11		+I (current)
12		COM (–V, –I)
13	Channel 4	+V (voltage)
14		+I (current)
15		COM (–V, –I)
16	Channel 5	+V (voltage)
17		+I (current)
18		COM (–V, –I)
19	—	NC
20	—	NC

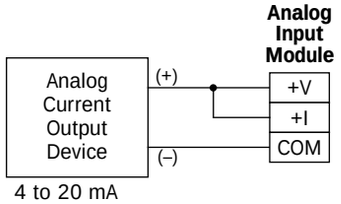
Wiring Diagram

Voltage Input



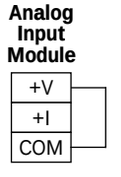
0 to 10V, ±10V, 0 to 5V, ±5V

Current Input



4 to 20 mA

Unused Channel



Connect +V and COM terminals of unused channels together.

Example: When converting an analog voltage input (0 to 10V, ±10V, 0 to 5V, or ±5V DC) using channel 4, connect the signal to terminals 13 and 15. When the analog input module is the second functional module installed in the OpenNet Controller system, the converted digital value is stored to link register L204. When connecting an analog current input (4 to 20 mA), connect terminals +I and +V together, and connect the input across terminals +I and COM as shown in the middle above.

For wiring schematic and precautions, see page 3-8.

Notes:

- Before mounting the analog input module, first set the rotary switch to meet the required analog input range. After setting the rotary switch, power up the CPU and other modules.
- The COM (–V, –I) terminal of each channel is independent from each other.
- Connect the +V and COM terminals of unused channels together. Connecting these terminals together will reduce the AD conversion time in the analog input module (by approximately 10% for every unused slot).

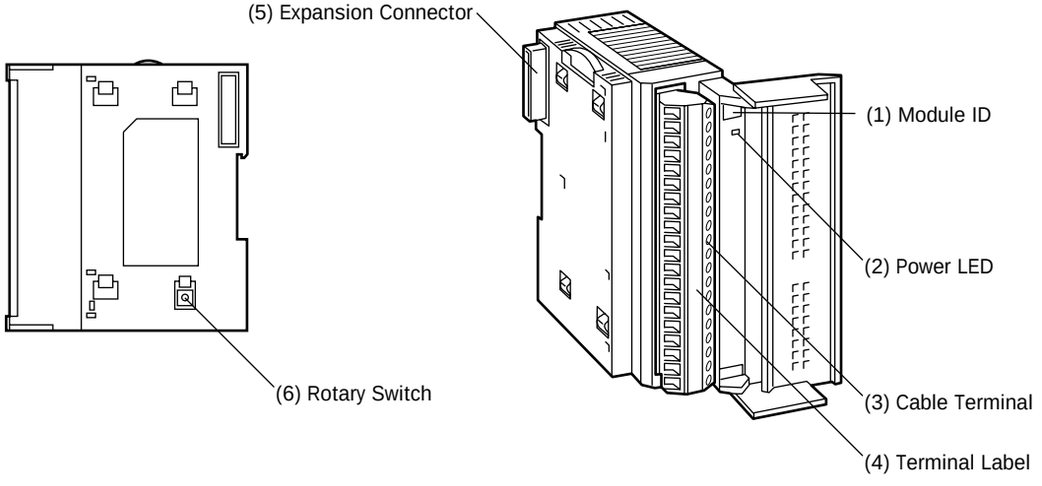
Analog Output Module (D / A Converter)

The 12-bit analog output module converts digital data of 0 through 4000 to 2 channels of analog signals. The analog output module is a functional module and the digital data for conversion must be stored to a link register, depending on the analog channel and the mounting slot number of the analog output module in the system setup. The output mode can be selected using the rotary switch to meet five different analog signal ranges; 0 to 10V, ±10V, 0 to 5V, ±5V, or 4 to 20 mA.

Analog Output Module Type Number

Module Name	2-channel Analog Output Module
Type No.	FC3A-DA1221

Parts Description



(1) Module ID D/A indicates the analog output module ID.

(2) Power LED Turns on when power is on.

(3) Cable Terminal Screw terminal block

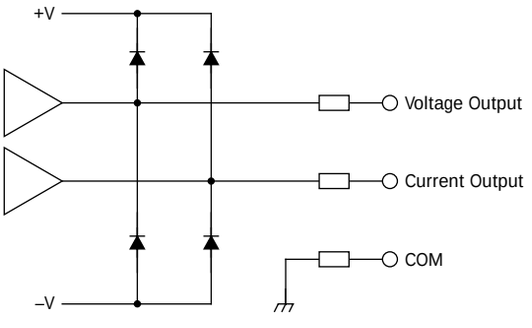
(4) Terminal Label Indicates terminal numbers on the terminal block.

(5) Expansion Connector Connects to CPU and other modules.

(6) Rotary Switch Selects the output mode from five different signal ranges

Rotary Switch Position	Output Signal Range	Resolution (Output value of LSB)	Output when Stopped
0	0 to 10V DC	2.5 mV	0V
1	±10V DC	5 mV	–10V
2	0 to 5V DC	1.25 mV	0V
3	±5V DC	2.5 mV	–5V
4	4 to 20 mA DC	4 µA	4 mA

Type of Protection



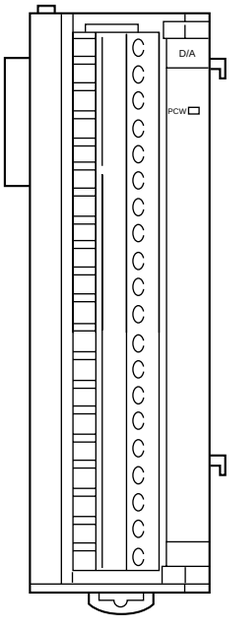
Analog Output Module Specifications

Type No.		FC3A-DA1221
Quantity of Output Channels		2 channels
Terminal Arrangement		See page 2-33.
Output Error	Maximum Error at 25°C	±0.6% of full scale
	Temperature Coefficient	±0.013 %/°C (typical)
	Maximum Error over Full Temperature Range	±1% of full scale
Digital Resolution		4000 increments
Data Type in Application Program		0 to 4000
Total Output System Transfer Time		3 msec + 1 scan time maximum
Settling Time after Maximum Range Change		3 msec
Overshoot		0%
Maximum Temporary Deviation during Electrical Noise Tests and Test Conditions		3% maximum of full scale at 500V impulse test
Output Voltage Drop		1% maximum of full scale
Calibration or Verification to Maintain Rated Accuracy		Impossible
Maximum Capacitive Load		Not applicable
Maximum Inductive Load		Not applicable
Monotonicity		Yes
Crosstalk		2 LSB maximum
Non-lineality		0.1% of full scale maximum
Repeatability after Stabilization Time		0.5% of full scale maximum (more than 30 minutes after powerup)
Output Ripple		1 LSB maximum
Output Response at Power Up and Down		Output returns to the lower limit value within 1 msec
Output Mode Selection and Output Value of LSB		Using a rotary switch (see page 2-31)
Load Impedance in Signal Range		Voltage output: 2 kΩ minimum Current output: 250Ω (300Ω maximum)
Maximum Allowed Output Voltage		Voltage output: ±12V DC (between output terminals) Current output: ±12V DC (between output terminals)
Dielectric Strength		500V AC between output channel and power supply under normal operating conditions
Cable		Shielded cable is recommended for improved noise immunity
Quantity of Channels per COM		1 channel per COM
Effect of Improper Output Connection		Permanent damage may be caused
Terminal Block Insertion / Removal Durability		100 times minimum
Applicable Load Type		Resistive load
Internal Current Draw		120 mA (24V DC)
Weight (approx.)		230g

Analog Output Module Terminal Arrangement

FC3A-DA1221 (2-channel Analog Output Module) — Screw Terminal Type

Applicable Connector: SMSTB2.5/20-ST-5.08 (Phoenix Contact)



Terminal No.	Channel	Rotary Switch Position	Name
1	Channel 0	0	Voltage output (0 to 10V)
2			COM (GND)
3		1	Voltage output (±10V)
4			COM (GND)
5		2	Voltage output (0 to 5V)
6			COM (GND)
7		3	Voltage output (±5V)
8			COM (GND)
9		4	Current output (4 to 20mA)
10			COM (GND)
11	Channel 1	0	Voltage output (0 to 10V)
12			COM (GND)
13		1	Voltage output (±10V)
14			COM (GND)
15		2	Voltage output (0 to 5V)
16			COM (GND)
17		3	Voltage output (±5V)
18			COM (GND)
19		4	Current output (4 to 20mA)
20			COM (GND)

Wiring Example:

Suppose that an analog output module is the sixth functional module installed in the OpenNet Controller system. To generate a 4V analog output voltage from channel 1 using the 0 to 5V output range, set the rotary switch to 2 and store a digital value of 3200 to link register L601, which is assigned to channel 1 of the sixth functional module.

Because 5V × 3200/4000 = 4V, digital value 3200 is converted to an analog value of 4V and outputted to terminals 15 and 16 of the analog output module.

For wiring schematic and precautions, see page 3-8.

Notes:

- Before mounting the analog output module, first set the rotary switch to meet the required analog output range. After setting the rotary switch, power up the CPU and other modules.
- The COM (GND) terminals of each channel are connected together internally.

Expansion Power Supply Module

The FC3A-EA1 expansion power supply module is used to mount more than seven I/O and functional modules. When a maximum of 15 I/O modules are mounted, the number of I/O points is expanded from 224 to 480 maximum.

Whether an expansion module is used or not, seven functional modules such as analog I/O, DeviceNet slave, and LONWORKS interface modules can be mounted at the maximum in either the normal or expansion slots.

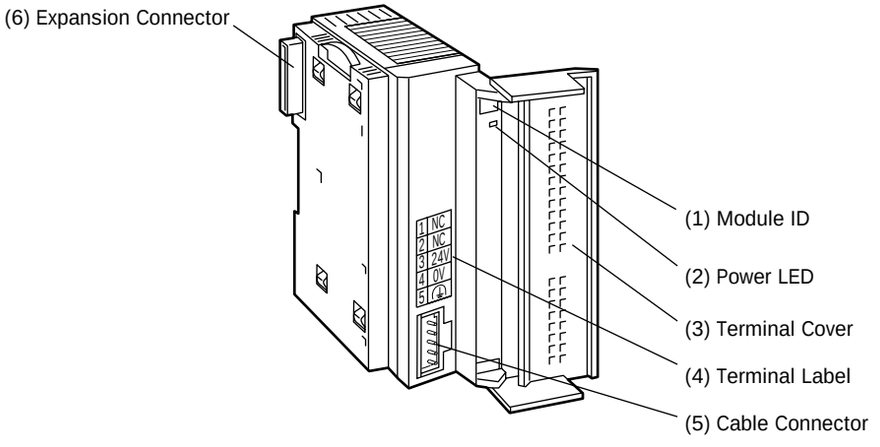
Expansion Power Supply Module Type Number

Module Name	Expansion Power Supply Module
Type No.	FC3A-EA1

The expansion power supply module is supplied with the following attachments:

Cable / Connector	1 pc, cable length 1m (3.28 ft.)
Contact	3 pcs, used to extend the cable length

Parts Description

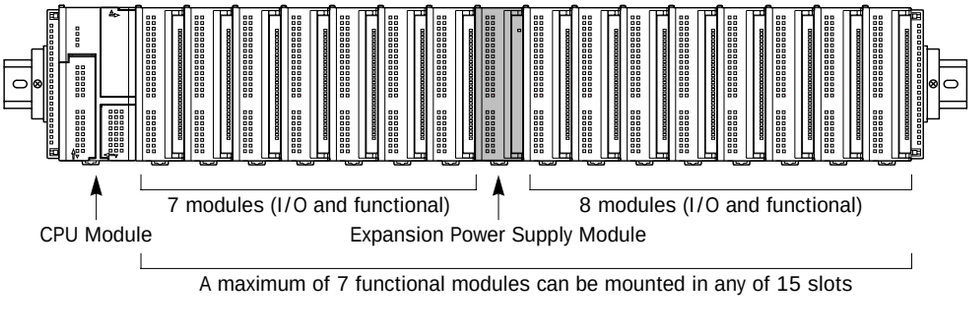


(1) Module ID	EXP indicates the expansion power supply module ID.
(2) Power LED	Turns on when power is on.
(3) Terminal Cover	The terminal cover flips open to the right.
(4) Terminal Label	Indicates terminal numbers.
(5) Cable Connector	Nylon connector (5-pin)
(6) Expansion Connector	Connects to CPU and other modules.

Expansion Power Supply Module Mounting Position

Mount the expansion power supply module in the eighth slot.

Do not mount the expansion power supply module in any other slot than the eighth, otherwise correct allocation of I/O and link register numbers may not occur.



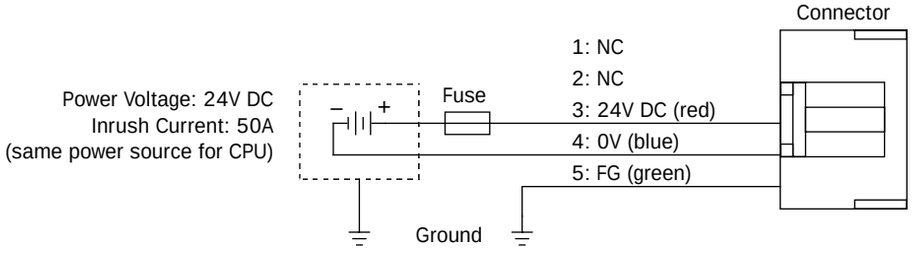
Expansion Power Supply Module Specifications

Type No.	FC3A-EA1
Rated Power Voltage	24V DC
Allowable Voltage Range	19 to 30V DC (including ripple)
Dielectric Strength	Between power terminal and FG: 1,000V AC, 1 minute
Maximum Input Current	5A at 24V DC
Internal Current Draw	30 mA (24V DC)
Allowable Momentary Power Interruption	10 msec (24V DC), Level PS-2 (EN61131)
Insulation Resistance	Between power terminal and FG: 10 MΩ minimum (500V DC megger)
Inrush Current	50A (total of inrush currents into CPU and expansion power supply modules)
Ground	Grounding resistance: 100Ω maximum
Grounding Wire	UL1015 AWG22
Power Supply Wire	UL1015 AWG22
Effect of Improper Power Supply Connection	Reverse polarity: No operation, no damage Improper voltage or frequency: Permanent damage may be caused Improper lead connection: Permanent damage may be caused
Weight (approx.)	180g

Power Supply Wiring to Expansion Power Supply Module

Connect a 24V DC power source to the 24V and 0V pins on the expansion power supply module connector.

Use the same power source for the CPU module to power the expansion power supply module. The inrush current to both the CPU and expansion power supply module is 50A total. AC power source cannot be used. Internal current draw of the expansion power supply module is 30 mA.



The length of the attached cable is 1 meter (3.28 feet). When a longer cable is needed, use the attached contacts to connect the cable to the attached connector.

Remote I/O Master Module

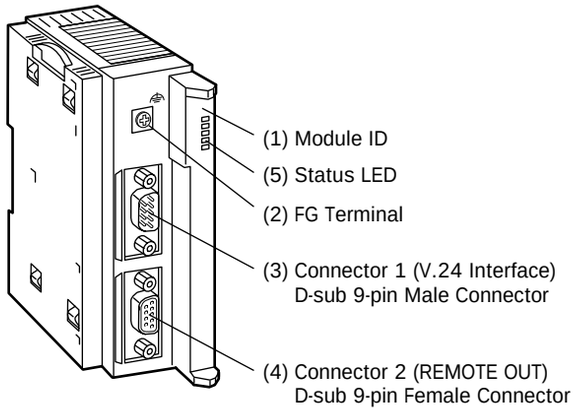
The remote I/O master module is used to configure a remote I/O network to increase I/O points at remote stations. The OpenNet Controller uses the INTERBUS network for communication with a maximum of 32 remote I/O slave stations. For the remote I/O slave stations, IDEC's SX5S communication I/O terminals are used. When using 32 SX5S modules with 16 input or output points, a total of 512 I/O points can be distributed to 32 remote slave stations at the maximum.

For details about the remote I/O system, see page 24-1.

Remote I/O Master Module Type Number and Weight

Module Name	Remote I/O Master Module
Type No.	FC3A-SX5SM1
Weight (approx.)	200g

Parts Description



(1) Module ID FC3A-SX5SM1 indicates the remote I/O master module ID.

(2) FG Terminal Frame ground

(3) Connector 1 V.24 Interface for monitoring the communication line using CMD (CMD is a software program to run on Windows 3.1/95 for configuration, monitoring, and diagnosis supplied by Phoenix Contact.)

(4) Connector 2 REMOTE OUT for connecting a communication cable to the REMOTE IN connector on a remote I/O slave module

(5) Status LED Turns on to indicate the following status:

RDY/RUN	READY/RUN
FAIL	NO ERR REMOTE_BUS_ERR LOCAL_BUS_ERR CONTROLLER_ERR WATCHDOG_ERR HARDWARE_FAULT
BSA	BUS_SEGMENT_DISABLED
PF	MODULE_ERROR
HF	HOST_HARDWARE_FAULT

Remote I/O Master Module General Specifications

Type No.	FC3A-SX5SM1
Power Voltage	Supplied by the CPU module
Dielectric Strength	Between power terminal on the CPU module and FG: 500V AC, 1 minute
Insulation Resistance	Between REMOTE OUT terminal and FG: 10 MΩ minimum (500V DC megger) Between V.24 Interface terminal and FG: 10 MΩ minimum (500V DC megger)
Internal Current Draw	Approx. 142 mA (24V DC) See Power Consumption on page 2-4.
FG Terminal	M3 screw (Tightening torque: 0.6 to 1.0 N·m)
Ground	Grounding resistance: 100Ω maximum
Grounding Wire	UL1015 AWG22, UL1007 AWG18
Weight (approx.)	200g

Remote I/O Master Module Function Specifications

Network Protocol	INTERBUS
Transmission Speed	500 kbps
Transmission Distance	Between remote I/O master and remote bus station: 400m maximum Between remote bus stations: 400m maximum Remote bus total length: 12.8 km maximum
Quantity of Nodes	32 remote I/O slave stations maximum
I/O Points per Node	128 points maximum (64 inputs and 64 outputs)
Branch Levels	16 maximum (INTERBUS device levels 0 through 15)
Remote I/O Connector	D-sub 9-pin female connector on the remote I/O master module
Network Cable	INTERBUS cable
V.24 Interface Connector	D-sub 9-pin male connector on the remote I/O master module
V.24 Interface Cable	Serial straight cable
Electrostatic Discharge Severity Level	ESD-3 (network interface) See page 24-11.

DeviceNet Slave Module

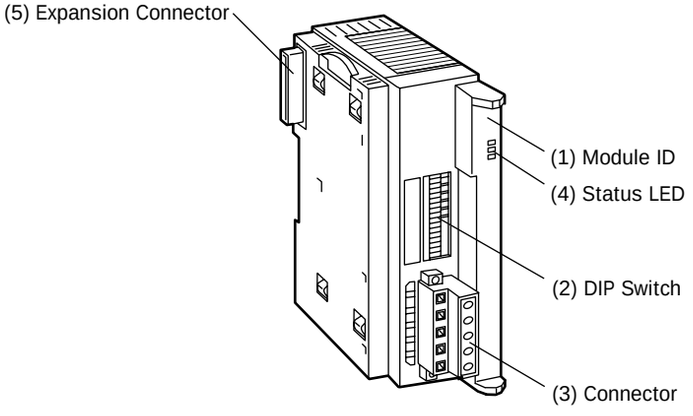
The OpenNet Controller can be linked to DeviceNet networks. For communication through the DeviceNet network, the DeviceNet slave module is available.

For details about the DeviceNet slave module and DeviceNet communication system, see page 25-1.

DeviceNet Slave Module Type Number and Weight

Module Name	DeviceNet Slave Module
Type No.	FC3A-SX5DS1
Weight (approx.)	180g

Parts Description



(1) Module ID FC3A-SX5DS1 indicates the DeviceNet slave module ID.

(2) DIP Switch 10-pole DIP switch for setting the node address (MAC ID: media access control identifier), data rate, output hold/load off, and physical port number

(3) Connector Network interface connector for connecting an input communication cable

(4) Status LED Indicates operating status

POW	POWER Green ON: Power is on
MNS	MODULE/NETWORK STATUS OFF: Duplicate MAC ID test not completed Green Flash: Normal operation (not communicating with master) Green ON: Normal operation (communicating with master) Red Flash: Minor fault (e.g. timeout) Red ON: Critical fault (e.g. duplicate MAC ID)
IO	I/O STATUS Green ON: Normal operation Red ON: Fault

(5) Expansion Connector Connects to CPU and other modules.

LONWORKS Interface Module

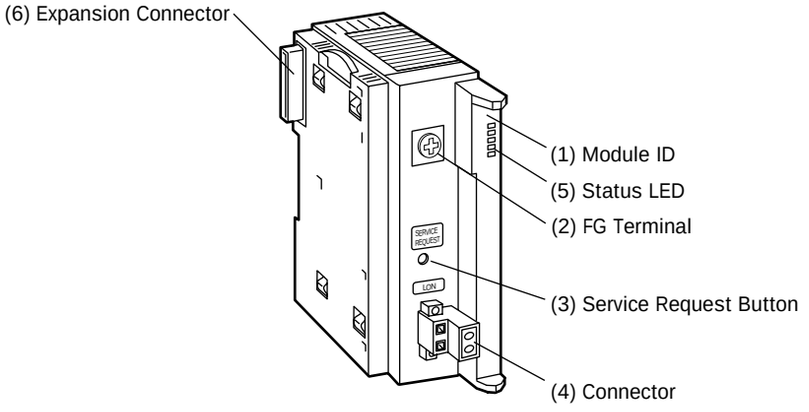
The OpenNet Controller can be linked to LONWORKS networks. For communication through the LONWORKS network, the LONWORKS interface module is available.

For details about the LONWORKS interface module and LONWORKS communication system, see page 26-1.

LONWORKS Interface Module Type Number and Weight

Module Name	LONWORKS Interface Module
Type No.	FC3A-SX5LS1
Weight (approx.)	180g

Parts Description



(1) Module ID FC3A-SX5LS1 indicates the LONWORKS interface module ID.

(2) FG Terminal Frame ground

(3) Service Request Button Pushbutton used for network management

(4) Connector Network interface connector for connecting an input communication cable

(5) Status LED Indicates operating status

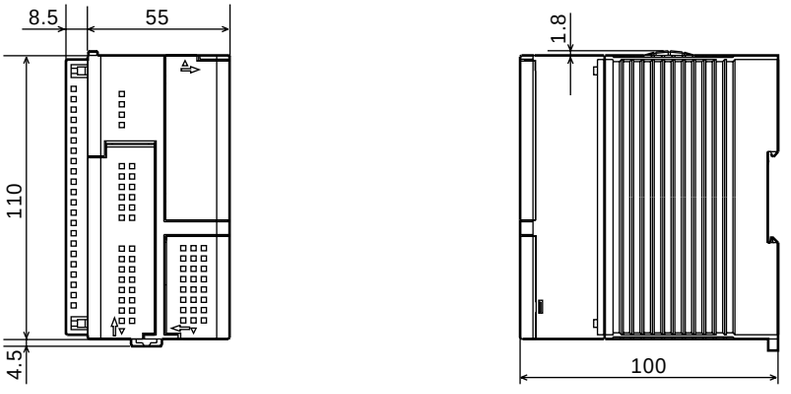
POW	POWER Green ON:	 Power is on
RUN	RUN Green ON:	 Normal operation
ERR	COM_ERROR Red ON: OFF:	 Communication error Normal
I/O	I/O_ERROR Red ON:	 Access error to the CPU through I/O bus
SER	SERVICE Yellow ON: Yellow Flash:	 Application program not configured Network management not configured

(6) Expansion Connector Connects to CPU and other modules.

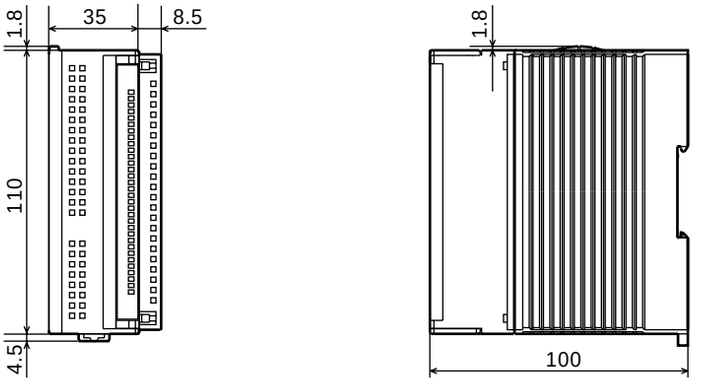
Dimensions

All OpenNet Controller modules have the same profile for consistent mounting on a DIN rail.

CPU Module

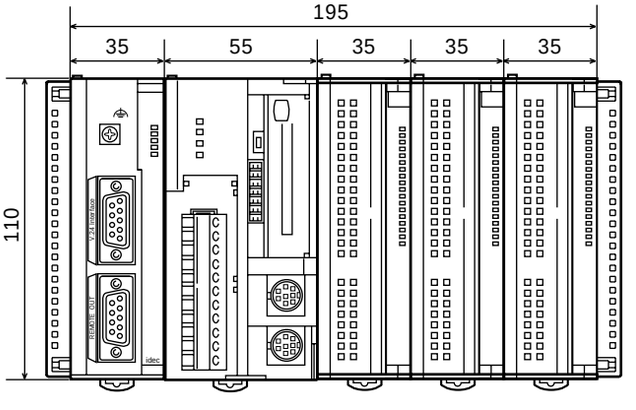


Digital I/O, Analog I/O, Expansion Power Supply, Remote I/O Master, DeviceNet Slave, and LONWORKS Interface Modules



Digital I/O, analog I/O, expansion power supply, remote I/O master, Devicenet Slave, and LONWORKS interface modules have the same outside dimensions.

Example: The following figure illustrates a system setup consisting of a remote I/O master module, a CPU module, and three I/O modules.



All dimensions in mm.

3: INSTALLATION AND WIRING

Introduction

This chapter describes the methods and precautions for installing and wiring OpenNet Controller modules.

Before starting installation and wiring, be sure to read "Safety Precautions" in the beginning of this manual and understand precautions described under Warning and Caution.

⚠ Warning

- Turn power off to the OpenNet Controller before starting installation, removal, wiring, maintenance, and inspection of the OpenNet Controller. Failure to turn power off may cause electrical shocks or fire hazard.
- Emergency stop and interlocking circuits must be configured outside the OpenNet Controller. If such a circuit is configured inside the OpenNet Controller, failure of the OpenNet Controller may cause disorder of the control system, damage, or accidents.
- Special expertise is required to install, wire, program, and operate the OpenNet Controller. People without such expertise must not use the OpenNet Controller.

⚠ Caution

- Prevent metal fragments and pieces of wire from dropping inside the OpenNet Controller housing. Put a cover on the OpenNet Controller modules during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage, or malfunction.

Installation Location

The OpenNet Controller must be installed correctly for optimum performance.

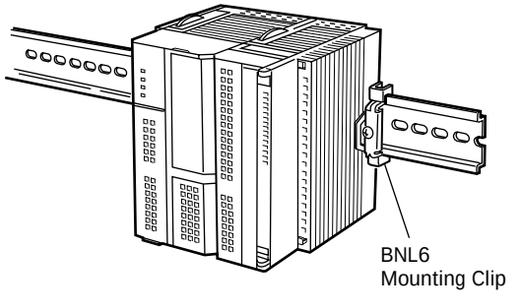
The environment for using the OpenNet Controller is "Pollution degree 2." Use the OpenNet Controller in environments of pollution degree 2 (according to IEC 60664-1).

Make sure that the operating temperature does not drop below 0°C or exceed 55°C. If the temperature does exceed 55°C, use a fan or cooler.

Mount the OpenNet Controller on a vertical plane.

To eliminate excessive temperature build-up, provide ample ventilation. Do not install the OpenNet Controller near, and especially above, any device which generates considerable heat, such as a heater, transformer, or large capacity resistor. The relative humidity should be above 30% and below 95%.

The OpenNet Controller should not be exposed to excessive dust, dirt, salt, direct sunlight, vibrations, or shocks. Do not use the OpenNet Controller in an area where corrosive chemicals or flammable gases are present. The modules should not be exposed to chemical, oil, or water splashes.



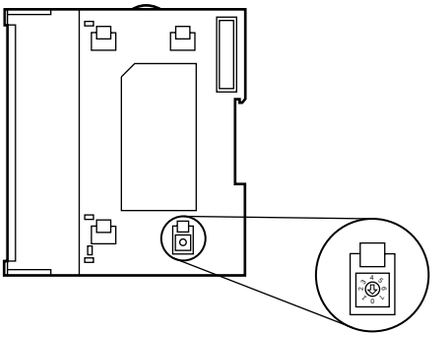
Assembling Modules

⚠ Caution

- Assemble OpenNet Controller modules together before mounting the modules onto a DIN rail. Attempt to assemble modules on a DIN rail may cause damage to the modules.
- When using analog input or output modules, first set the rotary switch on the side of the module to the desired input/output mode before assembling the module. The rotary switch cannot be changed after the module has been assembled. For the operation modes of analog input and output modules, see pages 2-28 and 2-31.

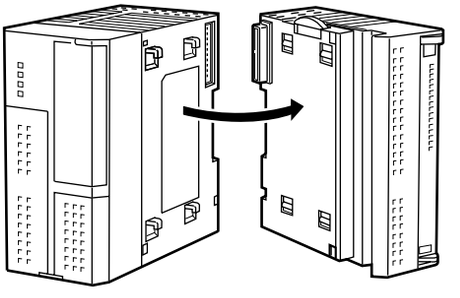
The following example demonstrates the procedure for assembling a CPU module and an I/O module together.

1. When assembling an analog input or output module, set the rotary switch to select the desired operation mode. Use a small flat screwdriver to turn the rotary switch.

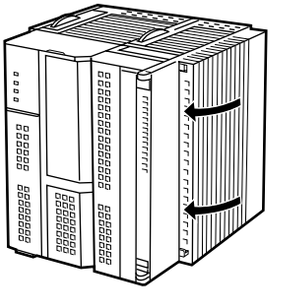


2. Place the CPU module and I/O module side by side. Put the expansion connectors together for easy alignment.

3. With the expansion connectors aligned correctly, press the CPU module and I/O module together until the latches click to attach the modules together firmly.



4. Press the end plate to each side of the module assembly. A pair of end plates are supplied with each CPU module.

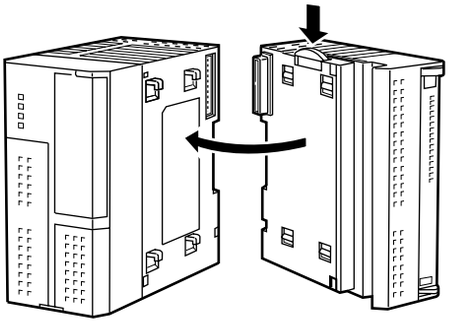


Disassembling Modules

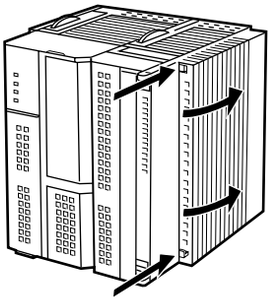
Caution

- Remove the OpenNet Controller modules from the DIN rail before disassembling the modules. Attempt to disassemble modules on a DIN rail may cause damage to the modules.

1. If the modules are mounted on a DIN rail, first remove the modules from the DIN rail as described below on this page.
2. Press the blue unlatch button on top of the module to disengage the latches. With the button held depressed, pull the modules apart as shown.



3. To remove the end plate, push in the square button at the top and bottom of the end plate from the front and pull the end plate from the module row as shown. Attach the end plate to the CPU module, if required.

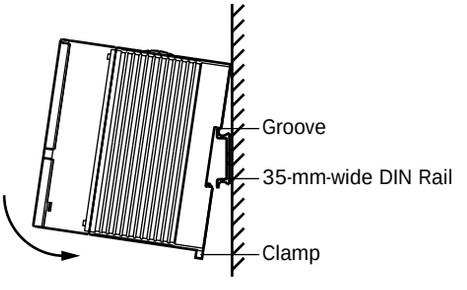


Mounting on DIN Rail

Caution

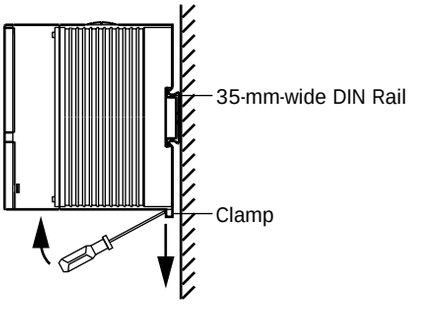
- Install the OpenNet Controller modules according to instructions described in this user's manual. Improper installation will result in falling, failure, or malfunction of the OpenNet Controller.
- Mount the OpenNet Controller modules on a 35-mm-wide DIN rail. Applicable DIN rail: IDEC's BAA1000 (1000mm/39.4" long)

1. Fasten the DIN rail to a panel using screws firmly.
2. Pull out the clamp from each OpenNet Controller module, and put the groove of the module on the DIN rail. Press the modules towards the DIN rail and push in the clamps as shown on the right.
3. Use BNL6 mounting clips on both sides of the OpenNet Controller modules to prevent moving sideways.



Removing from DIN Rail

1. Insert a flat screwdriver into the slot in the clamp.
2. Pull out the clamps from the modules
3. Turn the OpenNet Controller modules bottom out.

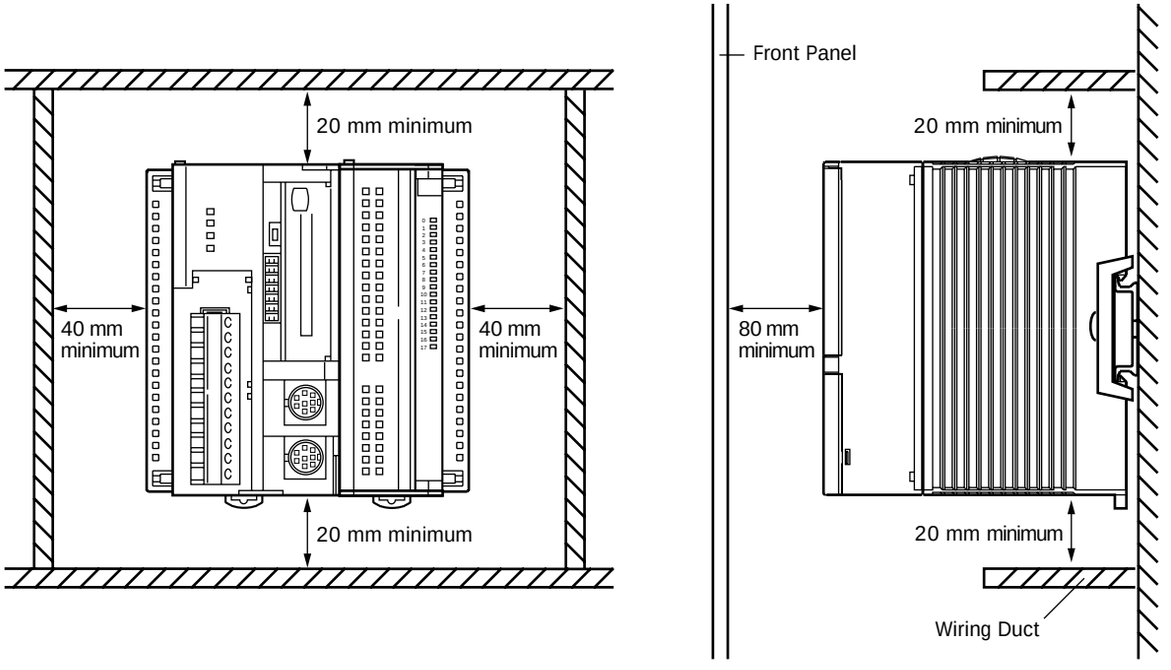


Installation in Control Panel

The OpenNet Controller modules are designed for installation in equipment. Do not install the OpenNet Controller modules outside equipment.

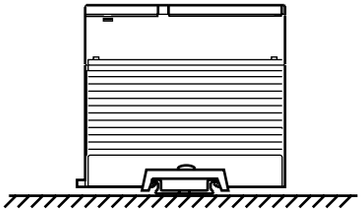
The environment for using the OpenNet Controller is "Pollution degree 2." Use the OpenNet Controller in environments of pollution degree 2 (according to IEC 60664-1).

When installing the OpenNet Controller modules in a control panel, take the convenience of operation and maintenance, and resistance against environments into consideration.

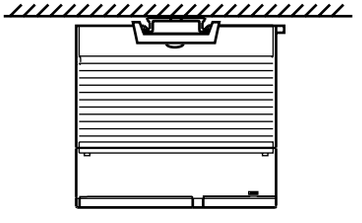


Mounting Direction

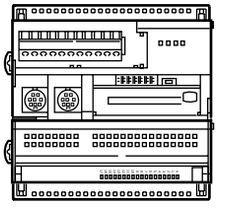
Mount the OpenNet Controller modules horizontally on a vertical plane as shown above. Keep a sufficient spacing around the OpenNet Controller modules to ensure proper ventilation. When the ambient temperature is 40°C or below, the OpenNet Controller modules can also be mounted upright on a horizontal plane as shown at left below.



Allowable Mounting Direction at 40°C or below



Incorrect Mounting Direction



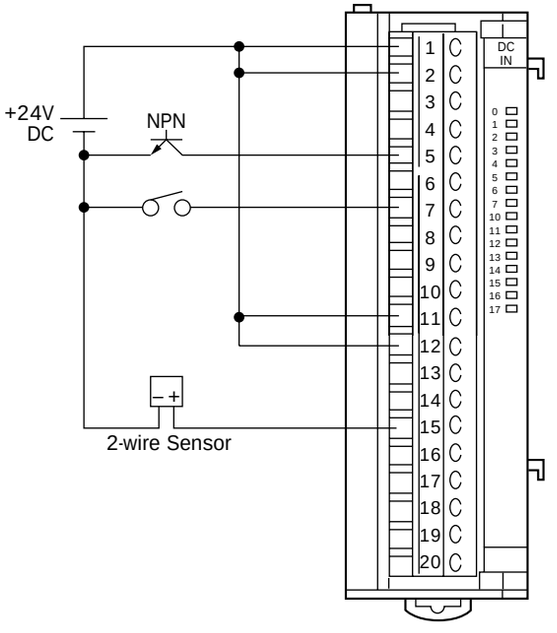
Incorrect Mounting Direction

Input Wiring

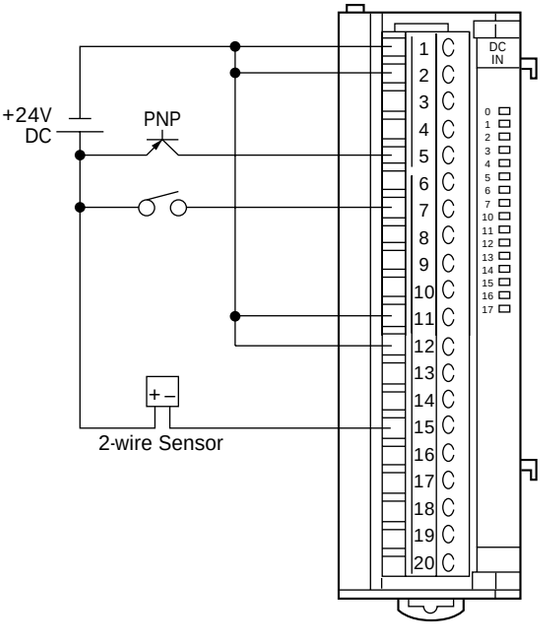
Caution

- Terminal name “NC” means “No Connection.” Do not connect input or any other wiring to NC terminals.
- Separate the input wiring from the output line, power line, and motor line.
- Use UL1015AWG22 or UL1007AWG18 wires for input wiring.

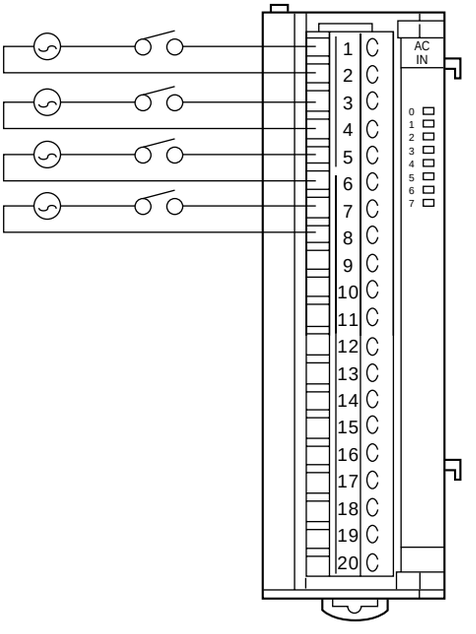
DC Source Input



DC Sink Input



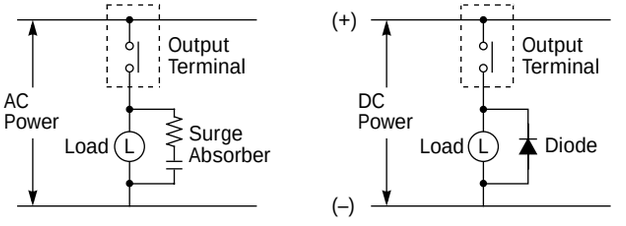
AC Input



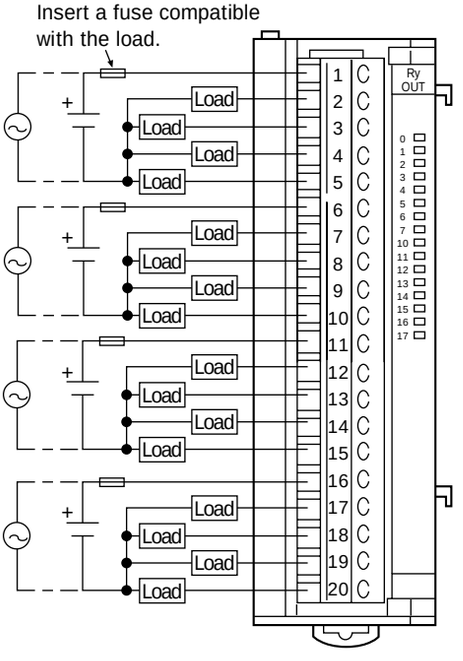
Output Wiring

⚠ Caution

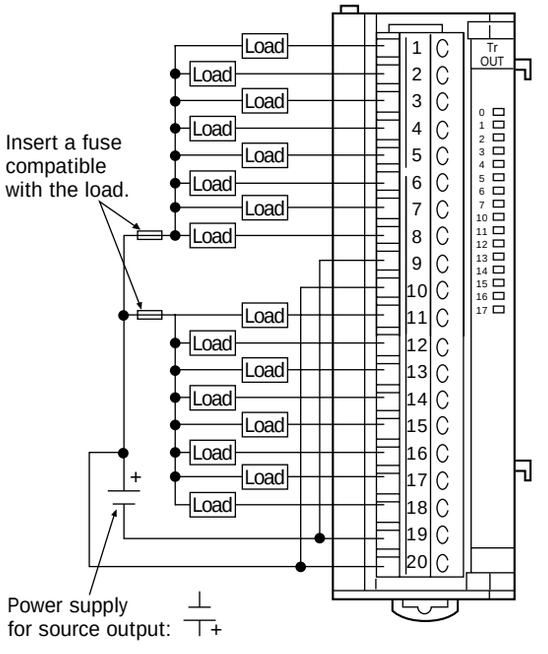
- Terminal name “NC” means “No Connection.” Do not connect output or any other wiring to NC terminals.
- If relays or transistors in the OpenNet Controller output modules should fail, outputs may remain on or off. For output signals which may cause heavy accidents, provide a monitor circuit outside the OpenNet Controller.
- Connect a fuse to the output module, selecting a fuse appropriate for the load.
- Use UL1015AWG22 or UL1007AWG18 wires for output wiring.
- When driving loads which generate noise, such as electromagnetic contactors and solenoid valves, use a surge absorber for AC power or a diode for DC power.



Relay Output



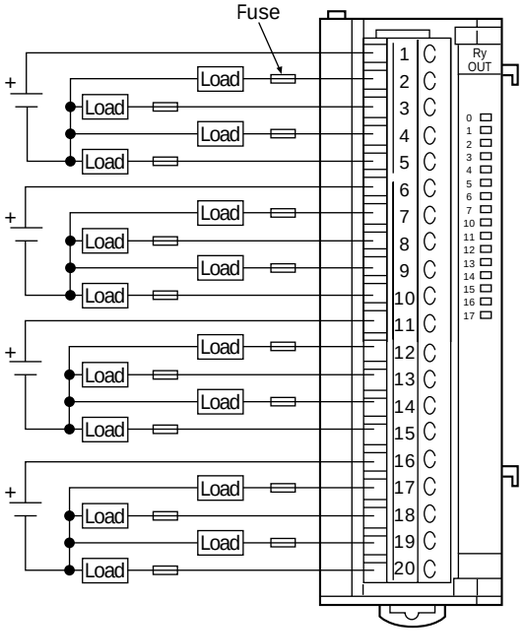
Transistor Sink Output



Output Wiring for Application in Europe

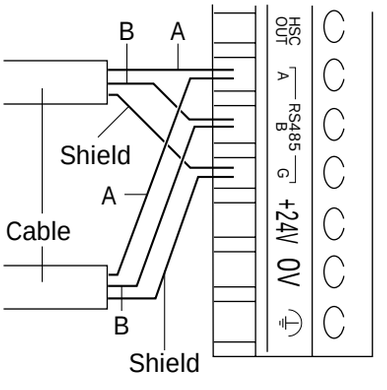
When equipment containing the OpenNet Controller is intended for use in European countries, insert an IEC 60127-approved fuse to each output of every output module for protection against overload or short-circuit. This is required when exporting equipment containing the OpenNet Controller to Europe.

Example: FC3A-R161 Relay Output Module Wiring



Data Link Wiring

- For wiring the data link cable to the RS485 terminals on the CPU module, use a two-core twisted pair shielded cable with a minimum core diameter of 0.9 mm.
- Separate the data link cable from the output line, power line, and motor line.



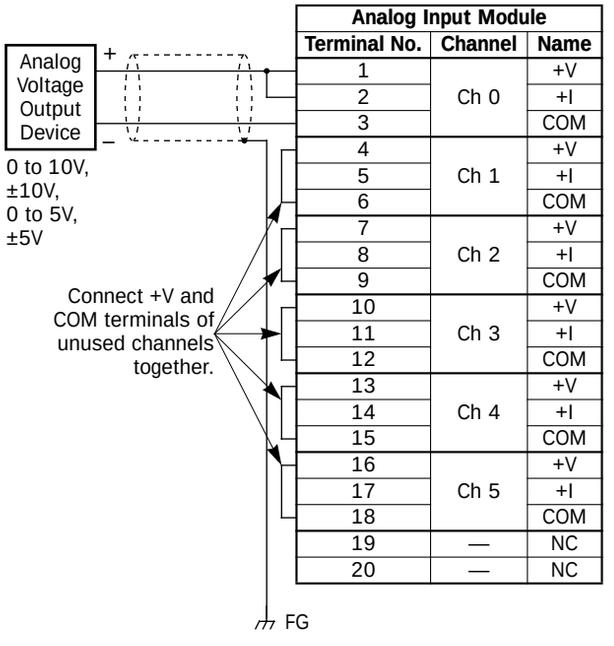
Analog Input / Output Wiring

When using an analog input or output module, connect analog signals and ground wire as shown below.

- For wiring analog input or output module, use a two-core twisted pair shielded cable with a minimum core diameter of 0.9 mm. Connect the shield to a proper frame ground (grounding resistance 100Ω maximum).
- Connect the FG terminals of the 24V DC power supply and the CPU module to the ground (grounding resistance 100Ω maximum). The ground connection improves the stability of analog/digital conversion.
- Terminal numbers are marked on the terminal block label on the input/output module.
- For analog input and output module specifications, see pages 2-28 and 2-31.

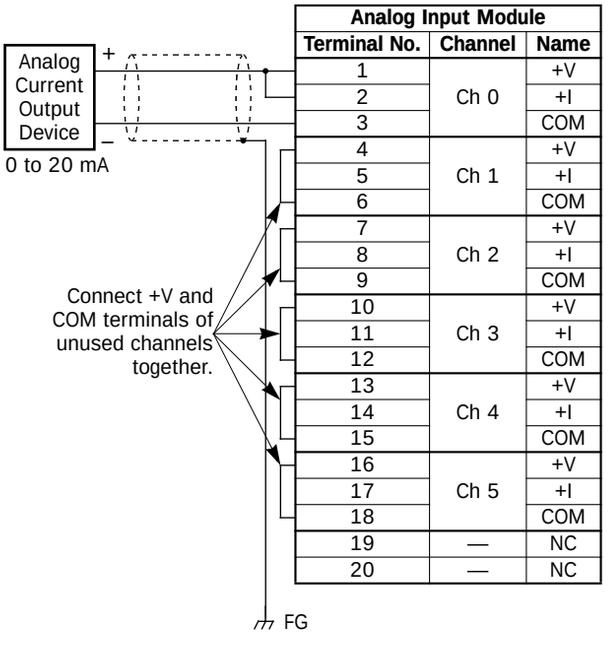
Wiring Schematic

Analog Voltage Input (rotary switch set to 0 through 3)



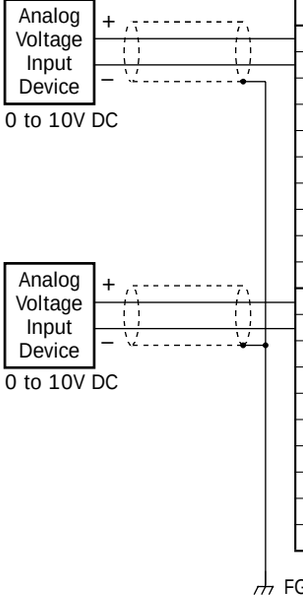
Analog Input Module		
Terminal No.	Channel	Name
1	Ch 0	+V
2		+I
3		COM
4	Ch 1	+V
5		+I
6		COM
7	Ch 2	+V
8		+I
9		COM
10	Ch 3	+V
11		+I
12		COM
13	Ch 4	+V
14		+I
15		COM
16	Ch 5	+V
17		+I
18		COM
19	—	NC
20	—	NC

Analog Current Input (rotary switch set to 4)



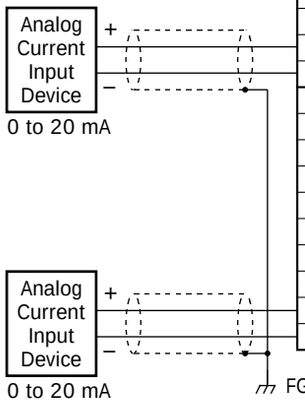
Analog Input Module		
Terminal No.	Channel	Name
1	Ch 0	+V
2		+I
3		COM
4	Ch 1	+V
5		+I
6		COM
7	Ch 2	+V
8		+I
9		COM
10	Ch 3	+V
11		+I
12		COM
13	Ch 4	+V
14		+I
15		COM
16	Ch 5	+V
17		+I
18		COM
19	—	NC
20	—	NC

Analog Voltage Output (rotary switch set to 0)



Analog Output Module			
Term No.	Chan	Rotary Sw.	Name
1	Ch 0	0	0-10V
2			COM
3		1	±10V
4			COM
5		2	0-5V
6			COM
7		3	±5V
8			COM
9		4	4-20mA
10			COM
11	Ch 1	0	0-10V
12			COM
13		1	±10V
14			COM
15		2	0-5V
16			COM
17		3	±5V
18			COM
19		4	4-20mA
20			COM

Analog Current Output (rotary switch set to 4)



Analog Output Module			
Term No.	Chan	Rotary Sw.	Name
1	Ch 0	0	0-10V
2			COM
3		1	±10V
4			COM
5		2	0-5V
6			COM
7		3	±5V
8			COM
9		4	4-20mA
10			COM
11	Ch 1	0	0-10V
12			COM
13		1	±10V
14			COM
15		2	0-5V
16			COM
17		3	±5V
18			COM
19		4	4-20mA
20			COM

Power Supply

⚠ Caution

- Use a power supply of the rated value. Use of a wrong power supply may cause fire hazard.
- The allowable power voltage range for the OpenNet Controller is 19 to 30V DC. Do not use the OpenNet Controller on any other voltage.
- If the power voltage turns on or off very slowly between 5 and 15V DC, the OpenNet Controller may run and stop repeatedly between these voltages. If failure or disorder of the control system, damage, or accidents may be caused, provide a measure for prevention using a voltage monitoring circuit outside the OpenNet Controller.
- Use an IEC 60127-approved fuse on the power line outside the OpenNet Controller. This is required when exporting equipment containing OpenNet Controller to Europe.

Power Supply Voltage

The allowable power voltage range for the OpenNet Controller is 19 to 30V DC.

Power failure detection voltage depends on the quantity of used input and output points. Basically, power failure is detected when the power voltage drops below 19V DC, stopping operation to prevent malfunction.

A momentary power interruption for 10 msec or less is not recognized as a power failure at the rated voltage of 24V DC.

Inrush Current at Powerup

When the OpenNet Controller is powered up, an inrush current of 40A or less flows at the rated voltage of 24V DC.

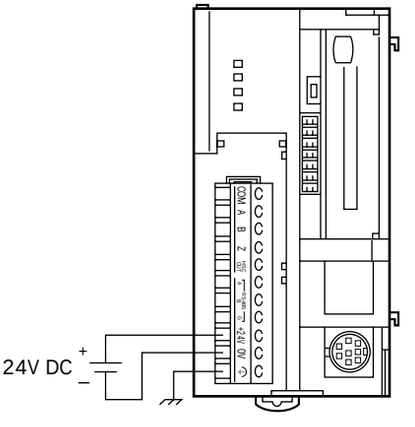
Power Supply Wiring

Use a stranded wire of UL1015 AWG22 or UL1007 AWG18 for power supply wiring. Make the power supply wiring as short as possible.

Run the power supply wiring as far away as possible from motor lines.

Grounding (CPU Module)

To prevent electrical shocks or malfunctioning due to noise, connect the FG terminal to the ground using a wire of UL1015 AWG22 or UL1007 AWG18 (grounding resistance 100Ω maximum). Do not connect the grounding wire in common with the grounding wire of motor equipment.



Grounding (Remote I/O Master and LONWORKS Interface Modules)

Connect the FG terminal to the ground using a wire of UL1015 AWG22 or UL1007 AWG18 (grounding resistance 100Ω maximum) and a ring-shape wire terminal. Tighten the M3 FG terminal screw to a torque of 0.6 to 1.0 N·m. Do not connect the grounding wire in common with the grounding wire of motor equipment.

Note: For power supply wiring to the expansion power supply module, see page 2-35.

Terminal Connection

⚠ Caution

- Make sure that the operating conditions and environments are within the specification values.
- Be sure to connect the grounding wire to a proper ground, otherwise electrical shocks may be caused.
- Do not touch live terminals, otherwise electrical shocks may be caused.
- Do not touch terminals immediately after power is turned off, otherwise electrical shocks may be caused.

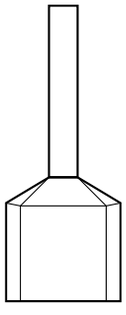
Ferrules, Crimping Tool, and Screwdriver for Phoenix Terminal Blocks

The screw terminal block can be wired with or without using ferrules on the end of cable. Applicable ferrules for the Phoenix terminal blocks and crimping tool for the ferrules are listed below. The screwdriver is used for tightening the screw terminals on the OpenNet Controller modules. These ferrules, crimping tool, and screwdriver are made by Phoenix Contact and are available from Phoenix Contact.

Type numbers of the ferrules, crimping tool, and screwdriver listed below are the type numbers of Phoenix Contact. When ordering these products from Phoenix Contact, specify the Order No. and quantity listed below.

Ferrule Order No.

Quantity of Cables	Cable Size	Phoenix Type	Order No.	Pcs. / Pkt.
For 1-cable connection	UL1007 AWG18	AI 1-8 RD	32 00 03 0	100
	UL1015 AWG22	AI 0,5-8 WH	32 00 01 4	100
For 2-cable connection	UL1007 AWG18	AI-TWIN 2 x 1-8 RD	32 00 81 0	100
	UL1015 AWG22	AI-TWIN 2 x 0,5-8 WH	32 00 93 3	100



Crimping Tool and Screwdriver Order No.

Tool Name	Phoenix Type	Order No.	Pcs. / Pkt.
Crimping Tool	CRIMPFOX UD 6	12 04 43 6	1
Screwdriver	SZS 0,6 x 3,5	12 05 05 3	10

Screw Terminal Tightening Torque	0.5 to 0.6 N·m

If ferrules other than listed above are used, the ferrule may come in contact with the terminal block cover. Then, remove the terminal block cover from the module.

4: OPERATION BASICS

Introduction

This chapter describes general information about setting up the basic OpenNet Controller system for programming, starting and stopping OpenNet Controller operation, and introduces simple operating procedures from creating a user program using WindLDR on a computer to monitoring the OpenNet Controller operation.

Connecting OpenNet Controller to PC (1:1 Computer Link System)

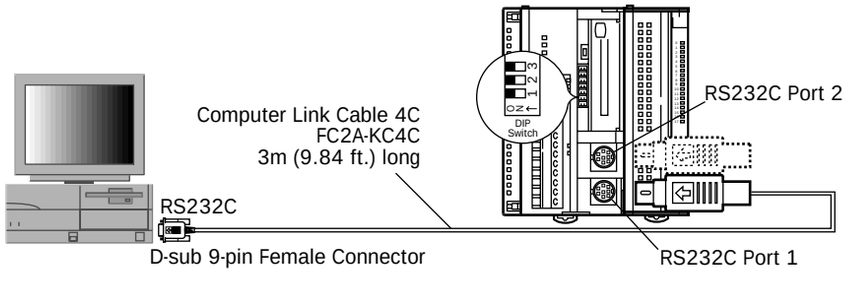
The OpenNet Controller can be connected to an IBM PC or compatible computer in two ways.

Computer Link through RS232C Port 1 or Port 2

When connecting a Windows computer to the RS232C port 1 or port 2 on the OpenNet Controller CPU module, enable the maintenance mode for the RS232C port.

To enable the maintenance mode for the RS232C port 1, set the DIP switch 2 to OFF.
To enable the maintenance mode for the RS232C port 2, set the DIP switch 3 to OFF.

To set up a 1:1 computer link system, connect a computer to the OpenNet Controller using the computer link cable 4C (FC2A-KC4C).

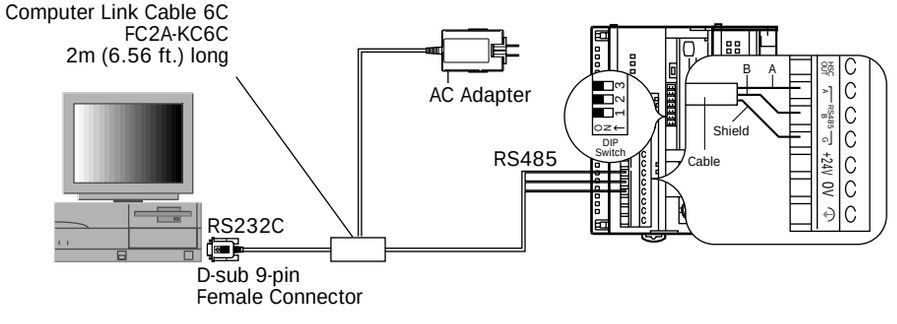


Computer Link through RS485 Port

When connecting a Windows computer to the RS485 port on the OpenNet Controller CPU module, enable the maintenance mode for the RS485 port.

To enable the maintenance mode for the RS485, set the DIP switch 1 to OFF.

To set up a 1:1 computer link system, connect a computer to the OpenNet Controller using the computer link cable 6C (FC2A-KC6C). An AC adapter is needed to supply 5V DC power to the RS232C/RS485 converter on the computer link cable 6C. For the applicable output plug of the AC adapter, see page A-5.



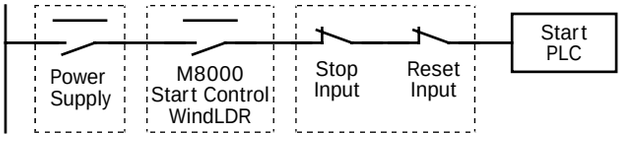
Start / Stop Operation

This section describes operations to start and stop the OpenNet Controller and to use the stop and reset inputs.

> **⚠ Caution** • Make sure of safety before starting and stopping the OpenNet Controller. Incorrect operation on the OpenNet Controller may cause machine damage or accidents.

Start / Stop Schematic

The start/stop circuit of the OpenNet Controller consists of three blocks; power supply, M8000 (start control special internal relay), and stop/reset inputs. Each block can be used to start and stop the OpenNet Controller while the other two blocks are set to run the OpenNet Controller.



Start / Stop Operation Using WindLDR

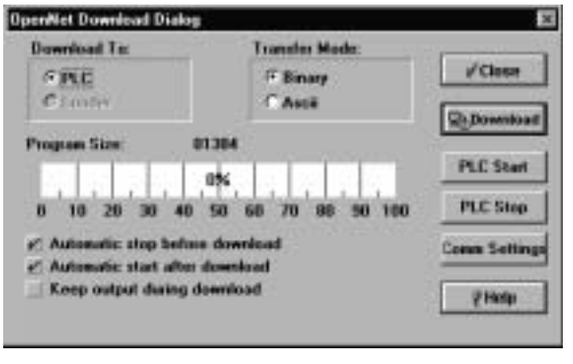
The OpenNet Controller can be started and stopped using WindLDR run on a PC connected to the OpenNet Controller CPU module. When the **PLC Start** button is pressed in the dialog box shown below, start control special internal relay M8000 is turned on to start the OpenNet Controller. When the **PLC Stop** button is pressed, M8000 is turned off to stop the OpenNet Controller.

1. Connect the PC to the OpenNet Controller, start WindLDR, and power up the OpenNet Controller. See page 4-1.
2. Check that a stop input is not designated using **Configure** > **Function Area Settings** > **Run/Stop**. See page 5-1.

Note: When a stop input is designated, the OpenNet Controller cannot be started or stopped by turning start control special internal relay M8000 on or off.

3. Select **Online** from the WindLDR menu bar, then select **Download Program**. Or, click the download icon .

OpenNet Download Program dialog box appears.



4. Click the **PLC Start** button to start operation, then the start control special internal relay M8000 is turned on.
5. Click the **PLC Stop** button to stop operation, then the start control special internal relay M8000 is turned off.

The PLC operation can also be started and stopped while WindLDR is in the monitor mode. To access the **Start** or **Stop** button, select **Online** > **Monitor** and select **Online** > **PLC Status** > **Run/Stop Status**.

Note: Special internal relay M8000 is a keep type internal relay and stores the status when power is turned off. M8000 retains its previous status when power is turned on again. However, when the backup battery is dead, M8000 loses the stored status, and can be turned on or off as programmed when the OpenNet Controller is powered up. The selection is made in **Configure > Function Area Settings > Run / Stop > Run / Stop Selection at Memory Backup Error**. See page 5-2.

The backup duration is approximately 30 days (typical) at 25°C after the backup battery is fully charged.

Start/Stop Operation Using the Power Supply

The OpenNet Controller can be started and stopped by turning power on and off.

1. Power up the OpenNet Controller to start operation. See page 4-1.
2. If the OpenNet Controller does not start, check that start control special internal relay M8000 is on using WindLDR. If M8000 is off, turn it on. See page 4-2.
3. Turn power on and off to start and stop operation.

Note: If M8000 is off, the OpenNet Controller does not start operation when power is turned on. To start operation, turn power on, and turn M8000 on by clicking the Start button in WindLDR.

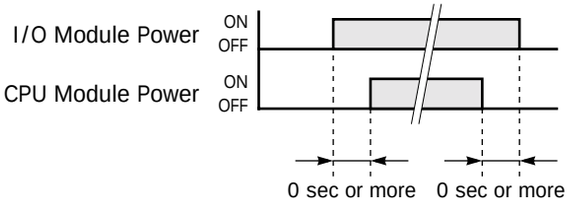
The response time of the OpenNet Controller at powerup depends on such factors as the contents of the user program, data link usage, and system setup. The table below shows an approximate time delay before starting operation after powerup.

Response time when no data link and remote I/O modules are used:

Program Size	After powerup, the CPU starts operation in
1K words	Approx. 1 second
4K words	Approx. 2 seconds
8K words	Approx. 3 seconds
16K words	Approx. 5 seconds

Order of Powerup and Powerdown

To ensure I/O data transfer, power up the I/O modules first, followed by the CPU module or power up the CPU and I/O modules at the same time. When shutting down the system, power down the CPU first, followed by I/O modules or power down the CPU and I/O modules at the same time.



Start/Stop Operation Using Stop Input and Reset Input

Any input I0 through I597 can be designated as a stop or reset input using Function Area Settings. The procedure for selecting stop and reset inputs is described on page 5-1.

Note: When using a stop and/or reset input to start and stop operation, make sure that start control special internal relay M8000 is on. If M8000 is off, then the CPU does not start operation when the stop or reset input is turned off. M8000 is not turned on or off when the stop and/or reset input is turned on or off.

When a stop or reset input is turned on during program operation, the CPU stops operation, the RUN LED is turned off, and all outputs are turned off.

The reset input has priority over the stop input.

System Statuses

The system statuses during running, stop, reset, and restart after stopping are listed below:

Mode	Outputs	Internal Relays, Shift Registers, Counters, Data Registers		Timer Current Value	Link Register (Note)
		Keep Type	Clear Type		
Run	Operating	Operating	Operating	Operating	Operating
Stop (Stop input ON)	OFF	Unchanged	Unchanged	Unchanged	Unchanged
Reset (Reset input ON)	OFF	OFF/Reset to zero	OFF/Reset to zero	Reset to zero	Reset to zero
Restart	Unchanged	Unchanged	OFF/Reset to zero	Reset to preset	Unchanged

Note: Link registers used as outputs are turned off like outputs.

Simple Operation

This section describes how to edit a simple program using WindLDR on a computer, transfer the program from WindLDR on the PC to the OpenNet Controller, run the program, and monitor the operation on WindLDR.

Connect the OpenNet Controller to the computer as described on page 4-1.

Sample User Program

Create a simple program using WindLDR. The sample program performs the following operation:

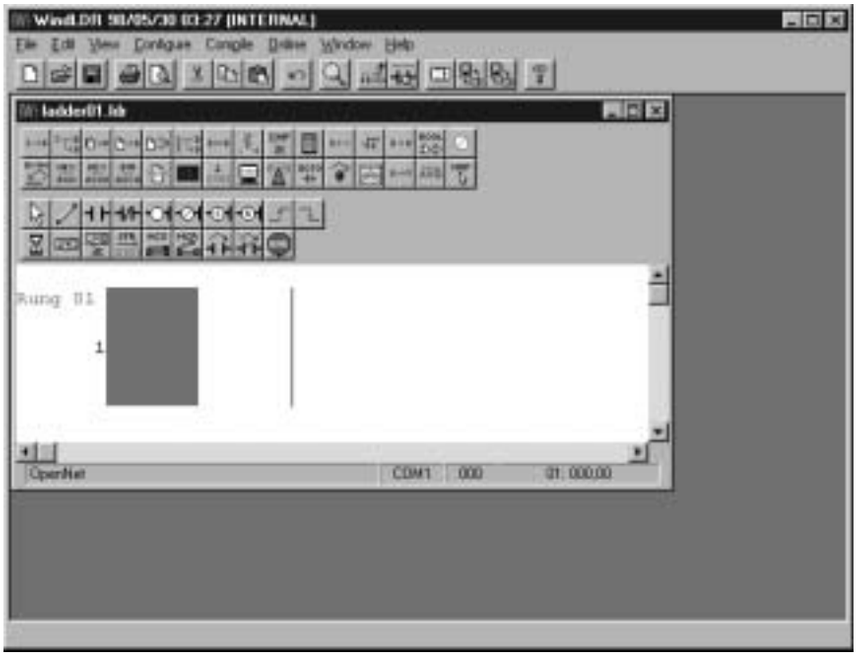
When only input I0 is turned on, output Q0 is turned on.
When only input I1 is turned on, output Q1 is turned on.
When both inputs I0 and I1 are turned on, output Q2 flashes in 1-sec increments.

Rung No.	Input I0	Input I1	Output Operation
01	ON	OFF	Output Q0 is turned ON.
02	OFF	ON	Output Q1 is turned ON.
03	ON	ON	Output Q2 flashes in 1-sec increments.

Start WindLDR

From the Start menu of Windows, select **Programs** > **WindLDR** > **WindLDR**.

WindLDR starts and a blank ladder editing screen appears with menus and tool bars shown on top of the screen.



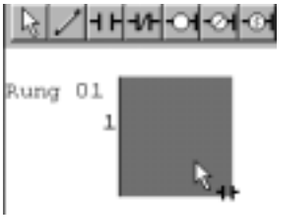
Edit User Program Rung by Rung

Start the user program with the LOD instruction by inserting a NO contact of input I0.

1. Click the **Normally Open** contact icon .

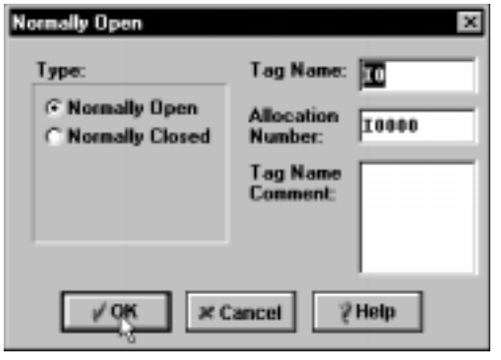
When the mouse pointer is placed on an icon, the name of the icon is indicated.

2. Move the mouse pointer to the first column of the first line where you want to insert a NO contact, and click the left mouse button.



The **Normally Open** dialog box appears.

3. Enter I0 in the **Tag Name** field, and click **OK**.



A NO contact of input I0 is programmed in the first column of the first ladder line.

Next, program the ANDN instruction by inserting a NC contact of input I1.

4. Click the **Normally Closed** contact icon .

The mouse pointer is indicated with the name of the icon “Normally Closed.”

5. Move the mouse pointer to the second column of the first ladder line where you want to insert a NC contact, and click the left mouse button.

The **Normally Closed** dialog box appears.

6. Enter I1 in the **Tag Name** field, and click **OK**.

A NC contact of input I1 is programmed in the second column of the first ladder line.

At the end of the first ladder line, program the OUT instruction by inserting a NO coil of output Q0.

7. Click the **Output** coil icon .

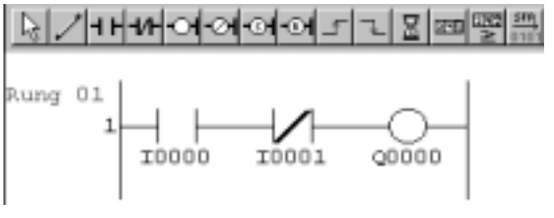
The mouse pointer is indicated with the name of the icon “Output.”

8. Move the mouse pointer to the third column of the first ladder line where you want to insert an output coil, and click the left mouse button.

The **Output** dialog box appears.

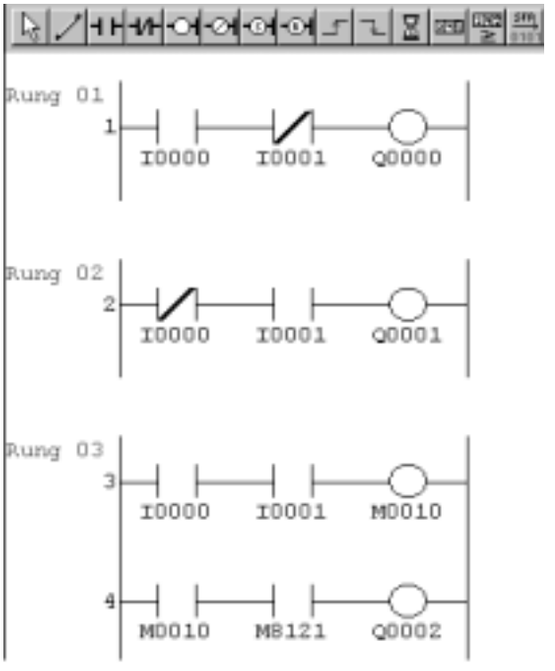
9. Enter Q0 in the **Tag Name** field, and click **OK**.

A NO output coil of output Q0 is programmed in the third column of the first ladder line. This completes programming for rung 1.



Continue programming for rungs 2 and 3 by repeating the similar procedures.

A new rung is inserted by pressing the **Enter** key while the cursor is on the preceding rung. A new rung can also be inserted by selecting **Edit** > **Append** > **Rung**. When completed, the ladder program looks like below.



Now, save the file with a new name.

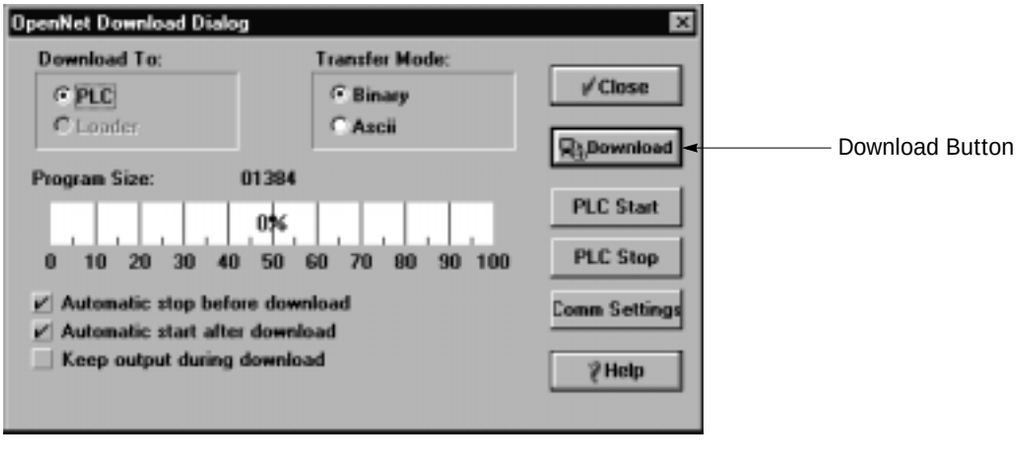
10. From the menu bar, select **File** > **Save As** and type TEST01.LDR in the **File Name** field. Change the **Folder** or **Drive** as necessary.

Click **OK**, and the file is saved in the selected folder and drive.

Download Program

You can download the user program from WindLDR running on a PC to the OpenNet Controller.

From the WindLDR menu bar, select **Online** > **Download Program**. The **Download Program** Dialog shows, then click the **Download** button. The user program is downloaded to the OpenNet Controller.



Note: When downloading a user program, all values and selections in the Function Area Settings are also downloaded to the OpenNet Controller. For Function Area Settings, see pages 5-1 through 5-18.

Monitor Operation

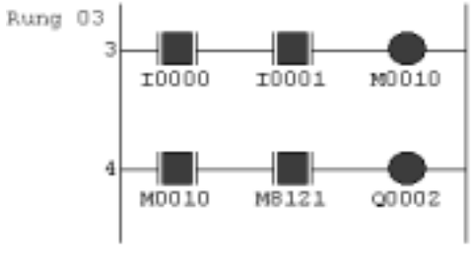
Another powerful function of WindLDR is to monitor the PLC operation on the PC. The input and output statuses of the sample program can be monitored in the ladder diagram.

From the WindLDR menu bar, select **Online** > **Monitor**.

When both inputs I0 and I1 are on, the ladder diagram on the monitor screen looks as follows:

Rung 01: When both inputs I0 and I1 are on, output Q0 is turned off.

Rung 02: When both inputs I0 and I1 are on, output Q1 is turned off.



Rung 03: When both input I0 and I1 are on, internal relay M10 is turned on.

M8121 is the 1-sec clock special internal relay.

While M10 is on, output Q2 flashes in 1-sec increments.

Quitting WindLDR

When you have completed monitoring, you can quit WindLDR either directly from the monitor screen or from the editing screen. In both cases, from the menu bar select **File** > **Exit WindLDR**.

5: SPECIAL FUNCTIONS

Introduction

The OpenNet Controller features special functions such as stop/reset inputs, run/stop selection at memory backup error, keep designation for internal relays, shift registers, counters, and data registers. These functions are programmed using the Function Area Settings menu. Also included in the Function Area Settings are module ID selection and run/stop operation upon disparity, input filter, catch input, high-speed counter, key matrix input, and user program read/write protection.

This chapter describes these special functions. Constant scan and memory card features are also described in this chapter.

Although included in the Function Area Settings, the data link communication function is detailed on pages 21-1 through 21-12.

> **⚠ Caution** • Since all Function Area Settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Stop Input and Reset Input

As described on page 4-2, the OpenNet Controller can be started and stopped using a stop input or reset input, which can be designated from the Function Area Settings menu. When the designated stop or reset input is turned on, the OpenNet Controller stops operation. For the system statuses in the stop and reset modes, see page 4-3.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Run/Stop** tab.

Stop Input: Click the check box on the left and type a desired input number I0 through I597 in the input number field.

Reset Input: Click the check box on the left and type a desired reset number I0 through I597 in the input number field.

This example designates input I0 as a stop input and input I12 as a reset input.

Default: No stop and reset inputs are designated.

Run / Stop Selection at Memory Backup Error

Start control special internal relay M8000 maintains its status when the CPU is powered down. After the CPU has been off for a period longer than the battery backup duration, the data designated to be maintained during power failure is broken. The Run/Stop Selection at Memory Backup Error dialog box is used to select whether to start or stop the CPU when attempting to restart operation after the "keep" data in the CPU RAM has been lost.

Since this setting relates to the user program, the user program must be downloaded to the OpenNet Controller after changing this setting.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Run/Stop** tab.

Run (Default): Click the button on the left to start the CPU at memory backup error.

Stop: Click the button on the left to stop the CPU when attempting to start at memory backup error. When the CPU does not start because of the Stop selection, the CPU can not be started alone, then the CPU can still be started by sending a start command from WindLDR. For start/stop operation, see page 4-2.

This example designates to allow to start operation when the "keep" data has been lost.

Default: Run

Keep Designation for Internal Relays, Shift Registers, Counters, and Data Registers

The statuses of internal relays and shift register bits are usually cleared at startup. It is also possible to designate all or a block of consecutive internal relays or shift register bits as “keep” types. Counter current values and data register values are usually maintained at powerup. It is also possible to designate all or a block of consecutive counters and data registers as “clear” types.

When the CPU is stopped, these statuses and values are maintained. When the CPU is reset by turning on a designated reset input, these statues and values are cleared despite the settings in the Keep dialog box shown below. The keep/clear settings in this dialog box have effect when restarting the CPU.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.

2. Select the **Keep** tab. The Keep page appears.

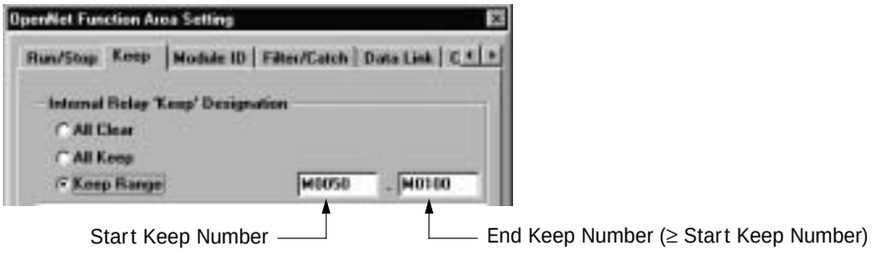
Internal Relay 'Keep' Designation

All Clear: All internal relay statuses are cleared at startup (default).

All Keep: All internal relay statuses are maintained at startup.

Keep Range: A designated area of internal relays are maintained at startup. Enter the start "keep" number in the left field and the end "keep" number in the right field. The start "keep" number must be smaller than or equal to the end "keep" number.

Valid internal relay numbers are M0 through M2557. Special internal relays cannot be designated.



When a range of M50 - M100 is designated as shown in the example above, M50 through M100 are keep types, M0 through M49 and M101 through M2557 are clear types.

Shift Register 'Keep' Designation

All Clear: All shift register bit statuses are cleared at startup (default).

All Keep: All shift register bit statuses are maintained at startup.

Keep Range: A designated area of shift register bits are maintained at startup. Enter the start "keep" number in the left field and the end "keep" number in the right field. The start "keep" number must be smaller than or equal to the end "keep" number. Valid shift register bit numbers are R0 through R255.

When a range of R17 - R32 is designated, R17 through R32 are keep types, R0 through R16 and R33 through R255 are clear types.

Counter 'Clear' Designation

All Keep: All counter current values are maintained at startup (default).

All Clear: All counter current values are cleared at startup.

Clear Range: A designated area of counter current values are cleared at startup. Enter the start "clear" number in the left field and the end "clear" number in the right field. The start "clear" number must be smaller than or equal to the end "clear" number. Valid counter numbers are C0 through C255.

When a range of C0 - C10 is designated, C0 through C10 are clear types, and C11 through C255 are keep types.

Data Register 'Clear' Designation

All Keep: All data register values are maintained at startup (default).

All Clear: All data register values are cleared at startup.

Clear Range: A designated area of data register values are cleared at startup. Enter the start "clear" number in the left field and the end "clear" number in the right field. The start "clear" number must be smaller than or equal to the end "clear" number. Valid data register numbers are D0 through D7999. Special data registers cannot be designated.

When a range of D100 - D7999 is designated, D0 through D99 are keep types, and D100 through D7999 are clear types.

Module ID Selection and Run / Stop Operation upon Disparity

The CPU module can be mounted with a maximum of seven I/O modules and functional modules without using an expansion power supply module. When using an expansion power supply module, a maximum of 15 modules can be mounted with one CPU module.

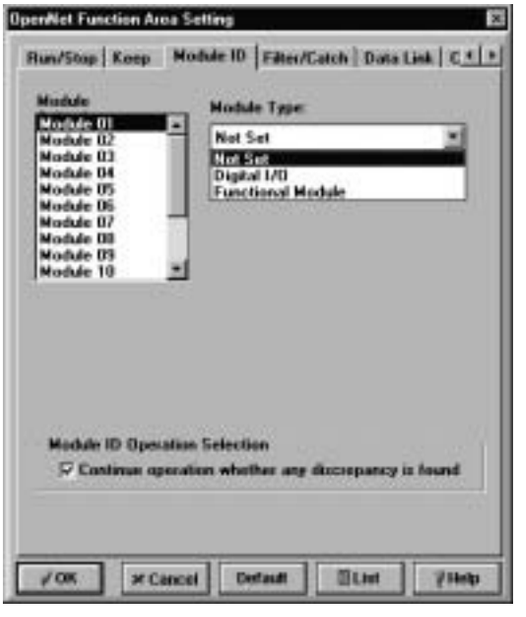
The Module ID function is used to register the type of module installed in each slot. If the information in the memory about the module ID for each slot is found different from the actual module installed at startup, the CPU can be stopped to run in order to prevent accidents.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.

2. Select the **Module ID** tab.



3. Click **Module 01** through **Module 15** in the **Module Selection** list box to select a slot number to mount a module.

Digital I/O and functional modules are numbered Module 01 through Module 15 starting with the module mounted next to the CPU module.

4. Select a module type in the **Module Type** list box.

Not Set: Module type is not selected for the selected slot.

Digital I/O: A digital I/O module is selected for the selected slot.

Functional Module: A functional module is selected for the selected slot; such as an analog I/O or OpenNet I/F module.

5. Click the check box under **Module ID Operation Selection**.

Check in the Box (default): The CPU starts to run even if actual modules differ from the module ID settings.

No Check in the Box: The CPU does not start to run when actual modules differ from the module ID settings. (Terminal and connector type difference has no effect.)

When the check box is unchecked and the CPU does not start, the ERROR LED is turned on and I/O bus error is caused (error code 0800h). Then, replace the I/O and functional modules to match the information specified in the user program, and retry to start the CPU.

Input Filter

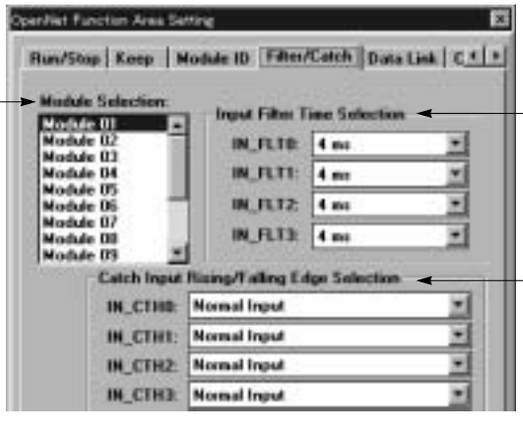
The input filter function is used to reject input noises. The catch input function described in the next section is used to receive short input pulses. On the contrary, the input filter function ignores short input pulses when the OpenNet Controller is used with input signals containing noises.

Normal inputs require a pulse width of the filter value plus one scan time to receive input signals. Input filter values have effect on the performance of the catch inputs, key matrix inputs, and digital read instruction.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Filter/Catch** tab.



Module Number Selection
Module 1 to 15

Input Filter Time Selection
Groups of 8 inputs
0, 0.5, 1, 2, 4, 8, 16, 32 msec
Default: 4 msec

Catch Input Rising / Falling Edge Selection
No effect on the input filter

Module Number Selection — Select the module number from 1 through 15 to designate input filter (or catch input) function. Module number 1 is the input module mounted next to the CPU module. Module number 2 is the second from the CPU module, and so on.

Input Filter Time Selection — Input filter time is selected in groups of eight inputs. For example, input numbers of module number 1 containing 32 inputs are divided into four groups:

IN_FLT0: I0 through I7 (only IN_FLT0 has effect on catch inputs)
IN_FLT1: I10 through I17
IN_FLT2: I20 through I27
IN_FLT3: I30 through I37

Select an input filter value from 0, 0.5, 1, 2, 4, 8, 16, or 32 msec for each input group.

Default: 4 msec

Catch Input Rising / Falling Edge Selection — No effect on the input filter

Input Filter Values and Input Operation

Depending on the selected values, the input filter has three response areas to receive or reject input signals.

Input reject area:	Input signals are ignored and not received (one-third of the selected filter value or less).
Input indefinite area:	Input signals may be received or ignored.
Input accept area:	Input signals are received (the selected filter value or higher).

Example: Rejecting Input Pulses of 2.6 msec at Inputs 0 through 7

To accept input pulses of 8 msec plus 1 scan time using normal inputs, select 8 msec in the **Input Filter Time Selection** area for **IN_FLT0**. Then, since 8/3 approximately equals 2.6 msec, input pulses shorter than 2.6 msec are rejected.

	2.6 msec	8 msec + 1 scan	
Inputs I0 to I7	Reject	Indefinite	Accept

Catch Input

The catch input function is used to receive short pulses from sensor outputs regardless of the scan time. Input pulses shorter than one scan time can be received. First eight inputs of every DC input module can be designated to catch a rising or falling edge of short input pulses. The Function Area Settings is used to designate first eight inputs of every DC input module as a catch input or normal input.

Input signals to normal input terminals are read when the END instruction is executed at the end of a scan.

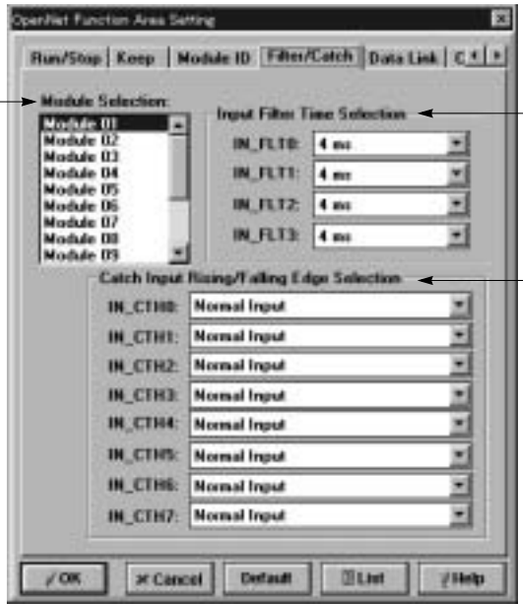
Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Catch Input Specifications

Minimum Turn ON Pulse Width	40 µsec (when the input filter is set to 0 msec)
Minimum Turn OFF Pulse Width	150 µsec (when the input filter is set to 0 msec)

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Filter/Catch** tab.



Module Number Selection
Module 1 to 15

Input Filter Time Selection
Groups of 8 inputs
0, 0.5, 1, 2, 4, 8, 16, 32 msec
Default: 4 msec

Catch Input Rising / Falling Edge Selection
Normal Input (default)
Catch Input Falling Edge
Catch Input Rising Edge

Module Number Selection

Select the module number from 1 through 15 to designate catch input or input filter function. Module number 1 is the input module mounted next to the CPU module. Module number 2 is the second from the CPU module, and so on.

Input Filter Time Selection

Input filter time is selected in groups of eight inputs. For example, input numbers of module number 1 are divided into four groups:

IN_FLT0: I0 through I7 (only IN_FLT0 has effect on catch inputs)
IN_FLT1, IN_FLT2, and IN_FLT3 have no effect on catch inputs.

Select an input filter value from 0, 0.5, 1, 2, 4, 8, 16, or 32 msec for IN_FLT0 of each DC input module.

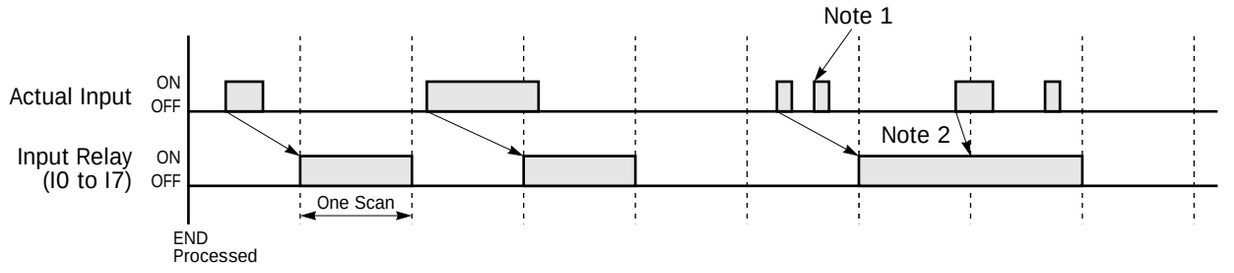
Default: 4 msec

Catch Input Rising / Falling Edge Selection

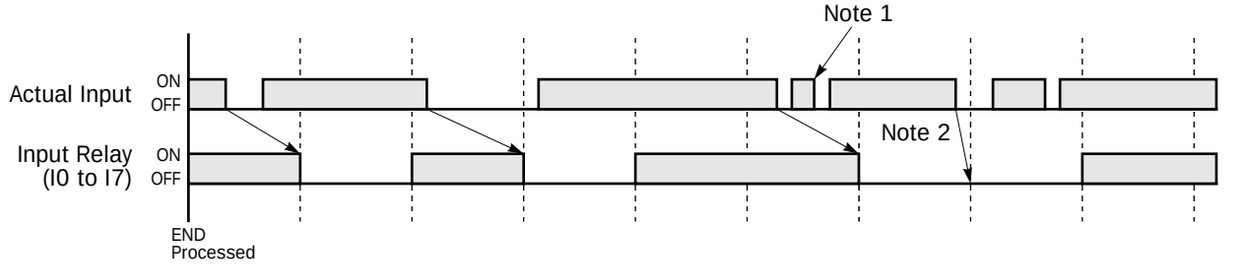
Select catch input of rising or falling edge or normal input for the first eight inputs of each DC input module.

Default: Normal Input

Catching Rising Edge of Input Pulse



Catching Falling Edge of Input Pulse

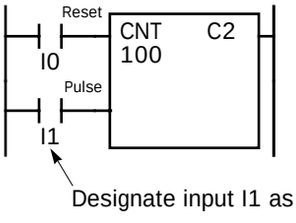


Note 1: When two or more pulses enter within one scan, subsequent pulses are ignored.

Note 2: The pulse entering at the timing shown above cannot be used as pulse inputs for counters and shift registers.

Example: Counting Catch Input Pulses

This example demonstrates a program to count short pulses using the catch input function.

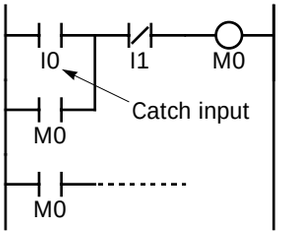


Input I0 is used as a reset input for adding counter C2.
Input I1 is designated as a catch input using the Function Area Settings.
Counter C2 counts short-pulse inputs to input I1.

Note: When a catch input is used as a pulse input to a counter, the repeat cycle period of the pulse inputs must be more than 2 scan times.

Example: Maintaining Catch Input

When a catch input is received, the input relay assigned to a catch input is turned on for only one scan. This example demonstrates a program to maintain a catch input status for more than one scan.



Input I0 is designated as a catch input using the Function Area Settings.
When input I0 is turned on, internal relay M0 is turned on, and M0 is maintained in the self-holding circuit.
When NC input I1 is turned off, the self-holding circuit is unlatched, and M0 is turned off.

M0 is used as an input condition for the subsequent program instructions.

Note: To catch as short inputs as possible, select 0 msec in the Input Filter Time Selection field.

High-speed Counter

This section describes the high-speed counter function to count many pulse inputs within one scan. Using the built-in 16-bit high-speed counter, the OpenNet Controller counts up to 65535 high-speed pulses from a rotary encoder or proximity switch without regard to the scan time, compares the current value with a preset value, and turns on the output when the current value exceeds the preset value. This function can be used for simple motor control or to measure lengths of objects.

The high-speed counter can be used in the rotary encoder mode or dual-pulse reversible counter mode, which can be selected using the Function Area Settings in WindLDR.

The CPU module has screw terminals 1 through 5 dedicated to the high-speed counter. The high-speed counter counts up or down input pulses to terminals 2 (phase A or CW) and 3 (phase B or CCW), and turns on the comparison output at terminal 5 (comparison output) when the current value *exceeds* the preset value. The comparison output does not go on when the preset value is reached, but goes on when another input pulse enters after reaching the preset value. Use of the comparison output is selected using the Function Area Settings.

When the input to terminal 4 (phase Z or reset-to-zero input) is turned on, the current value is reset to zero.

Three special data registers and seven special internal relays are assigned to control and monitor the high-speed counter operation. The high-speed counter current value is stored in data register D8045 and is updated every scan. The value stored in D8046 is used as a reset value, and the value in D8047 is used as a preset value to compare with the current value. When a high-speed counter reset input (described later) is turned on, the current value in D8045 is reset to the value stored in D8046 and the high-speed counter counts subsequent input pulses starting at the reset value.

When comparison output reset special internal relay M8010 is turned on, the comparison output is turned off. While the high-speed counter is counting up, up/down status special internal relay M8130 remains on. While counting down, M8130 remains off. When the current value *exceeds* the preset value, comparison ON status special internal relay M8131 turns on in the next scan. When the current value is reset (cleared) to zero, current value zero-clear special internal relay M8132 turns on in the next scan. When a current value overflow or underflow occurs while counting up or down, special internal relay M8133 or M8134 turns on in the next scan, respectively. While the comparison output is on, comparison output status special internal relay M8135 remains on. While the comparison output is off, M8135 remains off. See page 5-12.

In addition, two inputs can be designated as a high-speed counter gate input and reset input to control the high-speed counter operation. The gate input and reset input are designated using the Function Area Settings. When a gate input is designated, counting is enabled while the gate input is on and is disabled while the gate input is off. When a gate input is not designated, counting is always enabled. When the reset input is turned on, the current value is reset to the reset value.

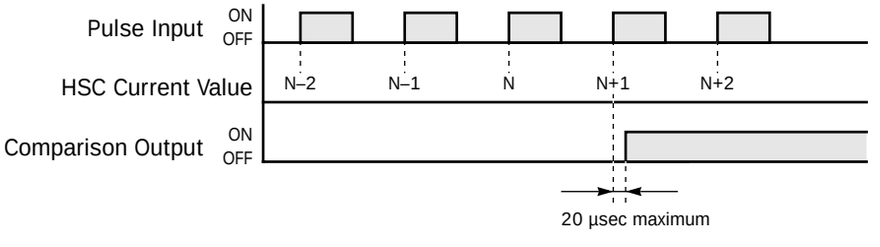
High-speed Counter Operation Modes and Input / Output Terminals

CPU Module Terminal No.	Rotary Encoder Mode	Dual-pulse Reversible Counter Mode
1	COM	COM
2	Phase A	CW
3	Phase B	CCW
4	Phase Z	Reset to zero
5	Comparison output	Comparison output

Note: When using the phase Z (reset to zero) input, keep the input signal on for 100 µsec or more.

Comparison Output Timing Chart

The comparison output at terminal 5 (comparison output) is turned on when the current value *exceeds* the preset value. The comparison output does not go on when the current value equals the preset value, but goes on when another input pulse enters after reaching the preset value. The figure below illustrates the comparison output timing when the preset value is N:



High-speed Counter Input Specifications

Maximum Counting Frequency	10 kHz
Counting Range	0 to 65535 (16 bits)
Input Voltage	24V DC ±15%
Input Impedance	6 kΩ

High-speed Counter Output Specifications

Comparison Output	1 point (terminal 5 on the CPU module)
Output Device	Transistor sink or source output depending on the CPU module type
Output Power Voltage	24V DC ±15%
Output Current	500 mA maximum
Comparison Output Delay	20 µsec maximum

Special Internal Relays for High-speed Counter

No.	Description	ON	OFF	Operation	R/W
M8010	Comparison Output Reset	Turns off comparison output	—	Continuous	R/W
M8130	Up/Down Status	Counting up	Counting down	Continuous	Read
M8131	Comparison ON Status	Comparison ON	—	ON for 1 scan	Read
M8132	Current Value Zero-clear	Phase Z input ON	—	ON for 1 scan	Read
M8133	Current Value Overflow	Overflow occurred	—	ON for 1 scan	Read
M8134	Current Value Underflow	Underflow occurred	—	ON for 1 scan	Read
M8135	Comparison Output Status	Comparison output ON	Comparison output OFF	Continuous	Read

Note: Special internal relays M8131 through M8134 go on for only one scan.

Special Data Registers for High-speed Counter

No.	Description	Updated	Read/Write
D8045	High-speed Counter Current Value	Every scan	Read only
D8046	High-speed Counter Reset Value	—	R/W
D8047	High-speed Counter Preset Value	—	R/W

In the first counting cycle, the value stored in D8047 at the second scan is used as a preset value to compare with the current value. In subsequent counting cycles, the D8047 value at the moment when coincidence occurred is used as a preset value for the next counting cycle.

Gate and Reset Inputs for High-speed Counter

No.	Description	ON	OFF	R/W
Any Input or Internal Relay	High-speed Counter Gate Input	Enables counting	Stops counting	R/W
Any Input or Internal Relay	High-speed Counter Reset Input	Resets the current value to the D8046 reset value	—	R/W

Any input or internal relay number can be designated as a high-speed counter gate input and reset input using **Function Area Settings** > **Others** > **Enable High-speed Counter** in WindLDR.

Clearing High-speed Counter Current Value

The high-speed counter current value is cleared to zero in five ways:

when the CPU is powered up,
when a user program is downloaded to the CPU,
when the phase Z or reset-to-zero input at terminal No. 4 is turned on,
when the communication enable button on the CPU module is pressed, or
when the reset input (*not* the high-speed counter reset input) designated in the Function Area Settings is turned on.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Others** tab.

3. Click the **Enable High-speed Counter** check box.

HSC Operation Mode

Two operation modes are available. Select a required operation mode in the pull-down list box.

Rotary Encoder: Counts input pulses from a rotary encoder
Dual-pulse Reversible Counter: Counts input pulses from a dual pulse reversible counter

Enable HSC Reset Input

Click the check box to enable the high-speed counter reset input, then a field appears to the right. Enter an input or internal relay number to designate a reset input. When the high-speed counter reset input is turned on, the current value in D8045 is reset to the value stored in D8046 (high-speed counter reset value) and the high-speed counter counts subsequent input pulses starting at the reset value.

Enable HSC Gate Input

Click the check box to enable the high-speed counter gate input. Enter an input or internal relay number to designate a gate input. When a gate input is designated, counting is enabled while the gate input is on and is disabled while the gate input is off. When a gate input is not designated, counting is always enabled.

Enable Comparison Output

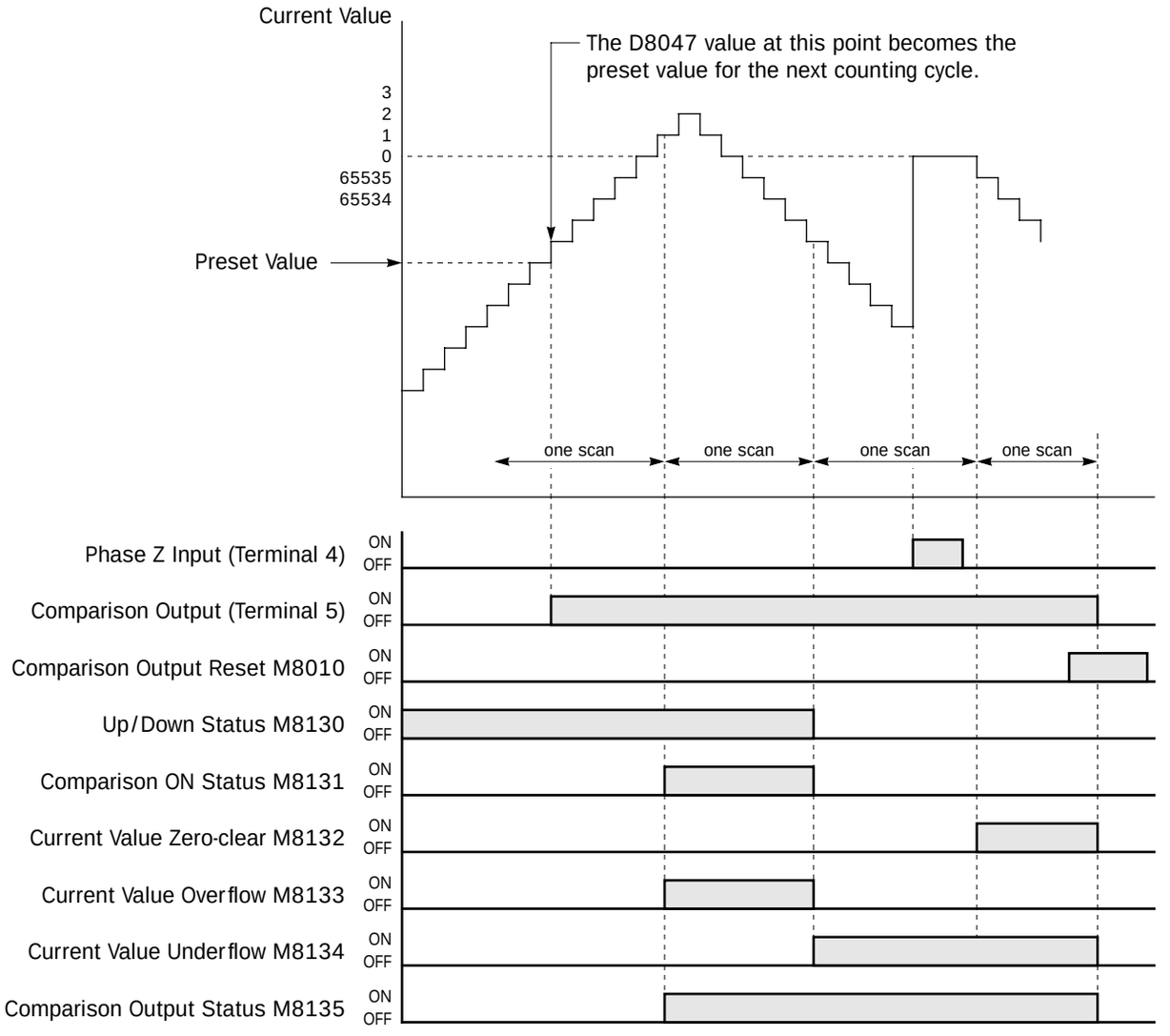
Click the check box to enable the high-speed counter comparison output. With this box checked, the high-speed current value is compared with the preset value. The comparison output at terminal 5 (comparison output) is turned on when the current value *exceeds* the preset value. The comparison output is turned off by turning on special internal relay M8010 (comparison output reset).

Current Value Automatic Reset

Click the check box to enable the high-speed counter current value automatic reset. When the comparison output is turned on with this box checked, the current value in D8045 is reset to the value stored in D8046 (high-speed counter reset value) automatically. The high-speed counter counts subsequent input pulses starting at the reset value.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

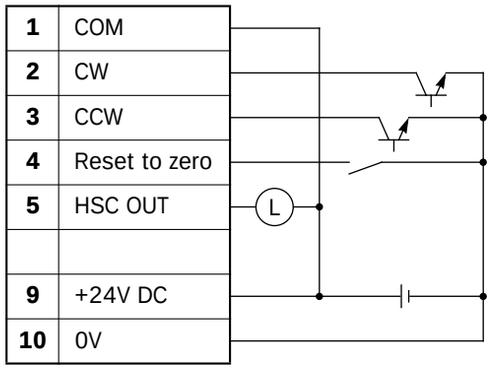
High-speed Counter Timing Chart



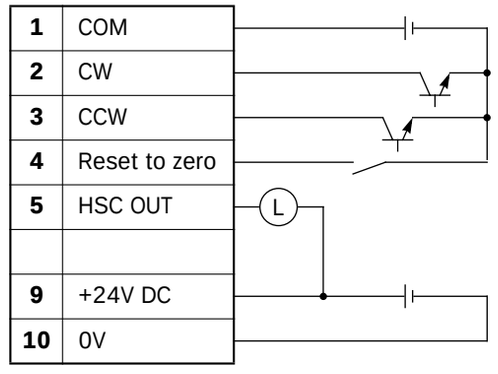
High-speed Counter Wiring Diagram

Sink Type High-speed Counter Comparison Output — FC3A-CP2K and FC3A-CP2KM

Wiring for loads insusceptible to noises

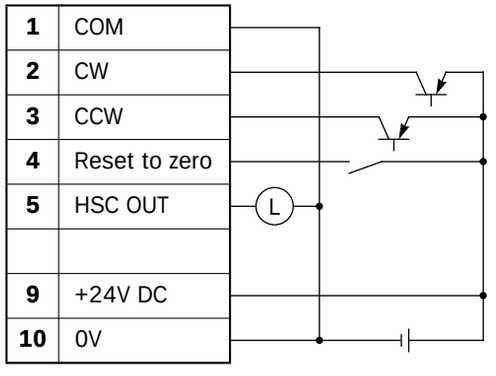


Wiring for loads susceptible to noises

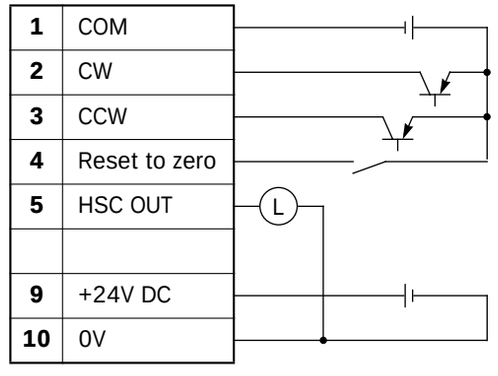


Source Type High-speed Counter Comparison Output — FC3A-CP2S and FC3A-CP2SM

Wiring for loads insusceptible to noises



Wiring for loads susceptible to noises



Caution

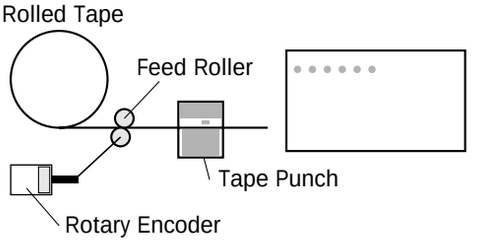
- Be sure to use shielded cables for wiring high-speed counter inputs. If the input cable is not shielded, high-speed input pulses may not be counted correctly.

Example: Counting High-speed Input Pulses from Rotary Encoder

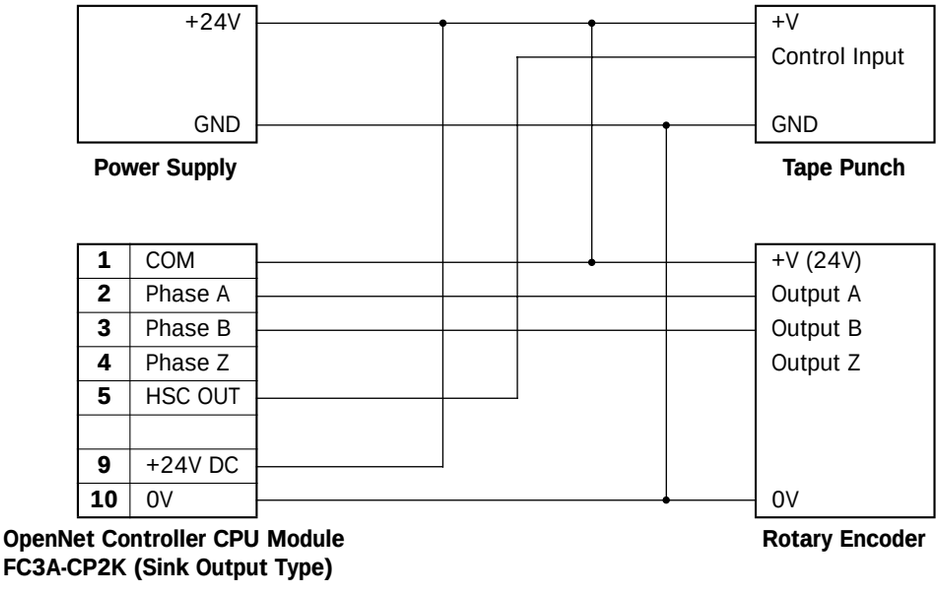
This example demonstrates a program to punch holes in a paper tape at regular intervals.

Description of Operation

A rotary encoder is linked to the tape feed roller directly, and the output pulses from the rotary encoder are counted by the high-speed counter in the OpenNet Controller CPU module. When the high-speed counter current value reaches 3,000, the comparison output is turned on. When the comparison output is turned on, the current value is reset to 300 automatically to continue another cycle of counting. The comparison output remains on for 0.5 second to punch holes in the tape, and is turned off until the preset value is reached again.



Wiring Diagram

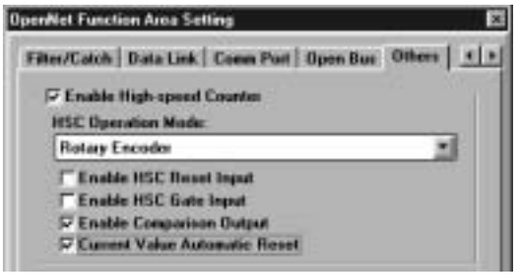


Note: This example does not use the Phase Z signal.

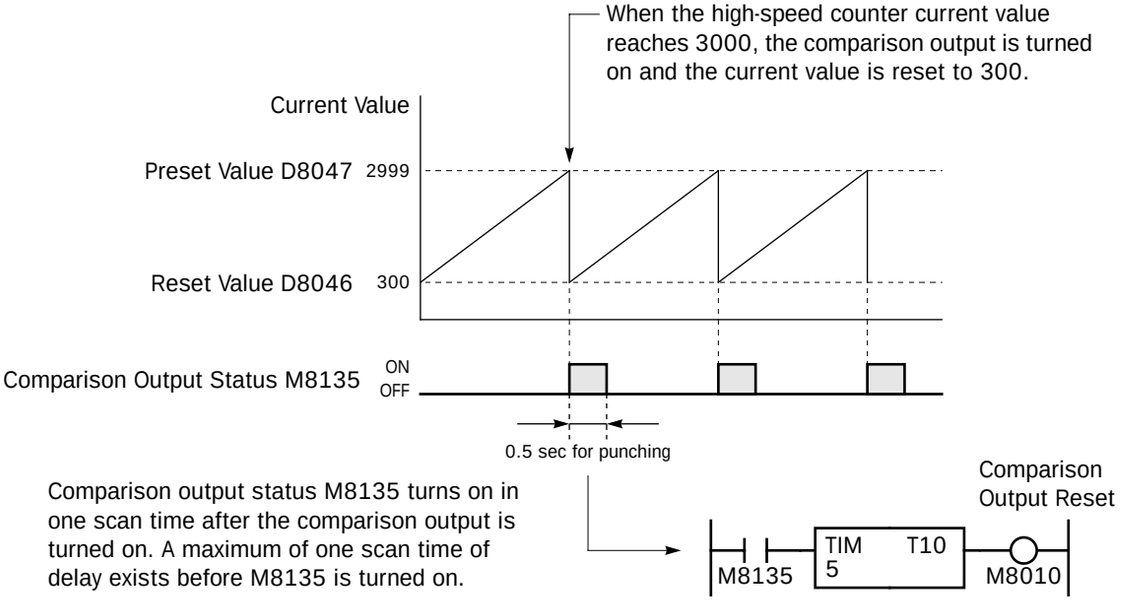
Program Parameters

Enable High-speed Counter	Yes
HSC Operation Mode	Rotary Encoder
Enable HSC Reset Input	No
Enable HSC Gate Input	No
Enable Comparison Output	Yes
Current Value Automatic Reset	Yes
HSC Reset Value (D8046)	300
HSC Preset Value (D8047)	2,999
Timer Preset Value	0.5 sec (needed for punching) programmed in TIM instruction

Programming WindLDR



Timing Chart



Comparison output status M8135 turns on in one scan time after the comparison output is turned on. A maximum of one scan time of delay exists before M8135 is turned on.

When M8135 turns on, the 100-msec timer TIM instruction starts to time down. When the preset value of 0.5 second is reached, M8010 is turned on to reset the comparison output.

Key Matrix Input

The key matrix input function can be programmed using the Function Area Settings in WindLDR to form a matrix with 1 to 16 input points and 1 to 16 output points to multiply input capability. A key matrix with 8 inputs and 4 outputs would equal 32 inputs, for example. The maximum, 16 inputs and 16 outputs, would result in 256 input points.

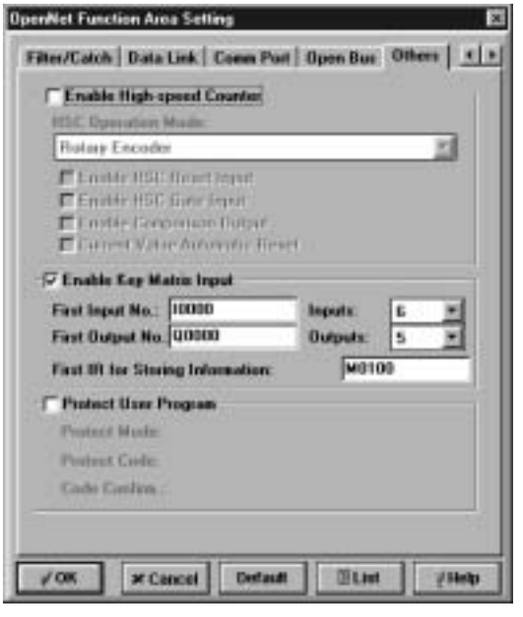
The input information is stored in consecutive internal relays as many as the quantity of input points multiplied by the quantity of output points, starting at the first internal relay number programmed in the Function Area Settings.

When using the key matrix input function, DC input modules and transistor output modules must be used.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Others** tab.



3. Click the **Enable Key Matrix Input** check box and enter required data in the areas shown below.

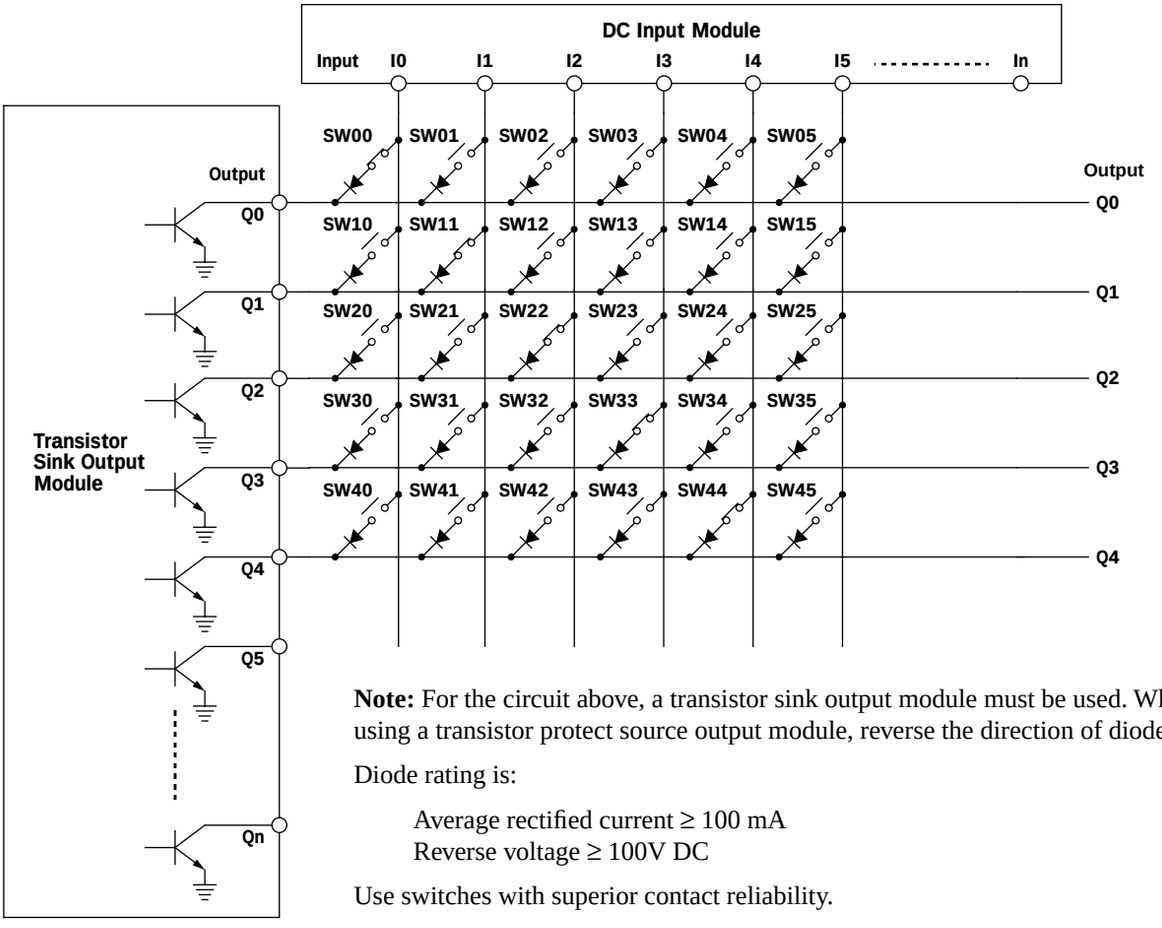
First Input No.:	Enter the first input number used for the key matrix.
Inputs:	Enter the quantity of input points used for the key matrix.
First Output No.:	Enter the first output number used for the key matrix.
Outputs:	Enter the quantity of output points used for the key matrix.
First IR for Storing Information:	Enter the first internal relay number used for storing key matrix input information.

Key Matrix Dialog Box

The screen display shown above is an example to configure a key matrix of 6 input points and 5 output points, starting with input I0 and output Q0. The key matrix information is stored to 30 internal relays starting with M100.

Key Matrix Circuit

The key matrix structure includes sequentially-numbered input points along the top and sequentially-numbered output points along the side. The I/O connecting blocks include a diode and a switch, as shown below.



Note: For the circuit above, a transistor sink output module must be used. When using a transistor protect source output module, reverse the direction of diodes.

Diode rating is:

Average rectified current ≥ 100 mA
Reverse voltage ≥ 100V DC

Use switches with superior contact reliability.

Internal Relay Allocation

The example of a key matrix configuration shown on page 5-16 stores input information to 30 internal relays starting with internal relay M100. The switches are assigned to internal relays as shown below:

Outputs	Inputs					
	I0	I1	I2	I3	I4	I5
Q0	M100 (SW00)	M101 (SW01)	M102 (SW02)	M103 (SW03)	M104 (SW04)	M105 (SW05)
Q1	M106 (SW10)	M107 (SW11)	M110 (SW12)	M111 (SW13)	M112 (SW14)	M113 (SW15)
Q2	M114 (SW20)	M115 (SW21)	M116 (SW22)	M117 (SW23)	M120 (SW24)	M121 (SW25)
Q3	M122 (SW30)	M123 (SW31)	M124 (SW32)	M125 (SW33)	M126 (SW34)	M127 (SW35)
Q4	M130 (SW40)	M131 (SW41)	M132 (SW42)	M133 (SW43)	M134 (SW44)	M135 (SW45)

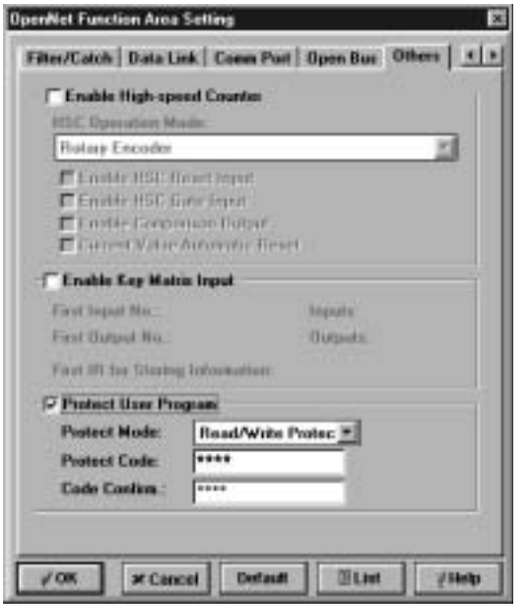
User Program Protection

The user program in the OpenNet Controller CPU module can be protected from reading, writing, or both using the Function Area Settings in WindLDR.

> **Warning** • When proceeding with the following steps, make sure to note the protect code, which is needed to disable the user program protection. If the user program in the OpenNet Controller CPU module is write- or read/write-protected, the user program cannot be changed without the protect code.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Others** tab.



3. Click the **Protect User Program** check box and enter required data in the areas shown below.

Protect Mode: Select from Write Protect, Read Protect, or Read/Write Protect.
Protect Code: Enter a protect code of 1 through 16 ASCII characters from the keyboard.
Code Confirm: Repeat to enter the same protect code for confirmation.

Download the user program to the OpenNet Controller after changing any of these settings.

Disabling and Enabling Protection

1. From the WindLDR menu bar, select **Online** > **Monitor**. The monitor mode is enabled.
2. From the WindLDR menu bar, select **Online** > **PLC Status**.
3. Under the **Protect Status** in the PLC Status dialog box, press the **Change** button. The Change Protect dialog box appears.
4. Enter the protect code, and click either button under **Disable/Enable Protect**.

Disable Protect: Disables the user program protection temporarily. When the CPU is powered up again, the protection stored in the user program takes effect again.

Enable Protect: After disabling, enables the user program protection again without turning power up and down the CPU.

Memory Card

A user program can be stored on a miniature memory card from a computer running WindLDR and downloaded to the OpenNet Controller CPU module without using a computer. This feature is available on FC3A-CP2KM and FC3A-CP2SM only.

Using a memory card, the user program in the CPU module can be replaced where WindLDR or a computer cannot be used.

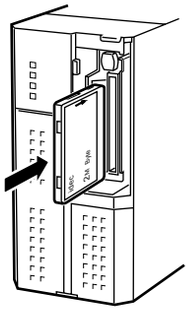
Depending whether a memory card is installed in the OpenNet Controller CPU module or not, a user program stored on the memory card or in the CPU is executed, respectively.

Memory Card	User Program
Installed in the CPU	The user program stored on the memory card is executed.
Not installed in the CPU	The user program stored in the flash ROM in the CPU module is executed.

⚠ Caution

- When the user program is downloaded from the memory card to the CPU, the user program stored in the flash ROM in the OpenNet Controller CPU module is overwritten.
- Power down the CPU before inserting or removing the memory card.
- Program execution using the memory card must be limited to operation check only. Do not use the memory card for normal execution of user programs.

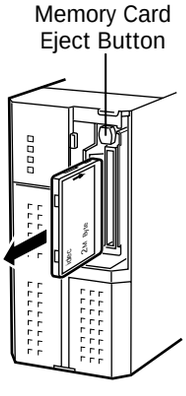
Downloading User Program from Memory Card to the CPU



1. Power down the OpenNet Controller CPU module.
2. Insert a memory card into the CPU module until the card clicks into place as shown at right.
3. Power up the CPU module. The CPU starts to run the user program stored on the memory card.
4. Check the operation of the user program stored on the memory card.
5. If there is no problem in the program operation, power down the CPU.
6. Hold the communication enable button depressed, and power up the CPU. The user program is downloaded from the memory card to the flash ROM in the CPU. For the communication enable button, see page 2-1.

While program download is in progress, the ERROR LED flashes. If program download fails, the ERROR LED goes on.

7. Power down the CPU, and remove the miniature card by pressing the miniature card eject button.
8. Power up the CPU to start the program.



Specifications

Card Type	Miniature memory card (FC9Z-MC02)
Accessible Memory Capacity	2MB, 5V type
Download Destination	CPU module (FC3A-CP2KM and -CP2SM)
Software for Writing Card	WindLDR
Quantity of Stored Programs	One user program stored on one memory card
Program Execution Priority	When a memory card is inserted, user program on the memory card is executed.

Downloading User Program from WindLDR to Miniature Card

For the procedures to download a user program from WindLDR on a computer to a miniature card, see page 4-6. When a miniature card is inserted in the CPU module, the user program is downloaded to the miniature card.

Constant Scan Time

The scan time may vary whether basic and advanced instructions are executed or not depending on input conditions to these instructions. The scan time can be made constant by entering a required scan time preset value into special data register D8022 reserved for constant scan time. When performing accurate repetitive control, make the scan time constant using this function. The constant scan time preset value can be between 1 and 1,000 msec.

The scan time error is ±1 msec of the preset value normally. When the data link or other communication functions are used, the scan time error may be increased to several milliseconds.

When the actual scan time is longer than the scan time preset value, the scan time cannot be reduced to the constant value.

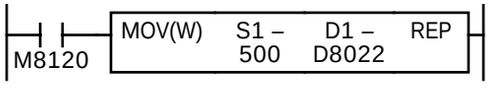
Special Data Registers for Scan Time

In addition to D8022, three more special data registers are reserved to indicate current, maximum, and minimum scan time values.

D8022	Constant Scan Time Preset Value (1 to 1,000 msec)
D8023	Scan Time Current Value (msec)
D8024	Scan Time Maximum Value (msec)
D8025	Scan Time Minimum Value (msec)

Example: Constant Scan Time

This example sets the scan time to a constant value of 500 msec.



M8120 is the initialize pulse special internal relay.
When the CPU starts operation, the MOV (move) instruction sets 500 to special data register D8022.
The scan time is set to a constant value of 500 msec.

6: ALLOCATION NUMBERS

Introduction

This chapter describes allocation numbers available for the OpenNet Controller CPU module to program basic and advanced instructions. Special internal relays and special data registers are also described.

The OpenNet Controller is programmed using operands such as inputs, outputs, internal relays, timers, counters, shift registers, data registers, and link registers.

Inputs (I) are relays to receive input signals through the input terminals.

Outputs (Q) are relays to send the processed results of the user program to the output terminals.

Internal relays (M) are relays used in the CPU and cannot be outputted to the output terminals.

Special internal relays (M) are internal relays dedicated to specific functions.

Timers (T) are relays used in the user program, available in 1-sec, 100-msec, 10-msec, and 1-msec timers.

Counters (C) are relays used in the user program, available in adding counters and reversible counters.

Shift registers (R) are registers to shift the data bits according to pulse inputs.

Data registers (D) are registers used to store numerical data. Some of the data registers are dedicated to special functions.

Link registers (L) are registers used for inputting and outputting numerical values to and from functional modules.

Operand Allocation Numbers

Operand	Allocation Numbers	Total Points
Input (I)	I0000-I0007 I0010-I0017 I0020-I0027 I0030-I0037 I0040-I0047 I0050-I0057 I0060-I0067 I0070-I0077 I0080-I0087 I0090-I0097 I0100-I0107 I0110-I0117 I0120-I0127 I0130-I0137 I0140-I0147 I0150-I0157 I0160-I0167 I0170-I0177 I0180-I0187 I0190-I0197 I0200-I0207 I0210-I0217 I0220-I0227 I0230-I0237 I0240-I0247 I0250-I0257 I0260-I0267 I0270-I0277	224
	I0280-I0287 I0290-I0297 I0300-I0307 I0310-I0317 I0320-I0327 I0330-I0337 I0340-I0347 I0350-I0357 I0360-I0367 I0370-I0377 I0380-I0387 I0390-I0397 I0400-I0407 I0410-I0417 I0420-I0427 I0430-I0437 I0440-I0447 I0450-I0457 I0460-I0467 I0470-I0477 I0480-I0487 I0490-I0497 I0500-I0507 I0510-I0517 I0520-I0527 I0530-I0537 I0540-I0547 I0550-I0557 I0560-I0567 I0570-I0577 I0580-I0587 I0590-I0597	480 total when using an expansion power supply module
Output (Q)	Q0000-Q0007 Q0010-Q0017 Q0020-Q0027 Q0030-Q0037 Q0040-Q0047 Q0050-Q0057 Q0060-Q0067 Q0070-Q0077 Q0080-Q0087 Q0090-Q0097 Q0100-Q0107 Q0110-Q0117 Q0120-Q0127 Q0130-Q0137 Q0140-Q0147 Q0150-Q0157 Q0160-Q0167 Q0170-Q0177 Q0180-Q0187 Q0190-Q0197 Q0200-Q0207 Q0210-Q0217 Q0220-Q0227 Q0230-Q0237 Q0240-Q0247 Q0250-Q0257 Q0260-Q0267 Q0270-Q0277	224
	Q0280-Q0287 Q0290-Q0297 Q0300-Q0307 Q0310-Q0317 Q0320-Q0327 Q0330-Q0337 Q0340-Q0347 Q0350-Q0357 Q0360-Q0367 Q0370-Q0377 Q0380-Q0387 Q0390-Q0397 Q0400-Q0407 Q0410-Q0417 Q0420-Q0427 Q0430-Q0437 Q0440-Q0447 Q0450-Q0457 Q0460-Q0467 Q0470-Q0477 Q0480-Q0487 Q0490-Q0497 Q0500-Q0507 Q0510-Q0517 Q0520-Q0527 Q0530-Q0537 Q0540-Q0547 Q0550-Q0557 Q0560-Q0567 Q0570-Q0577 Q0580-Q0587 Q0590-Q0597	480 total when using an expansion power supply module
Internal Relay (M)	M0000-M0007 M0010-M0017 M0020-M0027 M0030-M0037 M0040-M0047 M0050-M0057 M0060-M0067 M0070-M0077 M0080-M0087 M0090-M0097 M0100-M0107 M0110-M0117 M0120-M0127 M0130-M0137 M0140-M0147 M0150-M0157 M0160-M0167 M0170-M0177 M0180-M0187 M0190-M0197 M0200-M0207 M0210-M0217 M0220-M0227 M0230-M0237 M0240-M0247 M0250-M0257 M0260-M0267 M0270-M0277 M0280-M0287 M0290-M0297 M0300-M0307 M0310-M0317 M0320-M0327 M0330-M0337 M0340-M0347 M0350-M0357 M0360-M0367 M0370-M0377 M0380-M0387 M0390-M0397 M0400-M0407 M0410-M0417 M0420-M0427 M0430-M0437 M0440-M0447 M0450-M0457 M0460-M0467 M0470-M0477 M0480-M0487 M0490-M0497 M0500-M0507 M0510-M0517 M0520-M0527 M0530-M0537 M0540-M0547 M0550-M0557 M0560-M0567 M0570-M0577 M0580-M0587 M0590-M0597 M0600-M0607 M0610-M0617 M0620-M0627 M0630-M0637 M0640-M0647 M0650-M0657 M0660-M0667 M0670-M0677 M0680-M0687 M0690-M0697 M0700-M0707 M0710-M0717 M0720-M0727 M0730-M0737 M0740-M0747 M0750-M0757 M0760-M0767 M0770-M0777 M0780-M0787 M0790-M0797 M0800-M0807 M0810-M0817 M0820-M0827 M0830-M0837 M0840-M0847 M0850-M0857 M0860-M0867 M0870-M0877 M0880-M0887 M0890-M0897 M0900-M0907 M0910-M0917 M0920-M0927 M0930-M0937 M0940-M0947 M0950-M0957 M0960-M0967 M0970-M0977 M0980-M0987 M0990-M0997	2048

Operand	Allocation Numbers	Total Points
Internal Relay (M)	M1000-M1007 M1010-M1017 M1020-M1027 M1030-M1037 M1040-M1047 M1050-M1057 M1060-M1067 M1070-M1077 M1080-M1087 M1090-M1097 M1100-M1107 M1110-M1117 M1120-M1127 M1130-M1137 M1140-M1147 M1150-M1157 M1160-M1167 M1170-M1177 M1180-M1187 M1190-M1197 M1200-M1207 M1210-M1217 M1220-M1227 M1230-M1237 M1240-M1247 M1250-M1257 M1260-M1267 M1270-M1277 M1280-M1287 M1290-M1297 M1300-M1307 M1310-M1317 M1320-M1327 M1330-M1337 M1340-M1347 M1350-M1357 M1360-M1367 M1370-M1377 M1380-M1387 M1390-M1397 M1400-M1407 M1410-M1417 M1420-M1427 M1430-M1437 M1440-M1447 M1450-M1457 M1460-M1467 M1470-M1477 M1480-M1487 M1490-M1497 M1500-M1507 M1510-M1517 M1520-M1527 M1530-M1537 M1540-M1547 M1550-M1557 M1560-M1567 M1570-M1577 M1580-M1587 M1590-M1597 M1600-M1607 M1610-M1617 M1620-M1627 M1630-M1637 M1640-M1647 M1650-M1657 M1660-M1667 M1670-M1677 M1680-M1687 M1690-M1697 M1700-M1707 M1710-M1717 M1720-M1727 M1730-M1737 M1740-M1747 M1750-M1757 M1760-M1767 M1770-M1777 M1780-M1787 M1790-M1797 M1800-M1807 M1810-M1817 M1820-M1827 M1830-M1837 M1840-M1847 M1850-M1857 M1860-M1867 M1870-M1877 M1880-M1887 M1890-M1897 M1900-M1907 M1910-M1917 M1920-M1927 M1930-M1937 M1940-M1947 M1950-M1957 M1960-M1967 M1970-M1977 M1980-M1987 M1990-M1997 M2000-M2007 M2010-M2017 M2020-M2027 M2030-M2037 M2040-M2047 M2050-M2057 M2060-M2067 M2070-M2077 M2080-M2087 M2090-M2097 M2100-M2107 M2110-M2117 M2120-M2127 M2130-M2137 M2140-M2147 M2150-M2157 M2160-M2167 M2170-M2177 M2180-M2187 M2190-M2197 M2200-M2207 M2210-M2217 M2220-M2227 M2230-M2237 M2240-M2247 M2250-M2257 M2260-M2267 M2270-M2277 M2280-M2287 M2290-M2297 M2300-M2307 M2310-M2317 M2320-M2327 M2330-M2337 M2340-M2347 M2350-M2357 M2360-M2367 M2370-M2377 M2380-M2387 M2390-M2397 M2400-M2407 M2410-M2417 M2420-M2427 M2430-M2437 M2440-M2447 M2450-M2457 M2460-M2467 M2470-M2477 M2480-M2487 M2490-M2497 M2500-M2507 M2510-M2517 M2520-M2527 M2530-M2537 M2540-M2547 M2550-M2557	2048
Special Internal Relay (M) M8120-M8237 for read only	M8000-M8007 M8010-M8017 M8020-M8027 M8030-M8037 M8040-M8047 M8050-M8057 M8060-M8067 M8070-M8077 M8080-M8087 M8090-M8097 M8100-M8107 M8110-M8117 M8120-M8127 M8130-M8137 M8140-M8147 M8150-M8157 M8160-M8167 M8170-M8177 M8180-M8187 M8190-M8197 M8200-M8207 M8210-M8217 M8220-M8227 M8230-M8237	192
Shift Register (R)	R0000-R0255	256
Timer (T)	T0000-T0255	256
Counter (C)	C0000-C0255	256
Data Register (D)	D0000-D7999	8000
Special Data Register (D)	D8000-D8999	1000
Link Register (L)	L0100-L0127 L0200-L0227 L0300-L0327 L0400-L0427 L0500-L0527 L0600-L0627 L0700-L0727	Slave: 168
	L1000-L1317	Master: 256

For details about allocation numbers of link registers, see page 6-4.

For details about allocation numbers used for data link communication, see page 6-5.

Operand Allocation Numbers for Functional Modules

Functional Module	Allocation Numbers		
	Data Area	Status Area (Read Only)	Reserved Area (Access Prohibited)
Functional Module 1	L0100-L0107	L0110-L0117	L0120-L0127
Functional Module 2	L0200-L0207	L0210-L0217	L0220-L0227
Functional Module 3	L0300-L0307	L0310-L0317	L0320-L0327
Functional Module 4	L0400-L0407	L0410-L0417	L0420-L0427
Functional Module 5	L0500-L0507	L0510-L0517	L0520-L0527
Functional Module 6	L0600-L0607	L0610-L0617	L0620-L0627
Functional Module 7	L0700-L0707	L0710-L0717	L0720-L0727

Operand Allocation Numbers for Master Module

Node	Allocation Numbers	
	Input Data	Output Data
Node 0	L1000-L1003	L1004-L1007
Node 1	L1010-L1013	L1014-L1017
Node 2	L1020-L1023	L1024-L1027
Node 3	L1030-L1033	L1034-L1037
Node 4	L1040-L1043	L1044-L1047
Node 5	L1050-L1053	L1054-L1057
Node 6	L1060-L1063	L1064-L1067
Node 7	L1070-L1073	L1074-L1077
Node 8	L1080-L1083	L1084-L1087
Node 9	L1090-L1093	L1094-L1097
Node 10	L1100-L1103	L1104-L1107
Node 11	L1110-L1113	L1114-L1117
Node 12	L1120-L1123	L1124-L1127
Node 13	L1130-L1133	L1134-L1137
Node 14	L1140-L1143	L1144-L1147
Node 15	L1150-L1153	L1154-L1157
Node 16	L1160-L1163	L1164-L1167
Node 17	L1170-L1173	L1174-L1177
Node 18	L1180-L1183	L1184-L1187
Node 19	L1190-L1193	L1194-L1197
Node 20	L1200-L1203	L1204-L1207
Node 21	L1210-L1213	L1214-L1217
Node 22	L1220-L1223	L1224-L1227
Node 23	L1230-L1233	L1234-L1237
Node 24	L1240-L1243	L1244-L1247
Node 25	L1250-L1253	L1254-L1257
Node 26	L1260-L1263	L1264-L1267
Node 27	L1270-L1273	L1274-L1277
Node 28	L1280-L1283	L1284-L1287
Node 29	L1290-L1293	L1294-L1297
Node 30	L1300-L1303	L1304-L1307
Node 31	L1310-L1313	L1314-L1317

Operand Allocation Numbers for Data Link Master Station

Slave Station Number	Allocation Number		
	Transmit Data to Slave Station	Receive Data from Slave Station	Data Link Communication Error
Slave Station 1	D7000-D7009	D7010-D7019	D8400
Slave Station 2	D7020-D7029	D7030-D7039	D8401
Slave Station 3	D7040-D7049	D7050-D7059	D8402
Slave Station 4	D7060-D7069	D7070-D7079	D8403
Slave Station 5	D7080-D7089	D7090-D7099	D8404
Slave Station 6	D7100-D7109	D7110-D7119	D8405
Slave Station 7	D7120-D7129	D7130-D7139	D8406
Slave Station 8	D7140-D7149	D7150-D7159	D8407
Slave Station 9	D7160-D7169	D7170-D7179	D8408
Slave Station 10	D7180-D7189	D7190-D7199	D8409
Slave Station 11	D7200-D7209	D7210-D7219	D8410
Slave Station 12	D7220-D7229	D7230-D7239	D8411
Slave Station 13	D7240-D7249	D7250-D7259	D8412
Slave Station 14	D7260-D7269	D7270-D7279	D8413
Slave Station 15	D7280-D7289	D7290-D7299	D8414
Slave Station 16	D7300-D7309	D7310-D7319	D8415
Slave Station 17	D7320-D7329	D7330-D7339	D8416
Slave Station 18	D7340-D7349	D7350-D7359	D8417
Slave Station 19	D7360-D7369	D7370-D7379	D8418
Slave Station 20	D7380-D7389	D7390-D7399	D8419
Slave Station 21	D7400-D7409	D7410-D7419	D8420
Slave Station 22	D7420-D7429	D7430-D7439	D8421
Slave Station 23	D7440-D7449	D7450-D7459	D8422
Slave Station 24	D7460-D7469	D7470-D7479	D8423
Slave Station 25	D7480-D7489	D7490-D7499	D8424
Slave Station 26	D7500-D7509	D7510-D7519	D8425
Slave Station 27	D7520-D7529	D7530-D7539	D8426
Slave Station 28	D7540-D7549	D7550-D7559	D8427
Slave Station 29	D7560-D7569	D7570-D7579	D8428
Slave Station 30	D7580-D7589	D7590-D7599	D8429
Slave Station 31	D7600-D7609	D7610-D7619	D8430

Note: When any slave stations are not connected, master station data registers which are assigned to the vacant slave stations can be used as ordinary data registers.

Operand Allocation Numbers for Data Link Slave Station

Data	Allocation Number		
	Transmit Data to Master Station	Receive Data from Master Station	Data Link Communication Error
Slave Station Data	D7000-D7009	D7010-D7019	D8400

Note: Slave station data registers D7020 through D7619 and D8401 through D8430 can be used as ordinary data registers.

Special Internal Relay Allocation Numbers

Special internal relays M8000 through M8117 are read/write internal relays used for controlling the CPU operation and communication. Special internal relays M8120 through M8237 are read-only internal relays primarily used for indicating the CPU statuses. All special internal relays cannot be used as destinations of advanced instructions.

Special Internal Relays (Read / Write)

Allocation Number	Description	CPU Stopped	Power OFF
M8000	Start Control	Maintained	Maintained
M8001	1-sec Clock Reset	Cleared	Cleared
M8002	All Outputs OFF	Cleared	Cleared
M8003	Carry (Cy) or Borrow (Bw)	Cleared	Cleared
M8004	User Program Execution Error	Cleared	Cleared
M8005	Data Link Communication Error	Maintained	Cleared
M8006	Data Link Communication Prohibit Flag (Master Station)	Maintained	Maintained
M8007	Data Link Communication Initialize Flag (Master Station) Data Link Communication Stop Flag (Slave Station)	Cleared	Cleared
M8010	High-speed Counter Comparison Output Reset	Cleared	Cleared
M8011	Maintain Outputs While CPU Stopped	Maintained	Cleared
M8012	SFR(N) Shifting Flag	Maintained	Maintained
M8013	— Reserved —	—	—
M8014	Write Communication Command Execution at Receive Completion	Maintained	Maintained
M8015-M8017	— Reserved —	—	—
M8020	Calendar/Clock Data Write Flag	Maintained	Cleared
M8021	Clock Data Adjust Flag	Maintained	Cleared
M8022	User Communication Receive Instruction Cancel Flag (RS232C Port 1)	Cleared	Cleared
M8023	User Communication Receive Instruction Cancel Flag (RS232C Port 2)	Cleared	Cleared
M8024-M8027	— Reserved —	—	—
M8030	INTERBUS Master Initialize	Maintained	Cleared
M8031-M8035	— Reserved —	—	—
M8036	INTERBUS Master Bus NG (read only)	Maintained	Cleared
M8037	INTERBUS Master Peripheral Fault (read only)	Maintained	Cleared
M8040	INTERBUS Master Error (read only)	Cleared	Cleared
M8041	INTERBUS Master Error (read only)	Cleared	Cleared
M8042-M8047	— Reserved —	—	—
M8050	RS232C Port 1 Modem Mode (Originate): Initialization String Start	Maintained	Maintained
M8051	RS232C Port 1 Modem Mode (Originate): ATZ Start	Maintained	Maintained
M8052	RS232C Port 1 Modem Mode (Originate): Dialing Start	Maintained	Maintained
M8053	RS232C Port 1 Modem Mode (Disconnect): Disconnect Line Start	Maintained	Maintained
M8054	RS232C Port 1 Modem Mode (General Command): AT Command Start	Maintained	Maintained
M8055	RS232C Port 1 Modem Mode (Answer): Initialization String Start	Maintained	Maintained
M8056	RS232C Port 1 Modem Mode (Answer): ATZ Start	Maintained	Maintained
M8057	RS232C Port 1 Modem Mode AT Command Execution	Maintained	Cleared
M8060	RS232C Port 1 Modem Mode (Originate): Initialization String Completion	Maintained	Cleared
M8061	RS232C Port 1 Modem Mode (Originate): ATZ Completion	Maintained	Cleared
M8062	RS232C Port 1 Modem Mode (Originate): Dialing Completion	Maintained	Cleared
M8063	RS232C Port 1 Modem Mode (Disconnect): Disconnect Line Completion	Maintained	Cleared
M8064	RS232C Port 1 Modem Mode (General Command): AT Command Completion	Maintained	Cleared

Allocation Number	Description	CPU Stopped	Power OFF
M8065	RS232C Port 1 Modem Mode (Answer): Initialization String Completion	Maintained	Cleared
M8066	RS232C Port 1 Modem Mode (Answer): ATZ Completion	Maintained	Cleared
M8067	RS232C Port 1 Modem Mode Operational State	Maintained	Cleared
M8070	RS232C Port 1 Modem Mode (Originate): Initialization String Failure	Maintained	Cleared
M8071	RS232C Port 1 Modem Mode (Originate): ATZ Failure	Maintained	Cleared
M8072	RS232C Port 1 Modem Mode (Originate): Dialing Failure	Maintained	Cleared
M8073	RS232C Port 1 Modem Mode (Disconnect): Disconnect Line Failure	Maintained	Cleared
M8074	RS232C Port 1 Modem Mode (General Command): AT Command Failure	Maintained	Cleared
M8075	RS232C Port 1 Modem Mode (Answer): Initialization String Failure	Maintained	Cleared
M8076	RS232C Port 1 Modem Mode (Answer): ATZ Failure	Maintained	Cleared
M8077	RS232C Port 1 Modem Mode Line Connection Status	Maintained	Cleared
M8080	RS232C Port 2 Modem Mode (Originate): Initialization String Start	Maintained	Maintained
M8081	RS232C Port 2 Modem Mode (Originate): ATZ Start	Maintained	Maintained
M8082	RS232C Port 2 Modem Mode (Originate): Dialing Start	Maintained	Maintained
M8083	RS232C Port 2 Modem Mode (Disconnect): Disconnect Line Start	Maintained	Maintained
M8084	RS232C Port 2 Modem Mode (General Command): AT Command Start	Maintained	Maintained
M8085	RS232C Port 2 Modem Mode (Answer): Initialization String Start	Maintained	Maintained
M8086	RS232C Port 2 Modem Mode (Answer): ATZ Start	Maintained	Maintained
M8087	RS232C Port 2 Modem Mode AT Command Execution	Maintained	Cleared
M8090	RS232C Port 2 Modem Mode (Originate): Initialization String Completion	Maintained	Cleared
M8091	RS232C Port 2 Modem Mode (Originate): ATZ Completion	Maintained	Cleared
M8092	RS232C Port 2 Modem Mode (Originate): Dialing Completion	Maintained	Cleared
M8093	RS232C Port 2 Modem Mode (Disconnect): Disconnect Line Completion	Maintained	Cleared
M8094	RS232C Port 2 Modem Mode (General Command): AT Command Completion	Maintained	Cleared
M8095	RS232C Port 2 Modem Mode (Answer): Initialization String Completion	Maintained	Cleared
M8096	RS232C Port 2 Modem Mode (Answer): ATZ Completion	Maintained	Cleared
M8097	RS232C Port 2 Modem Mode Operational State	Maintained	Cleared
M8100	RS232C Port 2 Modem Mode (Originate): Initialization String Failure	Maintained	Cleared
M8101	RS232C Port 2 Modem Mode (Originate): ATZ Failure	Maintained	Cleared
M8102	RS232C Port 2 Modem Mode (Originate): Dialing Failure	Maintained	Cleared
M8103	RS232C Port 2 Modem Mode (Disconnect): Disconnect Line Failure	Maintained	Cleared
M8104	RS232C Port 2 Modem Mode (General Command): AT Command Failure	Maintained	Cleared
M8105	RS232C Port 2 Modem Mode (Answer): Initialization String Failure	Maintained	Cleared
M8106	RS232C Port 2 Modem Mode (Answer): ATZ Failure	Maintained	Cleared
M8107	RS232C Port 2 Modem Mode Line Connection Status	Maintained	Cleared
M8110-M8117	— Reserved —	—	—

Special Internal Relays (Read Only)

Allocation Number	Description	CPU Stopped	Power OFF
M8120	Initialize Pulse	Cleared	Cleared
M8121	1-sec Clock	Operating	Cleared
M8122	100-msec Clock	Operating	Cleared
M8123	10-msec Clock	Operating	Cleared
M8124	Timer/Counter Preset Value Changed	Maintained	Maintained

Allocation Number	Description	CPU Stopped	Power OFF
M8125	In-operation Output	Cleared	Cleared
M8126-M8127	— Reserved —	—	—
M8130	High-speed Counter Up/Down Status	Maintained	Cleared
M8131	High-speed Counter Comparison ON Status (ON for 1 scan)	Maintained	Cleared
M8132	High-speed Counter Current Value Zero-clear (ON for 1 scan)	Maintained	Cleared
M8133	High-speed Counter Current Value Overflow (ON for 1 scan)	Maintained	Cleared
M8134	High-speed Counter Current Value Underflow (ON for 1 scan)	Maintained	Cleared
M8135	High-speed Counter Comparison Output Status	Maintained	Cleared
M8136-M8137	— Reserved —	—	—
M8140	Data Link (Separate Refresh) Slave Station 1 Comm. Completion Relay	Operating	Cleared
M8141	Data Link (Separate Refresh) Slave Station 2 Comm. Completion Relay	Operating	Cleared
M8142	Data Link (Separate Refresh) Slave Station 3 Comm. Completion Relay	Operating	Cleared
M8143	Data Link (Separate Refresh) Slave Station 4 Comm. Completion Relay	Operating	Cleared
M8144	Data Link (Separate Refresh) Slave Station 5 Comm. Completion Relay	Operating	Cleared
M8145	Data Link (Separate Refresh) Slave Station 6 Comm. Completion Relay	Operating	Cleared
M8146	Data Link (Separate Refresh) Slave Station 7 Comm. Completion Relay	Operating	Cleared
M8147	Data Link (Separate Refresh) Slave Station 8 Comm. Completion Relay	Operating	Cleared
M8150	Data Link (Separate Refresh) Slave Station 9 Comm. Completion Relay	Operating	Cleared
M8151	Data Link (Separate Refresh) Slave Station 10 Comm. Completion Relay	Operating	Cleared
M8152	Data Link (Separate Refresh) Slave Station 11 Comm. Completion Relay	Operating	Cleared
M8153	Data Link (Separate Refresh) Slave Station 12 Comm. Completion Relay	Operating	Cleared
M8154	Data Link (Separate Refresh) Slave Station 13 Comm. Completion Relay	Operating	Cleared
M8155	Data Link (Separate Refresh) Slave Station 14 Comm. Completion Relay	Operating	Cleared
M8156	Data Link (Separate Refresh) Slave Station 15 Comm. Completion Relay	Operating	Cleared
M8157	Data Link (Separate Refresh) Slave Station 16 Comm. Completion Relay	Operating	Cleared
M8160	Data Link (Separate Refresh) Slave Station 17 Comm. Completion Relay	Operating	Cleared
M8161	Data Link (Separate Refresh) Slave Station 18 Comm. Completion Relay	Operating	Cleared
M8162	Data Link (Separate Refresh) Slave Station 19 Comm. Completion Relay	Operating	Cleared
M8163	Data Link (Separate Refresh) Slave Station 20 Comm. Completion Relay	Operating	Cleared
M8164	Data Link (Separate Refresh) Slave Station 21 Comm. Completion Relay	Operating	Cleared
M8165	Data Link (Separate Refresh) Slave Station 22 Comm. Completion Relay	Operating	Cleared
M8166	Data Link (Separate Refresh) Slave Station 23 Comm. Completion Relay	Operating	Cleared
M8167	Data Link (Separate Refresh) Slave Station 24 Comm. Completion Relay	Operating	Cleared
M8170	Data Link (Separate Refresh) Slave Station 25 Comm. Completion Relay	Operating	Cleared
M8171	Data Link (Separate Refresh) Slave Station 26 Comm. Completion Relay	Operating	Cleared
M8172	Data Link (Separate Refresh) Slave Station 27 Comm. Completion Relay	Operating	Cleared
M8173	Data Link (Separate Refresh) Slave Station 28 Comm. Completion Relay	Operating	Cleared
M8174	Data Link (Separate Refresh) Slave Station 29 Comm. Completion Relay	Operating	Cleared
M8175	Data Link (Separate Refresh) Slave Station 30 Comm. Completion Relay	Operating	Cleared
M8176	Data Link (Separate Refresh) Slave Station 31 Comm. Completion Relay	Operating	Cleared
M8177	Data Link All Slave Station Communication Completion Relay	Operating	Cleared
M8180-M8237	— Reserved —	—	—

M8000 Start Control

M8000 indicates the operating status of the OpenNet Controller. The OpenNet Controller stops operation when M8000 is turned off while the CPU is running. M8000 can be turned on or off using the WindLDR Online menu. When a stop or reset input is designated, M8000 must remain on to control the CPU operation using the stop or reset input. For the start and stop operation, see page 4-2.

M8000 maintains its status when the CPU is powered down. When the data to be maintained during power failure is broken after the CPU has been off for a period longer than the battery backup duration, the CPU restarts operation or not as selected in **Function Area Settings** > **Run/Stop** > **Run/Stop Selection at Memory Backup Error**. See page 5-2.

M8001 1-sec Clock Reset

While M8001 is on, M8121 (1-sec clock) is turned off.

M8002 All Outputs OFF

When M8002 is turned on, all outputs (Q0 through Q597) go off until M8002 is turned off. Self-maintained circuits using outputs also go off and are not restored when M8002 is turned off.

M8003 Carry (Cy) and Borrow (Bw)

When a carry or borrow results from executing an addition or subtraction instruction, M8003 turns on. M8003 is also used for the bit shift and rotate instructions. See pages 11-2 and 13-1.

M8004 User Program Execution Error

When an error occurs while executing a user program, M8004 turns on. The cause of the user program execution error can be checked using **Online** > **Monitor** > **PLC Status** > **Error Status** > **Details**. See page 27-6.

M8005 Data Link Communication Error

When an error occurs during communication in the data link system, M8005 turns on. The M8005 status is maintained when the error is cleared and remains on until M8005 is reset using WindLDR or until the CPU is turned off. The cause of the data link communication error can be checked using **Online** > **Monitor** > **PLC Status** > **Error Status** > **Details**. See page 21-4.

M8006 Data Link Communication Prohibit Flag (Master Station)

When M8006 at the master station is turned on in the data link system, data link communication is stopped. The M8006 status is maintained when the CPU is turned off and remains on until M8006 is reset using WindLDR.

M8007 Data Link Communication Initialize Flag (Master Station)
Data Link Communication Stop Flag (Slave Station)

M8007 has a different function at the master or slave station of the data link communication system.

Master station: Data link communication initialize flag

When M8007 at the master station is turned on during operation, the link configuration is checked to initialize the data link system. When a slave station is powered up after the master station, turn M8007 on to initialize the data link system. After a data link setup is changed, M8007 must also be turned on to ensure correct communication.

Slave station: Data link communication stop flag

When a slave station does not receive communication data from the master station for 10 sec or more in the data link system, M8007 turns on. When the slave station receives correct communication data, M8007 turns off.

M8010 High-speed Counter Comparison Output Reset

When M8010 is turned on, the high-speed counter comparison output is turned off. See page 5-10.

M8011 Maintain Outputs While CPU Stopped

Outputs are normally turned off when the CPU is stopped. M8011 is used to maintain the output statuses when the CPU is stopped. When the CPU is stopped with M8011 turned on, the output ON/OFF statuses are maintained. When the CPU restarts, M8011 is turned off automatically.

M8012 SFR(N) Shifting Flag

When power failure occurs while data shift is in progress in a shift register, M8012 is turned on. If M8012 is on when the CPU is powered up again, the data in keep-designated shift registers may be broken and cannot be used to continue correct data shifting. To prevent continuation of incorrect data shifting at startup, include M8012 in the user program to prevent program execution. If a shift register is not designated as a keep type, the shift register data is cleared when power is restored.

M8014 Write Communication Command Execution at Receive Completion

When M8014 is off while maintenance protocol communication is in progress, incoming write commands are executed at the END processing of a user program and the data is written into the CPU. When M8014 is on, write commands are executed immediately when the receive completion flag of a user communication RXD instruction is turned on, without waiting for the END processing. M8014 is valid for all communication ports; RS232C port 1 and port 2, and RS485. When an IDEC's HG series operator interface is linked to the OpenNet Controller, use the OpenNet Controller with M8014 set on.

M8020 Calendar / Clock Data Write Flag

When M8020 is turned on, data in data registers D8015 through D8021 (calendar/clock preset data) are set to the internal clock of the CPU. See page 15-7.

M8021 Clock Data Adjust Flag

When M8021 is turned on, the clock is adjusted with respect to seconds. If *seconds* are between 0 and 29 for current time, adjustment for *seconds* will be set to 0 and minutes remain the same. If *seconds* are between 30 and 59 for current time, adjustment for *seconds* will be set to 0 and *minutes* are incremented one. See page 15-8.

M8022 User Communication Receive Instruction Cancel Flag (RS232C Port 1)

When M8022 is turned on, all RXD1 instructions ready for receiving user communication through RS232C port 1 are disabled.

M8023 User Communication Receive Instruction Cancel Flag (RS232C Port 2)

When M8023 is turned on, all RXD2 instructions ready for receiving user communication through RS232C port 2 are disabled.

M8030 INTERBUS Master Initialize

When M8030 is turned on, the INTERBUS master is initialized. See page 24-11.

M8036 INTERBUS Master Bus NG

When the INTERBUS master detects a BUS NG, M8036 is turned on. See page 24-11.

M8037 INTERBUS Master Peripheral Fault

When the INTERBUS master detects a peripheral fault, M8037 is turned on. See page 24-11.

M8040 INTERBUS Master Error

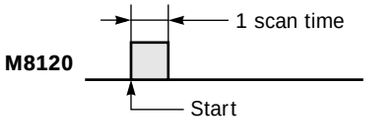
When a critical error is found in the INTERBUS master hardware/software, M8040 or M8041 is turned on, depending on error contents, and the master module is initialized. See page 24-11.

M8041 INTERBUS Master Error

When a critical error is found in the INTERBUS master hardware/software, M8040 or M8041 is turned on, depending on error contents, and the master module is initialized. See page 24-11.

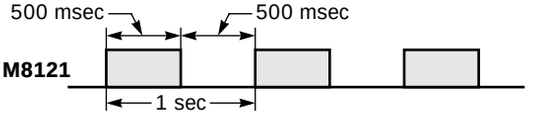
M8120 Initialize Pulse

When the CPU starts operation, M8120 turns on for a period of one scan.



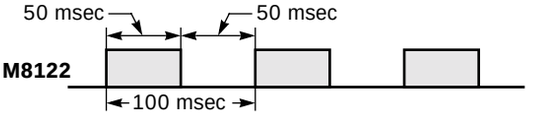
M8121 1-sec Clock

While M8001 is off, M8121 generates clock pulses in 1-sec increments, with a duty ratio of 1:1 (500 msec on and 500 msec off).



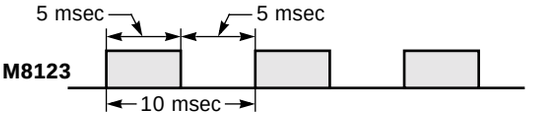
M8122 100-msec Clock

M8122 always generates clock pulses in 100-msec increments, whether M8001 is on or off, with a duty ratio of 1:1 (50 msec on and 50 msec off).



M8123 10-msec Clock

M8123 always generates clock pulses in 10-msec increments, whether M8001 is on or off, with a duty ratio of 1:1 (5 msec on and 5 msec off).



M8124 Timer / Counter Preset Value Changed

When timer or counter preset values are changed in the CPU module RAM, M8124 turns on. When a user program is transferred to the CPU from WindLDR or when the changed timer/counter preset value is cleared, M8124 turns off.

M8125 In-operation Output

M8125 remains on while the CPU is running.

Special Data Registers

Special Data Register Allocation Numbers

Allocation Number	Description	Updated	See Page
D8000	System Setup ID (Quantity of Inputs)	When I/O initialized	
D8001	System Setup ID (Quantity of Outputs)	When I/O initialized	
D8002	System Setup ID (Quantity of Functional Modules)	When I/O initialized	
D8003	System Setup ID (Data Link Usage) — 1: Yes, 0: No	When I/O initialized	
D8004	System Setup ID (INTERBUS Master Usage) — 1: Yes, 0: No	When I/O initialized	
D8005	General Error Code	When error occurred	27-3
D8006	User Program Execution Error Code	When error occurred	27-6
D8007	User Program Execution Error Address	When error occurred	27-6
D8008	Year (Current Data) Read only	Every 100 msec	15-7
D8009	Month (Current Data) Read only	Every 100 msec	15-7
D8010	Day (Current Data) Read only	Every 100 msec	15-7
D8011	Day of Week (Current Data) Read only	Every 100 msec	15-7
D8012	Hour (Current Data) Read only	Every 100 msec	15-7
D8013	Minute (Current Data) Read only	Every 100 msec	15-7
D8014	Second (Current Data) Read only	Every 100 msec	15-7
D8015	Year (New Data) Write only		15-7
D8016	Month (New Data) Write only		15-7
D8017	Day (New Data) Write only		15-7
D8018	Day of Week (New Data) Write only		15-7
D8019	Hour (New Data) Write only		15-7
D8020	Minute (New Data) Write only		15-7
D8021	Second (New Data) Write only		15-7
D8022	Constant Scan Time Preset Value		5-20
D8023	Scan Time (Current Value)	Every scan	5-20
D8024	Scan Time (Maximum Value)	At occurrence	5-20
D8025	Scan Time (Minimum Value)	At occurrence	5-20
D8026	Communication Selector Switch Value (0 through 7)	Power-up	
D8027	Communication Device Number (0 through 31)	Power-up	
D8028	Internal System Program Version	Power-up	
D8029	External System Program Version	Power-up	
D8030	Protect Transistor Output Error (1st) — 1: Error, 0: No error	When error occurred	2-20
D8031	Protect Transistor Output Error (2nd) — 1: Error, 0: No error	When error occurred	2-20
D8032	Protect Transistor Output Error (3rd) — 1: Error, 0: No error	When error occurred	2-20
D8033	Protect Transistor Output Error (4th) — 1: Error, 0: No error	When error occurred	2-20
D8034	Protect Transistor Output Error (5th) — 1: Error, 0: No error	When error occurred	2-20
D8035	Protect Transistor Output Error (6th) — 1: Error, 0: No error	When error occurred	2-20
D8036	Protect Transistor Output Error (7th) — 1: Error, 0: No error	When error occurred	2-20
D8037-D8039	— Reserved —	—	—
D8040	Advanced Instruction Error Address 1	At advanced inst. error	
D8041	Advanced Instruction Error Address 2	At advanced inst. error	
D8042	Advanced Instruction Error Address 3	At advanced inst. error	
D8043	Advanced Instruction Error Address 4	At advanced inst. error	
D8044	Advanced Instruction Error Address 5	At advanced inst. error	

Special Data Registers for High-speed Counter

Allocation Number	Description	Updated	See Page
D8045	High-speed Counter Current Value	Every scan	5-10
D8046	High-speed Counter Reset Value		5-10
D8047	High-speed Counter Preset Value		5-10
D8048-D8049	— Reserved —	—	—

Special Data Registers for INTERBUS

Allocation Number	Description	Updated	See Page
D8050	INTERBUS (Node 0) Logical Device No.	When initialized	24-6
D8051	INTERBUS (Node 0) Length Code	When initialized	24-6
D8052	INTERBUS (Node 0) ID Code	When initialized	24-6
D8053	INTERBUS (Node 0) Device Level	When initialized	24-6
D8054	INTERBUS (Node 1) Logical Device No.	When initialized	24-6
D8055	INTERBUS (Node 1) Length Code	When initialized	24-6
D8056	INTERBUS (Node 1) ID Code	When initialized	24-6
D8057	INTERBUS (Node 1) Device Level	When initialized	24-6
D8058	INTERBUS (Node 2) Logical Device No.	When initialized	24-6
D8059	INTERBUS (Node 2) Length Code	When initialized	24-6
D8060	INTERBUS (Node 2) ID Code	When initialized	24-6
D8061	INTERBUS (Node 2) Device Level	When initialized	24-6
D8062	INTERBUS (Node 3) Logical Device No.	When initialized	24-6
D8063	INTERBUS (Node 3) Length Code	When initialized	24-6
D8064	INTERBUS (Node 3) ID Code	When initialized	24-6
D8065	INTERBUS (Node 3) Device Level	When initialized	24-6
D8066	INTERBUS (Node 4) Logical Device No.	When initialized	24-6
D8067	INTERBUS (Node 4) Length Code	When initialized	24-6
D8068	INTERBUS (Node 4) ID Code	When initialized	24-6
D8069	INTERBUS (Node 4) Device Level	When initialized	24-6
D8070	INTERBUS (Node 5) Logical Device No.	When initialized	24-6
D8071	INTERBUS (Node 5) Length Code	When initialized	24-6
D8072	INTERBUS (Node 5) ID Code	When initialized	24-6
D8073	INTERBUS (Node 5) Device Level	When initialized	24-6
D8074	INTERBUS (Node 6) Logical Device No.	When initialized	24-6
D8075	INTERBUS (Node 6) Length Code	When initialized	24-6
D8076	INTERBUS (Node 6) ID Code	When initialized	24-6
D8077	INTERBUS (Node 6) Device Level	When initialized	24-6
D8078	INTERBUS (Node 7) Logical Device No.	When initialized	24-6
D8079	INTERBUS (Node 7) Length Code	When initialized	24-6
D8080	INTERBUS (Node 7) ID Code	When initialized	24-6
D8081	INTERBUS (Node 7) Device Level	When initialized	24-6
D8082	INTERBUS (Node 8) Logical Device No.	When initialized	24-6
D8083	INTERBUS (Node 8) Length Code	When initialized	24-6

Allocation Number	Description	Updated	See Page
D8084	INTERBUS (Node 8) ID Code	When initialized	24-6
D8085	INTERBUS (Node 8) Device Level	When initialized	24-6
D8086	INTERBUS (Node 9) Logical Device No.	When initialized	24-6
D8087	INTERBUS (Node 9) Length Code	When initialized	24-6
D8088	INTERBUS (Node 9) ID Code	When initialized	24-6
D8089	INTERBUS (Node 9) Device Level	When initialized	24-6
D8090	INTERBUS (Node 10) Logical Device No.	When initialized	24-6
D8091	INTERBUS (Node 10) Length Code	When initialized	24-6
D8092	INTERBUS (Node 10) ID Code	When initialized	24-6
D8093	INTERBUS (Node 10) Device Level	When initialized	24-6
D8094	INTERBUS (Node 11) Logical Device No.	When initialized	24-6
D8095	INTERBUS (Node 11) Length Code	When initialized	24-6
D8096	INTERBUS (Node 11) ID Code	When initialized	24-6
D8097	INTERBUS (Node 11) Device Level	When initialized	24-6
D8098	INTERBUS (Node 12) Logical Device No.	When initialized	24-6
D8099	INTERBUS (Node 12) Length Code	When initialized	24-6
D8100	INTERBUS (Node 12) ID Code	When initialized	24-6
D8101	INTERBUS (Node 12) Device Level	When initialized	24-6
D8102	INTERBUS (Node 13) Logical Device No.	When initialized	24-6
D8103	INTERBUS (Node 13) Length Code	When initialized	24-6
D8104	INTERBUS (Node 13) ID Code	When initialized	24-6
D8105	INTERBUS (Node 13) Device Level	When initialized	24-6
D8106	INTERBUS (Node 14) Logical Device No.	When initialized	24-6
D8107	INTERBUS (Node 14) Length Code	When initialized	24-6
D8108	INTERBUS (Node 14) ID Code	When initialized	24-6
D8109	INTERBUS (Node 14) Device Level	When initialized	24-6
D8110	INTERBUS (Node 15) Logical Device No.	When initialized	24-6
D8111	INTERBUS (Node 15) Length Code	When initialized	24-6
D8112	INTERBUS (Node 15) ID Code	When initialized	24-6
D8113	INTERBUS (Node 15) Device Level	When initialized	24-6
D8114	INTERBUS (Node 16) Logical Device No.	When initialized	24-6
D8115	INTERBUS (Node 16) Length Code	When initialized	24-6
D8116	INTERBUS (Node 16) ID Code	When initialized	24-6
D8117	INTERBUS (Node 16) Device Level	When initialized	24-6
D8118	INTERBUS (Node 17) Logical Device No.	When initialized	24-6
D8119	INTERBUS (Node 17) Length Code	When initialized	24-6
D8120	INTERBUS (Node 17) ID Code	When initialized	24-6
D8121	INTERBUS (Node 17) Device Level	When initialized	24-6
D8122	INTERBUS (Node 18) Logical Device No.	When initialized	24-6
D8123	INTERBUS (Node 18) Length Code	When initialized	24-6
D8124	INTERBUS (Node 18) ID Code	When initialized	24-6
D8125	INTERBUS (Node 18) Device Level	When initialized	24-6
D8126	INTERBUS (Node 19) Logical Device No.	When initialized	24-6
D8127	INTERBUS (Node 19) Length Code	When initialized	24-6

Allocation Number	Description	Updated	See Page
D8128	INTERBUS (Node 19) ID Code	When initialized	24-6
D8129	INTERBUS (Node 19) Device Level	When initialized	24-6
D8130	INTERBUS (Node 20) Logical Device No.	When initialized	24-6
D8131	INTERBUS (Node 20) Length Code	When initialized	24-6
D8132	INTERBUS (Node 20) ID Code	When initialized	24-6
D8133	INTERBUS (Node 20) Device Level	When initialized	24-6
D8134	INTERBUS (Node 21) Logical Device No.	When initialized	24-6
D8135	INTERBUS (Node 21) Length Code	When initialized	24-6
D8136	INTERBUS (Node 21) ID Code	When initialized	24-6
D8137	INTERBUS (Node 21) Device Level	When initialized	24-6
D8138	INTERBUS (Node 22) Logical Device No.	When initialized	24-6
D8139	INTERBUS (Node 22) Length Code	When initialized	24-6
D8140	INTERBUS (Node 22) ID Code	When initialized	24-6
D8141	INTERBUS (Node 22) Device Level	When initialized	24-6
D8142	INTERBUS (Node 23) Logical Device No.	When initialized	24-6
D8143	INTERBUS (Node 23) Length Code	When initialized	24-6
D8144	INTERBUS (Node 23) ID Code	When initialized	24-6
D8145	INTERBUS (Node 23) Device Level	When initialized	24-6
D8146	INTERBUS (Node 24) Logical Device No.	When initialized	24-6
D8147	INTERBUS (Node 24) Length Code	When initialized	24-6
D8148	INTERBUS (Node 24) ID Code	When initialized	24-6
D8149	INTERBUS (Node 24) Device Level	When initialized	24-6
D8150	INTERBUS (Node 25) Logical Device No.	When initialized	24-6
D8151	INTERBUS (Node 25) Length Code	When initialized	24-6
D8152	INTERBUS (Node 25) ID Code	When initialized	24-6
D8153	INTERBUS (Node 25) Device Level	When initialized	24-6
D8154	INTERBUS (Node 26) Logical Device No.	When initialized	24-6
D8155	INTERBUS (Node 26) Length Code	When initialized	24-6
D8156	INTERBUS (Node 26) ID Code	When initialized	24-6
D8157	INTERBUS (Node 26) Device Level	When initialized	24-6
D8158	INTERBUS (Node 27) Logical Device No.	When initialized	24-6
D8159	INTERBUS (Node 27) Length Code	When initialized	24-6
D8160	INTERBUS (Node 27) ID Code	When initialized	24-6
D8161	INTERBUS (Node 27) Device Level	When initialized	24-6
D8162	INTERBUS (Node 28) Logical Device No.	When initialized	24-6
D8163	INTERBUS (Node 28) Length Code	When initialized	24-6
D8164	INTERBUS (Node 28) ID Code	When initialized	24-6
D8165	INTERBUS (Node 28) Device Level	When initialized	24-6
D8166	INTERBUS (Node 29) Logical Device No.	When initialized	24-6
D8167	INTERBUS (Node 29) Length Code	When initialized	24-6
D8168	INTERBUS (Node 29) ID Code	When initialized	24-6
D8169	INTERBUS (Node 29) Device Level	When initialized	24-6
D8170	INTERBUS (Node 30) Logical Device No.	When initialized	24-6
D8171	INTERBUS (Node 30) Length Code	When initialized	24-6

Allocation Number	Description	Updated	See Page
D8172	INTERBUS (Node 30) ID Code	When initialized	24-6
D8173	INTERBUS (Node 30) Device Level	When initialized	24-6
D8174	INTERBUS (Node 31) Logical Device No.	When initialized	24-6
D8175	INTERBUS (Node 31) Length Code	When initialized	24-6
D8176	INTERBUS (Node 31) ID Code	When initialized	24-6
D8177	INTERBUS (Node 31) Device Level	When initialized	24-6
D8178	INTERBUS Master System Error Information	When initialized	24-10
D8179	INTERBUS Master Status Transition Number	When accessed	24-10
D8180	INTERBUS Master Acknowledge Code	When accessed	24-10
D8181	INTERBUS Master Additional Error Information	When accessed	24-10
D8182	INTERBUS Master Error Code	When accessed	24-10
D8183	INTERBUS Master Error Location	When accessed	24-10
D8184-D8199	— Reserved —	—	—

Special Data Registers for Modem Mode

Allocation Number	Description	Updated	See Page
D8200	Port 1 RS232C Port Communication Mode Selection	Every scan	23-3
D8201	Port 1 Modem Initialization String Selection	Every scan	23-3
D8202	— Reserved —	—	—
D8203	Port 1 On-line Mode Protocol Selection	When sending/receiving data	23-3
D8204	Port 1 Control Signal Status	Every scan	17-27
D8205	Port 1 DSR Input Control Signal Option	When sending/receiving data	17-28
D8206	Port 1 DTR Output Control Signal Option	When sending/receiving data	17-29
D8207	Port 1 RTS Output Control Signal Option	When sending/receiving data	17-29
D8208	— Reserved —	—	—
D8209	Port 1 Retry Cycles	At retry	23-3
D8210	Port 1 Retry Interval	Every scan during retry	23-3
D8211	Port 1 Modem Mode Status	At status transition	23-3
D8212-D8214	— Reserved —	—	—
D8215-D8229	Port 1 AT Command Result Code	When returning result code	23-3
D8230-D8244	Port 1 AT Command String	When sending AT command	23-3
D8245-D8269	Port 1 Initialization String	When sending init. string	23-3
D8270-D8299	Port 1 Telephone Number	When dialing	23-3
D8300	Port 2 RS232C Port Communication Mode Selection	Every scan	23-3
D8301	Port 2 Modem Initialization String Selection	Every scan	23-3
D8302	— Reserved —	—	—
D8303	Port 2 On-line Mode Protocol Selection	When sending/receiving data	23-3
D8304	Port 2 Control Signal Status	Every scan	17-27
D8305	Port 2 DSR Input Control Signal Option	When sending/receiving data	17-28
D8306	Port 2 DTR Output Control Signal Option	When sending/receiving data	17-29
D8307	Port 2 RTS Output Control Signal Option	When sending/receiving data	17-29
D8308	— Reserved —	—	—
D8309	Port 2 Retry Cycles	At retry	23-3

Allocation Number	Description	Updated	See Page
D8310	Port 2 Retry Interval	Every scan during retry	23-3
D8311	Port 2 Modem Mode Status	At status transition	23-3
D8312-D8314	— Reserved —	—	—
D8315-D8329	Port 2 AT Command Result Code	When returning result code	23-3
D8330-D8344	Port 2 AT Command String	When sending AT command	23-3
D8345-D8369	Port 2 Initialization String	When sending init. string	23-3
D8370-D8399	Port 2 Telephone Number	When dialing	23-3

Special Data Registers for Data Link Master / Slave Stations

Allocation Number	Description	Updated	See Page
D8400	Slave Station 1 Communication Error (at Master Station) Slave Station Communication Error (at Slave Station)	When error occurred	21-4
D8401	Slave Station 2 Communication Error (at Master Station)	When error occurred	21-4
D8402	Slave Station 3 Communication Error (at Master Station)	When error occurred	21-4
D8403	Slave Station 4 Communication Error (at Master Station)	When error occurred	21-4
D8404	Slave Station 5 Communication Error (at Master Station)	When error occurred	21-4
D8405	Slave Station 6 Communication Error (at Master Station)	When error occurred	21-4
D8406	Slave Station 7 Communication Error (at Master Station)	When error occurred	21-4
D8407	Slave Station 8 Communication Error (at Master Station)	When error occurred	21-4
D8408	Slave Station 9 Communication Error (at Master Station)	When error occurred	21-4
D8409	Slave Station 10 Communication Error (at Master Station)	When error occurred	21-4
D8410	Slave Station 11 Communication Error (at Master Station)	When error occurred	21-4
D8411	Slave Station 12 Communication Error (at Master Station)	When error occurred	21-4
D8412	Slave Station 13 Communication Error (at Master Station)	When error occurred	21-4
D8413	Slave Station 14 Communication Error (at Master Station)	When error occurred	21-4
D8414	Slave Station 15 Communication Error (at Master Station)	When error occurred	21-4
D8415	Slave Station 16 Communication Error (at Master Station)	When error occurred	21-4
D8416	Slave Station 17 Communication Error (at Master Station)	When error occurred	21-4
D8417	Slave Station 18 Communication Error (at Master Station)	When error occurred	21-4
D8418	Slave Station 19 Communication Error (at Master Station)	When error occurred	21-4
D8419	Slave Station 20 Communication Error (at Master Station)	When error occurred	21-4
D8420	Slave Station 21 Communication Error (at Master Station)	When error occurred	21-4
D8421	Slave Station 22 Communication Error (at Master Station)	When error occurred	21-4
D8422	Slave Station 23 Communication Error (at Master Station)	When error occurred	21-4
D8423	Slave Station 24 Communication Error (at Master Station)	When error occurred	21-4
D8424	Slave Station 25 Communication Error (at Master Station)	When error occurred	21-4
D8425	Slave Station 26 Communication Error (at Master Station)	When error occurred	21-4
D8426	Slave Station 27 Communication Error (at Master Station)	When error occurred	21-4
D8427	Slave Station 28 Communication Error (at Master Station)	When error occurred	21-4
D8428	Slave Station 29 Communication Error (at Master Station)	When error occurred	21-4
D8429	Slave Station 30 Communication Error (at Master Station)	When error occurred	21-4
D8430	Slave Station 31 Communication Error (at Master Station)	When error occurred	21-4
D8431-D8999	— Reserved —	—	—

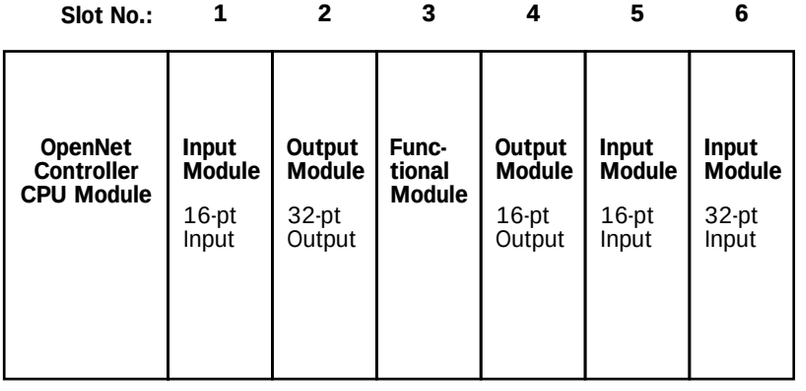
Digital I/O Module Operands

Input and output numbers are automatically allocated to each digital I/O module in the order of increasing distance from the CPU module. A maximum of 7 digital I/O or functional modules can be mounted with one CPU module without using an expansion power supply module, so that a maximum of 224 I/O points can be allocated in total. When using an expansion power supply module, 15 modules can be mounted so that the I/O numbers can be expanded up to 480 points in total.

I/O Operand Numbers

Operand	Without Expansion Power Supply Module	When Using Expansion Power Supply Module
Input	I0 through I277 (224 points)	I0 through I597 (480 points)
Output	Q0 through Q277 (224 points)	Q0 through Q597 (480 points)

Example:



The system setup shown above will have operand numbers allocated for each module as follows:

Slot No.	Module	Operand Numbers
1	**Input Module 1**	I0 through I7, I10 through I17
2	**Output Module 1**	Q0 through Q7, Q10 through Q17, Q20 through Q27, Q30 through Q37
3	**Functional Module**	L100 through L127
4	**Output Module 2**	Q40 through Q47, Q50 through Q57
5	**Output Module 3**	I20 through I27, I30 through I37
6	**Input Module 2**	I40 through I47, I50 through I57, I60 through I67, I70 through I77

Input and output modules may be grouped together for easy identification of I/O numbers. The I/O numbers are allocated automatically starting with I0 and Q0 at the module nearest to the CPU module. When the I/O modules are relocated, the I/O numbers are renumbered automatically.

The location of functional modules does not affect the I/O operand numbers.

Functional Module Operands

Functional modules are analog input, analog output, DeviceNet slave, and LONWORKS interface modules. A maximum of 7 functional modules can be mounted with one CPU module in a system setup of 15 modules at the maximum.

Operand numbers are automatically allocated to each functional module in the order of increasing distance from the CPU module, starting with L100, L200, L300 through L700. The location of digital I/O modules between CPU and functional modules does not affect the operand numbers for the functional modules.

Functional Module Operand Numbers

Allocation Number	Description	
L*00 through L*07	Data area	Data used in each functional module, such as analog data
L*10 through L*17	Status area	Status of each functional module
L*20 through L*27	Reserved area	Reserved for system program. Do not access this area.

Example:

Slot No.:	1	2	3	4	5	6
OpenNet Controller CPU Module	**Functional Module** OpenNet Interface	**Output Module** 32-pt Output	**Functional Module** Analog Output	**Output Module** 16-pt Output	**Functional Module** Analog Input	**Input Module** 32-pt Input

The system setup shown above will have operand numbers allocated to each module as follows:

Slot No.	Module	Operand Numbers
1	**Functional Module 1**	L100 through L127
2	**Output Module 1**	Q0 through Q7, Q10 through Q17, Q20 through Q27, Q30 through Q37
3	**Functional Module 2**	L200 through L227
4	**Output Module 2**	Q40 through Q47, Q50 through Q57
5	**Functional Module 3**	L300 through L327
6	**Input Module 1**	I0 through I7, I10 through I17, I20 through I27, I30 through I37

In the system setup shown above, the analog input module in slot 5 uses link register L300 for channel 0 data and L304 for channel 4 data.

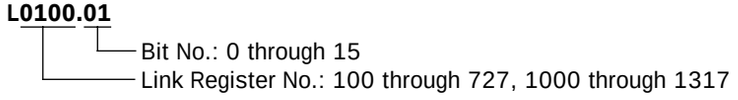
Bit Designation of Link Register

The following table illustrates how to read and write link register bits primarily used for basic instructions and some advanced instructions as bit operands.

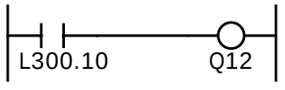
Link Register Mapping for Functional Modules

Functional Module	Allocation Numbers		
	Data Area	**Status Area (Read Only)**	**Reserved Area (Access Prohibited)**
Functional Module 1	L0100-L0107	L0110-L0117	L0120-L0127
Functional Module 2	L0200-L0207	L0210-L0217	L0220-L0227
Functional Module 3	L0300-L0307	L0310-L0317	L0320-L0327
Functional Module 4	L0400-L0407	L0410-L0417	L0420-L0427
Functional Module 5	L0500-L0507	L0510-L0517	L0520-L0527
Functional Module 6	L0600-L0607	L0610-L0617	L0620-L0627
Functional Module 7	L0700-L0707	L0710-L0717	L0720-L0727

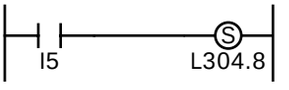
Each functional module has eight channels of data areas. One channel consists of one link register which can process one-word data, or 16 bits. Functional module data is addressed for bit operands in the following formula:



Example 1: Load link register L300, bit 10



Example 2: Set link register L304, bit 8



7: BASIC INSTRUCTIONS

Introduction

This chapter describes programming of the basic instructions, available operands, and sample programs.

Basic Instruction List

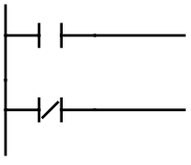
Symbol	Name	Function	Words
AND	And	Series connection of NO contact	2
AND LOD	And Load	Series connection of circuit blocks	1
ANDN	And Not	Series connection of NC contact	2
BPP	Bit Pop	Restores the result of bit logical operation which was saved temporarily	1
BPS	Bit Push	Saves the result of bit logical operation temporarily	1
BRD	Bit Read	Reads the result of bit logical operation which was saved temporarily	1
CC=	Counter Comparison (=)	Equal to comparison of counter current value	3
CC≥	Counter Comparison (≥)	Greater than or equal to comparison of counter current value	3
CDP	Dual Pulse Reversible Counter	Dual pulse reversible counter (0 to 65535)	3
CNT	Adding Counter	Adding counter (0 to 65535)	3
CUD	Up/Down Selection Reversible Counter	Up/down selection reversible counter (0 to 65535)	3
DC=	Data Register Comparison (=)	Equal to comparison of data register value	3
DC≥	Data Register Comparison (≥)	Greater than or equal to comparison of data register value	3
END	End	Ends a program	1
JEND	Jump End	Ends a jump instruction	1
JMP	Jump	Jumps a designated program area	1
LOD	Load	Stores intermediate results and reads contact status	2
LODN	Load Not	Stores intermediate results and reads inverted contact status	2
MCR	Master Control Reset	Ends a master control	1
MCS	Master Control Set	Starts a master control	1
OR	Or	Parallel connection of NO contacts	2
OR LOD	Or Load	Parallel connection of circuit blocks	1
ORN	Or Not	Parallel connection of NC contacts	2
OUT	Output	Outputs the result of bit logical operation	2
OUTN	Output Not	Outputs the inverted result of bit logical operation	2
RST	Reset	Resets output, internal relay, shift register, or link register bit	2
SET	Set	Sets output, internal relay, shift register, or link register bit	2
SFR	Shift Register	Forward shift register	3
SFRN	Shift Register Not	Reverse shift register	3
SOTD	Single Output Down	Falling-edge differentiation output	1
SOTU	Single Output Up	Rising-edge differentiation output	1
TC=	Timer Comparison (=)	Equal to comparison of timer current value	3
TC≥	Timer Comparison (≥)	Greater than or equal to comparison of timer current value	3
TIM	100-msec Timer	Subtracting 100-msec timer (0 to 6553.5 sec)	3
TMH	10-msec Timer	Subtracting 10-msec timer (0 to 655.35 sec)	3
TML	1-sec Timer	Subtracting 1-sec timer (0 to 65535 sec)	3
TMS	1-msec Timer	Subtracting 1-msec timer (0 to 65.535 sec)	3

LOD (Load) and LODN (Load Not)

The LOD instruction starts the logical operation with a NO (normally open) contact. The LODN instruction starts the logical operation with a NC (normally closed) contact.

A total of eight LOD and/or LODN instructions can be programmed consecutively.

Ladder Diagram



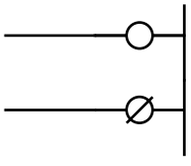
Valid Operands

Instruction	I	Q	M	T	C	R	L
LOD LODN	0-597	0-597	0-2557 8000-8237	0-255	0-255	0-255	100.0-717.15 1000.0-1317.15

OUT (Output) and OUTN (Output Not)

The OUT instruction outputs the result of bit logical operation to the specified operand. The OUTN instruction outputs the inverted result of bit logical operation to the specified operand.

Ladder Diagram



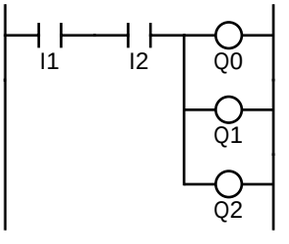
Valid Operands

Instruction	I	Q	M	T	C	R	L
OUT OUTN	—	0-597	0-2557 8000-8117	—	—	—	100.0-717.15 1000.0-1317.15

Multiple OUT and OUTN

There is no limit to the number of OUT and OUTN instructions that can be programmed into one rung.

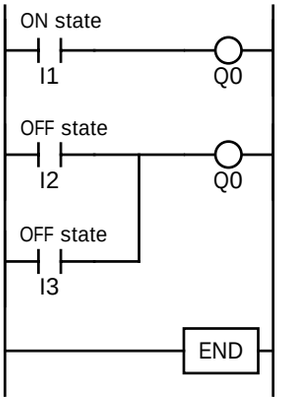
Ladder Diagram



Programming multiple outputs of the same output number is not recommended. However, when doing so, it is good practice to separate the outputs with the JMP/JEND set of instructions, or the MCS/MCR set of instructions. These instructions are detailed later in this chapter.

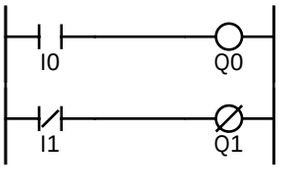
When the same output number is programmed more than once within one scan, the output nearest to the END instruction is given priority for outputting. In the example on the right, output Q0 is off.

Ladder Diagram



Examples: LOD (Load), NOT, and OUT (Output)

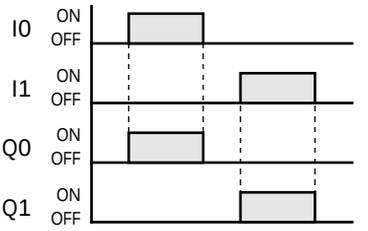
Ladder Diagram



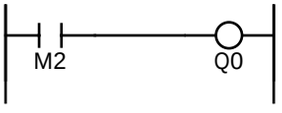
Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	OUT	Q0
2	LODN	I1
3	OUTN	Q1

Timing Chart



Ladder Diagram



Program List

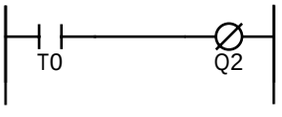
Prgm Adrs	Instruction	Data
0	LOD	M2
1	OUT	Q0

Ladder Diagram

Program List

Prgm Adrs	Instruction	Data
2	LODN	Q0
3	OUT	Q1

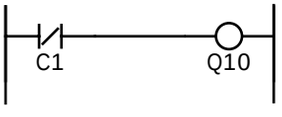
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
4	LOD	T0
5	OUTN	Q2

Ladder Diagram



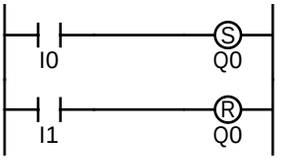
Program List

Prgm Adrs	Instruction	Data
6	LODN	C1
7	OUT	Q10

SET and RST (Reset)

The SET and RST (reset) instructions are used to set (on) or reset (off) outputs, internal relays, shift register bits, and link register bits. The same output can be set and reset many times within a program. SET and RST instructions operate in every scan while the input is on.

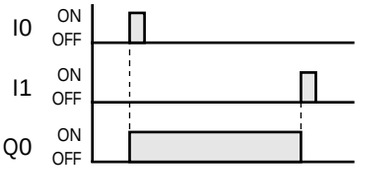
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	SET	Q0
2	LOD	I1
3	RST	Q0

Timing Chart



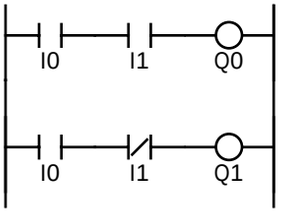
Valid Operands

Instruction	I	Q	M	T	C	R	L
SET RST	—	0-597	0-2557 8000-8117	—	—	0-255	100.0-717.15 1000.0-1317.15

AND and ANDN (And Not)

The AND instruction is used for programming a NO contact in series. The ANDN instruction is used for programming a NC contact in series. The AND or ANDN instruction is entered after the first set of contacts.

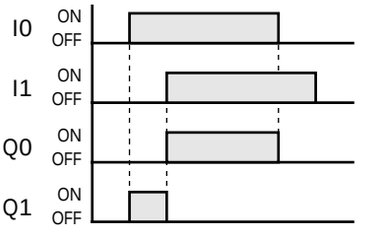
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	AND	I1
2	OUT	Q0
3	LOD	I0
4	ANDN	I1
5	OUT	Q1

Timing Chart



When both inputs I0 and I1 are on, output Q0 is on. When either input I0 or I1 is off, output Q0 is off.

When input I0 is on and input I1 is off, output Q1 is on. When either input I0 is off or input I1 is on, output Q1 is off.

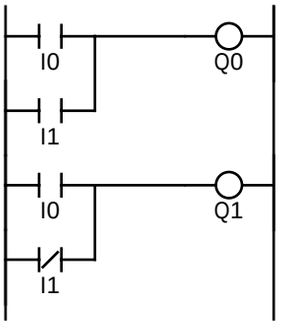
Valid Operands

Instruction	I	Q	M	T	C	R	L
AND ANDN	0-597	0-597	0-2557 8000-8237	0-255	0-255	0-255	100.0-717.15 1000.0-1317.15

OR and ORN (Or Not)

The OR instruction is used for programming a NO contact in parallel. The ORN instruction is used for programming a NC contact in parallel. The OR or ORN instruction is entered after the first set of contacts.

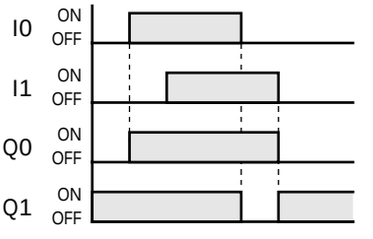
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	OR	I1
2	OUT	Q0
3	LOD	I0
4	ORN	I1
5	OUT	Q1

Timing Chart



When either input I0 or I1 is on, output Q0 is on. When both inputs I0 and I1 are off, output Q0 is off.

When either input I0 is on or input I1 is off, output Q1 is on. When input I0 is off and input I1 is on, output Q1 is off.

Valid Operands

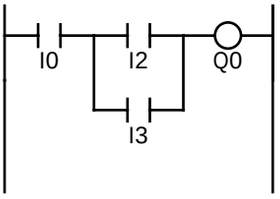
Instruction	I	Q	M	T	C	R	L
OR ORN	0-597	0-597	0-2557 8000-8237	0-255	0-255	0-255	100.0-717.15 1000.0-1317.15

AND LOD (Load)

The AND LOD instruction is used to connect, in series, two or more circuits starting with the LOD instruction. The AND LOD instruction is the equivalent of a “node” on a ladder diagram.

When using WindLDR, the user need not program the AND LOD instruction. The circuit in the ladder diagram shown below is converted into AND LOD when the ladder diagram is compiled.

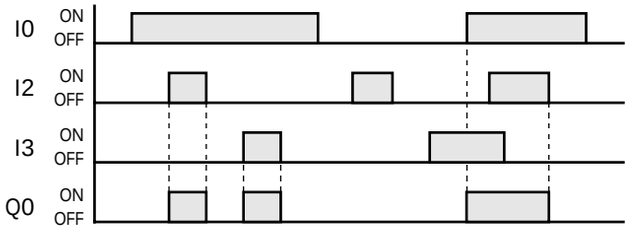
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	LOD	I2
2	OR	I3
3	ANDLOD	
4	OUT	Q0

Timing Chart



When input I0 is on and either input I2 or I3 is on, output Q0 is on.

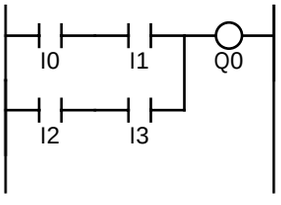
When input I0 is off or both inputs I2 and I3 are off, output Q0 is off.

OR LOD (Load)

The OR LOD instruction is used to connect, in parallel, two or more circuits starting with the LOD instruction. The OR LOD instruction is the equivalent of a “node” on a ladder diagram.

When using WindLDR, the user need not program the OR LOD instruction. The circuit in the ladder diagram shown below is converted into OR LOD when the ladder diagram is compiled.

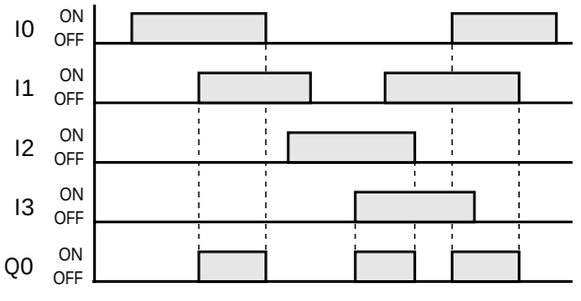
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	AND	I1
2	LOD	I2
3	AND	I3
4	ORLOD	
5	OUT	Q0

Timing Chart



When both inputs I0 and I1 are on or both inputs I2 and I3 are on, output Q0 is on.

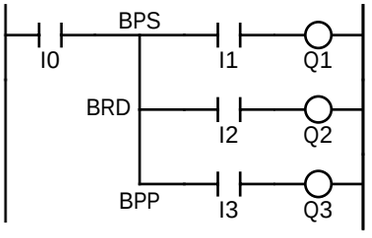
When either input I0 or I1 is off and either input I2 or I3 is off, output Q0 is off.

BPS (Bit Push), BRD (Bit Read), and BPP (Bit Pop)

The BPS (bit push) instruction is used to save the result of bit logical operation temporarily.
The BRD (bit read) instruction is used to read the result of bit logical operation which was saved temporarily.
The BPP (bit pop) instruction is used to restore the result of bit logical operation which was saved temporarily.

When using WindLDR, the user need not program the BPS, BRD, and BPP instructions. The circuit in the ladder diagram shown below is converted into BPS, BRD, and BPP when the ladder diagram is compiled.

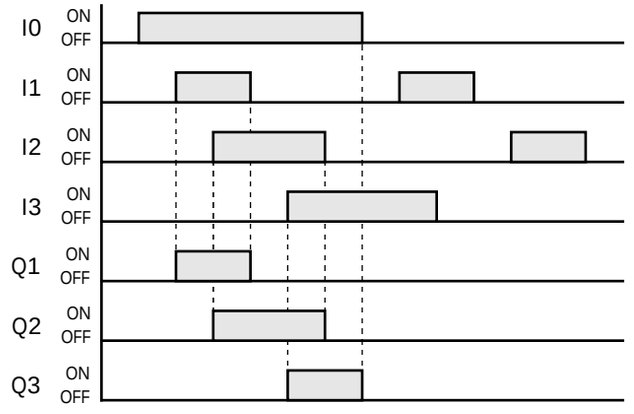
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	BPS	
2	AND	I1
3	OUT	Q1
4	BRD	
5	AND	I2
6	OUT	Q2
7	BPP	
8	AND	I3
9	OUT	Q3

Timing Chart



When both inputs I0 and I1 are on, output Q1 is turned on.

When both inputs I0 and I2 are on, output Q2 is turned on.

When both inputs I0 and I3 are on, output Q3 is turned on.

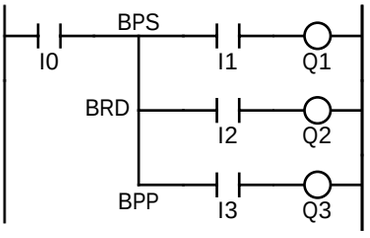
Data Movement in Operation Register and Bit Stack Register

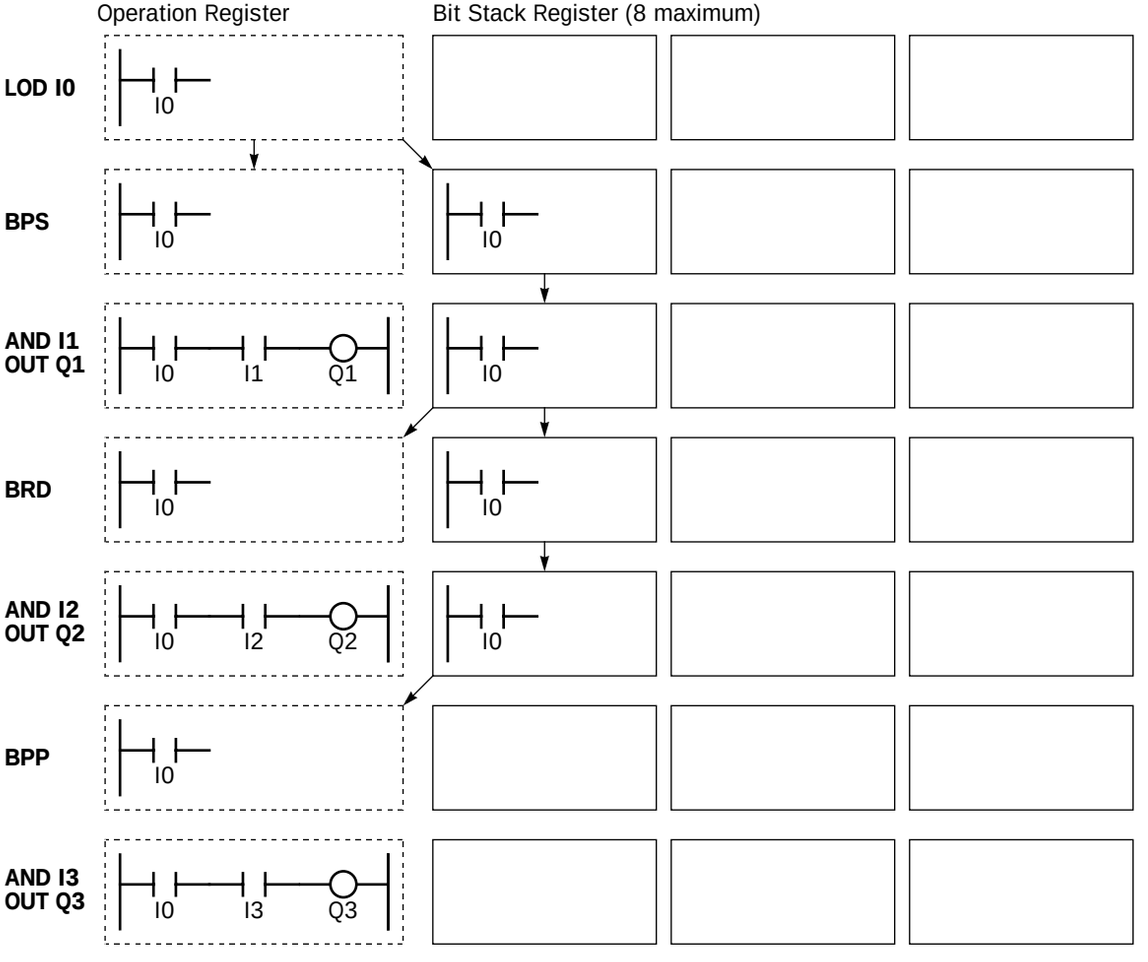
When the BPS (bit push) instruction is used, the program in the operation register is stored in the first bit stack register. When the BPS instruction is used again, the program in the first stack register is stored in the second bit stack register and the program in the operation register is stored in the first stack register. Each time the BPS instruction is used, the program is moved to the next bit stack register. Program blocks can be stored in a maximum of eight bit stack registers.

When the BRD (bit read) instruction is used, the program in the first bit stack register is read to the operation register. All program blocks stored in bit stack registers are not moved.

When the BPP (bit push) instruction is used, all program blocks in bit stack registers are shifted back by one place. The program in the first bit stack register is moved to the operation register.

Ladder Diagram





TML, TIM, TMH, and TMS (Timer)

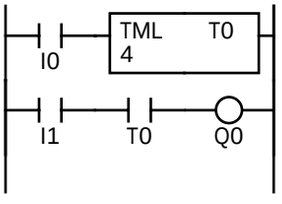
Four types of timers are available; 1-sec timedown timer TML, 100-msec timedown timer TIM, 10-msec timedown timer TMH, and 1-msec timedown timer TMS. A total of 256 timers can be programmed in a user program. Each timer must be allocated to a unique number T0 through T255.

Timer	Allocation Number	Range	Increments	Preset Value
TML (1-sec timer)	T0 to T255	0 to 65535 sec	1 sec	Constant: 0 to 65535 Data registers: D0 to D7999
TIM (100-msec timer)	T0 to T255	0 to 6553.5 sec	100 msec	
TMH (10-msec timer)	T0 to T255	0 to 655.35 sec	10 msec	
TMS (1-msec timer)	T0 to T255	0 to 65.535 sec	1 msec	

The preset value can be 0 through 65535 and designated using a decimal constant or data register.

TML (1-sec Timer)

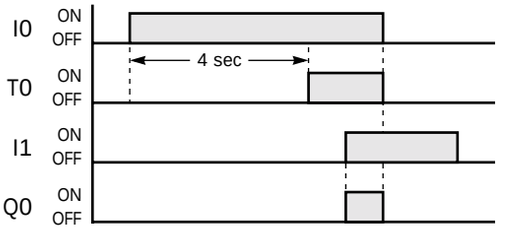
Ladder Diagram (TML)



Program List

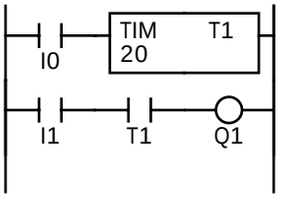
Prgm Adrs	Instruction	Data
0	LOD	I0
1	TML	T0
2		4
3	LOD	I1
4	AND	T0
5	OUT	Q0

Timing Chart



TIM (100-msec Timer)

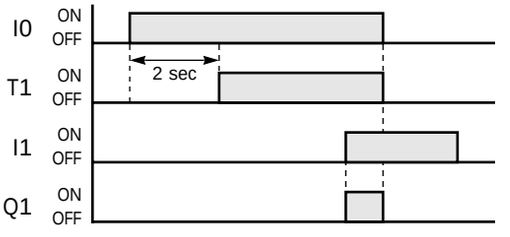
Ladder Diagram (TIM)



Program List

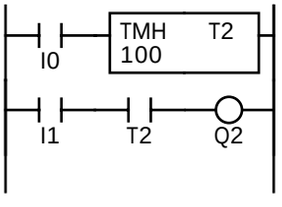
Prgm Adrs	Instruction	Data
0	LOD	I0
1	TIM	T1
2		20
3	LOD	I1
4	AND	T1
5	OUT	Q1

Timing Chart



TMH (10-msec Timer)

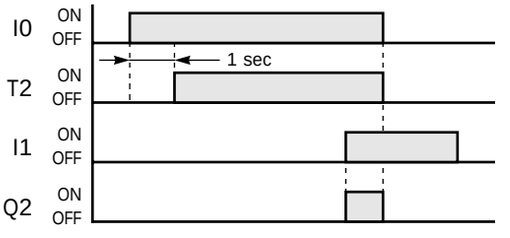
Ladder Diagram (TMH)



Program List

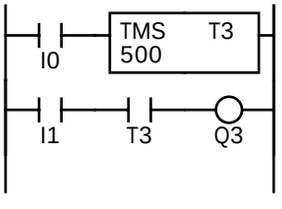
Prgm Adrs	Instruction	Data
0	LOD	I0
1	TMH	T2
2		100
3	LOD	I1
4	AND	T2
5	OUT	Q2

Timing Chart



TMS (1-msec Timer)

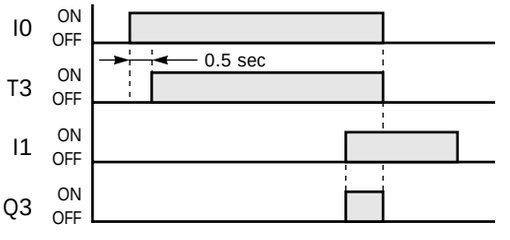
Ladder Diagram (TMS)



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	TMS	T3
2		500
3	LOD	I1
4	AND	T3
5	OUT	Q3

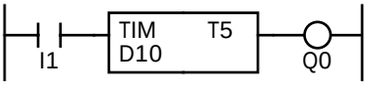
Timing Chart



Timer Circuit

The preset value 0 through 65535 can be designated using a data register D0 through D7999; then the data of the data register becomes the preset value. Directly after the TML, TIM, TMH, or TMS instruction, the OUT, OUTN, SET, RST, TML, TIM, TMH, or TMS instruction can be programmed.

Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I1
1	TIM	T5
2		D10
3	OUT	Q0

- Timedown from the preset value is initiated when the operation result directly before the timer input is on.
- The timer output turns on when the current value (timed value) reaches 0.
- The current value returns to the preset value when the timer input is off.
- Timer preset and current values can be changed using WindLDR without transferring the entire program to the CPU again. From the WindLDR menu bar, select **Online** > **Monitor**, then select **Online** > **Point Write**. To change a timer preset value, specify the timer number with a capital T and a new preset value. If the timer preset value is changed during timedown, the timer remains unchanged for that cycle. The change will be reflected in the next time cycle. To change a timer current value, specify the timer number with a small t and a new current value while the timer is in operation. The change takes effect immediately.
- If the timer preset value is changed to 0, then the timer stops operation, and the timer output is turned on immediately.
- If the current value is changed during timedown, the change becomes effective immediately.

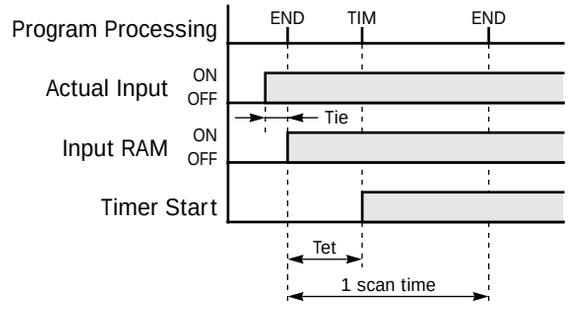
Timer Accuracy

Timer accuracy due to software configuration depends on three factors: timer input error, timer counting error, and timeout output error. These errors are not constant but vary with the user program and other causes.

Timer Input Error

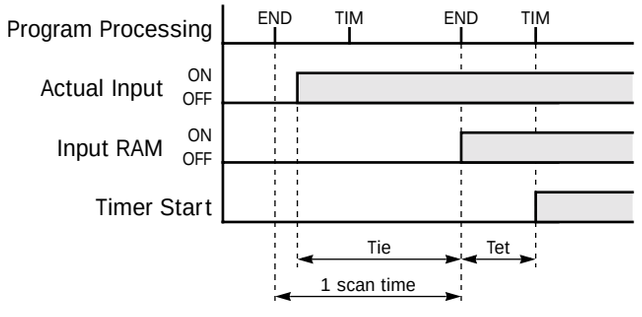
The input status is read at the END processing and stored to the input RAM. So, an error occurs depending on the timing when the timer input turns on in a scan cycle. The same error occurs on the normal input and the catch input. The timer input error shown below does not include input delay caused by the hardware.

Minimum Error



When the input turns on immediately before the END processing, Tie is almost 0. Then the timer input error is only Tet (behind error) and is at its minimum.

Maximum Error



When the input turns on immediately after the END processing, Tie is almost equal to one scan time. Then the timer input error is Tie + Tet = one scan time + Tet (behind error) and is at its maximum.

Tie: Time from input turning on to the END processing
Tet: Time from the END processing to the timer instruction execution

Timer Accuracy, continued

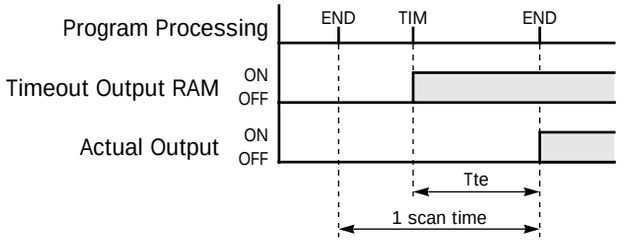
Timer Counting Error

Every timer instruction operation is individually based on asynchronous 16-bit reference timers. Therefore, an error occurs depending on the status of the asynchronous 16-bit timer when the timer instruction is executed.

Error		TML (1-sec timer)	TIM (100-msec timer)	TMH (10-msec timer)	TMS (1-msec timer)
Minimum	Advance error	0 msec	0 msec	0 msec	0 msec
	Behind error	0 msec	0 msec	0 msec	0 msec
Maximum	Advance error	1000 msec	100 msec	10 msec	1 msec
	Behind error	1 scan time	1 scan time	1 scan time	1 scan time

Timeout Output Error

The output RAM status is set to the actual output when the END instruction is processed. So, an error occurs depending on the timing when the timeout output turns on in a scan cycle. The timeout output error shown below does not include output delay caused by the hardware.



Timeout output error is equal to Tte (behind error) and can be between 0 and one scan time.

0 < Tte < 1 scan time

Tte: Time from the timer instruction execution to the END processing

Maximum and Minimum of Errors

Error		Timer Input Error	Timer Counting Error	Timeout Output Error	Total Error
Minimum	Advance error	0 (Note)	0	0 (Note)	0
	Behind error	Tet	0	Tte	0
Maximum	Advance error	0 (Note)	Increment	0 (Note)	Increment – (Tet + Tte)
	Behind error	1 scan time + Tet	1 scan time	Tte	2 scan times + (Tet + Tte)

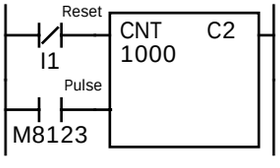
Notes: Advance error does not occur at the timer input and timeout output.
Tet + Tte = 1 scan time
Increment is 1 sec (TML), 100 msec (TIM), 10 msec (TMH), or 1 msec (TMS).
The maximum advance error is: Increment – 1 scan time
The maximum behind error is: 3 scan times

The timer input error and timeout output error do not include the input response time (behind error) and output response time (behind error).

Power Failure Memory Protection

Timers TML, TIM, TMH, and TMS do not have power failure protection. A timer with this protection can be devised using a counter instruction and special internal relay M8121 (1-sec clock), M8122 (100-msec clock), or M8123 (10-msec clock).

Ladder Diagram (10-sec Timer)



Program List

Prgm Adrs	Instruction	Data
0	LODN	I1
1	LOD	M8123
2	CNT	C2
3		1000

Timing Chart

Note: Designate counter C2 used in this program as a keep type counter. See page 5-3.

CNT, CDP, and CUD (Counter)

Three types of counters are available; adding (up) counter CNT, dual-pulse reversible counter CDP, and up/down selection reversible counter CUD. A total of 256 counters can be programmed in a user program. Each counter must be allocated to a unique number C0 through C255.

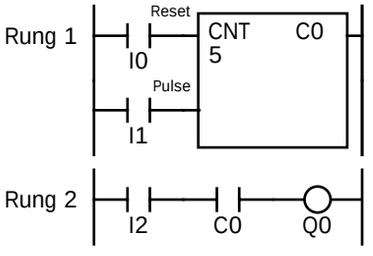
Counter	Allocation Number	Preset Value
CNT (adding counter)	C0 to C255	Constant: 0 to 65535 Data registers: D0 to D7999
CDP (dual-pulse reversible counter)	C0 to C255	
CUD (up/down selection reversible counter)	C0 to C255	

CNT (Adding Counter)

When counter instructions are programmed, two addresses are required. The circuit for an adding (UP) counter must be programmed in the following order: reset input, pulse input, the CNT instruction, and a counter number C0 through C255, followed by a counter preset value from 0 to 65535.

The preset value can be designated using a decimal constant or a data register. When a data register is used, the data of the data register becomes the preset value.

Ladder Diagram



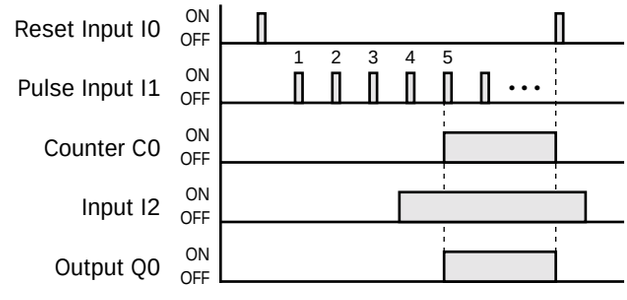
Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I0
	1	LOD	I1
	2	CNT	C0
	3		5
Rung 2	4	LOD	I2
	5	AND	C0
	6	OUT	Q0

Caution

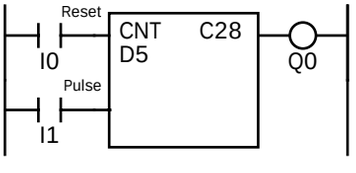
- When using WindLDR Ver. 3, any instruction cannot be programmed immediately above and below the CNT instruction. To program other instructions, start a new rung. If an instruction is entered above or below the CNT instruction in the same rung, the program is not compiled correctly.

Timing Chart



- The preset value 0 through 65535 can be designated using a data register D0 through D7999, then the data of the data register becomes the preset value. Directly after the CNT instruction, the OUT, OUTN, SET, RST, TML, TIM, TMH, or TMS instruction can be programmed.

Ladder Diagram



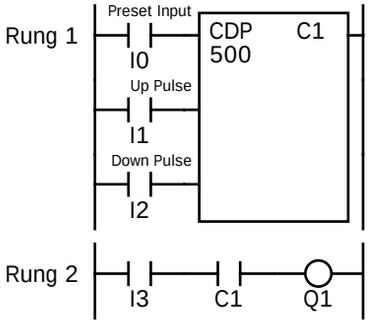
- The same counter number cannot be programmed more than once.
- While the reset input is off, the counter counts the leading edges of pulse inputs and compares them with the preset value.
- When the current value reaches the preset value, the counter turns output on. The output stays on until the reset input is turned on.
- When the reset input changes from off to on, the current value is reset.
- When the reset input is on, all pulse inputs are ignored.
- The reset input must be turned off before counting may begin.
- When power is off, the counter's current value is held, and can also be designated as "clear" type counters using Function Area Settings (see page 5-3).
- Counter preset and current values can be changed using WindLDR without transferring the entire program to the CPU (see page 7-12).
- When the preset or current value is changed during counter operation, the change becomes effective immediately.

CDP (Dual-Pulse Reversible Counter)

The dual-pulse reversible counter CDP has up and down pulse inputs, so that three inputs are required. The circuit for a dual-pulse reversible counter must be programmed in the following order: preset input, up-pulse input, down-pulse input, the CDP instruction, and a counter number C0 through C255, followed by a counter preset value from 0 to 65535.

The preset value can be designated using a decimal constant or a data register. When a data register is used, the data of the data register becomes the preset value.

Ladder Diagram



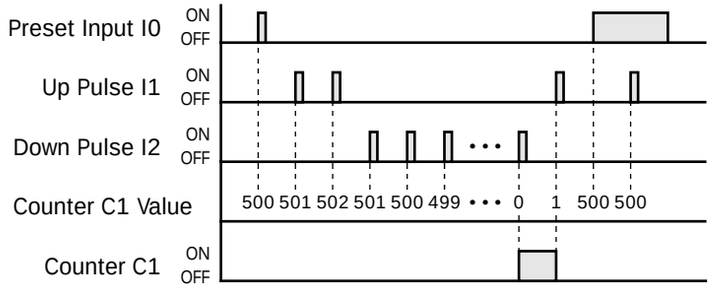
Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I0
	1	LOD	I1
	2	LOD	I2
	3	CDP	C1
	4		500
Rung 2	5	LOD	I3
	6	AND	C1
	7	OUT	Q1

Caution

- When using WindLDR Ver. 3, any instruction cannot be programmed immediately above and below the CDP instruction. To program other instructions, start a new rung. If an instruction is entered above or below the CDP instruction in the same rung, the program is not compiled correctly.

Timing Chart



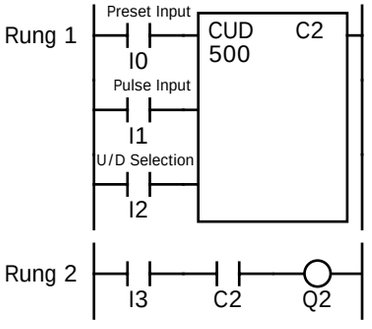
- The same counter number cannot be programmed more than once.
- The preset input must be turned on initially so that the current value returns to the preset value.
- The preset input must be turned off before counting may begin.
- When the up pulse and down pulses are on simultaneously, no pulse is counted.
- The counter output is on only when the current value is 0.
- After the current value reaches 0 (counting down), it changes to 65535 on the next count down.
- After the current value reaches 65535 (counting up), it changes to 0 on the next count up.
- When power is off, the counter's current value is held, and can also be designated as "clear" type counters using the Function Area Settings (see page 5-3).
- Counter preset and current values can be changed using WindLDR without transferring the entire program to the CPU again. From the WindLDR menu bar, select **Online** > **Monitor**, then select **Online** > **Point Write**. To change a counter preset value, specify the counter number with a capital C and a new preset value. To change a counter current value, specify the counter number with a small c and a new current value while the counter reset input is off.
- When the preset or current value is changed during counter operation, the change becomes effective immediately.

CUD (Up/Down Selection Reversible Counter)

The up/down selection reversible counter CUD has a selection input to switch the up/down gate, so that three inputs are required. The circuit for an up/down selection reversible counter must be programmed in the following order: preset input, pulse input, up/down selection input, the CUD instruction, and a counter number C0 through C255, followed by a counter preset value from 0 to 65535.

The preset value can be designated using a decimal constant or a data register. When a data register is used, the data of the data register becomes the preset value.

Ladder Diagram



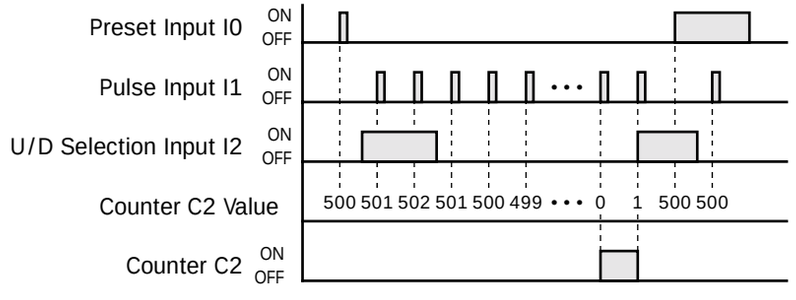
Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I0
	1	LOD	I1
	2	LOD	I2
	3	CUD	C2
	4		500
Rung 2	5	LOD	I3
	6	AND	C2
	7	OUT	Q2

⚠ Caution

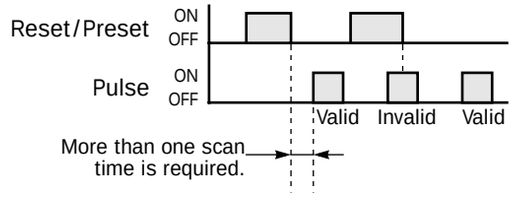
- When using WindLDR Ver. 3, any instruction cannot be programmed immediately above and below the CUD instruction. To program other instructions, start a new rung. If an instruction is entered above or below the CUD instruction in the same rung, the program is not compiled correctly.

Timing Chart

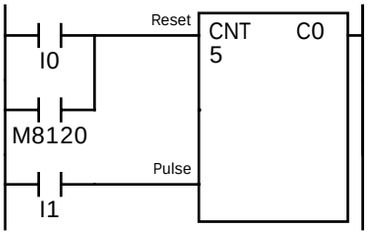


- The same counter number cannot be programmed more than once.
- The preset input must be turned on initially so that the current value returns to the preset value.
- The preset input must be turned off before counting may begin.
- The up mode is selected when the up/down selection input is on.
- The down mode is selected when the up/down selection input is off.
- The counter output is on only when the current value is 0.
- After the current value reaches 0 (counting down), it changes to 65535 on the next count down.
- After the current value reaches 65535 (counting up), it changes to 0 on the next count up.
- When power is off, the counter's current value is held, and can also be designated as "clear" type counters using the Function Area Settings (see page 5-3).
- Counter preset and current values can be changed using WindLDR without transferring the entire program to the CPU (see page 7-12).
- When the preset or current value is changed during counter operation, the change becomes effective immediately.

- The reset or preset input has priority over the pulse input. One scan after the reset or preset input has changed from on to off, the counter starts counting the pulse inputs as they change from off to on.



- When the CPU is turned off, counter current values are maintained unless designated as "clear" type counters. When resetting the counter current values is required at start up, include initialize pulse special internal relay M8120 in an OR circuit with the reset input.



CC= and CC≥ (Counter Comparison)

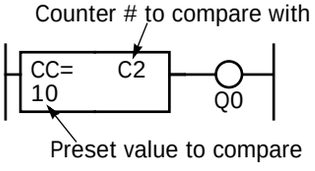
The CC= instruction is an equivalent comparison instruction for counter current values. This instruction will constantly compare current values to the value that has been programmed in. When the counter value equals the given value, the desired output will be initiated.

The CC≥ instruction is an equal to or greater than comparison instruction for counter current values. This instruction will constantly compare current values to the value that has been programmed in. When the counter value is equal to or greater than the given value, the desired output will be initiated.

When a counter comparison instruction is programmed, two addresses are required. The circuit for a counter comparison instruction must be programmed in the following order: the CC= or CC≥ instruction, a counter number C0 through C255, followed by a preset value to compare from 0 to 65535.

The preset value can be designated using a decimal constant or a data register D0 through D7999. When a data register is used, the data of the data register becomes the preset value.

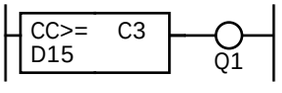
Ladder Diagram (CC=)



Program List

Prgm Adrs	Instruction	Data
0	CC=	C2
1		10
2	OUT	Q0

Ladder Diagram (CC≥)

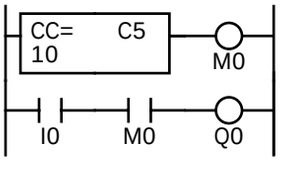


Program List

Prgm Adrs	Instruction	Data
0	CC>=	C3
1		D15
2	OUT	Q1

- The CC= and CC≥ instructions can be used repeatedly for different preset values.
- The comparison instructions only compare the current value. The status of the counter does not affect this function.
- The comparison instructions also serve as an implicit LOD instruction, and must be programmed at the beginning of a ladder line.
- The comparison instructions can be used with internal relays, which are ANDed or ORed at a separate program address.
- Like the LOD instruction, the comparison instructions can be followed by the AND and OR instructions.

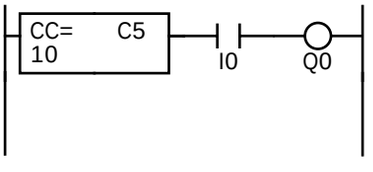
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	CC=	C5
1		10
2	OUT	M0
3	LOD	I0
4	AND	M0
5	OUT	Q0

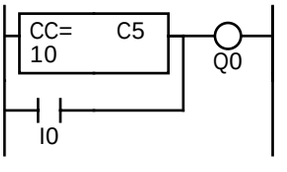
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	CC=	C5
1		10
2	AND	I0
3	OUT	Q0

Ladder Diagram



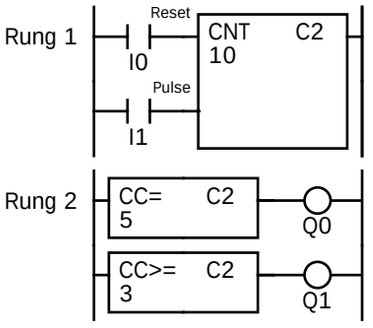
Program List

Prgm Adrs	Instruction	Data
0	CC=	C5
1		10
2	OR	I0
3	OUT	Q0

- To compare three values, use the ICMP (interval compare greater than or equal to). See page 10-4.

Examples: CC= and CC≥ (Counter Comparison)

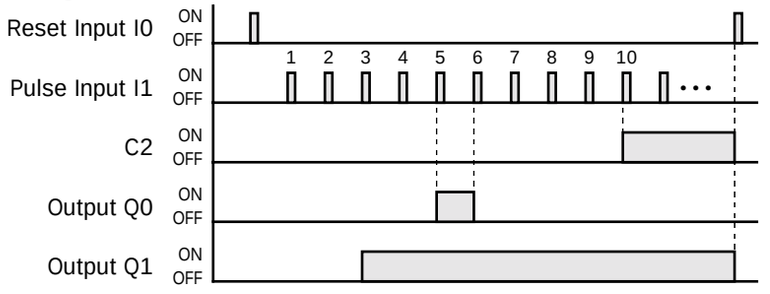
Ladder Diagram 1



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	LOD	I1
2	CNT	C2
3		10
4	CC=	C2
5		5
6	OUT	Q0
7	CC≥	C2
8		3
9	OUT	Q1

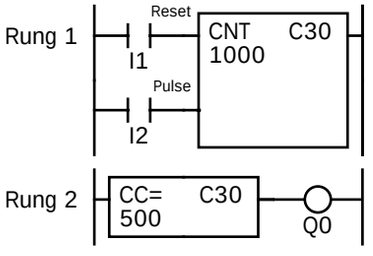
Timing Chart



Output Q0 is on when counter C2 current value is 5.

Output Q1 is turned on when counter C2 current value reaches 3 and remains on until counter C2 is reset.

Ladder Diagram 2



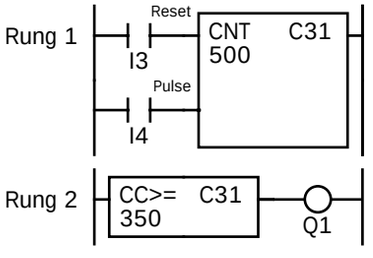
Program List

Prgm Adrs	Instruction	Data
0	LOD	I1
1	LOD	I2
2	CNT	C30
3		1000
4	CC=	C30
5		500
6	OUT	Q0

Timing Chart

Output Q0 is on when counter C30 current value is 500.

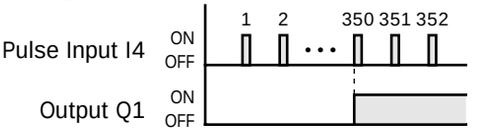
Ladder Diagram 3



Program List

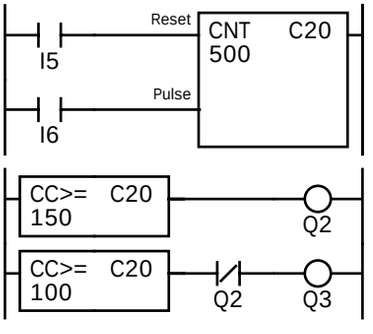
Prgm Adrs	Instruction	Data
0	LOD	I3
1	LOD	I4
2	CNT	C31
3		500
4	CC>=	C31
5		350
6	OUT	Q1

Timing Chart



Output Q1 is turned on when counter C31 current value reaches 350 and remains on until counter C31 is reset.

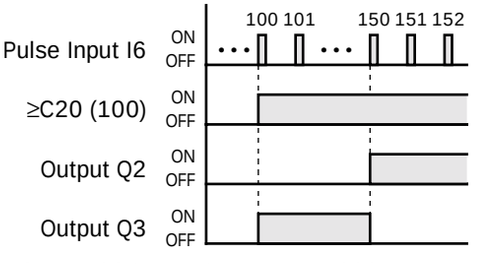
Ladder Diagram 4



Program List

Prgm Adrs	Instruction	Data
0	LOD	I5
1	LOD	I6
2	CNT	C20
3		500
4	CC>=	C20
5		150
6	OUT	Q2
7	CC>=	C20
8		100
9	ANDN	Q2
10	OUT	Q3

Timing Chart



Output Q3 is on when counter C20 current value is between 100 and 149.

TC= and TC≥ (Timer Comparison)

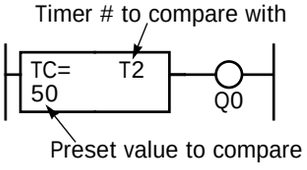
The TC= instruction is an equivalent comparison instruction for timer current values. This instruction will constantly compare current values to the value that has been programmed in. When the timer value equals the given value, the desired output will be initiated.

The TC≥ instruction is an equal to or greater than comparison instruction for timer current values. This instruction will constantly compare current values to the value that has been programmed in. When the timer value is equal to or greater than the given value, the desired output will be initiated.

When a timer comparison instruction is programmed, two addresses are required. The circuit for a timer comparison instruction must be programmed in the following order: the TC= or TC≥ instruction, a timer number T0 through T255, followed by the preset value to compare from 0 to 65535.

The preset value can be designated using a decimal constant or a data register D0 through D7999. When a data register is used, the data of the data register becomes the preset value.

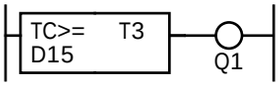
Ladder Diagram (TC=)



Program List

Prgm Adrs	Instruction	Data
0	TC=	T2
1		50
2	OUT	Q0

Ladder Diagram (TC≥)

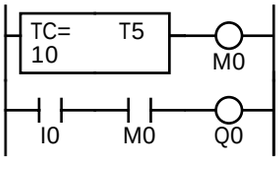


Program List

Prgm Adrs	Instruction	Data
0	TC>=	T3
1		D15
2	OUT	Q1

- The TC= and TC≥ instructions can be used repeatedly for different preset values.
- The comparison instructions only compare the current value. The status of the timer does not affect this function.
- The comparison instructions also serve as an implicit LOD instruction, and must be programmed at the beginning of a ladder line.
- The comparison instructions can be used with internal relays, which are ANDed or ORed at a separate program address.
- Like the LOD instruction, the comparison instructions can be followed by the AND and OR instructions.

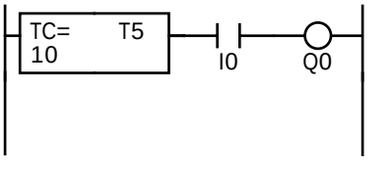
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	TC=	T5
1		10
2	OUT	M0
3	LOD	I0
4	AND	M0
5	OUT	Q0

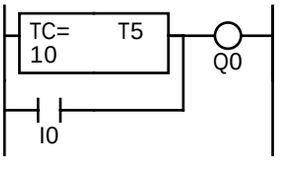
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	TC=	T5
1		10
2	AND	I0
3	OUT	Q0

Ladder Diagram



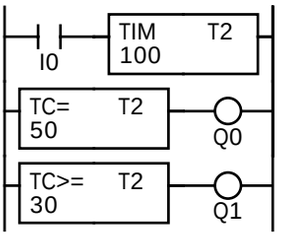
Program List

Prgm Adrs	Instruction	Data
0	TC=	T5
1		10
2	OR	I0
3	OUT	Q0

- To compare three values, use the ICMP (interval compare greater than or equal to). See page 10-4.

Examples: TC= and TC≥ (Timer Comparison)

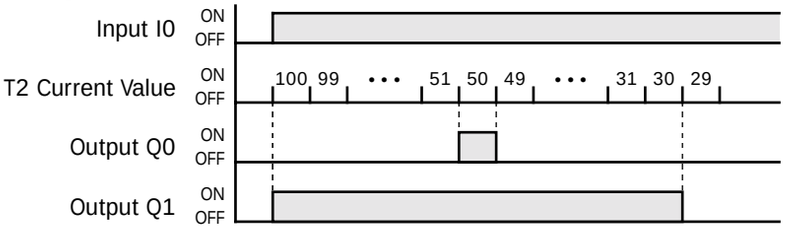
Ladder Diagram 1



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	TIM	T2
2		100
3	TC=	T2
4		50
5	OUT	Q0
6	TC≥	T2
7		30
8	OUT	Q1

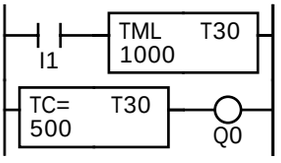
Timing Chart



Output Q0 is on when timer T2 current value is 50.

Output Q1 is turned on when timer T2 starts to timedown and remains on until the current value reaches 30.

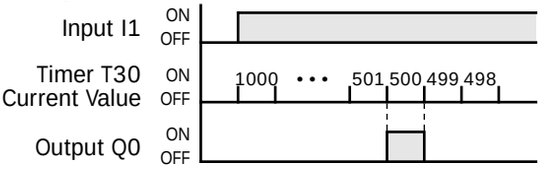
Ladder Diagram 2



Program List

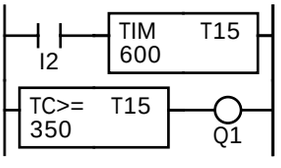
Prgm Adrs	Instruction	Data
0	LOD	I1
1	TML	T30
2		1000
3	TC=	T30
4		500
5	OUT	Q0

Timing Chart



Output Q0 is on when timer T30 current value is 500.

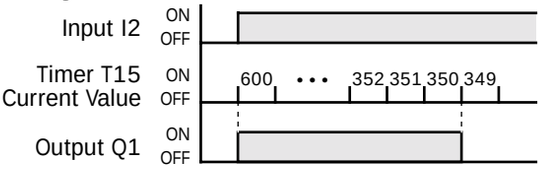
Ladder Diagram 3



Program List

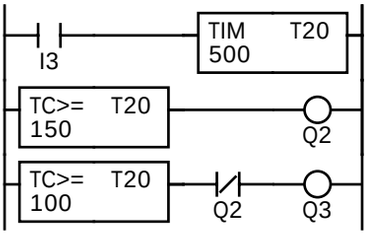
Prgm Adrs	Instruction	Data
0	LOD	I2
1	TIM	T15
2		600
3	TC>=	T15
4		350
5	OUT	Q1

Timing Chart



Output Q1 is turned on when timer T15 starts to time down and remains on until the current value reaches 350.

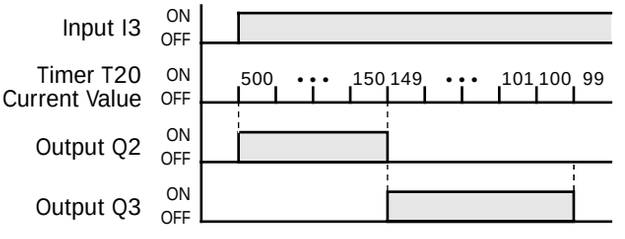
Ladder Diagram 4



Program List

Instruction	Data
LOD	I3
TIM	T20
	500
TC>=	T20
	150
OUT	Q2
TC>=	T20
	100
ANDN	Q2
OUT	Q3

Timing Chart



Output Q3 is turned on while timer T20 current value is between 149 and 100.

DC= and DC≥ (Data Register Comparison)

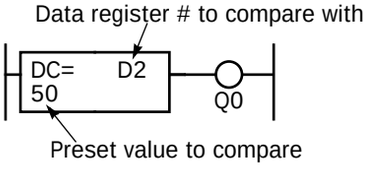
The DC= instruction is an equivalent comparison instruction for data register values. This instruction will constantly compare data register values to the value that has been programmed in. When the data register value equals the given value, the desired output will be initiated.

The DC≥ instruction is an equal to or greater than comparison instruction for data register values. This instruction will constantly compare data register values to the value that has been programmed in. When the data register value is equal to or greater than the given value, the desired output will be initiated.

When a data register comparison instruction is programmed, two addresses are required. The circuit for a data register comparison instruction must be programmed in the following order: the DC= or DC≥ instruction, a data register number D0 through D7999, followed by the preset value to compare from 0 to 65535.

The preset value can be designated using a decimal constant or a data register D0 through D7999. When a data register is used, the data of the data register becomes the preset value.

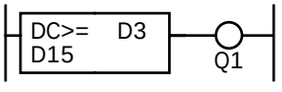
Ladder Diagram (DC=)



Program List

Prgm Adrs	Instruction	Data
0	DC=	D2
1		50
2	OUT	Q0

Ladder Diagram (DC≥)

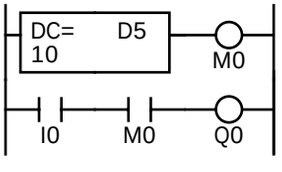


Program List

Prgm Adrs	Instruction	Data
0	DC>=	D3
1		D15
2	OUT	Q1

- The DC= and DC≥ instructions can be used repeatedly for different preset values.
- The comparison instructions also serve as an implicit LOD instruction, and must be programmed at the beginning of a ladder line.
- The comparison instructions can be used with internal relays, which are ANDed or ORed at a separate program address.
- Like the LOD instruction, the comparison instructions can be followed by the AND and OR instructions.

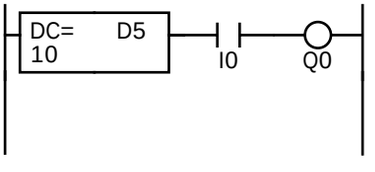
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	DC=	D5
1		10
2	OUT	M0
3	LOD	I0
4	AND	M0
5	OUT	Q0

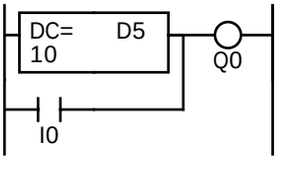
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	DC=	D5
1		10
2	AND	I0
3	OUT	Q0

Ladder Diagram



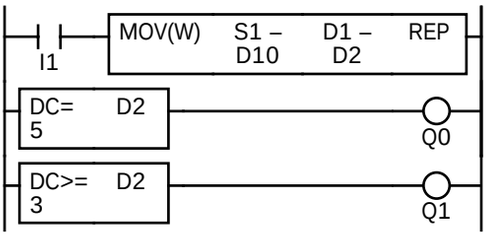
Program List

Prgm Adrs	Instruction	Data
0	DC=	D5
1		10
2	OR	I0
3	OUT	Q0

- To compare three values, use the ICMP (interval compare greater than or equal to). See page 10-4.

Examples: DC= and DC≥ (Data Register Comparison)

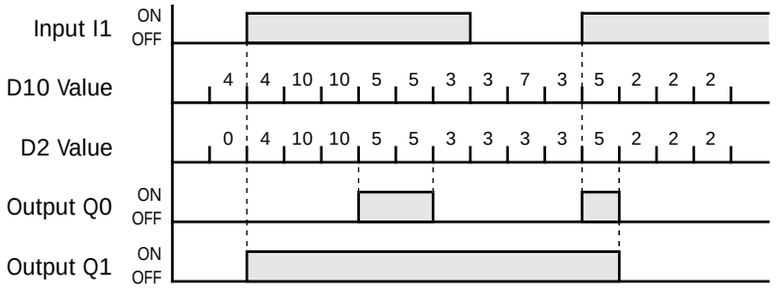
Ladder Diagram 1



Program List

Prgm Adrs	Instruction	Data
0	LOD	I1
1	MOV(W)	
2		D10 –
3		D2 –
4	DC=	D2
5		5
6	OUT	Q0
7	DC≥	D2
8		3
9	OUT	Q1

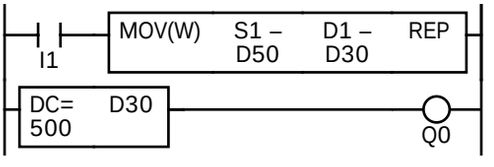
Timing Chart



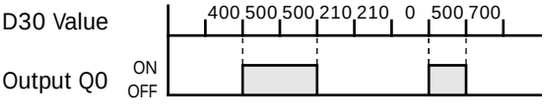
Output Q0 is on when data register D2 value is 5.

Output Q1 is turned on when data register D2 value is 3 or more.

Ladder Diagram 2

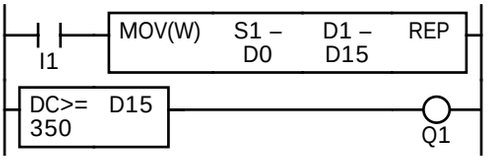


Timing Chart

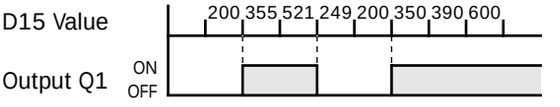


Output Q0 is on when data register D30 value is 500.

Ladder Diagram 3

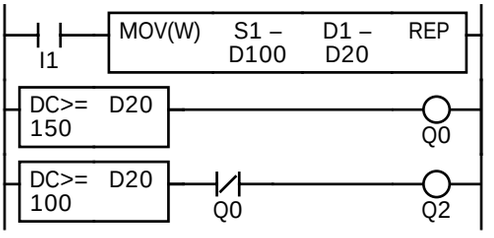


Timing Chart

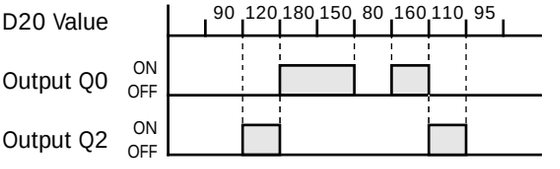


Output Q1 is on when data register D15 value is 350 or more.

Ladder Diagram 4



Timing Chart



Output Q2 is on while data register D20 value is between 149 and 100.

SFR and SFRN (Forward and Reverse Shift Register)

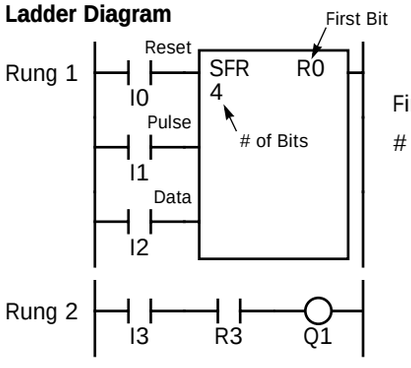
The shift register consists of a total of 256 bits which are allocated to R0 through R255. Any number of available bits can be selected to form a train of bits which store on or off status. The on/off data of constituent bits is shifted in the forward direction (forward shift register) or in the reverse direction (reverse shift register) when a pulse input is turned on.

Forward Shift Register (SFR)

When SFR instructions are programmed, two addresses are always required. The SFR instruction is entered, followed by a shift register number selected from appropriate operand numbers. The shift register number corresponds to the first, or head bit. The number of bits is the second required address after the SFR instruction.

The SFR instruction requires three inputs. The forward shift register circuit must be programmed in the following order: reset input, pulse input, data input, and the SFR instruction, followed by the first bit and the number of bits.

Ladder Diagram



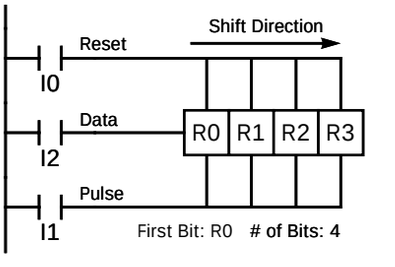
First Bit: R0 to R255

# of Bits: 1 to 256

Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I0
	1	LOD	I1
	2	LOD	I2
	3	SFR	R0
	4		4
Rung 2	5	LOD	I3
	6	AND	R3
	7	OUT	Q1

Structural Diagram



Caution

- When using WindLDR Ver. 3, any instruction cannot be programmed immediately above and below the SFR instruction. To program other instructions, start a new rung. If an instruction is entered above or below the SFR instruction in the same rung, the program is not compiled correctly.

Reset Input

The reset input will cause the value of each bit of the shift register to return to zero. Initialize pulse special internal relay, M8120, may be used to initialize the shift register at start-up.

Pulse Input

The pulse input triggers the data to shift. The shift is in the forward direction for a forward shift register and in reverse for a reverse shift register. A data shift will occur upon the leading edge of a pulse; that is, when the pulse *turns on*. If the pulse has been on and stays on, no data shift will occur.

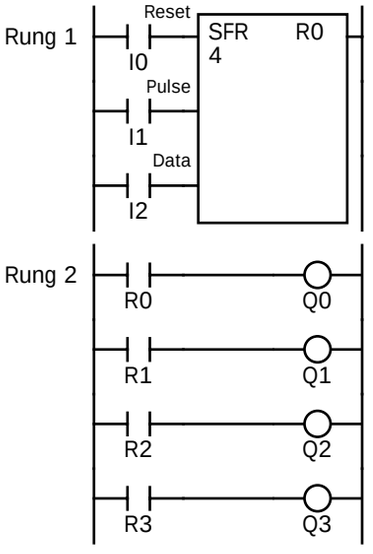
Data Input

The data input is the information which is shifted into the first bit when a forward data shift occurs, or into the last bit when a reverse data shift occurs.

Note: When power is turned off, the statuses of all shift register bits are normally cleared. It is also possible to maintain the statuses of shift register bits by using the Function Area Settings as required. See page 5-3. SFR(N) shifting flag special internal relay M8012 is turned on when the CPU is powered down while data shifting is in progress. See page 6-10.

Forward Shift Register (SFR), continued

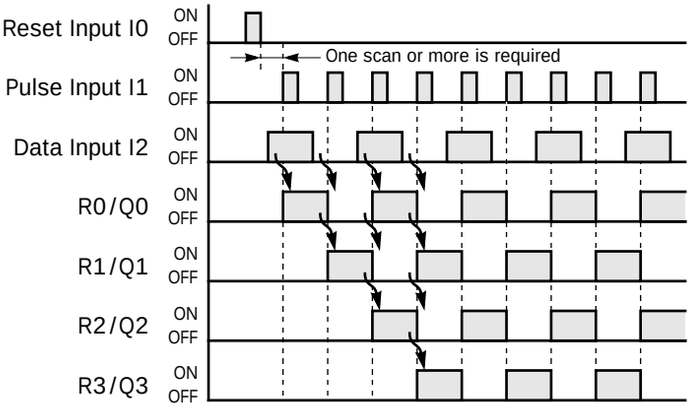
Ladder Diagram



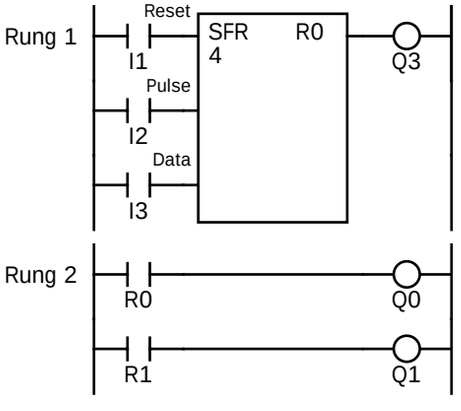
Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I0
	1	LOD	I1
	2	LOD	I2
	3	SFR	R0
	4		4
Rung 2	5	LOD	R0
	6	OUT	Q0
	7	LOD	R1
	8	OUT	Q1
	9	LOD	R2
	10	OUT	Q2
	11	LOD	R3
	12	OUT	Q3

Timing Chart



Ladder Diagram

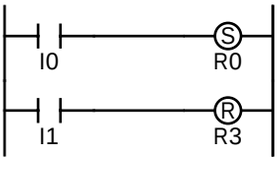


Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I1
	1	LOD	I2
	2	LOD	I3
	3	SFR	R0
	4		4
	5	OUT	Q3
Rung 2	6	LOD	R0
	7	OUT	Q0
	8	LOD	R1
	9	OUT	Q1

- The last bit status output can be programmed directly after the SFR instruction. In this example, the status of bit R3 is read to output Q3.
- Each bit can be loaded using the LOD R# instruction.

Setting and Resetting Shift Register Bits



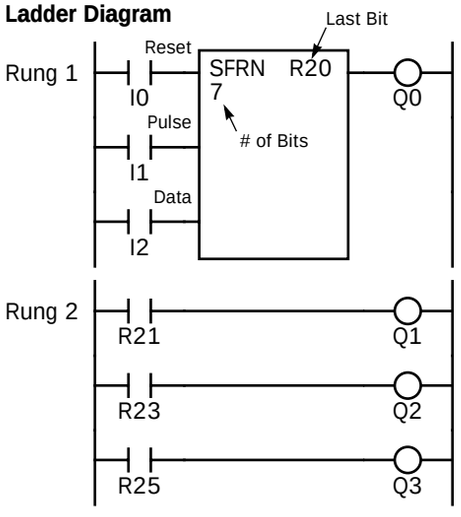
- Any shift register bit can be turned on using the SET instruction.
- Any shift register bit can be turned off using the RST instruction.
- The SET or RST instruction is actuated by any input condition.

Reverse Shift Register (SFRN)

For reverse shifting, use the SFRN instruction. When SFRN instructions are programmed, two addresses are always required. The SFRN instructions are entered, followed by a shift register number selected from appropriate operand numbers. The shift register number corresponds to the lowest bit number in a string. The number of bits is the second required address after the SFRN instructions.

The SFRN instruction requires three inputs. The reverse shift register circuit must be programmed in the following order: reset input, pulse input, data input, and the SFRN instruction, followed by the last bit and the number of bits.

Ladder Diagram



Last Bit: R0 to R255

# of Bits: 1 to 256

Program List

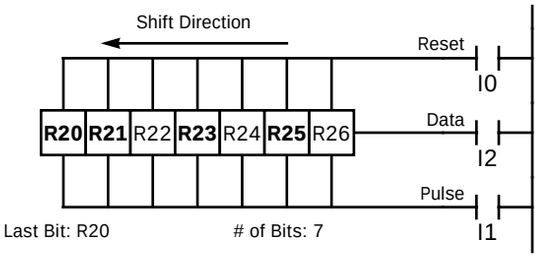
Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I0
	1	LOD	I1
	2	LOD	I2
	3	SFRN	R20
	4		7
	5	OUT	Q0
Rung 2	6	LOD	R21
	7	OUT	Q1
	8	LOD	R23
	9	OUT	Q2
	10	LOD	R25
	11	OUT	Q3

- The last bit status output can be programmed directly after the SFRN instruction. In this example, the status of bit R20 is read to output Q0.
- Each bit can be loaded using the LOD R# instructions.
- For details of reset, pulse, and data inputs, see page 7-20.

Caution

- When using WindLDR Ver 3, any instruction cannot be programmed immediately above and below the SFRN instruction. To program other instructions, start a new rung. If an instruction is entered above or below the SFRN instruction in the same rung, the program is not compiled correctly.

Structural Diagram



Note: Output is initiated only for those bits highlighted in bold print.

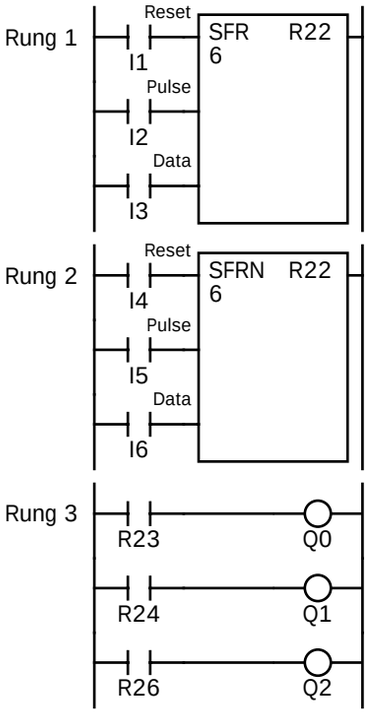
Note: When power is turned off, the statuses of all shift register bits are normally cleared. It is also possible to maintain the statuses of shift register bits by using the Function Area Settings as required. See page 5-3.

Note: SFR(N) shifting flag special internal relay M8012 is turned on when the CPU is powered down while data shifting is in progress. See page 6-10.

Bidirectional Shift Register

A bidirectional shift register can be created by first programming the SFR instruction as detailed in the Forward Shift Register section on page 7-20. Next, the SFRN instruction is programed as detailed in the Reverse Shift Register section on page 7-22.

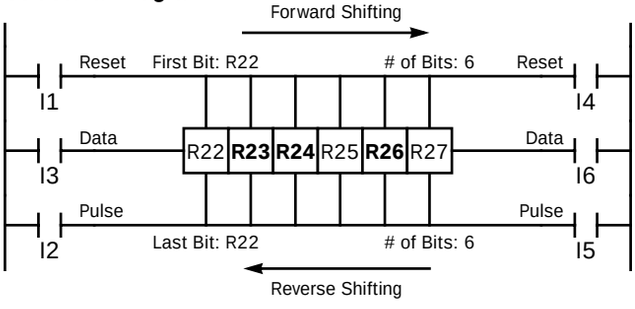
Ladder Diagram



Program List

Prgm Adrs		Instruction	Data
Rung 1	0	LOD	I1
	1	LOD	I2
	2	LOD	I3
	3	SFR	R22
	4		6
Rung 2	5	LOD	I4
	6	LOD	I5
	7	LOD	I6
	8	SFRN	R22
	9		6
Rung 3	10	LOD	R23
	11	OUT	Q0
	12	LOD	R24
	13	OUT	Q1
	14	LOD	R26
	15	OUT	Q2

Structural Diagram



Note: Output is initiated only for those bits highlighted in bold print.

SOTU and SOTD (Single Output Up and Down)

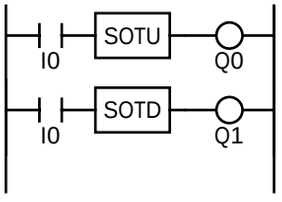
The SOTU instruction "looks for" the transition of a given input from off to on. The SOTD instruction looks for the transition of a given input from on to off. When this transition occurs, the desired output will turn on for the length of one scan. The SOTU or SOTD instruction converts an input signal to a "one-shot" pulse signal. The SOTU or SOTD instruction is followed by one address.

A total of 4096 SOTU and SOTD instructions can be used in a user program.

If operation is started while the given input is already on, the SOTU output will not turn on. The transition from off to on is what triggers the SOTU instruction.

When a relay of the OpenNet Controller relay output module is defined as the SOTU or SOTD output, it may not operate if the scan time is not compatible with relay requirements.

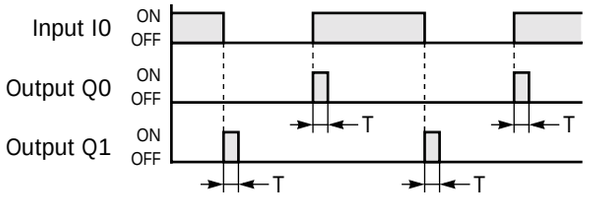
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	SOTU	
2	OUT	Q0
3	LOD	I0
4	SOTD	
5	OUT	Q1

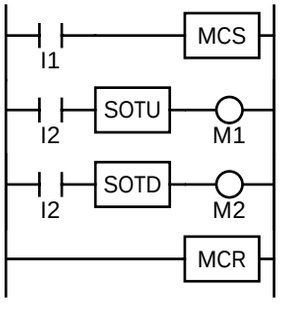
Timing Chart



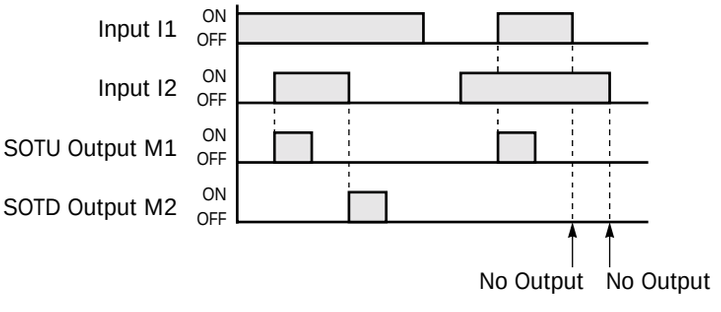
Note: "T" equals one scan time (one-shot pulse).

There is a special case when the SOTU and SOTD instructions are used between the MCS and MCR instructions (which are detailed on page 7-25). If input I2 to the SOTU instruction turns on while input I1 to the MCS instruction is on, then the SOTU output turns on. If input I2 to the SOTD instruction turns off while input I1 is on, then the SOTD output turns on. If input I1 turns on while input I2 is on, then the SOTU output turns on. However, if input I1 turns off while input I2 is on, then the SOTD output does not turn on as shown below.

Ladder Diagram



Timing Chart



MCS and MCR (Master Control Set and Reset)

The MCS (master control set) instruction is usually used in combination with the MCR (master control reset) instruction. The MCS instruction can also be used with the END instruction, instead of the MCR instruction.

When the input preceding the MCS instruction is off, the MCS is executed so that all inputs to the portion between the MCS and the MCR are forced off. When the input preceding the MCS instruction is on, the MCS is not executed so that the program following it is executed according to the actual input statuses.

When the input condition to the MCS instruction is off and the MCS is executed, other instructions between the MCS and MCR are executed as follows:

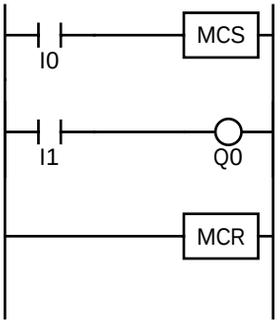
Instruction	Status
SOTU	Rising edges (ON pulses) are not detected.
SOTD	Falling edges (OFF pulses) are not detected.
OUT	All are turned off.
OUTN	All are turned on.
SET and RST	All are held in current status.
TML, TIM, TMH, and TMS	Current values are reset to zero. Timeout statuses are turned off.
CNT, CDP, and CUD	Current values are held. Pulse inputs are turned off. Countout statuses are turned off.
SFR and SFRN	Shift register bit statuses are held. Pulse inputs are turned off. The output from the last bit is turned off.

Input conditions cannot be set for the MCR instruction.

More than one MCS instruction can be used with one MCR instruction.

Corresponding MCS/MCR instructions cannot be nested within another pair of corresponding MCS/MCR instructions.

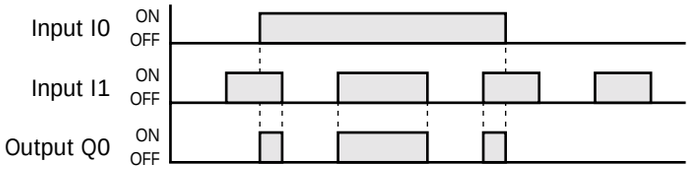
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	MCS	
2	LOD	I1
3	OUT	Q0
4	MCR	

Timing Chart



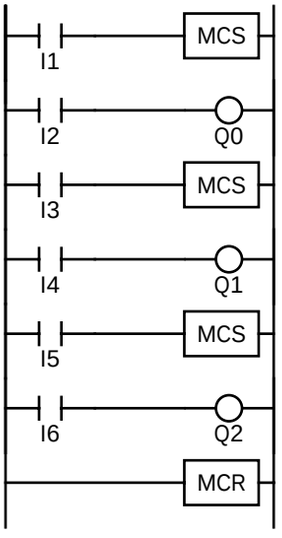
When input I0 is off, MCS is executed so that the subsequent input is forced off.

When input I0 is on, MCS is not executed so that the following program is executed according to the actual input statuses.

MCS and MCR (Master Control Set and Reset), continued

Multiple Usage of MCS instructions

Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I1
1	MCS	
2	LOD	I2
3	OUT	Q0
4	LOD	I3
5	MCS	
6	LOD	I4
7	OUT	Q1
8	LOD	I5
9	MCS	
10	LOD	I6
11	OUT	Q2
12	MCR	

This master control circuit will give priority to I1, I3, and I5, in that order.

When input I1 is off, the first MCS is executed so that subsequent inputs I2 through I6 are forced off.

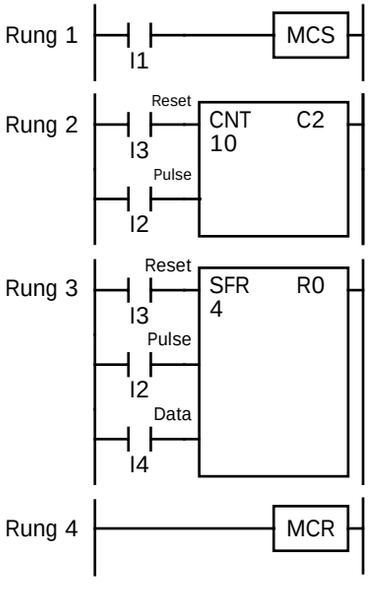
When input I1 is on, the first MCS is not executed so that the following program is executed according to the actual input statuses of I2 through I6.

When I1 is on and I3 is off, the second MCS is executed so that subsequent inputs I4 through I6 are forced off.

When both I1 and I3 are on, the first and second MCSs are not executed so that the following program is executed according to the actual input statuses of I4 through I6.

Counter and Shift Register in Master Control Circuit

Ladder Diagram

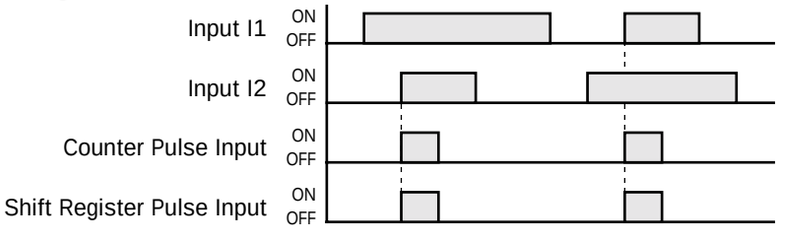


When input I1 is on, the MCS is not executed so that the counter and shift register are executed according to actual statuses of subsequent inputs I2 through I4.

When input I1 is off, the MCS is executed so that subsequent inputs I2 through I4 are forced off.

When input I1 is turned on while input I2 is on, the counter and shift register pulse inputs are turned on as shown below.

Timing Chart



JMP (Jump) and JEND (Jump End)

The JMP (jump) instruction is usually used in combination with the JEND (jump end) instruction. At the end of a program, the JMP instruction can also be used with the END instruction, instead of the JEND instruction.

These instructions are used to proceed through the portion of the program between the JMP and the JEND *without* processing. This is similar to the MCS/MCR instructions, except that the portion of the program between the MCS and MCR instruction *is* executed.

When the operation result immediately before the JMP instruction is on, the JMP is valid and the program is *not* executed. When the operation result immediately before the JMP instruction is off, the JMP is invalid and the program is executed.

When the input condition to the JMP instruction is on and the JMP is executed, other instructions between the JMP and JEND are executed as follows:

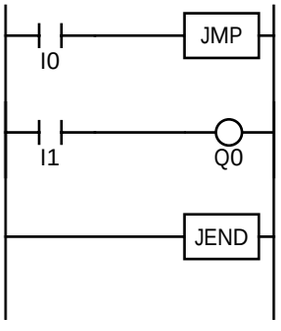
Instruction	Status
SOTU	Rising edges (ON pulses) are not detected.
SOTD	Falling edges (OFF pulses) are not detected.
OUT and OUTN	All are held in current status.
SET and RST	All are held in current status.
TML, TIM, TMH, and TMS	Current values are held. Timeout statuses are held.
CNT, CDP, and CUD	Current values are held. Pulse inputs are turned off. Countout statuses are held.
SFR and SFRN	Shift register bit statuses are held. Pulse inputs are turned off. The output from the last bit is held.

Input conditions cannot be set for the JEND instruction.

More than one JMP instruction can be used with one JEND instruction.

Corresponding JMP/JEND instructions cannot be nested within another pair of corresponding JMP/JEND instructions.

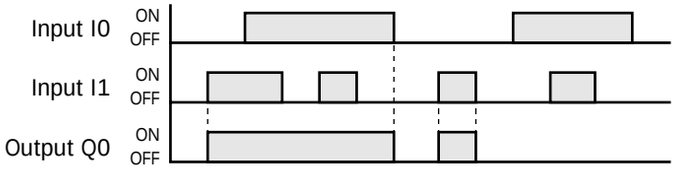
Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	JMP	
2	LOD	I1
3	OUT	Q0
4	JEND	

Timing Chart

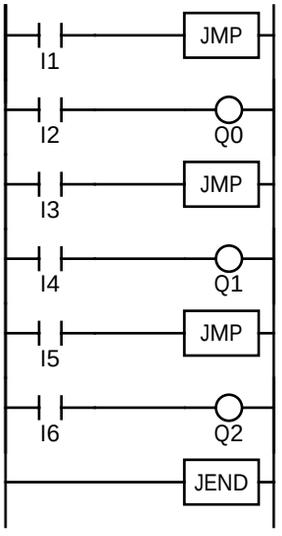


When input I0 is on, JMP is executed so that the subsequent output status is held.

When input I0 is off, JMP is not executed so that the following program is executed according to the actual input statuses.

JMP (Jump) and JEND (Jump End), continued

Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I1
1	JMP	
2	LOD	I2
3	OUT	Q0
4	LOD	I3
5	JMP	
6	LOD	I4
7	OUT	Q1
8	LOD	I5
9	JMP	
10	LOD	I6
11	OUT	Q2
12	JEND	

This jump circuit will give priority to I1, I3, and I5, in that order.

When input I1 is on, the first JMP is executed so that subsequent output statuses of Q0 through Q2 are held.

When input I1 is off, the first JMP is not executed so that the following program is executed according to the actual input statuses of I2 through I6.

When I1 is off and I3 is on, the second JMP is executed so that subsequent output statuses of Q1 and Q2 are held.

When both I1 and I3 are off, the first and second JMPs are not executed so that the following program is executed according to the actual input statuses of I4 through I6.

END

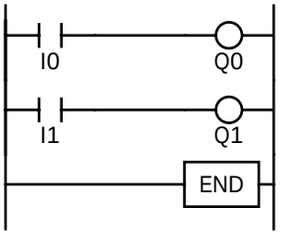
The END instruction is always required at the end of a program; however, it is not necessary to program the END instruction after the last programmed instruction. The END instruction already exists at every unused address. (When an address is used for programming, the END instruction is removed.)

A *scan* is the execution of all instructions from address zero to the END instruction. The time required for this execution is referred to as one *scan time*. The scan time varies with respect to program length, which corresponds to the address where the END instruction is found.

During the scan time, program instructions are processed sequentially. This is why the output instruction closest to the END instruction has priority over a previous instruction for the same output. No output is initiated until all logic within a scan is processed.

Output occurs simultaneously, and this is the first part of the END instruction execution. The second part of the END instruction execution is to monitor all inputs, also done simultaneously. Then program instructions are ready to be processed sequentially once again.

Ladder Diagram



Program List

Prgm Adrs	Instruction	Data
0	LOD	I0
1	OUT	Q0
2	LOD	I1
3	OUT	Q1
4	END	

8: ADVANCED INSTRUCTIONS

Introduction

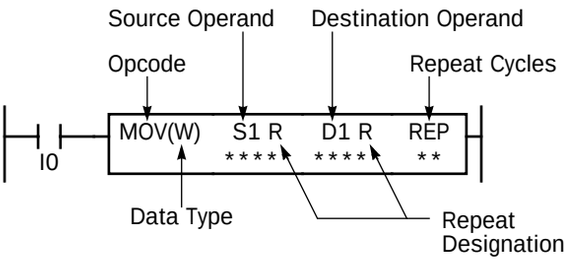
This chapter describes general rules of using advanced instructions, terms, data types, and formats used for advanced instructions.

Advanced Instruction List

Group	Symbol	Name	Data Type				Qty of Words	See Page
			W	I	D	L		
NOP	NOP	No Operation					1	8-6
Move	MOV	Move	X	X	X	X	6 or 7	9-1
	MOVN	Move Not	X	X	X	X	6 or 7	9-5
	IMOV	Indirect Move	X		X		9 or 10	9-6
	IMOVN	Indirect Move Not	X		X		9 or 10	9-7
	BMOV	Block Move	X				7	9-8
	NSET	N Data Set	X	X	X	X	2×S1 + 4	9-9
	NRS	N Data Repeat Set	X	X	X	X	7 or 8	9-10
	IBMV	Indirect Bit Move	X				9	9-11
	IBMVN	Indirect Bit Move Not	X				9	9-12
	XCHG	Exchange	X		X		5	9-13
Data Comparison	CMP=	Compare Equal To	X	X	X	X	8 to 10	10-1
	CMP<>	Compare Unequal To	X	X	X	X	8 to 10	10-1
	CMP<	Compare Less Than	X	X	X	X	8 to 10	10-1
	CMP>	Compare Greater Than	X	X	X	X	8 to 10	10-1
	CMP<=	Compare Less Than or Equal To	X	X	X	X	8 to 10	10-1
	CMP>=	Compare Greater Than or Equal To	X	X	X	X	8 to 10	10-1
	ICMP>=	Interval Compare Greater Than or Equal To	X	X	X	X	9 to 12	10-4
Binary Arithmetic	ADD	Addition	X	X	X	X	8 to 10	11-1
	SUB	Subtraction	X	X	X	X	8 to 10	11-1
	MUL	Multiplication	X	X	X	X	8 to 10	11-1
	DIV	Division	X	X	X	X	8 to 10	11-1
	INC	Increment	X		X		3	11-9
	DEC	Decrement	X		X		3	11-9
	ROOT	Root	X				5	11-10
	SUM	Sum	X				8	11-11
Boolean Computation	ANDW	AND Word	X		X		8 to 10	12-1
	ORW	OR Word	X		X		8 to 10	12-1
	XORW	Exclusive OR Word	X		X		8 to 10	12-1
	NEG	Negate		X		X	3	12-5

Group	Symbol	Name	Data Type				Qty of Words	See Page
			W	I	D	L		
Bit Shift and Rotate	SFTL	Shift Left	X		X		4	13-1
	SFTR	Shift Right	X		X		4	13-3
	ROTL	Rotate Left	X		X		4	13-5
	ROTR	Rotate Right	X		X		4	13-7
	ROTLC	Rotate Left with Carry	X		X		4	13-9
	ROTRC	Rotate Right with Carry	X		X		4	13-11
	BCDLS	BCD Left Shift			X		4	13-13
Data Conversion	HTOB	Hex to BCD	X		X		5 or 6	14-1
	BTOH	BCD to Hex	X		X		5 or 6	14-3
	HTOA	Hex to ASCII	X				7	14-5
	ATOH	ASCII to Hex	X				7	14-7
	BTOA	BCD to ASCII	X				7	14-9
	ATOB	ASCII to BCD	X				7	14-11
	DTDV	Data Divide	X				5	14-13
	DTCB	Data Combine	X				5	14-14
Week Programmer	WKCMP ON	Week Compare ON					9	15-1
	WKCMP OFF	Week Compare OFF					9	15-1
	WKTBL	Week Table					4 + 2n	15-2
Interface	DISP	Display					6	16-1
	DGRD	Digital Read					8	16-3
	CDISP	Character Display					4+2n+3m	16-5
User Communication	TXD1	Transmit 1					7+n+2m	17-4
	TXD2	Transmit 2					7+n+2m	17-4
	RXD1	Receive 1					7+n+2m	17-13
	RXD2	Receive 2					7+n+2m	17-13
Program Branching	LABEL	Label					2	18-1
	LJMP	Label Jump					3	18-1
	LCAL	Label Call					3	18-3
	LRET	Label Return					1	18-3
	DJNZ	Decrement Jump Non-zero					5	18-5
Coordinate Conversion	XYFS	XY Format Set		X			4 + 4n	19-1
	CVXTY	Convert X to Y		X			7	19-2
	CVYTX	Convert Y to X		X			7	19-3
	AVRG	Average	X	X			11	19-6
PID	PID	PID Control					11	20-1

Structure of an Advanced Instruction



Repeat Designation
Specifies whether repeat is used for the operand or not.

Repeat Cycles
Specifies the quantity of repeat cycles: 1 through 99.

Opcode
The opcode is a symbol to identify the advanced instruction.

Data Type
Specifies the word (W), integer (I), double word (D), or long (L) data type.

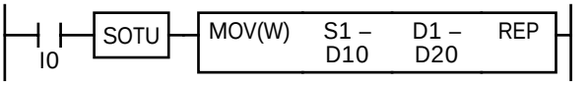
Source Operand
The source operand specifies the 16- or 32-bit data to be processed by the advanced instruction. Some advanced instructions require two source operands.

Destination Operand
The destination operand specifies the 16- or 32-bit data to store the result of the advanced instruction. Some advanced instructions require two destination operands.

Input Condition for Advanced Instructions

Almost all advanced instructions must be preceded by a contact, except NOP (no operation), LABEL (label), and LRET (label return) instructions. The input condition can be programmed using a bit operand such as input, output, internal relay, shift register, or link register bit. Timer and counter can also be used as an input condition to turn on the contact when the timer times out or the counter counts out.

While the input condition is on, the advanced instruction is executed in each scan. To execute the advanced instruction only at the rising or falling edge of the input, use the SOTU or SOTD instruction.



While the input condition is off, the advanced instruction is not executed and operand statuses are held.

Source and Destination Operands

The source and destination operands specify 16- or 32-bit data, depending on the selected data type. When a bit operand such as input, output, internal relay, or shift register is designated as a source or destination operand, 16 or 32 points starting with the designated number are processed as source or destination data. When a word operand such as timer or counter is designated as a source operand, the current value is read as source data. When a timer or counter is designated as a destination operand, the result of the advanced instruction is set to the preset value for the timer or counter. When a data register is designated as a source or destination operand, the data is read from or written to the designated data register.

Using Timer or Counter as Source Operand

Since all timer instructions—TML (1-sec timer), TIM (100-msec timer), TMH (10-msec timer), and TMS (1-msec timer)—subtract from the preset value, the current value is decremented from the preset value and indicates the remaining time. As described above, when a timer is designated as a source operand of an advanced instruction, the current value, or the remaining time, of the timer is read as source data. Adding counters CNT start counting at 0, and the current value is incremented up to the preset value. Reversible counters CDP and CUD start counting at the preset value and the current value is incremented or decremented from the preset value. When any counter is designated as a source operand of an advanced instruction, the current value is read as source data.

Using Timer or Counter as Destination Operand

As described above, when a timer or counter is designated as a destination operand of an advanced instruction, the result of the advanced instruction is set to the preset value of the timer or counter. Timer and counter preset values can be 0 through 65535.

When a timer or counter preset value is designated using a data register, the timer or counter cannot be designated as a destination of an advanced instruction. When executing such an advanced instruction, a user program execution error will result. If a timer or counter is designated as a destination of an advanced instruction and if the timer or counter is not programmed, then a user program execution error will also result. For details of user program execution error, see page 27-6.

Note: When a user program execution error occurs, the result is not set to the destination.

Data Types for Advanced Instructions

When using move, data comparison, binary arithmetic, Boolean computation, bit shift/rotate, data conversion, and coordinate conversion instructions for the OpenNet Controller, data types can be selected from word (W), integer (I), double word (D), or long (L). For other advanced instructions, the data is processed in units of 16-bit word.

Data Type	Symbol	Bits	Quantity of Data Registers Used	Range of Decimal Values
Word (Unsigned 16 bits)	**W**	16 bits	1	0 to 65,535
Integer (Signed 15 bits)	**I**	16 bits	1	–32,768 to 32,767
Double Word (Unsigned 32 bits)	**D**	32 bits	2	0 to 4,294,967,295
Long (Signed 31 bits)	**L**	32 bits	2	–2,147,483,648 to 2,147,483,647

Decimal Values and Hexadecimal Storage

The following table shows hexadecimal equivalents which are stored in the CPU, as the result of addition and subtraction of the decimal values shown:

Data Type	Result of Addition	Hexadecimal Storage	Result of Subtraction	Hexadecimal Storage
Word	0	0000	65535	FFFF
	65535	FFFF		
	131071	(CY) FFFF	–1	(BW) FFFF
			–65535	(BW) 0001
			–65536	(BW) 0000
Integer	65534	(CY) 7FFE	65534	(BW) 7FFE
	32768	(CY) 0000	32768	(BW) 0000
	32767	7FFF	32767	7FFF
	0	0000	0	0000
	–1	FFFF	–1	FFFF
	–32767	8001	–32767	8001
	–32768	8000	–32768	8000
	–32769	(CY) FFFF	–32769	(BW) FFFF
	–65535	(CY) 8001	–65535	(BW) 8001
Double Word	0	00000000	4294967295	FFFFFFFF
	4294967295	FFFFFFFF		
	8589934591	(CY) FFFFFFFF	–1	(BW) FFFFFFFF
			–4294967295	(BW) 00000001
			–4294967296	(BW) 00000000
Long	4294967294	(CY) 7FFFFFFE	4294967294	(BW) 7FFFFFFE
	2147483648	(CY) 00000000	2147483648	(BW) 00000000
	2147483647	7FFFFFFF	2147483647	7FFFFFFF
	0	00000000	0	00000000
	–1	FFFFFFFF	–1	FFFFFFFF
	–2147483647	80000001	–2147483647	80000001
	–2147483648	80000000	–2147483648	80000000
	–2147483649	(CY) FFFFFFFF	–2147483649	(BW) FFFFFFFF
	–4294967295	(CY) 80000001	–4294967295	(BW) 80000001

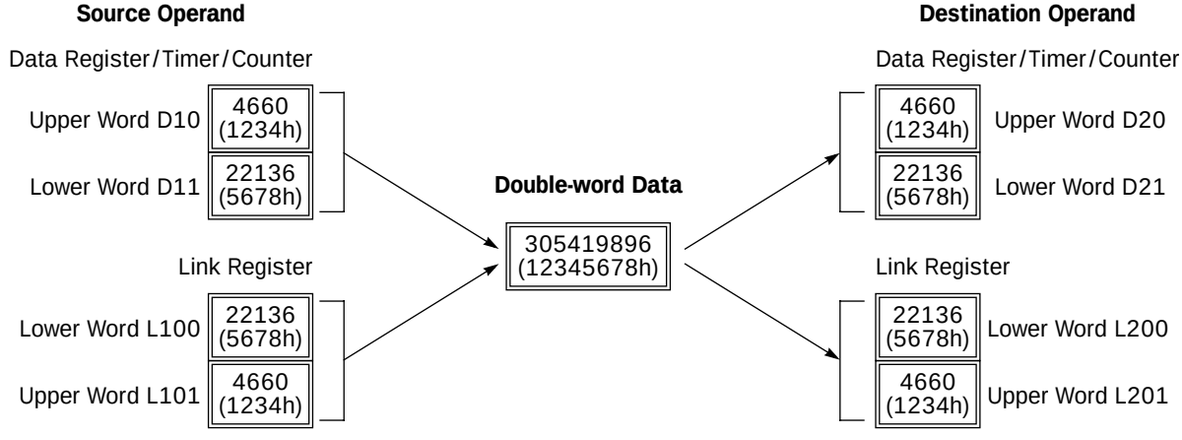
Double-Word Operands in Data Registers and Link Registers

When the double-word data type is selected for the source or destination operand, the data is loaded from or stored to two consecutive operands. The order of the two operands depends on the operand type.

When a data register, timer, or counter is selected as a double-word operand, the upper-word data is loaded from or stored to the first operand selected. The lower-word data is loaded from or stored to the subsequent operand.

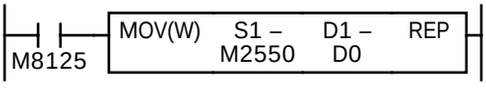
On the contrary, when a link register is selected as a double-word operand, the lower-word data is loaded from or stored to the first operand selected. The upper-word data is loaded from or stored to the subsequent operand.

Example: When data register D10 and link register L100 are designated as a double-word source operand and data register D20 and link register L200 are designated as a double-word destination operand, the data is loaded from or stored to two consecutive operands as illustrated below.

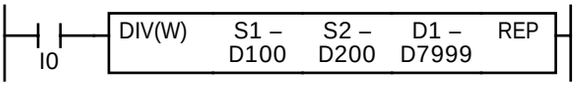


Discontinuity of Operand Areas

Each operand area is discrete and does not continue, for example, from input to output or from output to internal relay. In addition, special internal relays M8000 through M8237 are in a separate area from internal relays M0 through M2557. Special data registers D8000 through D8999 are in a separate area from data registers D0 through D7999. Slave link registers L100 through L727 are in a separate area from master link registers L1000 through L1317.

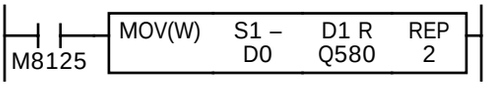


The internal relay ends at M2557. Since the MOV (move) instruction reads 16 internal relays, the last internal relay exceeds the valid range. When this program is downloaded to the OpenNet Controller CPU module, a user program syntax error occurs and the ERROR LED is lit.



This program results in a user program syntax error. The destination of the DIV (division) instruction requires two data registers D7999 and D8000. Since D8000 is a special data register and does not continue from the data register area, a user program syntax error is caused.

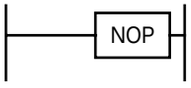
Advanced instructions execute operation only on the available operands in the valid area. If invalid operands are designated, a user program syntax error occurs when transferring the user program to the OpenNet Controller CPU module.



The MOV (move) instruction sets data of data register D0 to 16 outputs Q580 through Q597 in the first repeat cycle. The destination of the second cycle is the next 16 outputs Q600 through Q617, which are invalid, resulting in a user program syntax error.

For details about repeat operations of each advanced instruction, see the following chapters.

NOP (No Operation)



No operation is executed by the NOP instruction.

The NOP instruction may serve as a place holder. Another use would be to add a delay to the CPU scan time, in order to simulate communication with a machine or application, for debugging purposes.

The NOP instruction does not require an input and operand.

Details of all other advanced instructions are described in following chapters.

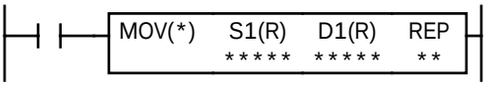
9: MOVE INSTRUCTIONS

Introduction

Data can be moved using the MOV (move), MOVN (move not), IMOV (indirect move), or IMOVN (indirect move not) instruction. The moved data is 16- or 32-bit data, and the repeat operation can also be used to increase the quantity of data moved. In the MOV or MOVN instruction, the source and destination operand are designated by S1 and D1 directly. In the IMOV or IMOVN instruction, the source and destination operand are determined by the offset values designated by S2 and D2 added to source operand S1 and destination operand D1.

Since the move instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

MOV (Move)



S1 → D1
When input is on, 16- or 32-bit data from operand designated by S1 is moved to operand designated by D1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	First operand number to move	X	X	X	X	X	X	X	X	X	1-99
D1 (Destination 1)	First operand number to move to	—	X	▲	X	X	X	X	X	—	1-99

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1. Source operand can be both internal relays M0 through M2557 and special internal relays M8000 through M8237.

When T (timer) or C (counter) is used as S1, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Valid Data Types

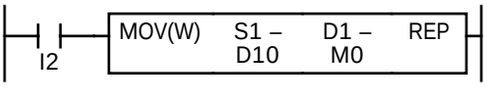
W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word or integer data type) or 32 points (double-word or long data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word or integer data type) or 2 points (double-word or long data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

Examples: MOV

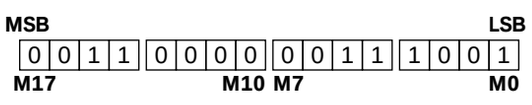
Data Type: Word



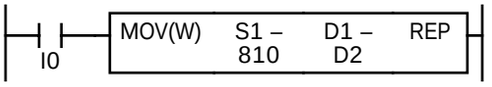
D10 → M0
When input I2 is on, the data in data register D10 designated by source operand S1 is moved to 16 internal relays starting with M0 designated by destination operand D1.

D10 [12345] ⟶ M0 through M7, M10 through M17

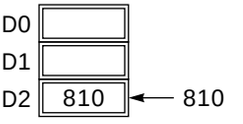
The data in the source data register is converted into 16-bit binary data, and the ON/OFF statuses of the 16 bits are moved to internal relays M0 through M7 and M10 through M17. M0 is the LSB (least significant bit). M17 is the MSB (most significant bit).



Data Type: Word

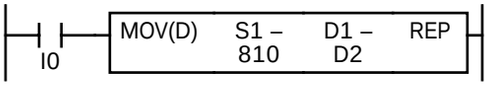


810 → D2
When input I0 is on, constant 810 designated by source operand S1 is moved to data register D2 designated by destination operand D1.

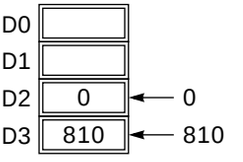


Data move operation for the integer data type is the same as for the word data type.

Data Type: Double Word

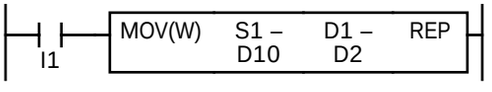


810 → D2·D3
When input I0 is on, constant 810 designated by source operand S1 is moved to data registers D2 and D3 designated by destination operand D1.

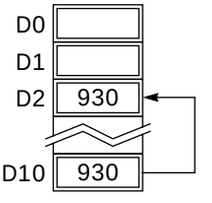


Data move operation for the long data type is the same as for the double-word data type.

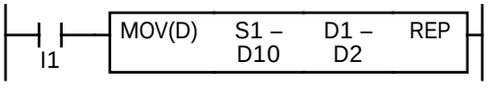
Data Type: Word



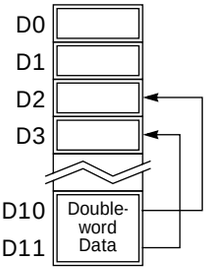
D10 → D2
When input I1 is on, the data in data register D10 designated by source operand S1 is moved to data register D2 designated by destination operand D1.



Data Type: Double Word



D10·D11 → D2·D3
When input I1 is on, the data in data registers D10 and D11 designated by source operand S1 is moved to data registers D2 and D3 designated by destination operand D1.

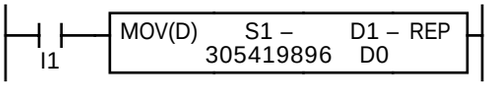


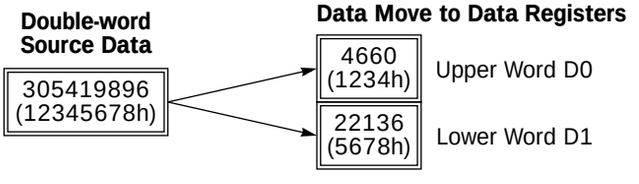
Double-word Data Move in Data Registers and Link Registers

The data movement differs depending on the selected double-word operand. When a data register, timer, or counter is selected as a double-word operand, the upper-word data is loaded from or stored to the first operand selected. The lower-word data is loaded from or stored to the subsequent operand.

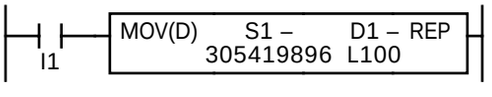
On the contrary, when a link register is selected as a double-word operand, the lower-word data is loaded from or stored to the first operand selected. The upper-word data is loaded from or stored to the subsequent operand.

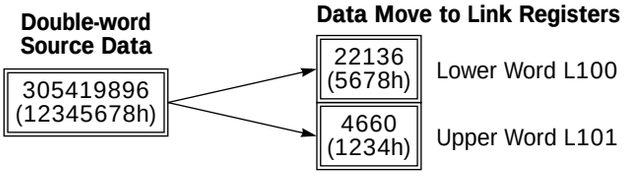
Double-word Destination Operand: Data Register





Double-word Destination Operand: Link Register



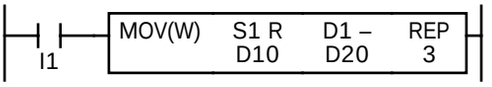


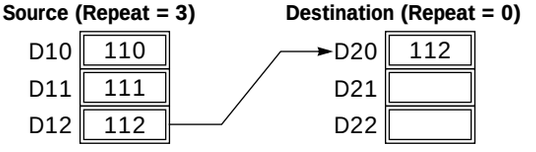
Repeat Operation in the Move Instructions

Repeat Source Operand

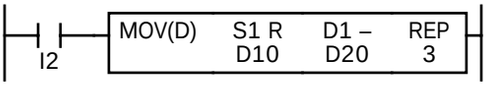
When the S1 (source) is designated with repeat, operands as many as the repeat cycles starting with the operand designated by S1 are moved to the destination. As a result, only the last of the source operands is moved to the destination.

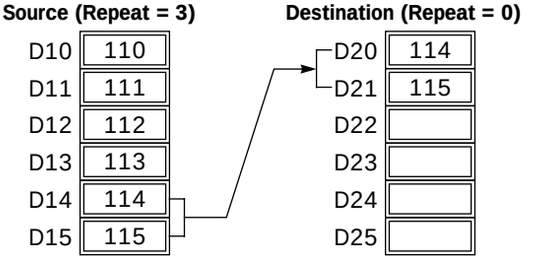
- **Data Type: Word**





- **Data Type: Double Word**



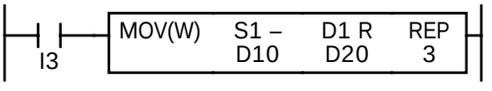


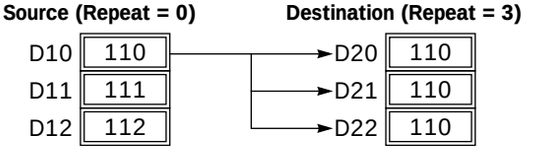
Repeat Destination Operand

When the D1 (destination) is designated to repeat, the source operand designated by S1 is moved to all destination operands as many as the repeat cycles starting with the destination designated by D1.

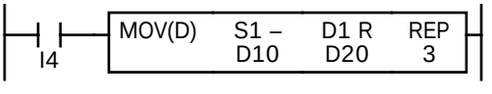
Note: The NRS (N data repeat set) instruction has the same effect as the MOV instruction with only the destination designated to repeat.

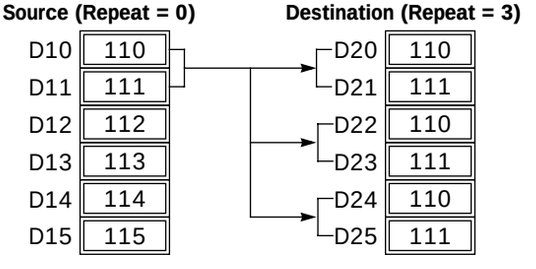
- **Data Type: Word**





- **Data Type: Double Word**



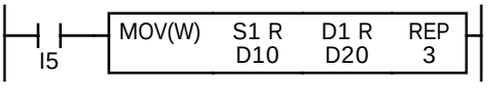


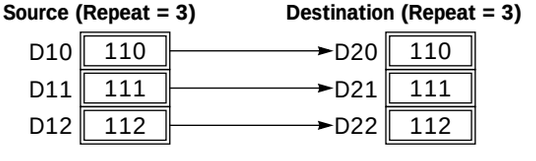
Repeat Source and Destination Operands

When both S1 (source) and D1 (destination) are designated to repeat, operands as many as the repeat cycles starting with the operand designated by S1 are moved to the same quantity of operands starting with the operand designated by D1.

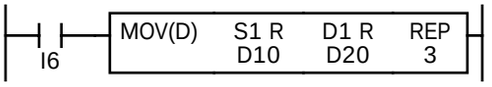
Note: The BMOV (block move) instruction has the same effect as the MOV instruction with both the source and destination designated to repeat.

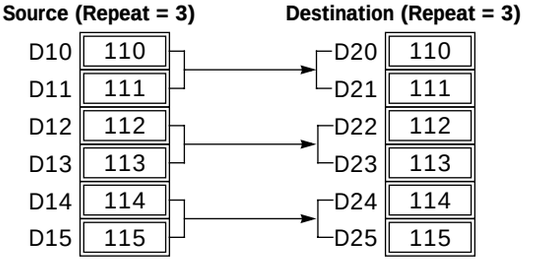
- **Data Type: Word**





- **Data Type: Double Word**

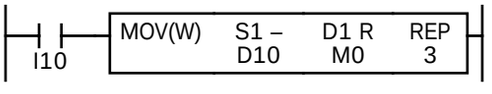


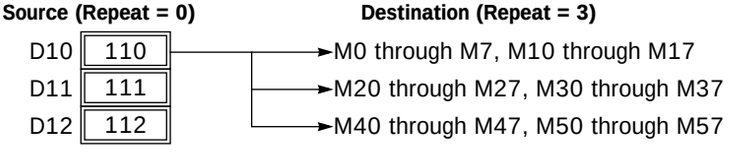


Repeat Bit Operands

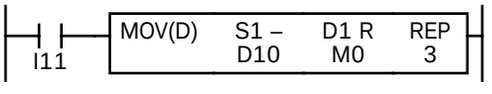
The MOV (move) instruction moves 16-bit data (word or integer data type) or 32-bit data (double-word or integer data type). When a bit operand such as input, output, internal relay, or shift register is designated as the source or destination operand, 16 or 32 bits starting with the one designated by S1 or D1 are the target data. If a repeat operation is designated for a bit operand, the target data increases in 16- or 32-bit increments, depending on the selected data type.

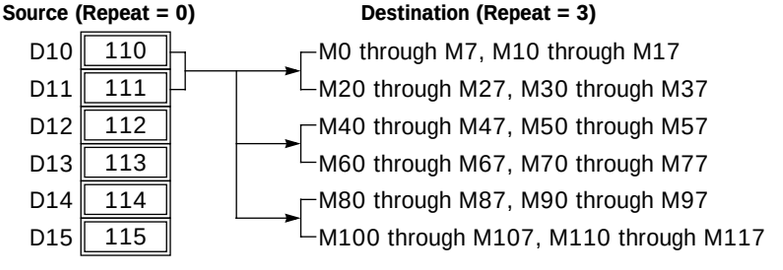
- **Data Type: Word**





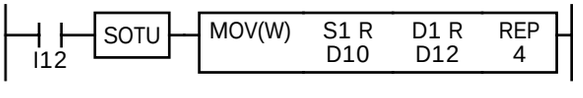
- **Data Type: Double Word**



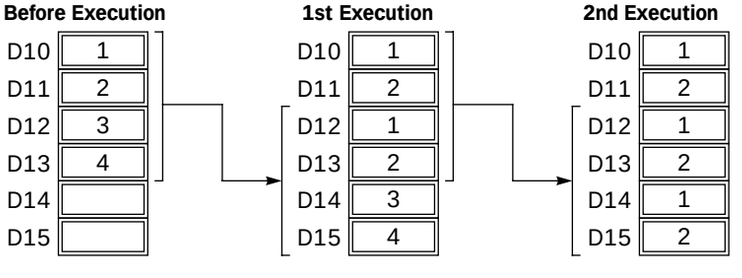


Overlapped Operands by Repeat

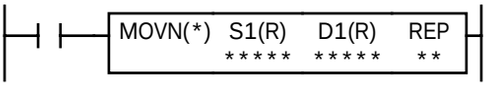
If the repeat operation is designated for both the source and destination and if a portion of the source and destination areas overlap each other, then the source data in the overlapped area is also changed.



Source: D10 through D13 (Repeat = 4)
Destination: D12 through D15 (Repeat = 4)



MOVN (Move Not)



S1 NOT → D1
When input is on, 16- or 32-bit data from operand designated by S1 is inverted bit by bit and moved to operand designated by D1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	First operand number to move	X	X	X	X	X	X	X	X	X	1-99
D1 (Destination 1)	First operand number to move to	—	X	▲	X	X	X	X	X	—	1-99

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

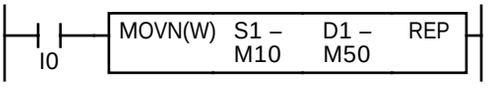
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word or integer data type) or 32 points (double-word or long data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

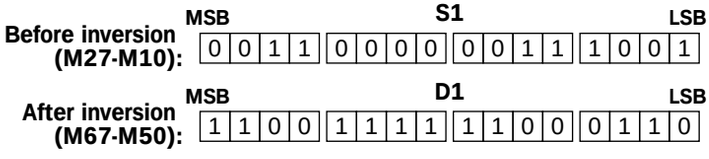
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word or integer data type) or 2 points (double-word or long data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

Examples: MOVN

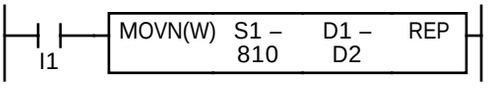


M10 NOT → M50
When input I0 is on, the 16 internal relays starting with M10 designated by source operand S1 are inverted bit by bit and moved to 16 internal relays starting with M50 designated by destination operand D1.

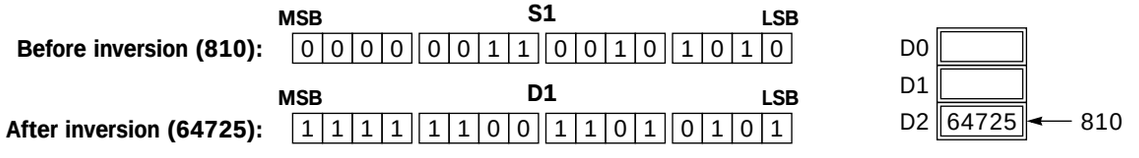
M10 through M17, M20 through M27 NOT ⟶ M50 through M57, M60 through M67

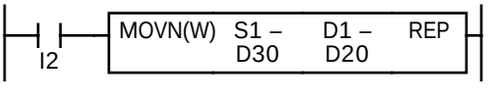


The ON/OFF statuses of the 16 internal relays M10 through M17 and M20 through M27 are inverted and moved to 16 internal relays M50 through M57 and M60 through M67. M50 is the LSB (least significant bit), and M67 is the MSB (most significant bit).

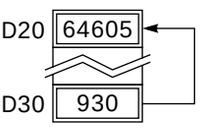


810 NOT → D2
When input I1 is on, decimal constant 810 designated by source operand S1 is converted into 16-bit binary data, and the ON/OFF statuses of the 16 bits are inverted and moved to data register D2 designated by destination operand D1.

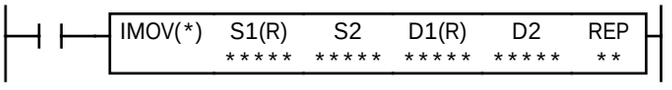




D30 NOT → D20
When input I2 is on, the data in data register D30 designated by S1 is inverted bit by bit and moved to data register D20 designated by D1.



IMOV (Indirect Move)



S1 + S2 → D1 + D2
When input is on, the values contained in operands designated by S1 and S2 are added to determine the source of data. The 16- or 32-bit data so determined is moved to destination, which is determined by the sum of values contained in operands designated by D1 and D2.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Base address to move from	X	X	X	X	X	X	X	X	—	1-99
S2 (Source 2)	Offset for S1	X	X	X	X	X	X	X	X	—	—
D1 (Destination 1)	Base address to move to	—	X	▲	X	X	X	X	X	—	1-99
D2 (Destination 2)	Offset for D1	X	X	X	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1, S2, or D2, the operand data is the timer/counter current value. When T (timer) or C (counter) is used as D1, the operand data is the timer/counter preset value which can be 0 through 65535.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

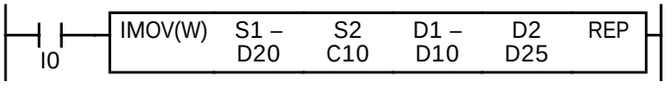
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source S1 or destination D1, 16 points (word data type) or 32 points (double-word data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source S1 or destination D1, 1 point (word data type) or 2 points (double-word data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

For source operand S2 and destination operand D2, 16 points (bit operand) or 1 point (word operand) is always used without regard to the data type. Source operand S2 and destination operand D2 do not have to be designated. If S2 or D2 is not designated, the source or destination operand is determined by S1 or D1 without offset.

Make sure that the source data determined by S1 + S2 and the destination data determined by D1 + D2 are within the valid operand range. If the derived source or destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED on the CPU module.

Example: IMOV



D20 + C10 → D10 + D25
Source operand S1 and destination operand D1 determine the type of operand. Source operand S2 and destination operand D2 are the offset values to determine the source and destination operands.

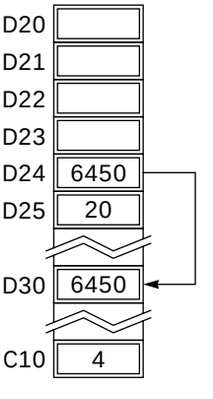
If the current value of counter C10 designated by source operand S2 is 4, the source data is determined by adding the offset to data register D20 designated by source operand S1:

D(20 + 4) = D24

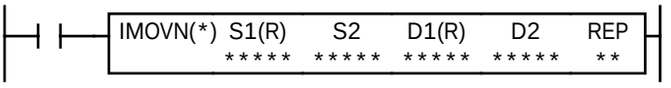
If data register D25 contains a value of 20, the destination is determined by adding the offset to data register D10 designated by destination operand D1:

D(10 + 20) = D30

As a result, when input I0 is on, the data in data register D24 is moved to data register D30.



IMOVN (Indirect Move Not)



S1 + S2 NOT → D1 + D2
When input is on, the values contained in operands designated by S1 and S2 are added to determine the source of data. The 16- or 32-bit data so determined is inverted and moved to destination, which is determined by the sum of values contained in operands designated by D1 and D2.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Base address to move from	X	X	X	X	X	X	X	X	—	1-99
S2 (Source 2)	Offset for S1	X	X	X	X	X	X	X	X	—	—
D1 (Destination 1)	Base address to move to	—	X	▲	X	X	X	X	X	—	1-99
D2 (Destination 2)	Offset for D1	X	X	X	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1, S2, or D2, the operand data is the timer/counter current value. When T (timer) or C (counter) is used as D1, the operand data is the timer/counter preset value which can be 0 through 65535.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

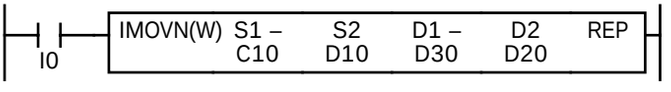
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source S1 or destination D1, 16 points (word data type) or 32 points (double-word data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source S1 or destination D1, 1 point (word data type) or 2 points (double-word data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

For source operand S2 and destination operand D2, 16 points (bit operand) or 1 point (word operand) is always used without regard to the data type. Source operand S2 and destination operand D2 do not have to be designated. If S2 or D2 is not designated, the source or destination operand is determined by S1 or D1 without offset.

Make sure that the source data determined by S1 + S2 and the destination data determined by D1 + D2 are within the valid operand range. If the derived source or destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED on the CPU module.

Example: IMOVN



C10 + D10 NOT → D30 + D20
Source operand S1 and destination operand D1 determine the type of operand. Source operand S2 and destination operand D2 are the offset values to determine the source and destination operands.

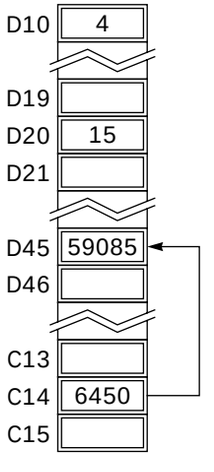
If the data of data register D10 designated by source operand S2 is 4, then the source data is determined by adding the offset to counter C10 designated by source operand S1:

C(10 + 4) = C14

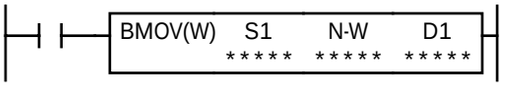
If data register D20 designated by destination operand D2 contains a value of 15, then the destination is determined by adding the offset to data register D30 designated by destination operand D1:

D(30 + 15) = D45

As a result, when input I0 is on, the current value of counter C14 is inverted and moved to data register D45.

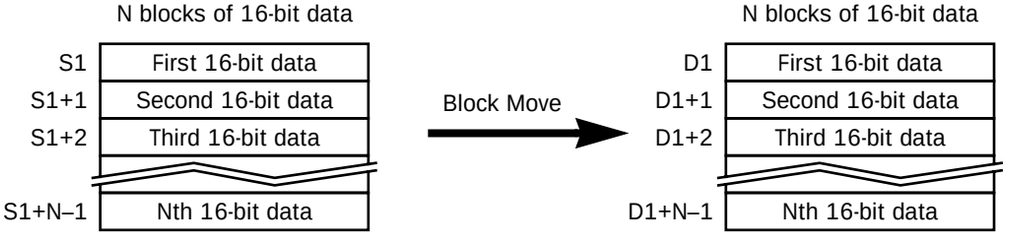


BMOV (Block Move)



S1, S1+1, S1+2, ... , S1+N–1 → D1, D1+1, D1+2, ... , D1+N–1

When input is on, N blocks of 16-bit word data starting with operand designated by S1 are moved to N blocks of destinations, starting with operand designated by D1.



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	First operand number to move	X	X	X	X	X	X	X	X	—	—
N-W (N words)	Quantity of blocks to move	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	First operand number to move to	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1 or N-W, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Make sure that the last source data determined by S1+N–1 and the last destination data determined by D1+N–1 are within the valid operand range. If the derived source or destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED on the CPU module.

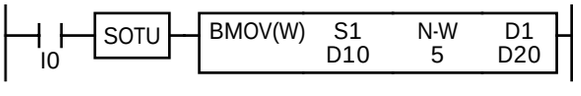
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

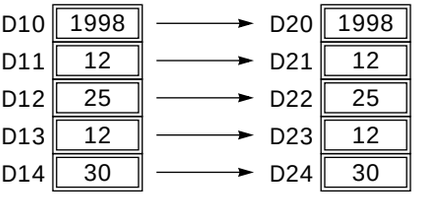
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source, N-W, or destination, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source, N-W, or destination, 1 point (word data type) is used.

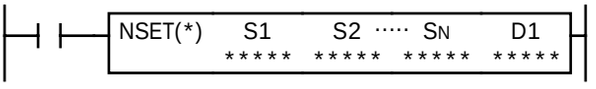
Example: BMOV



D10 through D14 → D20 through D24
When input I0 is turned on, data of 5 data registers starting with D10 designated by source operand S1 is moved to 5 data registers starting with D20 designated by destination operand D1.

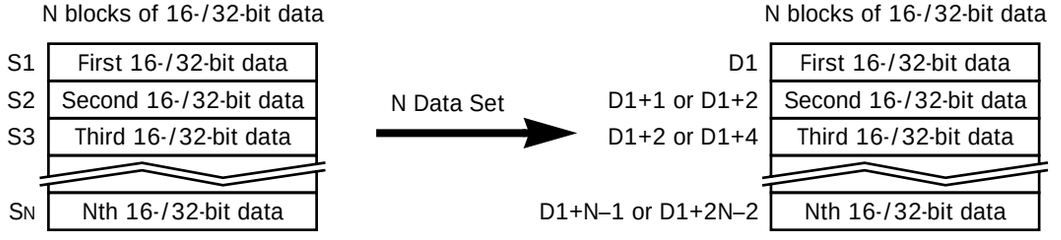


NSET (N Data Set)



S1, S2, S3, ... , SN → D1, D2, D3, ... , DN

When input is on, N blocks of 16- or 32-bit data in operands designated by S1, S2, S3, ... , SN are moved to N blocks of destinations, starting with operand designated by D1.



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	First operand number to move	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	First operand number to move to	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1 through SN, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Make sure that the last destination data determined by D1+N–1 (word or integer data type) or D1+2N–2 (double-word or long data type) is within the valid operand range. If the derived destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and ERROR LED on the CPU module.

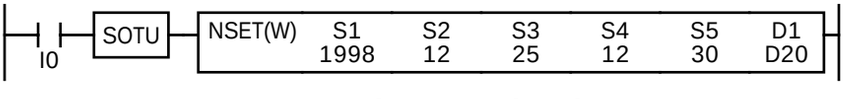
Valid Data Types

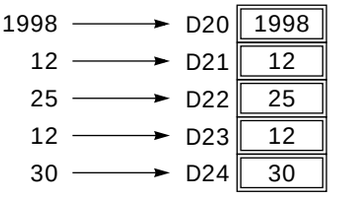
W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word or integer data type) or 32 points (double-word or long data type) are used.

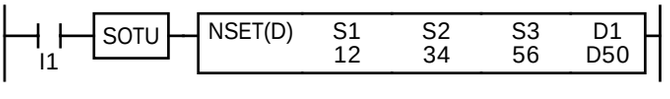
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word or integer data type) or 2 points (double-word or long data type) are used.

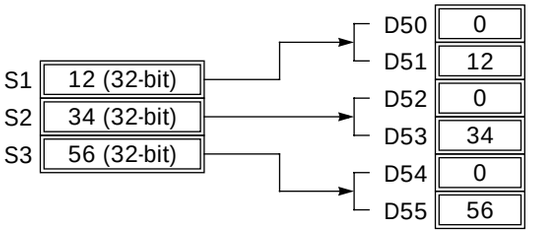
Examples: NSET





Five constants 1998, 12, 25, 12, and 30 → D20 through D24
When input I0 is turned on, 5 constants designated by source operands S1 through S5 are moved to 5 data registers starting with D20 designated by destination operand D1.



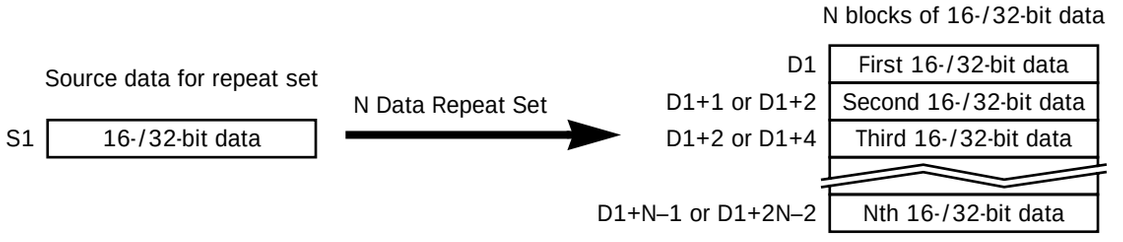


Three 32-bit constants 12, 34, and 56 → D50 through D55
When input I1 is turned on, 3 constants designated by source operands S1 through S3 are moved to 6 data registers starting with D50 designated by destination operand D1.

NRS (N Data Repeat Set)

S1 → D1, D2, D3, ... , DN–1

When input is on, 16- or 32-bit data designated by S1 is set to N blocks of destinations, starting with operand designated by D1.



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
N-W (N blocks)	Quantity of blocks to move	X	X	X	X	X	X	X	X	X	—
S1 (Source 1)	Operand number to move	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	First operand number to move to	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as N-W or S1, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Make sure that the last destination data determined by D1+N–1 (word or integer data type) or D1+2N–2 (double-word or long data type) are within the valid operand range. If the derived destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and ERROR LED.

Valid Data Types

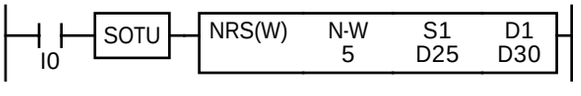
W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

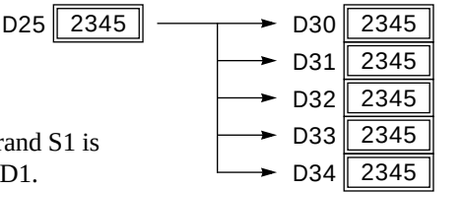
For the N-W, 16 points (bit operand) or 1 point (word operand) is always used without regard to the data type.

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word or integer data type) or 32 points (double-word or long data type) are used.

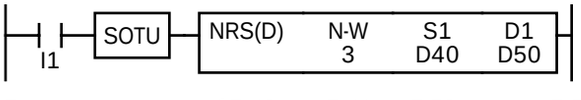
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word or integer data type) or 2 points (double-word or long data type) are used.

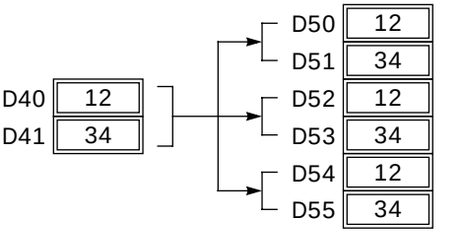
Examples: NRS





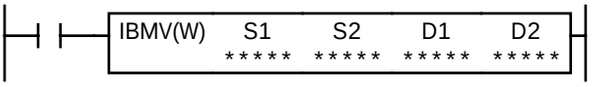
D25 → D30 through D34
When input I0 is turned on, data of data register D25 designated by source operand S1 is moved to 5 data registers starting with D30 designated by destination operand D1.





Double-word data of D40 and D41 → D50 through D55
When input I1 is turned on, double-word data of data registers D40 and D41 designated by source operand S1 is moved to 6 data registers starting with D50 designated by destination operand D1.

IBMV (Indirect Bit Move)



S1 + S2 → D1 + D2

When input is on, the values contained in operands designated by S1 and S2 are added to determine the source of data. The 1-bit data so determined is moved to destination, which is determined by the sum of values contained in operands designated by D1 and D2.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Base address to move from	X	X	X	X	—	—	—	—	—	—
S2 (Source 2)	Offset for S1	X	X	▲	X	X	X	X	X	—	—
D1 (Destination 1)	Base address to move to	—	X	▲	X	—	—	—	—	—	—
D2 (Destination 2)	Offset for D1	X	X	X	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S2 or D1. Special internal relays cannot be designated as S2 or D1.

When T (timer) or C (counter) is used as S2 or D2, the timer/counter current value is read out.

Make sure that the last source data determined by S1+S2 and the last destination data determined by D1+D2 are within the valid operand range. If the derived source or destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and ERROR LED.

Unlike the IMOV and IMOVN instructions, offset operands S2 and D2 must always be designated.

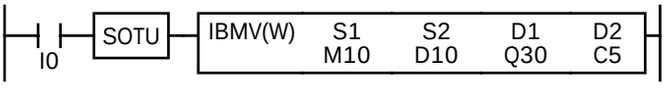
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the S2 or D2, 1 point is used.

Example: IBMV

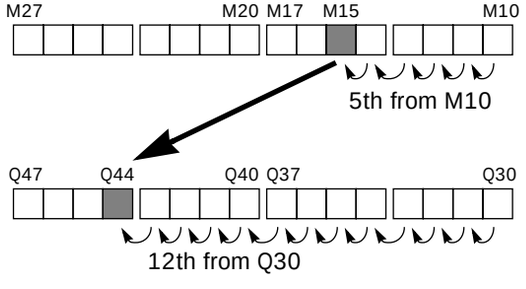


M10 + D10 → Q30 + C5

Source operand S1 and destination operand D1 determine the type of operand. Source operand S2 and destination operand D2 are the offset values to determine the source and destination operands.

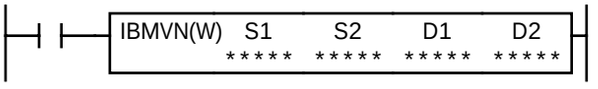
If the value of data register D10 designated by source operand S2 is 5, the source data is determined by adding the offset to internal relay M10 designated by source operand S1.

If the current value of counter C5 designated by destination operand D2 is 12, the destination is determined by adding the offset to output Q30 designated by destination operand D1.



As a result, when input I0 is on, the ON/OFF status of internal relay M15 is moved to output Q44.

IBMVN (Indirect Bit Move Not)



S1 + S2 NOT → D1 + D2

When input is on, the values contained in operands designated by S1 and S2 are added to determine the source of data. The 1-bit data so determined is inverted and moved to destination, which is determined by the sum of values contained in operands designated by D1 and D2.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Base address to move from	X	X	X	X	—	—	—	—	—	—
S2 (Source 2)	Offset for S1	X	X	▲	X	X	X	X	X	—	—
D1 (Destination 1)	Base address to move to	—	X	▲	X	—	—	—	—	—	—
D2 (Destination 2)	Offset for D1	X	X	X	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S2 or D1. Special internal relays cannot be designated as S2 or D1.

When T (timer) or C (counter) is used as S2 or D2, the timer/counter current value is read out.

Make sure that the last source data determined by S1+S2 and the last destination data determined by D1+D2 are within the valid operand range. If the derived source or destination operand is out of the valid operand range, a user program execution error will result, turning on special internal relay M8004 and ERROR LED.

Unlike the IMOV and IMOVN instructions, offset operands S2 and D2 must always be designated.

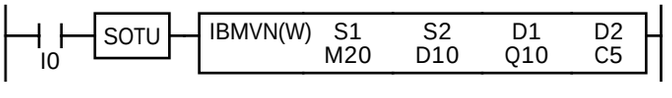
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the S2 or D2, 1 point is used.

Example: IBMVN

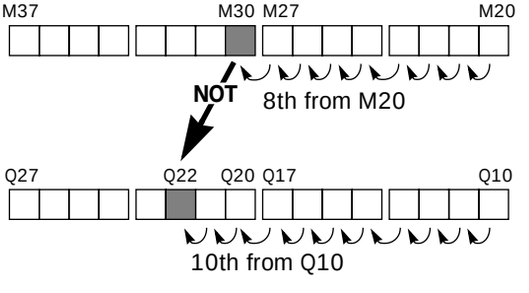


M20 + D10 NOT → Q10 + C5

Source operand S1 and destination operand D1 determine the type of operand. Source operand S2 and destination operand D2 are the offset values to determine the source and destination operands.

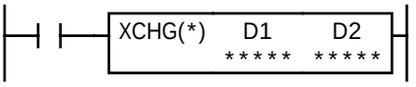
If the value of data register D10 designated by source operand S2 is 8, the source data is determined by adding the offset to internal relay M20 designated by source operand S1.

If the current value of counter C5 designated by destination operand D2 is 10, the destination is determined by adding the offset to output Q10 designated by destination operand D1.



As a result, when input I0 is on, the ON/OFF status of internal relay M30 is inverted and moved to output Q22.

XCHG (Exchange)



D1 ↔ D2

When input is on, the 16- or 32-bit data in operands designated by D1 and D2 are exchanged with each other.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
D1 (Destination 1)	First operand number to exchange	—	X	▲	X	X	X	X	X	—	—
D2 (Destination 2)	First operand number to exchange	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1 or D2. Special internal relays cannot be designated as D1 or D2.

When T (timer) or C (counter) is used as D1 or D2, the current value is read and written in as a preset value which can be 0 through 65535.

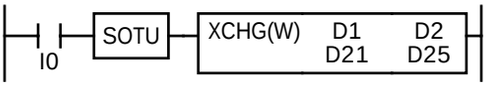
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

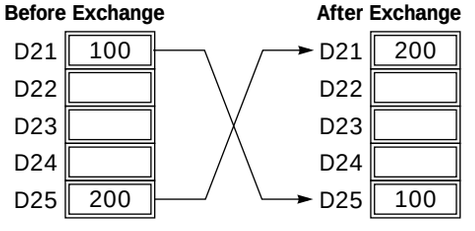
When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the destination, 16 points (word data type) or 32 points (double-word data type) are used.

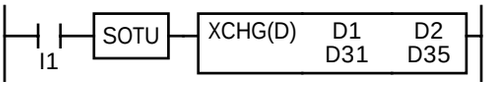
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the destination, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: XCHG

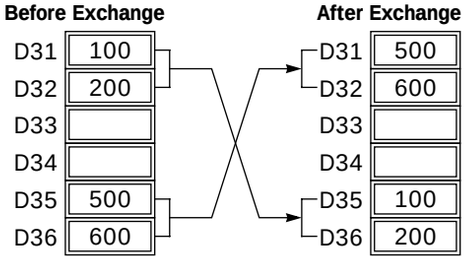


D21 ↔ D25
When input I0 is turned on, data of data registers D21 and D25 designated by operands D1 and D2 are exchanged with each other.





D31·D32 ↔ D35·D36
When input I1 is turned on, data of data registers D31·D32 and D35·D36 designated by operands D1 and D2 are exchanged with each other.



10: DATA COMPARISON INSTRUCTIONS

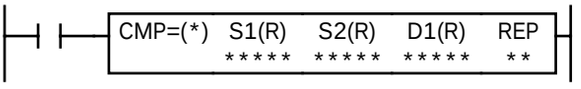
Introduction

Data can be compared using data comparison instructions, such as equal to, unequal to, less than, greater than, less than or equal to, and greater than or equal to. When the comparison result is true, an output or internal relay is turned on. The repeat operation can also be used to compare more than one set of data.

Three values can also be compared using the ICMP>= instruction.

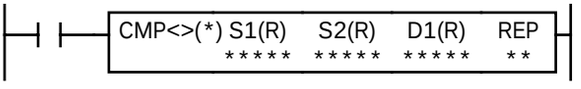
Since the data comparison instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

CMP= (Compare Equal To)



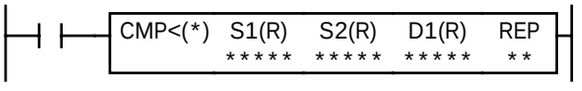
S1 = S2 → D1 on
When input is on, 16- or 32-bit data designated by source operands S1 and S2 are compared. When S1 data is equal to S2 data, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

CMP<> (Compare Unequal To)



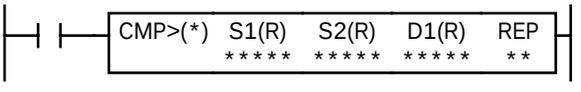
S1 ≠ S2 → D1 on
When input is on, 16- or 32-bit data designated by source operands S1 and S2 are compared. When S1 data is not equal to S2 data, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

CMP< (Compare Less Than)



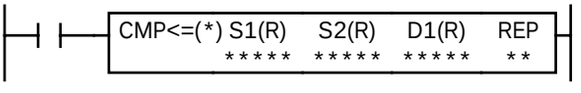
S1 < S2 → D1 on
When input is on, 16- or 32-bit data designated by source operands S1 and S2 are compared. When S1 data is less than S2 data, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

CMP> (Compare Greater Than)



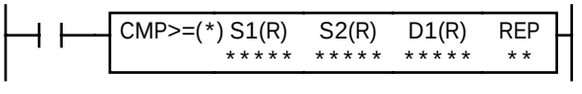
S1 > S2 → D1 on
When input is on, 16- or 32-bit data designated by source operands S1 and S2 are compared. When S1 data is greater than S2 data, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

CMP<= (Compare Less Than or Equal To)



S1 ≤ S2 → D1 on
When input is on, 16- or 32-bit data designated by source operands S1 and S2 are compared. When S1 data is less than or equal to S2 data, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

CMP>= (Compare Greater Than or Equal To)



S1 ≥ S2 → D1 on
When input is on, 16- or 32-bit data designated by source operands S1 and S2 are compared. When S1 data is greater than or equal to S2 data, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data to compare	X	X	X	X	X	X	X	X	X	1-99
S2 (Source 2)	Data to compare	X	X	X	X	X	X	X	X	X	1-99
D1 (Destination 1)	Comparison output	—	X	▲	—	—	—	—	—	—	1-99

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1 or S2, the timer/counter current value is read out.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

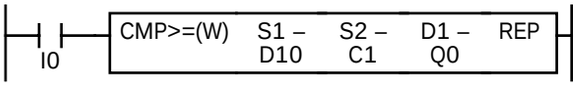
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word or integer data type) or 32 points (double-word or long data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

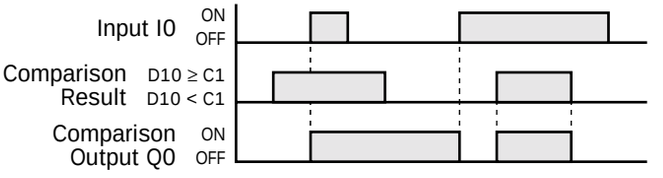
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source, 1 point (word or integer data type) or 2 points (double-word or long data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

When an output or internal relay is designated as the destination, only 1 point is used regardless of the selected data type. When repeat is designated for the destination, outputs or internal relays as many as the repeat cycles are used.

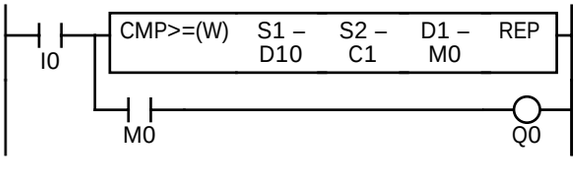
Examples: CMP>=

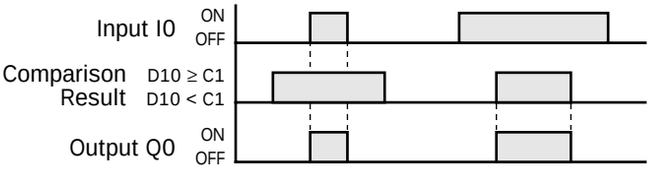
The comparison output is usually maintained while the input to the data comparison instruction is off. If the comparison output is on, the on status is maintained when the input is turned off as demonstrated by this program.





This program turns the output off when the input is off.



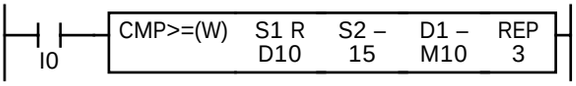


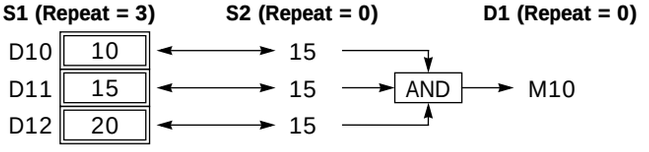
Repeat Operation in the Data Comparison Instructions

Repeat One Source Operand

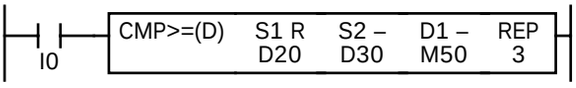
When only S1 (source) is designated to repeat, source operands (as many as the repeat cycles, starting with the operand designated by S1) are compared with the operand designated by S2. The comparison results are ANDed and set to the destination operand designated by D1.

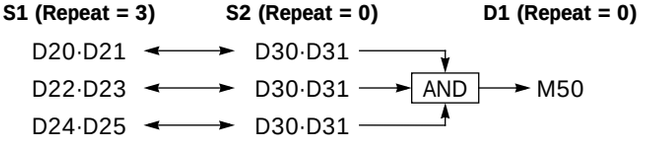
- **Data Type: Word**





- **Data Type: Double Word**

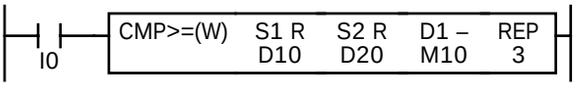


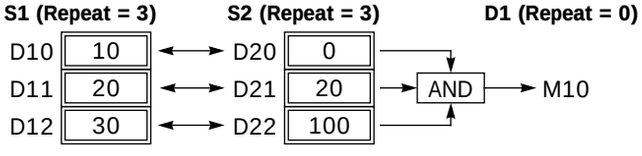


Repeat Two Source Operands

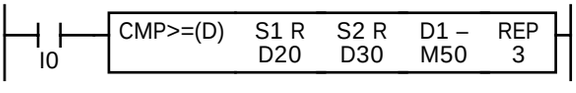
When S1 (source) and S2 (source) are designated to repeat, source operands (as many as the repeat cycles, starting with the operands designated by S1 and S2) are compared with each other. The comparison results are ANDed and set to the destination operand designated by D1.

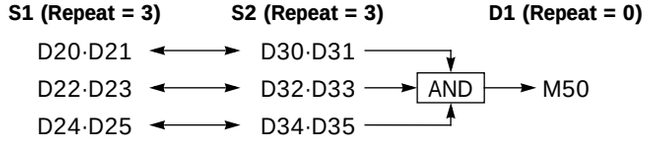
- **Data Type: Word**





- **Data Type: Double Word**

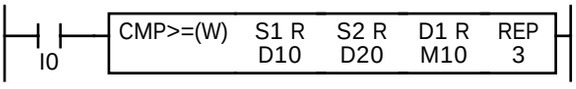


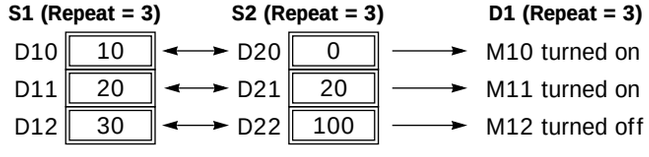


Repeat Source and Destination Operands

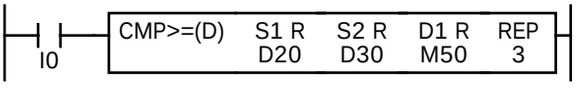
When S1, S2 (source), and D1 (destination) are designated to repeat, source operands (as many as the repeat cycles, starting with the operands designated by S1 and S2) are compared with each other. The comparison results are set to destination operands (as many as the repeat cycles, starting with the operand designated by D1).

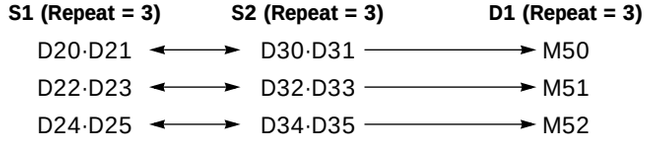
- **Data Type: Word**



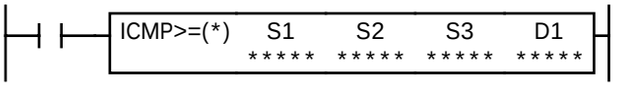


- **Data Type: Double Word**





ICMP>= (Interval Compare Greater Than or Equal To)



S1 ≥ S2 ≥ S3 → D1 on

When input is on, the 16- or 32-bit data designated by S1, S2, and S3 are compared. When the condition is met, destination operand D1 is turned on. When the condition is not met, D1 is turned off.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data to compare	X	X	X	X	X	X	X	X	X	—
S2 (Source 2)	Data to compare	X	X	X	X	X	X	X	X	X	—
S3 (Source 3)	Data to compare	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	Comparison output	—	X	▲	—	—	—	—	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1, S2, or S3, the timer/counter current value is read out.

Valid Data Types

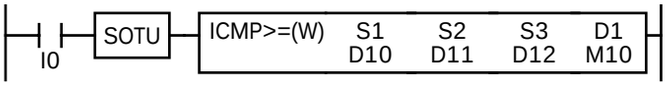
W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word or integer data type) or 32 points (double-word or long data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source, 1 point (word or integer data type) or 2 points (double-word or long data type) are used.

When an output or internal relay is designated as the destination, only 1 point is used regardless of the selected data type.

Example: ICMP>=



D10 ≥ D11 ≥ D12 → M10 goes on

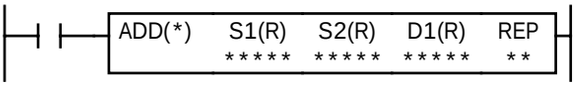
When input I0 is turned on, data of data registers D10, D11, and D12 designated by source operands S1, S2, and S3 are compared. When the condition is met, internal relay M10 designated by destination operand D1 is turned on. When the condition is not met, M10 is turned off.

11: BINARY ARITHMETIC INSTRUCTIONS

Introduction

The binary arithmetic instructions make it possible for the user to program computations using addition, subtraction, multiplication, and division. For addition and subtraction operands, internal relay M8003 is used to carry or to borrow.

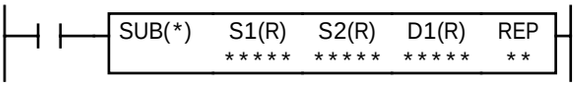
ADD (Addition)



Data type W or I: S1 + S2 → D1, CY
Data type D or L: S1·S1+1 + S2·S2+1 → D1·D1+1, CY

When input is on, 16- or 32-bit data designated by source operands S1 and S2 are added. The result is set to destination operand D1 and carry (M8003).

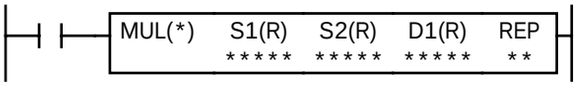
SUB (Subtraction)



Data type W or I: S1 – S2 → D1, BW
Data type D or L: S1·S1+1 – S2·S2+1 → D1·D1+1, BW

When input is on, 16- or 32-bit data designated by source operand S2 is subtracted from 16- or 32-bit data designated by source operand S1. The result is set to destination operand D1 and borrow (M8003).

MUL (Multiplication)

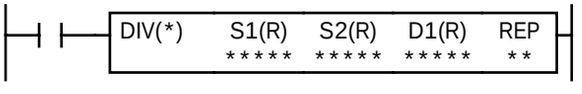


Data type W or I: S1 × S2 → D1·D1+1
Data type D or L: S1·S1+1 × S2·S2+1 → D1·D1+1

When input is on, 16- or 32-bit data designated by source operand S1 is multiplied by 16- or 32-bit data designated by source operand S2. The result is set to 32-bit data designated by destination operand D1.

When the result exceeds the valid range for data types D or L, the ERROR LED and special internal relay M8004 (user program execution error) are turned on.

DIV (Division)



Data type W or I:
S1 ÷ S2 → D1 (quotient), D1+1 (remainder)
Data type D or L:
S1·S1+1 ÷ S2·S2+1 → D1·D1+1 (quotient),
D1+2·D1+3 (remainder)

When input is on, 16- or 32-bit data designated by source operand S1 is divided by 16- or 32-bit data designated by source operand S2. The quotient is set to 16- or 32-bit destination operand D1, and the remainder is set to the next 16- or 32-bit data.

When S2 is 0 (dividing by 0), the ERROR LED and special internal relay M8004 (user program execution error) are turned on.

A user program execution error also occurs in the following division operations.
Data type I: –32768 ÷ (–1)
Data type L: –2147483648 ÷ (–1)

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for calculation	X	X	X	X	X	X	X	X	X	1-99
S2 (Source 2)	Data for calculation	X	X	X	X	X	X	X	X	X	1-99
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	X	—	1-99

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1 or S2, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Since the binary arithmetic instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	X	X	X

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word or integer data type) or 32 points (double-word or long data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word or integer data type) or 2 points (double-word or long data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

Using Carry or Borrow Signals

When the D1 (destination) data is out of the valid data range as a result of addition, a carry occurs, and special internal relay M8003 is turned on. When the D1 (destination) data is out of the valid data range as a result of subtraction, a borrow occurs, and special internal relay M8003 is turned on.

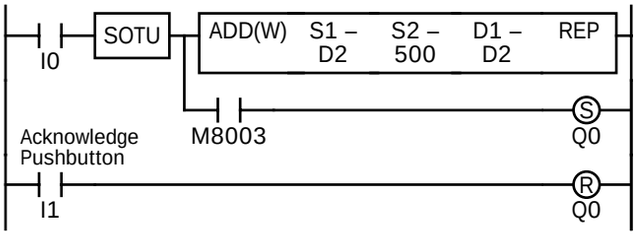
Data Type	Carry occurs when D1 is	Borrow occurs when D1 is
W (word)	over 65,535	below 0
I (integer)	below –32,768 or over 32,767	below –32,768 or over 32,767
D (double word)	over 4,294,967,295	below 0
L (long)	below –2,147,483,648 or over 2,147,483,647	below –2,147,483,648 or over 2,147,483,647

There are three ways to program the carrying process (see examples below). If a carry never goes on, the program does not have to include internal relay M8003 to process carrying. If a carry goes on unexpectedly, an output can be programmed to be set as a warning indicator. If a carry goes on, the number of times a carry occurs can be added to be used as one word data in a specified register.

Examples: ADD

- **Data Type: Word**

This example demonstrates the use of a carry signal from special internal relay M8003 to set an alarm signal.

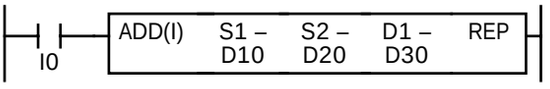


D2 + 500 → D2

When a carry occurs, output Q0 is set as a warning indicator.

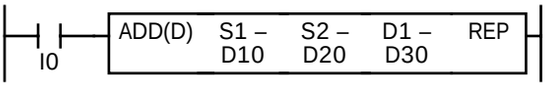
When the acknowledge pushbutton (input I1) is pressed, the warning indicator is reset.

• **Data Type: Integer**



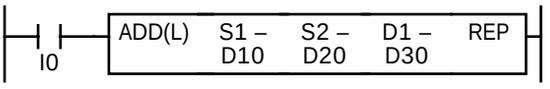
D10 [–4] + D20 [–11] ⟶ D30 [–15]

• **Data Type: Double Word**



D10·D11 [1957400] + D20·D21 [4112600] ⟶ D30·D31 [6070000]

• **Data Type: Long**

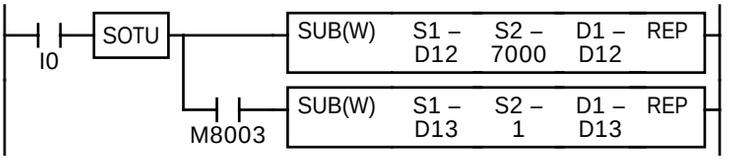


D10·D11 [216283] + D20·D21 [–964355] ⟶ D30·D31 [–748072]

Example: SUB

• **Data Type: Word**

The following example demonstrates the use of special internal relay M8003 to process a borrow.

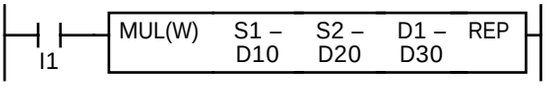


D12 – 7000 → D12

To process borrowing so that the number of times a borrow occurs is subtracted from D13. When a borrow occurs, D13 is decremented by one.

Examples: MUL

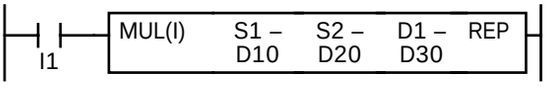
• **Data Type: Word**



D10 [50] × D20 [60] ⟶ D30·D31 [3000]

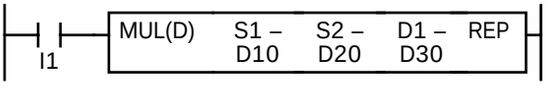
When input I1 is on, data of D10 is multiplied by data of D20, and the result is set to D30 and D31.

• **Data Type: Integer**



D10 [–50] × D20 [60] ⟶ D30·D31 [–3000]

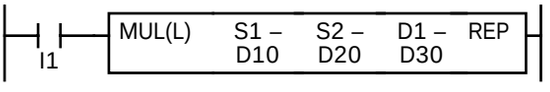
• **Data Type: Double Word**



D10·D11 [100000] × D20·D21 [5000] ⟶ D30·D31 [500000000]

Note: When the result exceeds 4,294,967,295, a user program execution error will result, turning on the ERROR LED and special internal relay M8004 (user program execution error). The result is not set to the destination operand.

• **Data Type: Long**

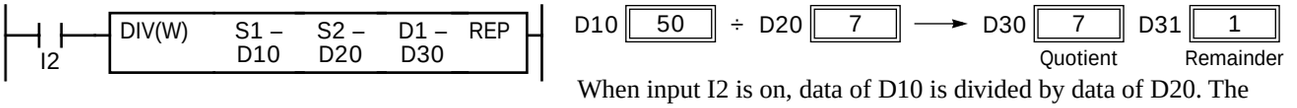


D10·D11 [–100000] × D20·D21 [–5000] ⟶ D30·D31 [500000000]

Note: When the result is below –2,147,483,648 or over 2,147,483,647, a user program execution error will result, turning on the ERROR LED and special internal relay M8004 (user program execution error). The result is not set to the destination operand.

Examples: DIV

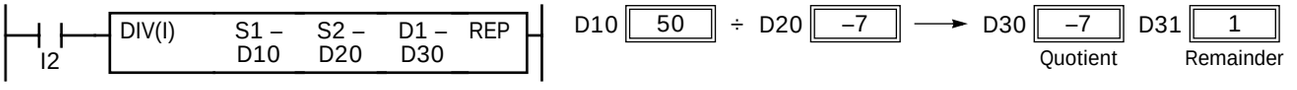
- **Data Type: Word**



When input I2 is on, data of D10 is divided by data of D20. The quotient is set to D30, and the remainder is set to D31.

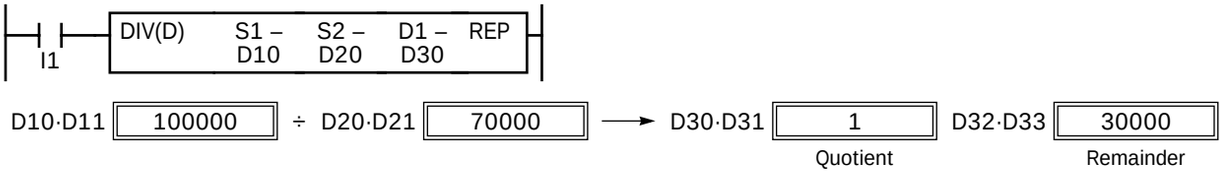
Note: Destination uses two word operands in the division operation of word data type, so do not use data register D7999 as destination operand D1, otherwise a user program syntax error occurs, and the ERROR LED is lit. When using a bit operand such as internal relay for destination, 32 internal relays are required; so do not use internal relay M2521 or a larger number as destination operand D1.

- **Data Type: Integer**



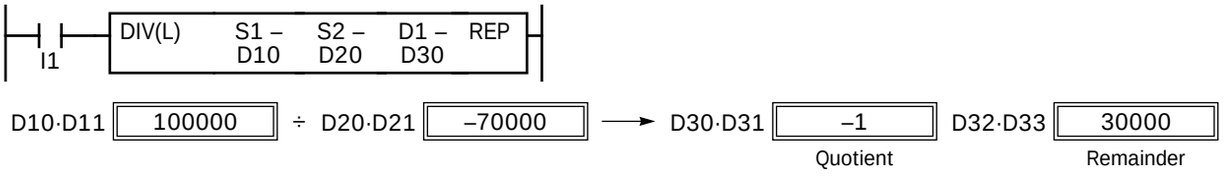
Note: Destination uses two word operands in the division operation of integer data type, so do not use data register D7999 as destination operand D1, otherwise a user program syntax error occurs, and the ERROR LED is lit. When using a bit operand such as internal relay for destination, 32 internal relays are required; so do not use internal relay M2521 or a larger number as destination operand D1.

- **Data Type: Double Word**



Note: Destination uses four word operands in the division operation of double-word data type, so do not use data register D7997 through D7999 as destination operand D1, otherwise a user program syntax error occurs, and the ERROR LED is lit. When using a bit operand such as internal relay for destination, 64 internal relays are required; so do not use internal relay M2481 or a larger number as destination operand D1.

- **Data Type: Long**



Note: Destination uses four word operands in the division operation of long data type, so do not use data register D7997 through D7999 as destination operand D1, otherwise a user program syntax error occurs, and the ERROR LED is lit. When using a bit operand such as internal relay for destination, 64 internal relays are required; so do not use internal relay M2481 or a larger number as destination operand D1.

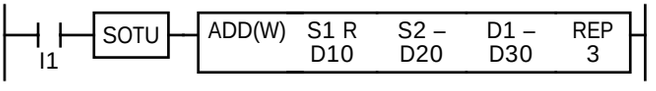
Repeat Operation in the ADD, SUB, and MUL Instructions

Source operands S1 and S2 and destination operand D1 can be designated to repeat individually or in combination. When destination operand D1 is not designated to repeat, the final result is set to destination operand D1. When repeat is designated, consecutive operands as many as the repeat cycles starting with the designated operand are used. Since the repeat operation works similarly on the ADD (addition), SUB (subtraction), and MUL (multiplication) instructions, the following examples are described using the ADD instruction.

Repeat One Source Operand

- **Data Type: Word**

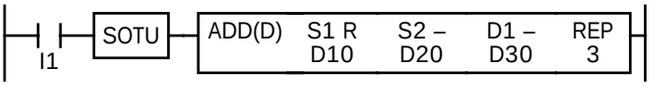
When only S1 (source) is designated to repeat, the final result is set to destination operand D1.



S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 0)
D10 10	+	D20 25	→	D30 (35)
D11 15	+	D20 25	→	D30 (40)
D12 20	+	D20 25	→	D30 45

- **Data Type: Double Word**

When only S1 (source) is designated to repeat, the final result is set to destination operand D1·D1+1.

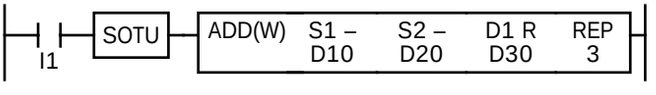


S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 0)
D10·D11	+	D20·D21	→	(D30·D31)
D12·D13	+	D20·D21	→	(D30·D31)
D14·D15	+	D20·D21	→	D30·D31

Repeat Destination Operand Only

- **Data Type: Word**

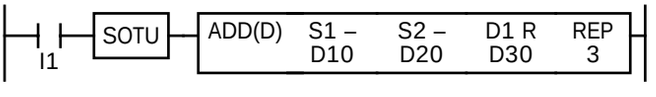
When only D1 (destination) is designated to repeat, the same result is set to 3 operands starting with D1.



S1 (Repeat = 0)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10 10	+	D20 25	→	D30 35
D10 10	+	D20 25	→	D31 35
D10 10	+	D20 25	→	D32 35

- **Data Type: Double Word**

When only D1 (destination) is designated to repeat, the same result is set to 3 operands starting with D1·D1+1.

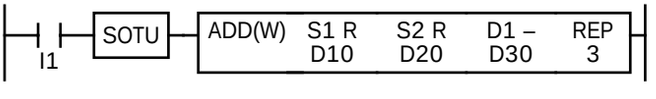


S1 (Repeat = 0)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10·D11	+	D20·D21	→	D30·D31
D10·D11	+	D20·D21	→	D32·D33
D10·D11	+	D20·D21	→	D34·D35

Repeat Two Source Operands

- **Data Type: Word**

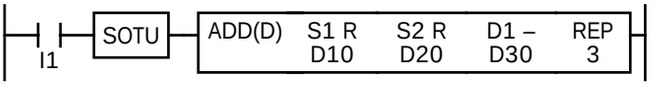
When S1 and S2 (source) are designated to repeat, the final result is set to destination operand D1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 0)
D10 10	+	D20 25	→	D30 (35)
D11 15	+	D21 35	→	D30 (50)
D12 20	+	D22 45	→	D30 65

- **Data Type: Double Word**

When S1 and S2 (source) are designated to repeat, the final result is set to destination operand D1·D1+1.

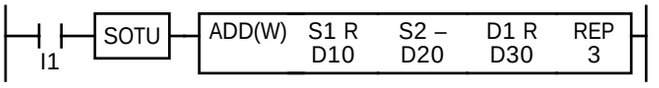


S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 0)
D10·D11	+	D20·D21	→	(D30·D31)
D12·D13	+	D22·D23	→	(D30·D31)
D14·D15	+	D24·D25	→	D30·D31

Repeat Source and Destination Operands

• Data Type: Word

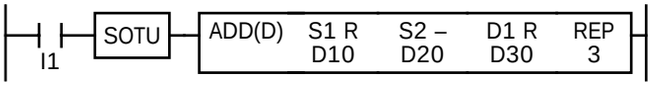
When S1 (source) and D1 (destination) are designated to repeat, different results are set to 3 operands starting with D1.



S1 (Repeat = 3)			S2 (Repeat = 0)			D1 (Repeat = 3)
D10	10	+	D20	25	→	D30 35
D11	15	+	D20	25	→	D31 40
D12	20	+	D20	25	→	D32 45

• Data Type: Double Word

When S1 (source) and D1 (destination) are designated to repeat, different results are set to 3 operands starting with D1·D1+1.

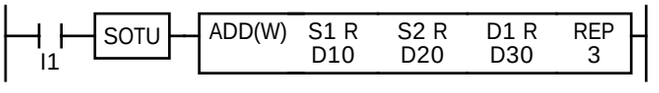


S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10·D11	+	D20·D21	→	D30·D31
D12·D13	+	D20·D21	→	D32·D33
D14·D15	+	D20·D21	→	D34·D35

Repeat All Source and Destination Operands

• Data Type: Word

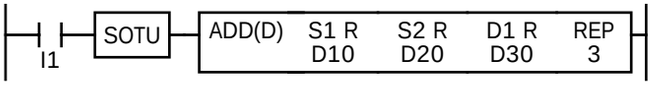
When all operands are designated to repeat, different results are set to 3 operands starting with D1.



S1 (Repeat = 3)			S2 (Repeat = 3)			D1 (Repeat = 3)
D10	10	+	D20	25	→	D30 35
D11	15	+	D21	35	→	D31 50
D12	20	+	D22	45	→	D32 65

• Data Type: Double Word

When all operands are designated to repeat, different results are set to 3 operands starting with D1·D1+1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 3)
D10·D11	+	D20·D21	→	D30·D31
D12·D13	+	D22·D23	→	D32·D33
D14·D15	+	D24·D25	→	D34·D35

Note: Special internal relay M8003 (carry/borrow) is turned on when a carry or borrow occurs in the last repeat operation. When a user program execution error occurs in any repeat operation, special internal relay M8004 (user program execution error) and the ERROR LED are turned on and maintained while operation for other instructions is continued. For the advanced instruction which has caused a user program execution error, results are not set to any destination.

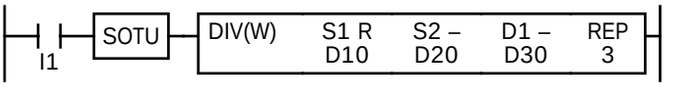
Repeat Operation in the DIV Instruction

Since the DIV (division) instruction uses two destination operands, the quotient and remainder are stored as described below. Source operands S1 and S2 and destination operand D1 can be designated to repeat individually or in combination. When destination operand D1 is not designated to repeat, the final result is set to destination operand D1 (quotient) and D+1 (remainder). When repeat is designated, consecutive operands as many as the repeat cycles starting with the designated operand are used.

Repeat One Source Operand

• Data Type: Word

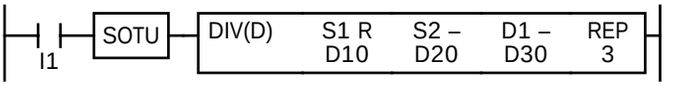
When only S1 (source) is designated to repeat, the final result is set to destination operands D1 and D1+1.



S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 0)	
D10	÷	D20	→	(D30)	(D31)
D11	÷	D20	→	(D30)	(D31)
D12	÷	D20	→	D30	D31
				Quotient	Remainder

• Data Type: Double Word

When only S1 (source) is designated to repeat, the final result is set to destination operands D1·D1+1 and D1+2·D1+3.

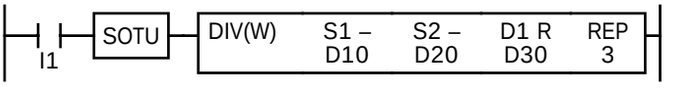


S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 0)	
D10·D11	÷	D20·D21	→	(D30·D31)	(D32·D33)
D12·D13	÷	D20·D21	→	(D30·D31)	(D32·D33)
D14·D15	÷	D20·D21	→	D30·D31	D32·D33
				Quotient	Remainder

Repeat Destination Operand Only

• Data Type: Word

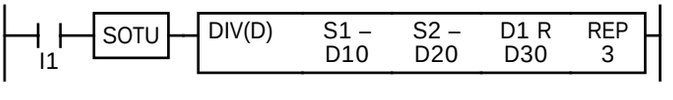
When only D1 (destination) is designated to repeat, the same result is set to 6 operands starting with D1.



S1 (Repeat = 0)		S2 (Repeat = 0)		D1 (Repeat = 3)	
D10	÷	D20	→	D30	D33
D10	÷	D20	→	D31	D34
D10	÷	D20	→	D32	D35
				Quotient	Remainder

• Data Type: Double Word

When only D1 (destination) is designated to repeat, the same result is set to 6 operands starting with D1·D1+1.

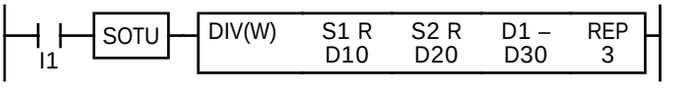


S1 (Repeat = 0)		S2 (Repeat = 0)		D1 (Repeat = 3)	
D10·D11	÷	D20·D21	→	D30·D31	D36·D37
D10·D11	÷	D20·D21	→	D32·D33	D38·D39
D10·D11	÷	D20·D21	→	D34·D35	D40·D41
				Quotient	Remainder

Repeat Two Source Operands

• Data Type: Word

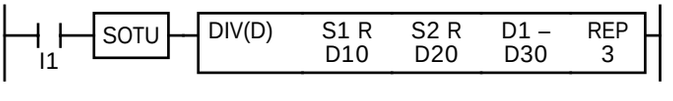
When S1 and S2 (source) are designated to repeat, the final result is set to destination operands D1 and D1+1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 0)	
D10	÷	D20	→	(D30)	(D31)
D11	÷	D21	→	(D30)	(D31)
D12	÷	D22	→	D30	D31
				Quotient	Remainder

• Data Type: Double Word

When S1 and S2 (source) are designated to repeat, the final result is set to destination operands D1·D1+1 and D1+2·D1+3

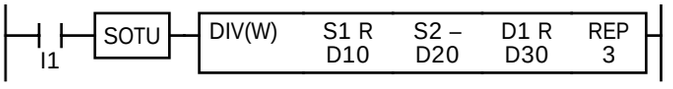


S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 0)	
D10·D11	÷	D20·D21	→	(D30·D31)	(D32·D33)
D12·D13	÷	D22·D23	→	(D30·D31)	(D32·D33)
D14·D15	÷	D24·D25	→	D30·D31	D32·D33
				Quotient	Remainder

Repeat Source and Destination Operands

• Data Type: Word

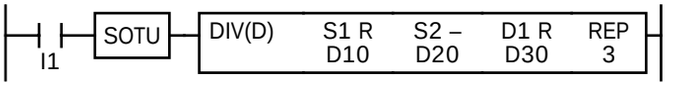
When S1 (source) and D1 (destination) are designated to repeat, different results are set to 6 operands starting with D1.



S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 3)	
D10	÷	D20	→	D30	D33
D11	÷	D20	→	D31	D34
D12	÷	D20	→	D32	D35
				Quotient	Remainder

• Data Type: Double Word

When S1 (source) and D1 (destination) are designated to repeat, different results are set to 6 operands starting with D1·D1+1.

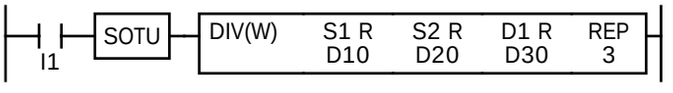


S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 3)	
D10·D11	÷	D20·D21	→	D30·D31	D36·D37
D12·D13	÷	D20·D21	→	D32·D33	D38·D39
D14·D15	÷	D20·D21	→	D34·D35	D40·D41
				Quotient	Remainder

Repeat All Source and Destination Operands

• Data Type: Word

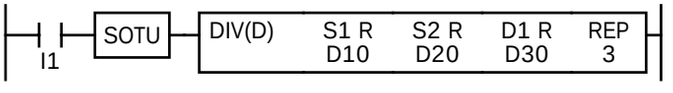
When all operands are designated to repeat, different results are set to 6 operands starting with D1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 3)	
D10	÷	D20	→	D30	D33
D11	÷	D21	→	D31	D34
D12	÷	D22	→	D32	D35
				Quotient	Remainder

• Data Type: Double Word

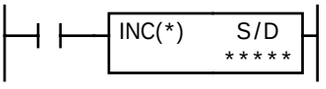
When all operands are designated to repeat, different results are set to 6 operands starting with D1·D1+1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 3)	
D10·D11	÷	D20·D21	→	D30·D31	D36·D37
D12·D13	÷	D22·D23	→	D32·D33	D38·D39
D14·D15	÷	D24·D25	→	D34·D35	D40·D41
				Quotient	Remainder

Note: When a user program execution error occurs in any repeat operation, special internal relay M8004 (user program execution error) and the ERROR LED are turned on and maintained while operation for other instructions is continued. For the advanced instruction which has caused a user program execution error, results are not set to any destination.

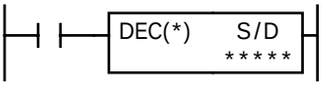
INC (Increment)



S/D + 1 → S/D

When input is on, one is added to the value in the operand and the new value is stored to the same operand.

DEC (Decrement)



S/D – 1 → S/D

When input is on, one is subtracted from the value in the operand and the new value is stored to the same operand.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S/D (Source/Destination)	Operand to increment data	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

Since the INC and DEC instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a word operand such as D (data register) or L (link register) is designated as the source/destination, 1 point (word data type) or 2 points (double-word data type) are used.

Increment beyond Limits

In the word data type, valid values are 0 to 65535. If the designated operand is currently 65535, the value will become 0 after it is incremented by one. The carry (M8003) is not set by this operation.

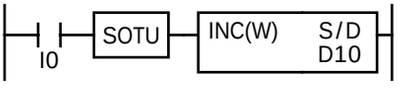
In the double-word data type, valid values are 0 to 4,294,967,295. If the designated operand is currently 4,294,967,295, the value will become 0 after it is incremented by one. The carry (M8003) is not set by this operation.

Decrement beyond Limits

In the word data type, valid values are 0 to 65535. If the designated operand is currently 0, the value will become 65535 after it is decremented by one. The borrow (M8003) is not set by this operation.

In the double-word data type, valid values are 0 to 4,294,967,295. If the designated operand is currently 0, the value will become 4,294,967,295 after it is decremented by one. The borrow (M8003) is not set by this operation.

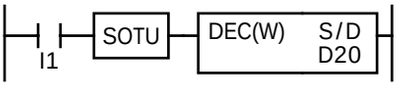
Example: INC



D10 100 + 1 → D10 101

When input I0 is turned on, the data of D10 is incremented by one.
If the SOTU is not programmed, the data of D10 is incremented in each scan.

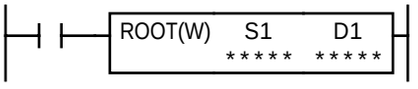
Example: DEC



D20 100 – 1 → D20 99

When input I1 is turned on, the data of D20 is decremented by one.
If the SOTU is not programmed, the data of D20 is decremented in each scan.

ROOT (Root)



$\sqrt{S1} \rightarrow D1$

When input is on, the square root of operand designated by S1 is extracted and is stored to the destination designated by D1.

Valid values are 0 to 65535. The square root is calculated to two decimals, omitting the figures below the second place of decimals.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Binary data	—	—	—	—	—	—	X	X	X	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

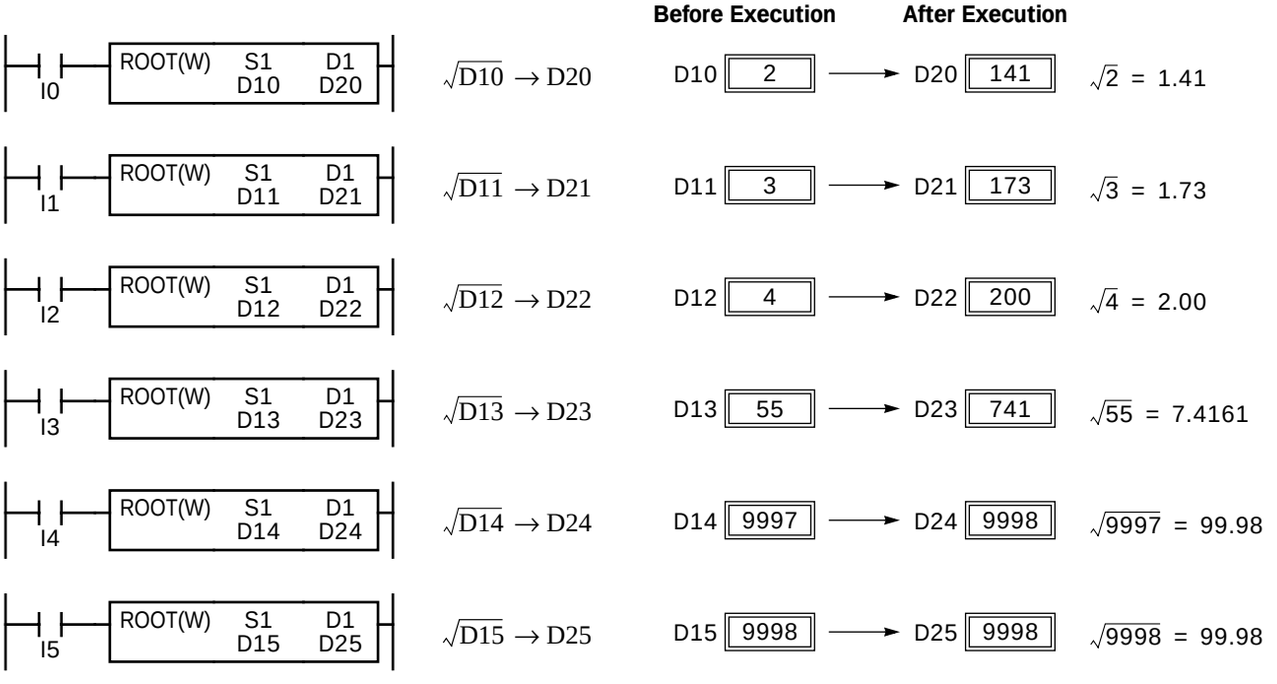
Since the ROOT instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

When a word operand such as D (data register) or L (link register) is designated as the source or destination, 1 point (word data type) is used.

Examples: ROOT



SUM (Sum)

The SUM instruction can be selected for ADD or XOR operation.

ADD: S1 through S2 added → D1·D1+1
XOR: S1 through S2 XORed → D1

When input is on with ADD selected, all data of operands designated by S1 through S2 are added, and the result is stored to the destination operand designated by D1 and the next operand D1+1.

When input is on with XOR selected, all data of operands designated by S1 through S2 are XORed, and the result is stored to the destination operand designated by D1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	First operand number for SUM	—	—	—	—	X	X	X	X	—	—
S2 (Source 2)	Last operand number for SUM	—	—	—	—	X	X	X	X	—	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S1 or S2, the timer/counter current value is read out.

Since the SUM instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

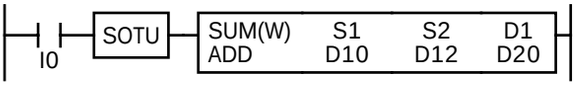
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

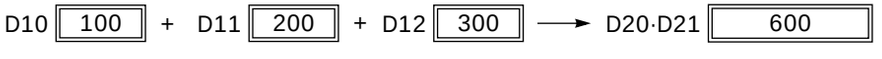
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

Example: SUM

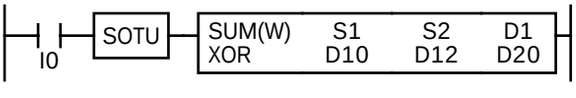
- **ADD**



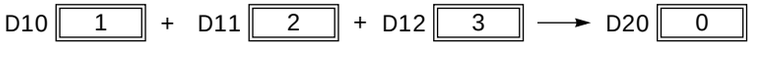
When input is on, all data of D10 through D12 are added, and the result is stored to D20 and D21.



- **XOR**



When input is on, all data of D10 through D12 are XORed, and the result is stored to D20.



1h = 0000 0000 0000 0001
2h = 0000 0000 0000 0010
3h = 0000 0000 0000 0011

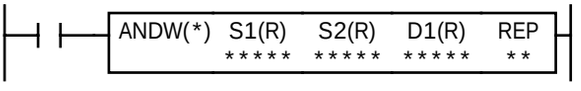
12: BOOLEAN COMPUTATION INSTRUCTIONS

Introduction

Boolean computations use the AND, OR, and exclusive OR statements as carried out by the ANDW, ORW, and XORW instructions in the word or double-word data type, respectively.

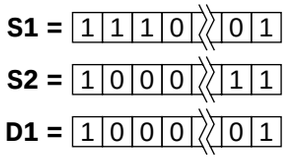
The NEG (negate) instruction is used to change the plus or minus sign of integer or long data.

ANDW (AND Word)



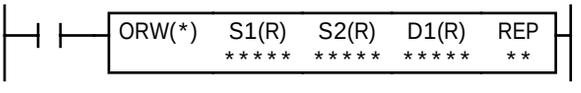
S1 · S2 → D1

When input is on, 16- or 32-bit data designated by source operands S1 and S2 are ANDed, bit by bit. The result is set to destination operand D1.



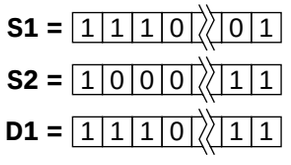
S1	S2	D1
0	0	0
0	1	0
1	0	0
1	1	1

ORW (OR Word)



S1 + S2 → D1

When input is on, 16- or 32-bit data designated by source operands S1 and S2 are ORed, bit by bit. The result is set to destination operand D1.

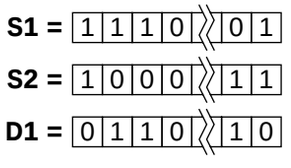


S1	S2	D1
0	0	0
0	1	1
1	0	1
1	1	1

XORW (Exclusive OR Word)

S1 ⊕ S2 → D1

When input is on, 16- or 32-bit data designated by source operands S1 and S2 are exclusive ORed, bit by bit. The result is set to destination operand D1.



S1	S2	D1
0	0	0
0	1	1
1	0	1
1	1	0

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for computation	X	X	X	X	X	X	X	X	X	1-99
S2 (Source 2)	Data for computation	X	X	X	X	X	X	X	X	X	1-99
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	X	—	1-99

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1 or S2, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Since the Boolean computation instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

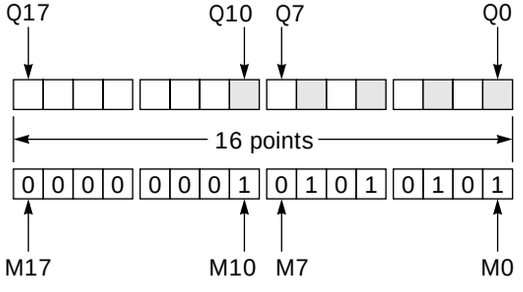
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word data type) or 32 points (double-word data type) are used. When repeat is designated for a bit operand, the quantity of operand bits increases in 16- or 32-point increments.

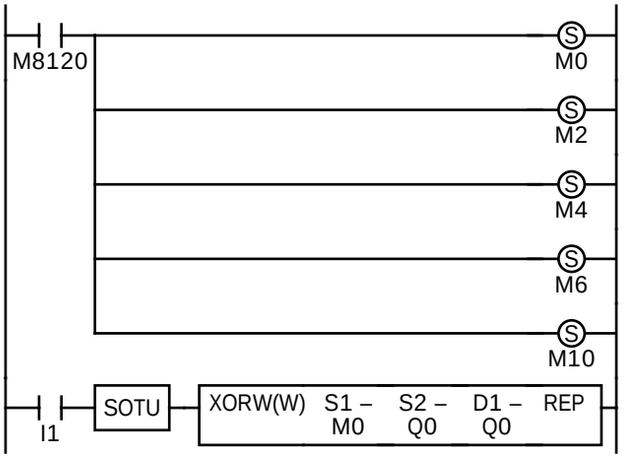
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) or 2 points (double-word data type) are used. When repeat is designated for a word operand, the quantity of operand words increases in 1- or 2-point increments.

Example: XORW

To convert optional output status among a series of 10 output points, use the XORW instruction in combination with 10 internal relay points.



This program will invert the status of the shaded outputs at the left from on to off, and those not shaded from off to on.



Sixteen outputs Q0 through Q17 are assigned to 16 internal relays M0 through M17.

Five internal relays M0, M2, M4, M6, and M10 are set by initialize pulse special internal relay M8120.

When input I1 is turned on, the XORW instruction is executed to invert the status of outputs Q0, Q2, Q4, Q6, and Q10.

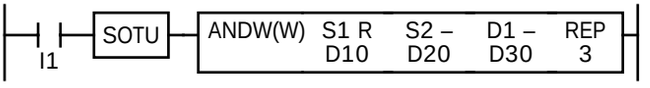
Repeat Operation in the ANDW, ORW, and XORW Instructions

Source operands S1 and S2 and destination operand D1 can be designated to repeat individually or in combination. When destination operand D1 is not designated to repeat, the final result is set to destination operand D1. When repeat is designated, consecutive operands as many as the repeat cycles starting with the designated operand are used. Since the repeat operation works similarly on the ANDW (AND word), ORW (OR word), and XORW (exclusive OR word) instructions, the following examples are described using the ANDW instruction.

Repeat One Source Operand

• Data Type: Word

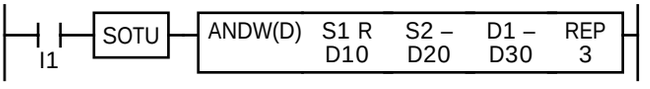
When only S1 (source) is designated to repeat, the final result is set to destination operand D1.



S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 0)
D10	·	D20	→	(D30)
D11	·	D20	→	(D30)
D12	·	D20	→	D30

• Data Type: Double Word

When only S1 (source) is designated to repeat, the final result is set to destination operand D1·D1+1.

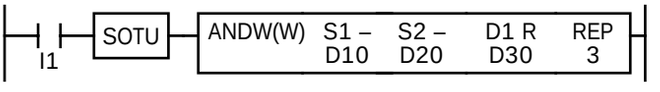


S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 0)
D10·D11	·	D20·D21	→	(D30·D31)
D12·D13	·	D20·D21	→	(D30·D31)
D14·D15	·	D20·D21	→	D30·D31

Repeat Destination Operand Only

• Data Type: Word

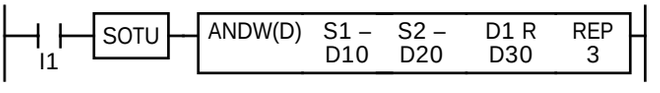
When only D1 (destination) is designated to repeat, the same result is set to 3 operands starting with D1.



S1 (Repeat = 0)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10	·	D20	→	D30
D10	·	D20	→	D31
D10	·	D20	→	D32

• Data Type: Double Word

When only D1 (destination) is designated to repeat, the same result is set to 3 operands starting with D1·D1+1.

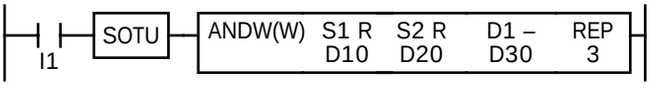


S1 (Repeat = 0)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10·D11	·	D20·D21	→	D30·D31
D10·D11	·	D20·D21	→	D32·D33
D10·D11	·	D20·D21	→	D34·D35

Repeat Two Source Operands

• Data Type: Word

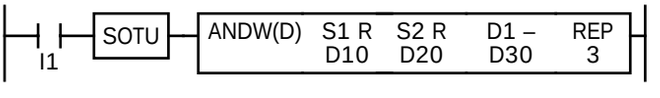
When S1 and S2 (source) are designated to repeat, the final result is set to destination operand D1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 0)
D10	·	D20	→	(D30)
D11	·	D21	→	(D30)
D12	·	D22	→	D30

• Data Type: Double Word

When S1 and S2 (source) are designated to repeat, the final result is set to destination operand D1·D1+1.

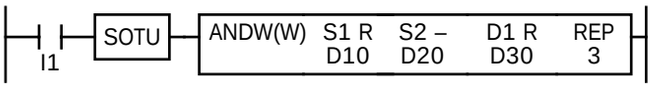


S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 0)
D10·D11	·	D20·D21	→	(D30·D31)
D12·D13	·	D22·D23	→	(D30·D31)
D14·D15	·	D24·D25	→	D30·D31

Repeat Source and Destination Operands

• Data Type: Word

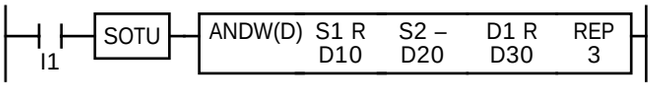
When S1 (source) and D1 (destination) are designated to repeat, different results are set to 3 operands starting with D1.



S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10	·	D20	→	D30
D11	·	D20	→	D31
D12	·	D20	→	D32

• Data Type: Double Word

When S1 (source) and D1 (destination) are designated to repeat, different results are set to 3 operands starting with D1·D1+1.

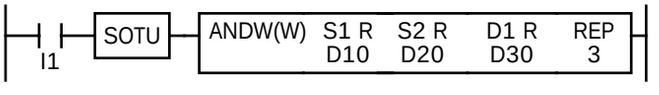


S1 (Repeat = 3)		S2 (Repeat = 0)		D1 (Repeat = 3)
D10·D11	·	D20·D21	→	D30·D31
D12·D13	·	D20·D21	→	D32·D33
D14·D15	·	D20·D21	→	D34·D35

Repeat All Source and Destination Operands

• Data Type: Word

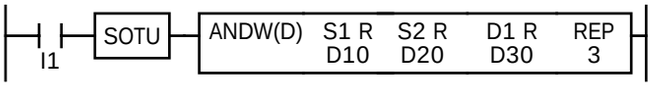
When all operands are designated to repeat, different results are set to 3 operands starting with D1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 3)
D10	·	D20	→	D30
D11	·	D21	→	D31
D12	·	D22	→	D32

• Data Type: Double Word

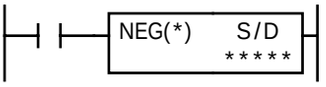
When all operands are designated to repeat, different results are set to 3 operands starting with D1·D1+1.



S1 (Repeat = 3)		S2 (Repeat = 3)		D1 (Repeat = 3)
D10·D11	·	D20·D21	→	D30·D31
D12·D13	·	D22·D23	→	D32·D33
D14·D15	·	D24·D25	→	D34·D35

Note: When a user program error occurs in any repeat operation, special internal relay M8004 (user program execution error) and the ERROR LED are turned on and maintained while operation for other instructions is continued. For the advanced instruction which has caused a user program execution error, results are not set to any destination.

NEG (Negate)



0 – S/D → S/D

When input is on, a two's complement of operand designated by S/D is produced, and the new value is stored to the same operand.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S/D (Source/Destination)	Operand to negate data	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

Since the NEG instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
—	X	—	X

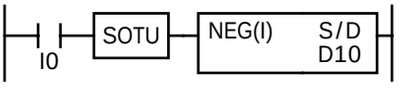
When a word operand such as D (data register) or L (link register) is designated as the source/destination, 1 point (integer data type) or 2 points (long data type) are used.

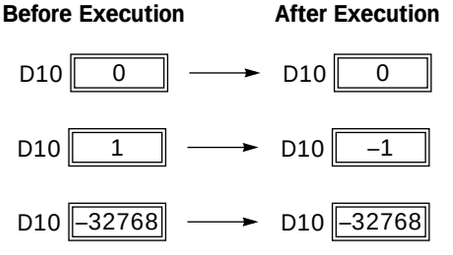
In the integer data type, valid values are –32768 to 32767. If the designated operand is currently –32768 (8000h), the value will become –32768 (8000h) after it is negated.

In the long data type, valid values are –2,147,483,648 to 2,147,483,647. If the designated operand is currently –2,147,483,648 (80000000h), the value will become –2,147,483,648 (80000000h) after it is negated.

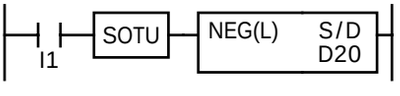
Example: NEG

- **Data Type: Integer**





- **Data Type: Long**

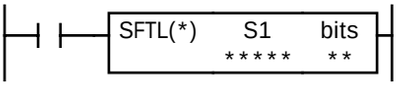


13: BIT SHIFT / ROTATE INSTRUCTIONS

Introduction

Bit shift and rotate instructions are used to shift the 16- or 32-bit data in the designated source operand S1 to the left or right by the quantity of bits designated. The result is set to the source operand S1 and a carry (special internal relay M8003).

SFTL (Shift Left)

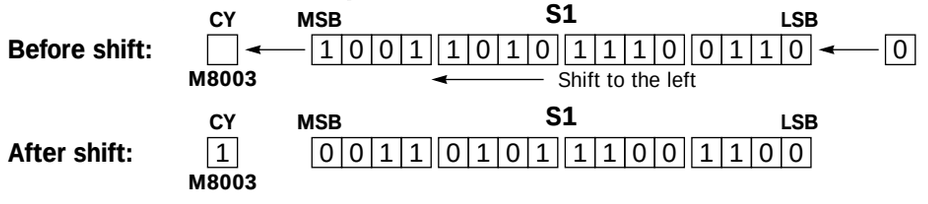


CY ← S1

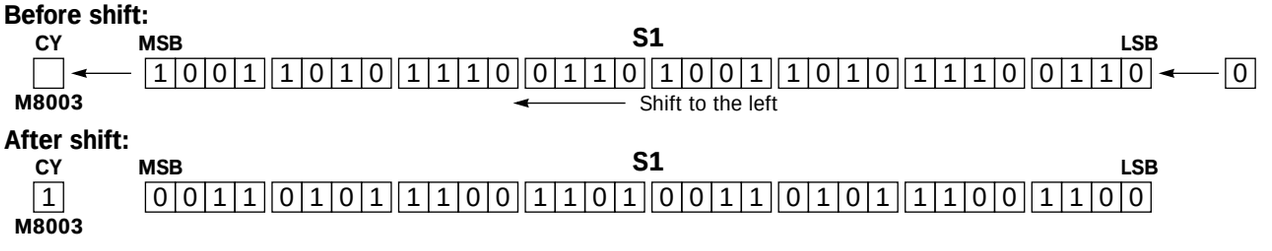
When input is on, 16- or 32-bit data of the designated source operand S1 is shifted to the left by the quantity of bits designated by operand bits.

The result is set to the source operand S1, and the last bit status shifted out is set to a carry (special internal relay M8003). Zeros are set to the LSB.

- **Data Type: Word (bits to shift = 1)**



- **Data Type: Double Word (bits to shift = 1)**



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for bit shift	—	X	▲	X	—	—	X	X	—	—
bits	Quantity of bits to shift	—	—	—	—	—	—	—	—	1-15, 1-31	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S1. Special internal relays cannot be designated as S1.

The quantity of bits to shift can be 1 through 15 for the word data type, or 1 through 31 for the double-word data type.

Since the SFTL instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

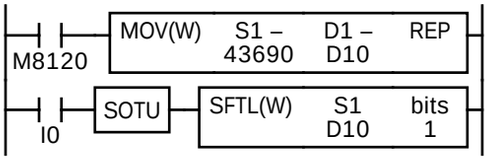
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as D (data register) or L (link register) is designated as the source, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: SFTL

- **Data Type: Word**

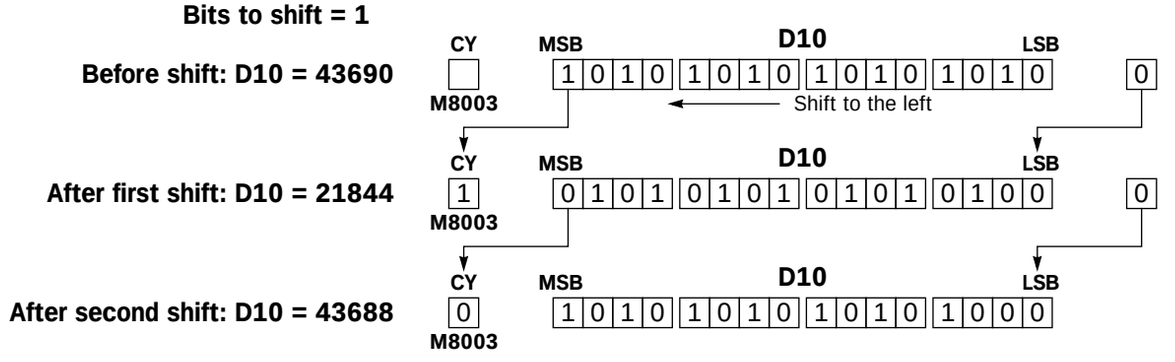


M8120 is the initialize pulse special internal relay.

When the CPU starts operation, the MOV (move) instruction sets 43690 to data register D10.

Each time input I0 is turned on, 16-bit data of data register D10 is shifted to the left by 1 bit as designated by operand bits. The last bit status shifted out is set to a carry (special internal relay M8003). Zeros are set to the LSB.

Bits to shift = 1

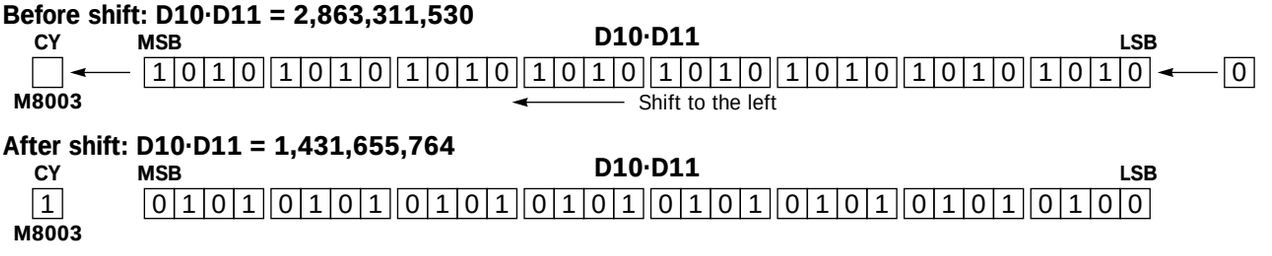


- **Data Type: Double Word**

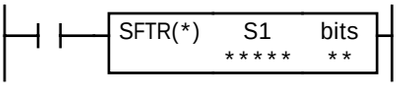
Each time input I1 is turned on, 32-bit data of data registers D10 and D11 is shifted to the left by 1 bit as designated by operand bits.

The last bit status shifted out is set to a carry (special internal relay M8003). Zeros are set to the LSB.

Bits to shift = 1



SFTR (Shift Right)

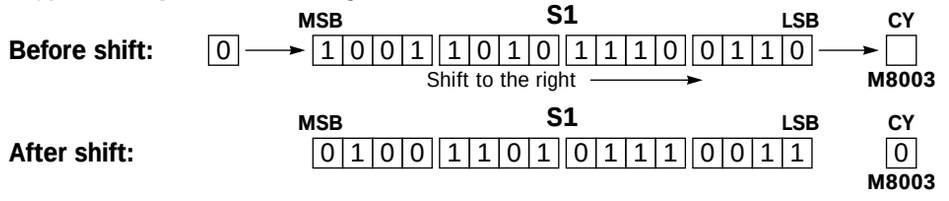


S1 → CY

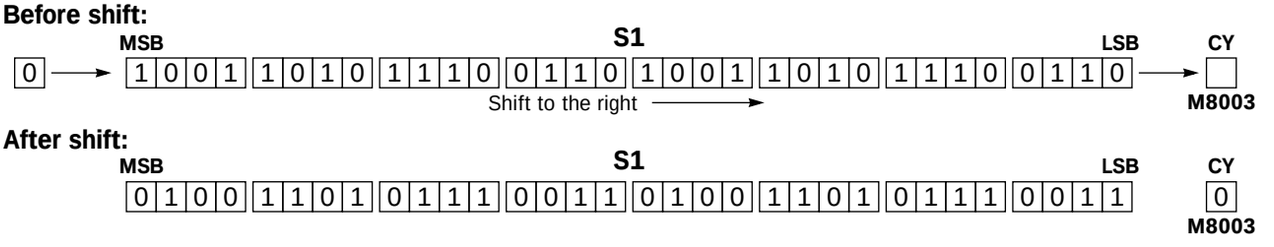
When input is on, 16- or 32-bit data of the designated source operand S1 is shifted to the right by the quantity of bits designated by operand bits.

The result is set to the source operand S1, and the last bit status shifted out is set to a carry (special internal relay M8003). Zeros are set to the MSB.

- **Data Type: Word (bits to shift = 1)**



- **Data Type: Double Word (bits to shift = 1)**



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for bit shift	—	X	▲	X	—	—	X	X	—	—
bits	Quantity of bits to shift	—	—	—	—	—	—	—	—	1-15, 1-31	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S1. Special internal relays cannot be designated as S1.

The quantity of bits to shift can be 1 through 15 for the word data type, or 1 through 31 for the double-word data type.

Since the SFTR instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

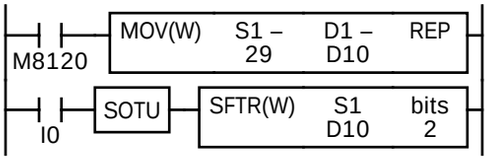
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as D (data register) or L (link register) is designated as the source, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: SFTR

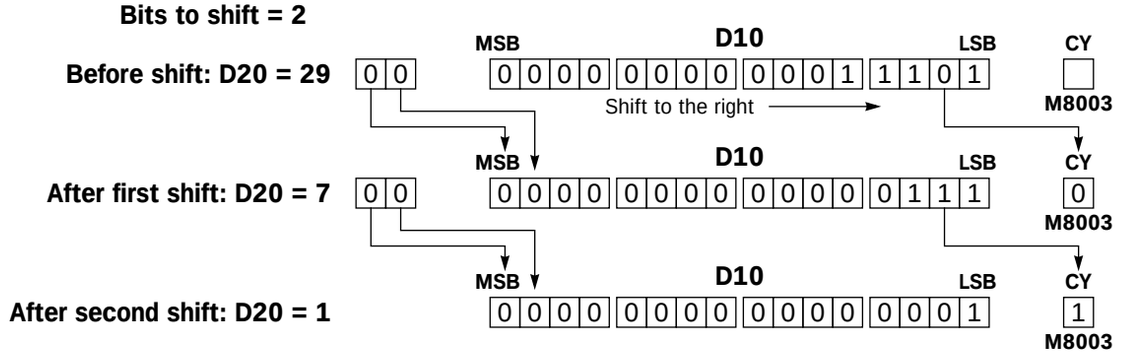
- **Data Type: Word**



M8120 is the initialize pulse special internal relay.

When the CPU starts operation, the MOV (move) instruction sets 29 to data register D10.

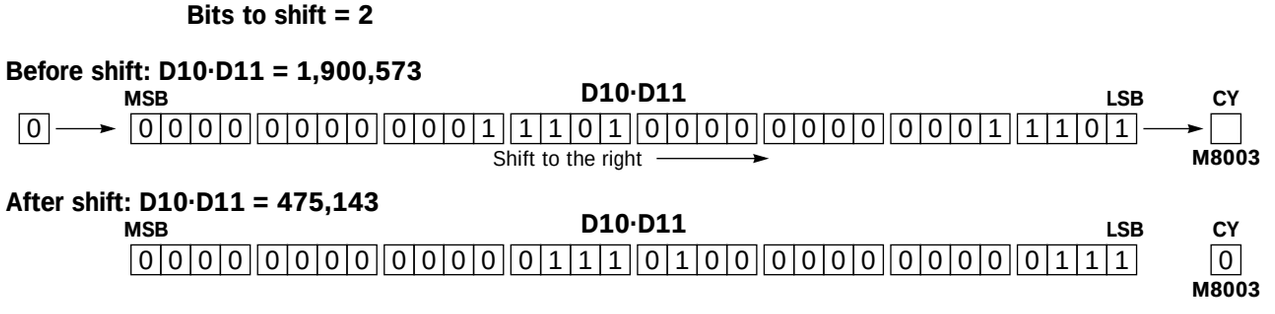
Each time input I0 is turned on, 16-bit data of data register D10 is shifted to the right by 2 bits as designated by operand bits. The last bit status shifted out is set to a carry (special internal relay M8003). Zeros are set to the MSB.



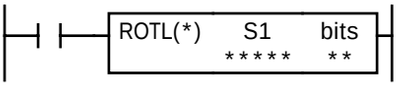
- **Data Type: Double Word**

Each time input I1 is turned on, 32-bit data of data registers D10 and D11 is shifted to the right by 2 bits as designated by operand bits.

The last bit status shifted out is set to a carry (special internal relay M8003). Zeros are set to the MSBs.



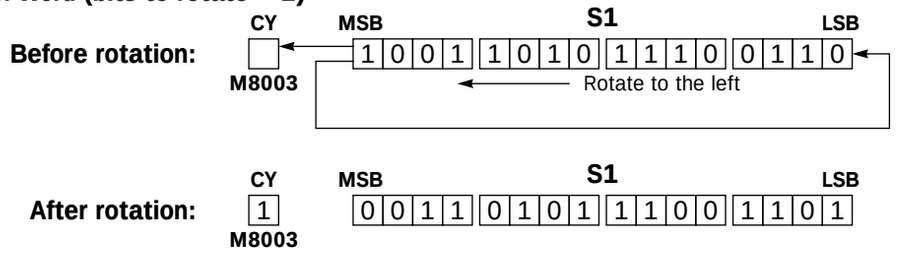
ROTL (Rotate Left)



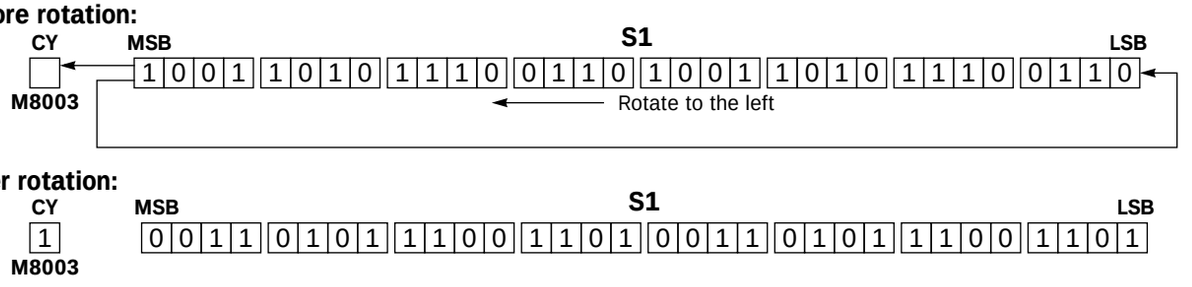
When input is on, 16- or 32-bit data of the designated source operand S1 is rotated to the left by the quantity of bits designated by operand bits.

The result is set to the source operand S1, and the last bit status rotated out is set to a carry (special internal relay M8003).

- **Data Type: Word (bits to rotate = 1)**



- **Data Type: Double Word (bits to rotate = 1)**



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for bit rotation	—	X	▲	X	—	—	X	X	—	—
bits	Quantity of bits to rotate	—	—	—	—	—	—	—	—	1-15, 1-31	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S1. Special internal relays cannot be designated as S1.

The quantity of bits to rotate can be 1 through 15 for the word data type, or 1 through 31 for the double-word data type.

Since the ROTL instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

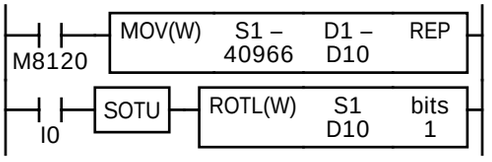
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as D (data register) or L (link register) is designated as the source, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: ROTL

- **Data Type: Word**



M8120 is the initialize pulse special internal relay.

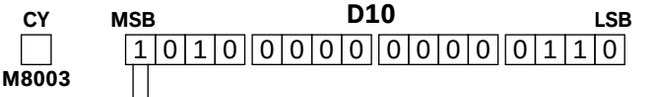
When the CPU starts operation, the MOV (move) instruction sets 40966 to data register D10.

Each time input I0 is turned on, 16-bit data of data register D10 is rotated to the left by 1 bit as designated by operand bits.

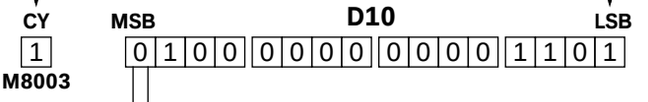
The status of the MSB is set to a carry (special internal relay M8003).

Bits to rotate = 1

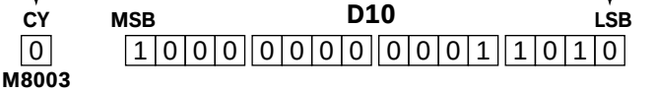
Before rotation: D10 = 40966



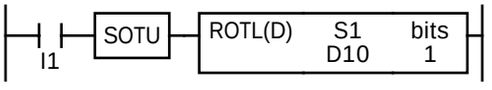
After first rotation: D10 = 16397



After second rotation: D10 = 32794



- **Data Type: Double Word**

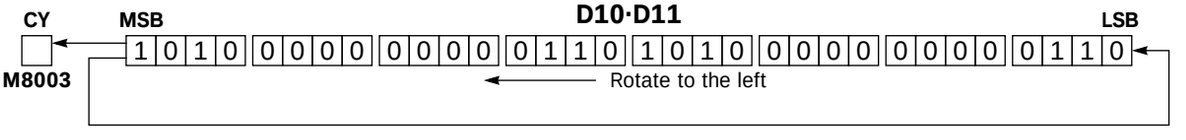


Each time input I1 is turned on, 32-bit data of data registers D10 and D11 is rotated to the left by 1 bit as designated by operand bits.

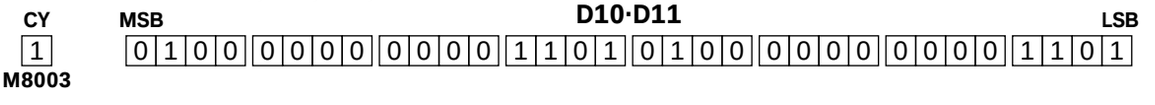
The status of the MSB is set to a carry (special internal relay M8003).

Bits to rotate = 1

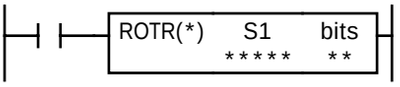
Before rotation: D10·D11 = 2,684,788,742



After rotation: D10·D11 = 1,074,610,189



ROTR (Rotate Right)

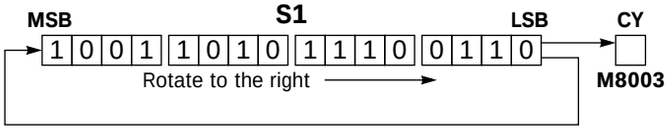


When input is on, 16- or 32-bit data of the designated source operand S1 is rotated to the right by the quantity of bits designated by operand bits.

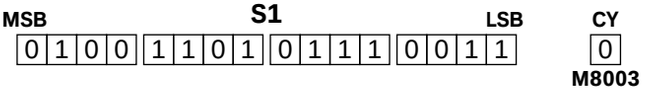
The result is set to the source operand S1, and the last bit status rotated out is set to a carry (special internal relay M8003).

- **Data Type: Word (bits to rotate = 1)**

Before rotation:

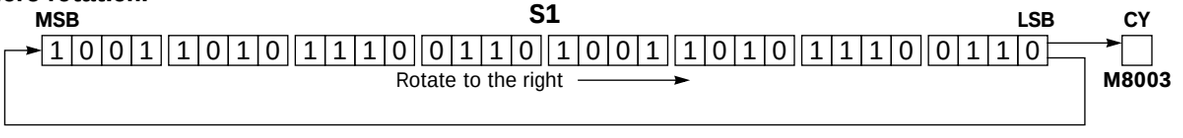


After rotation:

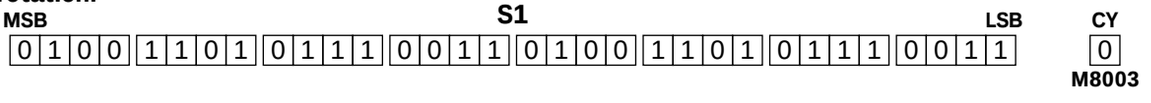


- **Data Type: Double Word (bits to rotate = 1)**

Before rotation:



After rotation:



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for bit rotation	—	X	▲	X	—	—	X	X	—	—
bits	Quantity of bits to rotate	—	—	—	—	—	—	—	—	1-15, 1-31	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S1. Special internal relays cannot be designated as S1.

The quantity of bits to rotate can be 1 through 15 for the word data type, or 1 through 31 for the double-word data type.

Since the ROTR instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

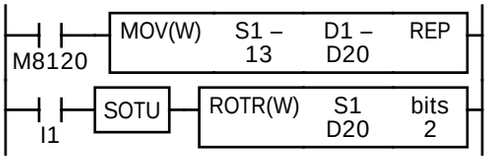
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as D (data register) or L (link register) is designated as the source, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: ROTR

- **Data Type: Word**



M8120 is the initialize pulse special internal relay.

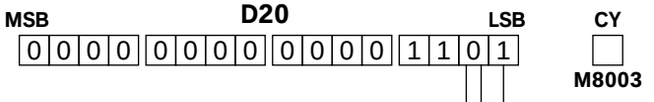
When the CPU starts operation, the MOV (move) instruction sets 13 to data register D20.

Each time input I1 is turned on, 16-bit data of data register D20 is rotated to the right by 2 bits as designated by operand bits.

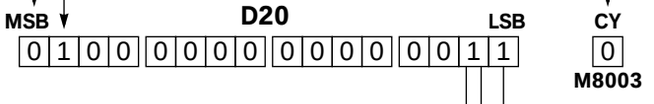
The last bit status rotated out is set to a carry (special internal relay M8003).

Bits to rotate = 2

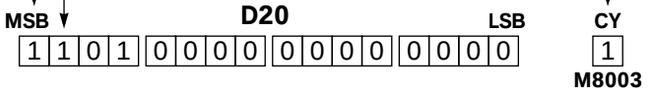
Before rotation: D20 = 13



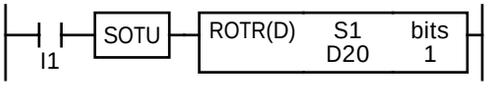
After first rotation: D20 = 16387



After second rotation: D20 = 53248



- **Data Type: Double Word**

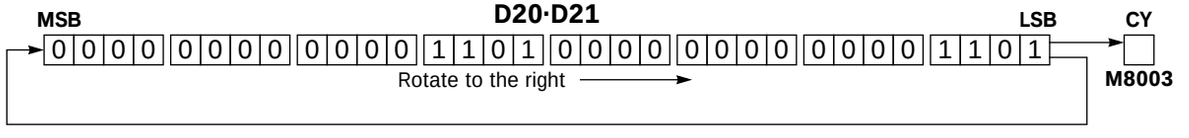


Each time input I1 is turned on, 32-bit data of data registers D20 and D21 is rotated to the right by 1 bit as designated by operand bits.

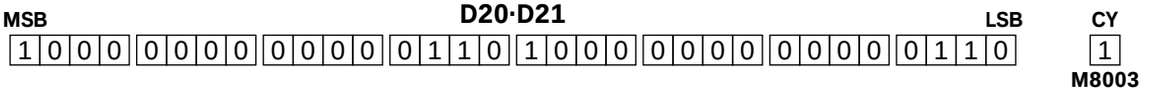
The last bit status rotated out is set to a carry (special internal relay M8003).

Bits to rotate = 1

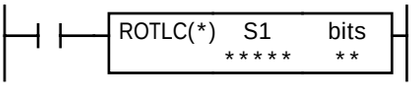
Before rotation: D20·D21 = 851,981



After rotation: D20·D21 = 2,147,909,638



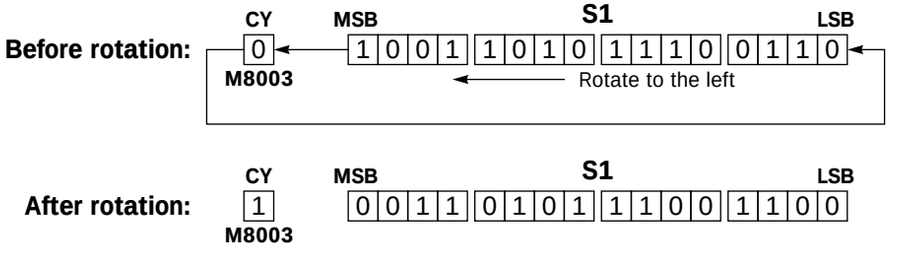
ROTLC (Rotate Left with Carry)



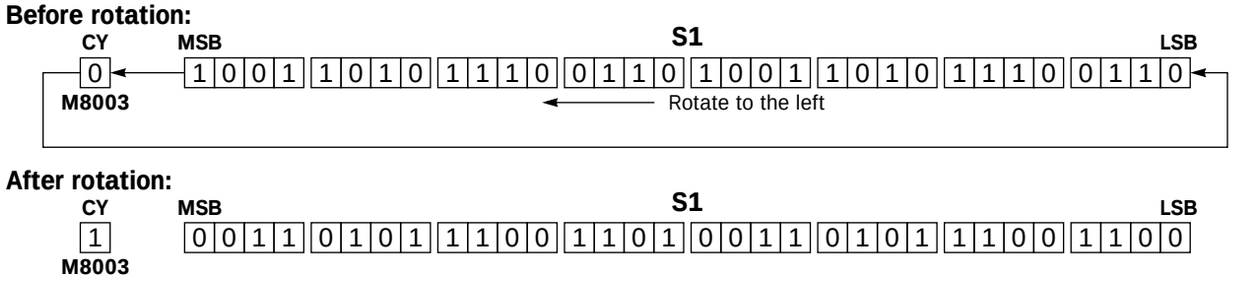
When input is on, the 16- or 32-bit data designated by S1 and a carry (special internal relay M8003) are rotated to the left by the quantity of bits designated by operand bits.

The last bit status rotated out of the source operand is set to a carry (M8003), and the carry status is set to the LSB of the source operand.

- **Data Type: Word (bits to rotate = 1)**



- **Data Type: Double Word (bits to rotate = 1)**



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for bit rotation	—	X	▲	X	—	—	X	X	—	—
bits	Quantity of bits to rotate	—	—	—	—	—	—	—	—	1-15, 1-31	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S1. Special internal relays cannot be designated as S1.

The quantity of bits to rotate can be 1 through 15 for the word data type, or 1 through 31 for the double-word data type.

Since the ROTLC instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

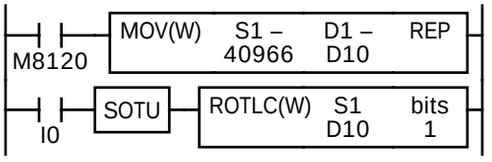
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as D (data register) or L (link register) is designated as the source, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: ROTLC

- **Data Type: Word**



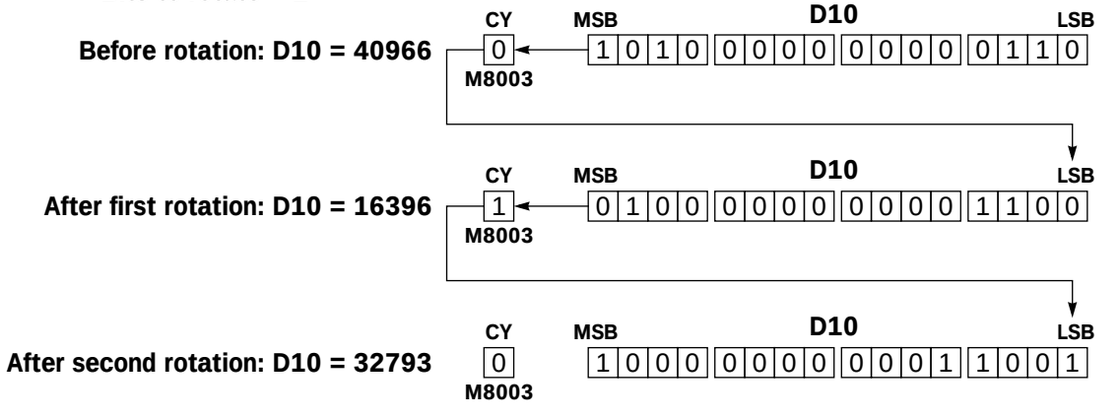
M8120 is the initialize pulse special internal relay.

When the CPU starts operation, the MOV (move) instruction sets 40966 to data register D10.

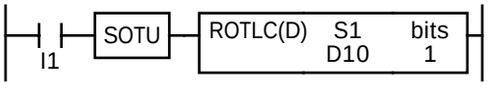
Each time input I0 is turned on, 16-bit data of data register D10 is rotated to the left by 1 bit as designated by operand bits.

The status of the MSB is set to a carry (special internal relay M8003), and the carry status is set to the LSB.

Bits to rotate = 1



- **Data Type: Double Word**

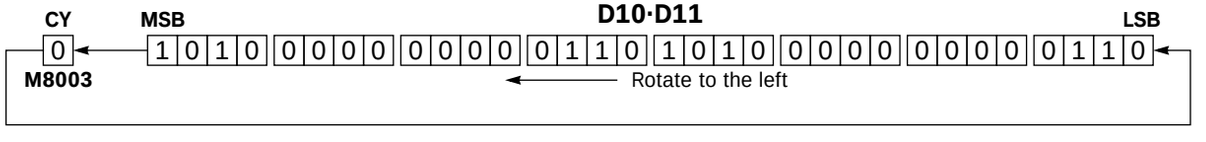


Each time input I1 is turned on, 32-bit data of data registers D10 and D11 is rotated to the left by 1 bit as designated by operand bits.

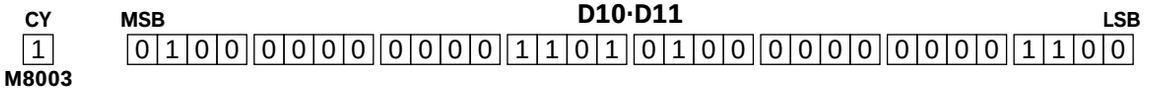
The status of the MSB is set to a carry (special internal relay M8003), and the carry status is set to the LSB.

Bits to rotate = 1

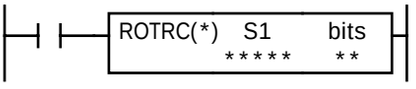
Before rotation: D10·D11 = 2,684,788,742



After rotation: D10·D11 = 1,074,610,188



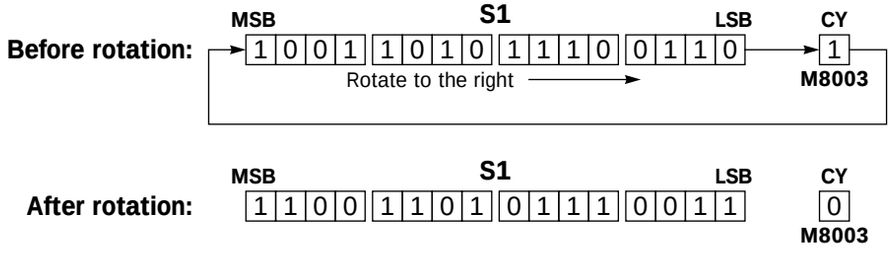
ROTRC (Rotate Right with Carry)



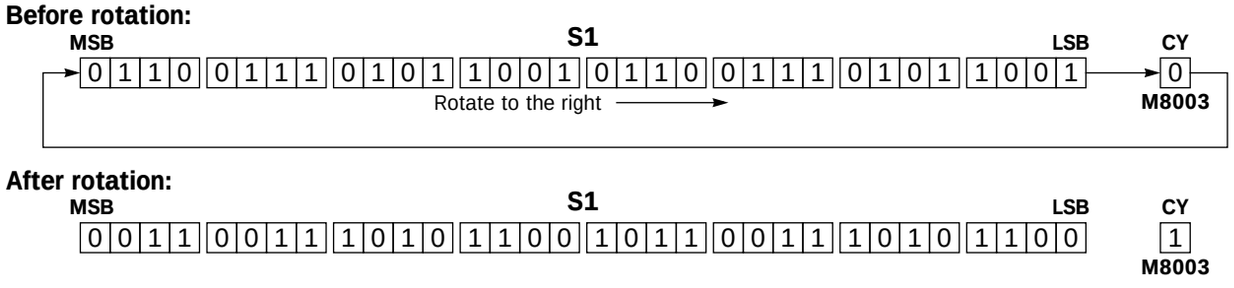
When input is on, the 16- or 32-bit data designated by S1 and a carry (special internal relay M8003) are rotated to the right by the quantity of bits designated by operand bits.

The last bit status rotated out of the source operand is set to a carry (M8003), and the carry status is set to the MSB of the source operand.

- **Data Type: Word (bits to rotate = 1)**



- **Data Type: Double Word (bits to rotate = 1)**



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for bit rotation	—	X	▲	X	—	—	X	X	—	—
bits	Quantity of bits to rotate	—	—	—	—	—	—	—	—	1-15, 1-31	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as S1. Special internal relays cannot be designated as S1.

The quantity of bits to rotate can be 1 through 15 for the word data type, or 1 through 31 for the double-word data type.

Since the ROTRC instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

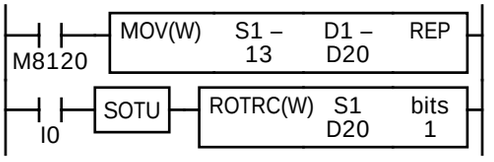
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as D (data register) or L (link register) is designated as the source, 1 point (word data type) or 2 points (double-word data type) are used.

Examples: ROTRC

- **Data Type: Word**



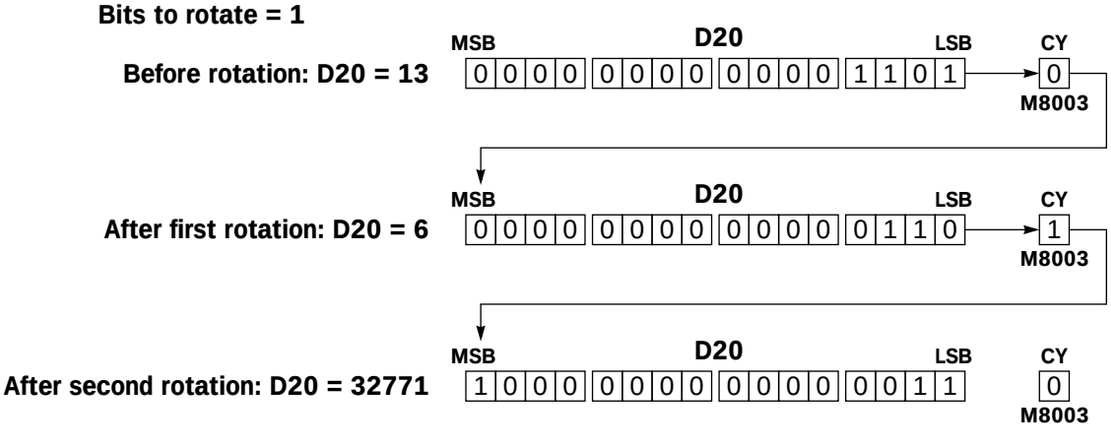
M8120 is the initialize pulse special internal relay.

When the CPU starts operation, the MOV (move) instruction sets 13 to data register D20.

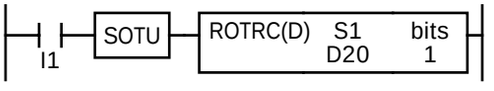
Each time input I0 is turned on, 16-bit data of data register D20 is rotated to the right by 1 bit as designated by operand bits.

The status of the LSB is set to a carry (special internal relay M8003), and the carry status is set to the MSB.

Bits to rotate = 1



- **Data Type: Double Word**

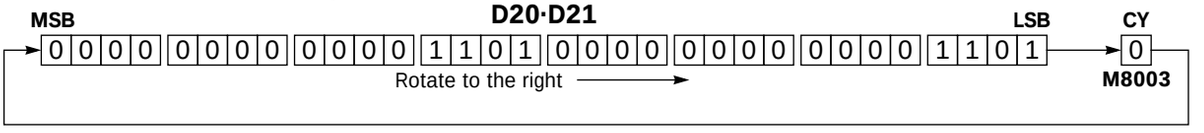


Each time input I1 is turned on, 32-bit data of data registers D20 and D21 is rotated to the right by 1 bit as designated by operand bits.

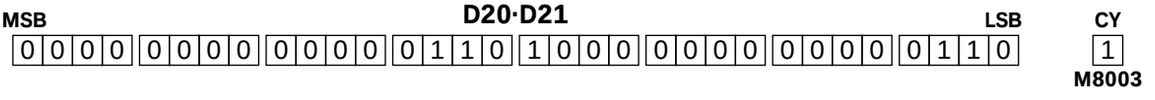
The status of the LSB is set to a carry (special internal relay M8003), and the carry status is set to the MSB.

Bits to rotate = 1

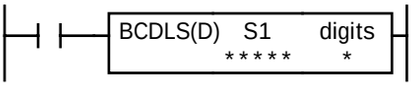
Before rotation: D20·D21 = 851,981



After rotation: D20·D21 = 425,990



BCDLS (BCD Left Shift)



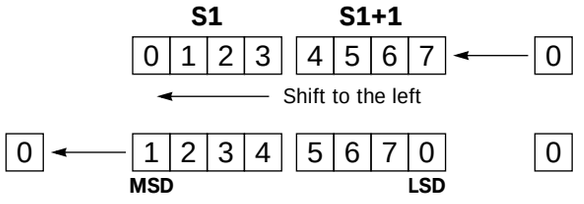
When input is on, the 32-bit binary data designated by S1 is converted into 8 BCD digits, shifted to the left by the quantity of digits designated by operand digits, and converted back to 32-bit binary data.

Valid values for each of S1 and S1+1 are 0 through 9999.

The quantity of digits to shift can be 1 through 7.

Zeros are set to the lowest digits as many as the digits shifted.

- **Data Type: Double Word (digits to shift = 1)**



Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data for BCD shift	—	—	—	—	—	—	X	X	—	—
digits	Quantity of digits to shift	—	—	—	—	—	—	—	—	1-7	—

For the valid operand number range, see page 6-2.

The quantity of digits to shift can be 1 through 7 for the double-word data type.

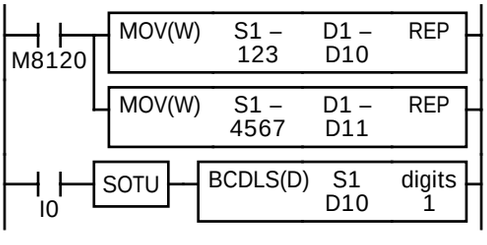
Make sure that the source data determined by S1 and S1+1 is between 0 and 9999 for each data register or link register. If either source data is over 9999, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
—	—	X	—

When a word operand such as D (data register) or L (link register) is designated as the source, 2 points (double-word type) are used.

Example: BCDLS



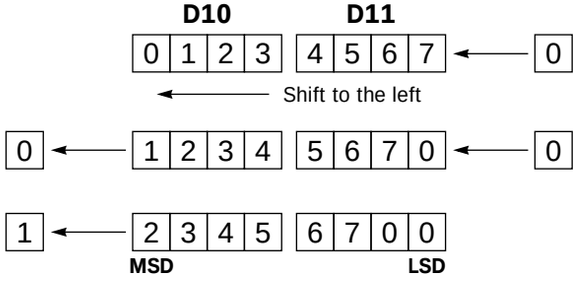
M8120 is the initialize pulse special internal relay.

When the CPU starts operation, the MOV (move) instructions set 123 and 4567 to data registers D10 and D11, respectively.

Each time input I0 is turned on, the 32-bit binary data of data registers D10 and D11 designated by S1 is converted into 8 BCD digits, shifted to the left by 1 digit as designated by operand digits, and converted back to 32-bit binary data.

Zeros are set to the lowest digits as many as the digits shifted.

- **Data Type: Double Word (digits to shift = 1)**



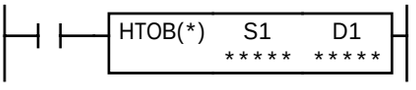
14: DATA CONVERSION INSTRUCTIONS

Introduction

Data conversion instructions are used to convert data format among binary, BCD, and ASCII.

Data divide and data combine instructions are used for conversion between byte data and word data.

HTOB (Hex to BCD)



S1 → D1

When input is on, the 16- or 32-bit data designated by S1 is converted into BCD and stored to the destination designated by operand D1.

Valid values for the source operand are 0 through 9999 for the word data type, and 0 through 9999 9999 for the double-word data type.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Binary data to convert	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Valid values for the source operand are 0 through 9999 (270Fh) for the word data type, and 0 through 9999 9999 (5F5 E0FFh) for the double-word data type. Make sure that the source designated by S1 is within the valid value range. If the source data is out of the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Since the HTOB instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

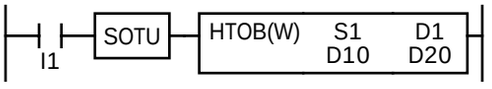
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

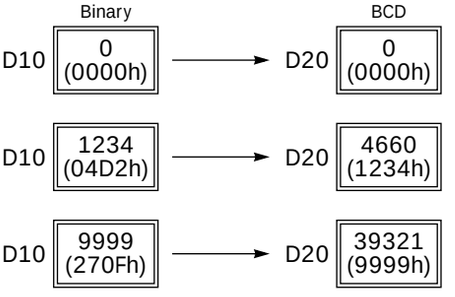
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) or 2 points (double-word data type) are used.

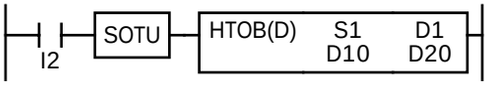
Examples: HTOB

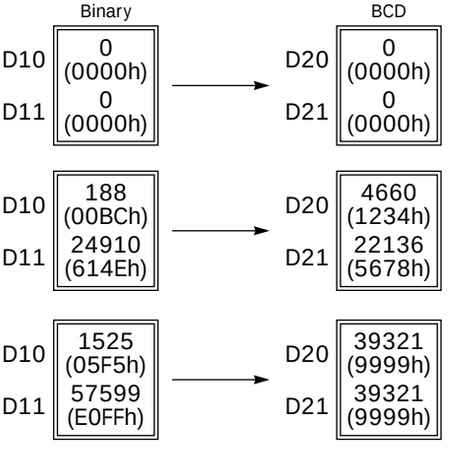
- **Data Type: Word**



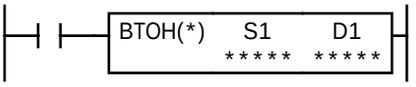


- **Data Type: Double Word**





BTOH (BCD to Hex)



S1 → D1

When input is on, the BCD data designated by S1 is converted into 16- or 32-bit binary data and stored to the destination designated by operand D1.

Valid values for the source operand are 0 through 9999 (BCD) for the word data type, and 0 through 9999 9999 (BCD) for the double-word data type.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	BCD data to convert	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S1, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Valid values for the source operand are 0 through 9999 (BCD) for the word data type, and 0 through 9999 9999 (BCD) for the double-word data type. Make sure that each digit of the source designated by S1 is 0 through 9. If the source data is out of the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Since the BTOH instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

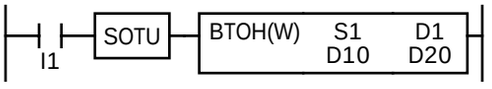
W (word)	I (integer)	D (double word)	L (long)
X	—	X	—

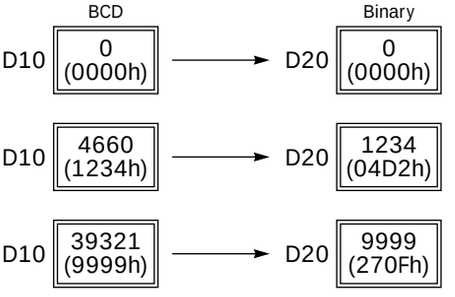
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word data type) or 32 points (double-word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) or 2 points (double-word data type) are used.

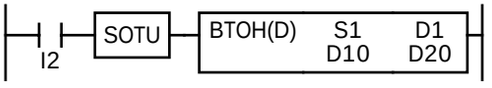
Examples: BTOH

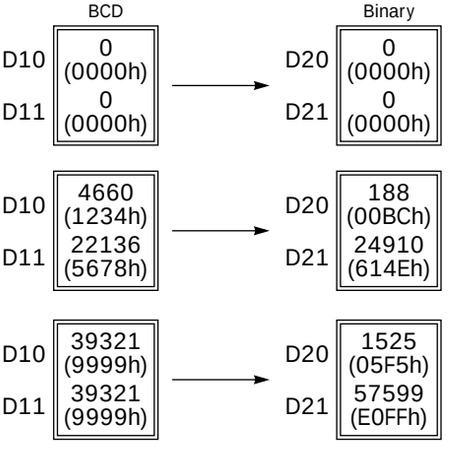
- **Data Type: Word**





- **Data Type: Double Word**





HTOA (Hex to ASCII)

S1 → D1, D1+1, D1+2, D1+3

When input is on, the 16-bit binary data designated by S1 is read from the lowest digit as many as the quantity of digits designated by S2, converted into ASCII data, and stored to the destination starting with the operand designated by D1.

The quantity of digits to convert can be 1 through 4.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Binary data to convert	X	X	X	X	X	X	X	X	X	—
S2 (Source 2)	Quantity of digits to convert	X	X	X	X	X	X	X	X	1-4	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S1 or S2, the timer/counter current value is read out.

The quantity of digits to convert can be 1 through 4. Make sure that the quantity of digits designated by S2 is within the valid range. If the S2 data is out of the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Since the HTOA instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

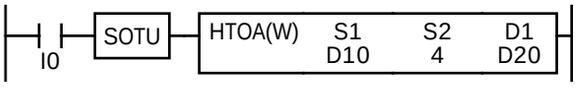
W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

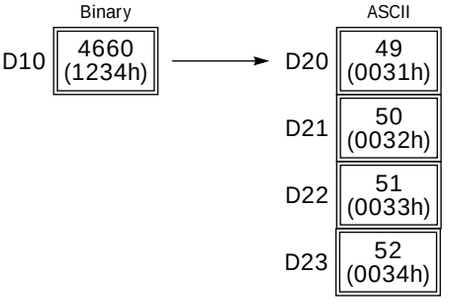
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

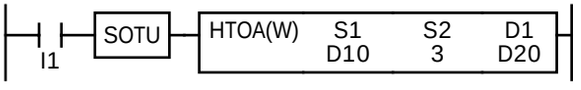
Examples: HTOA

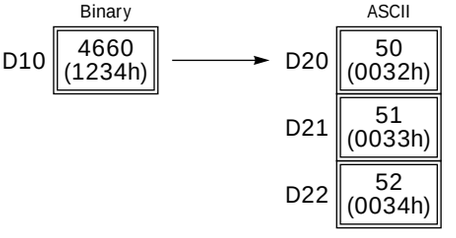
- **Quantity of Digits: 4**



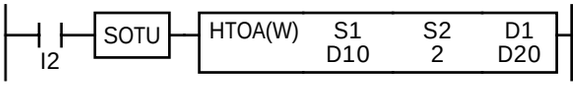


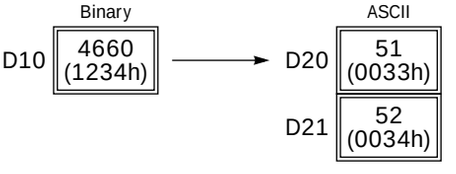
- **Quantity of Digits: 3**



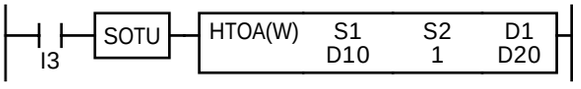


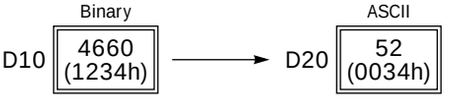
- **Quantity of Digits: 2**





- **Quantity of Digits: 1**





ATOH (ASCII to Hex)

S1, S1+1, S1+2, S1+3 → D1

When input is on, the ASCII data designated by S1 as many as the quantity of digits designated by S2 is converted into 16-bit binary data, and stored to the destination designated by operand D1.

Valid values for source data to convert are 30h to 39h and 41h to 46h.

The quantity of digits to convert can be 1 through 4.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	ASCII data to convert	—	—	—	—	—	—	X	X	—	—
S2 (Source 2)	Quantity of digits to convert	X	X	X	X	X	X	X	X	1-4	—
D1 (Destination 1)	Destination to store conversion results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S2, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Valid values for source S1 data to convert are 30h to 39h and 41h to 46h. Make sure that the values for each source designated by S1 and the quantity of digits designated by S2 are within the valid range. If the S1 or S2 data is out of the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Since the ATOH instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

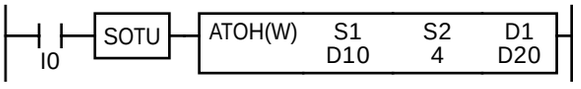
W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

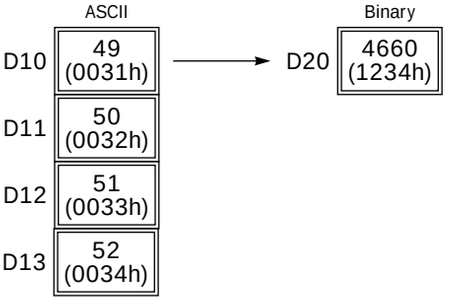
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

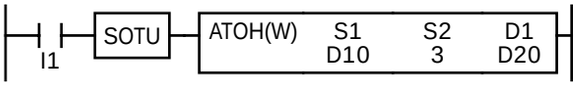
Examples: ATOH

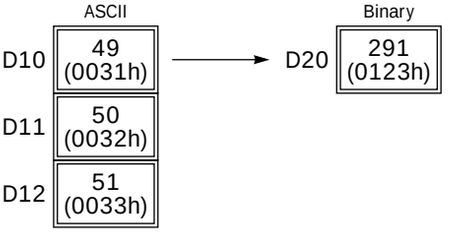
- **Quantity of Digits: 4**



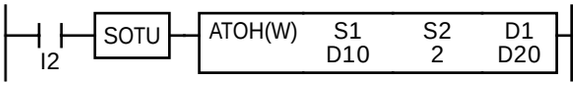


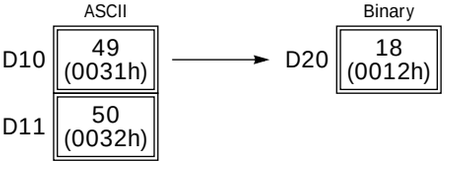
- **Quantity of Digits: 3**



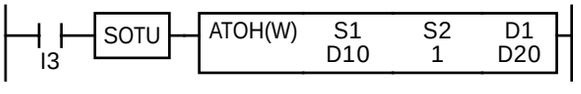


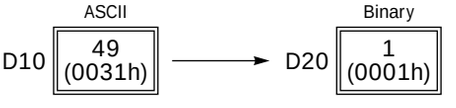
- **Quantity of Digits: 2**





- **Quantity of Digits: 1**





BTOA (BCD to ASCII)

S1 → D1, D1+1, D1+2, D1+3, D1+4

When input is on, the 16-bit binary data designated by S1 is converted into BCD, and converted into ASCII data. The data is read from the lowest digit as many as the quantity of digits designated by S2. The result is stored to the destination starting with the operand designated by D1.

The quantity of digits to convert can be 1 through 5.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Binary data to convert	X	X	X	X	X	X	X	X	X	—
S2 (Source 2)	Quantity of digits to convert	X	X	X	X	X	X	X	X	1-5	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S1 or S2, the timer/counter current value is read out.

The quantity of digits to convert can be 1 through 5. Make sure that the quantity of digits designated by S2 is within the valid range. If the S2 data is out of the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Since the BTOA instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

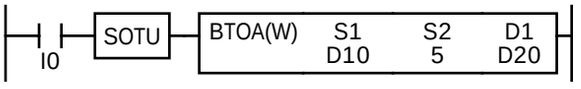
W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

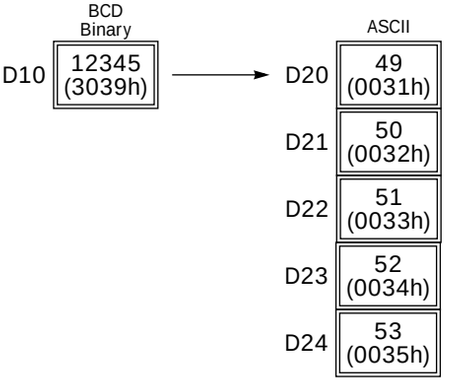
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

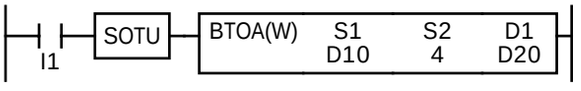
Examples: BTOA

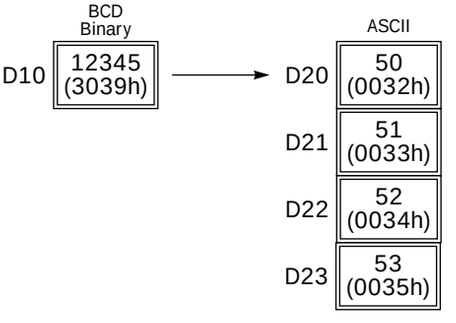
- **Quantity of Digits: 5**



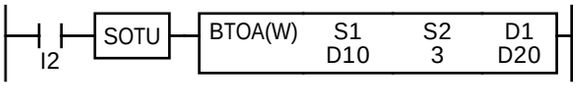


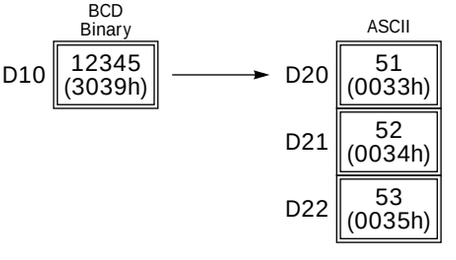
- **Quantity of Digits: 4**



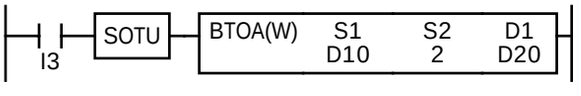


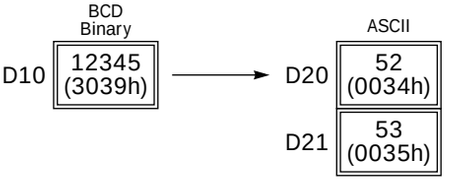
- **Quantity of Digits: 3**



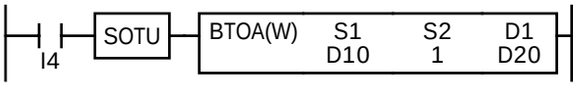


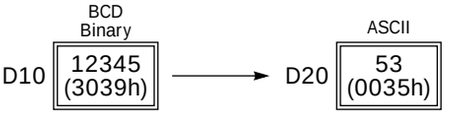
- **Quantity of Digits: 2**





- **Quantity of Digits: 1**





ATOB (ASCII to BCD)

S1, S1+1, S1+2, S1+3, S1+4 → D1

When input is on, the ASCII data designated by S1 as many as the quantity of digits designated by S2 is converted into BCD, and converted into 16-bit binary data. The result is stored to the destination designated by operand D1.

Valid values for source data to convert are 30h through 39h.

The quantity of digits to convert can be 1 through 5.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	ASCII data to convert	—	—	—	—	—	—	X	X	—	—
S2 (Source 2)	Quantity of digits to convert	X	X	X	X	X	X	X	X	1-5	—
D1 (Destination 1)	Destination to store conversion results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S2, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Valid values for source S1 data to convert are 30h through 39h. Make sure that the values for each source designated by S1 and the quantity of digits designated by S2 are within the valid range. If the S1 or S2 data is out of the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Since the ATOB instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

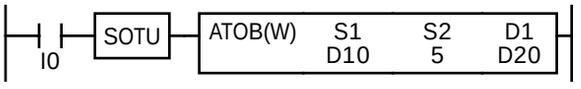
W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

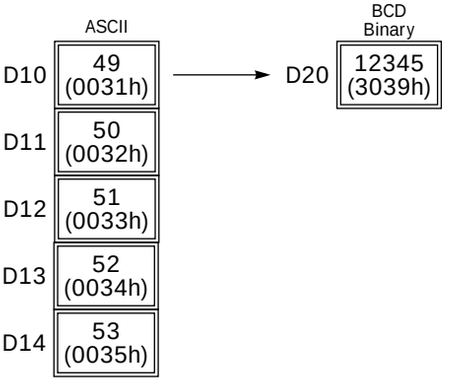
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

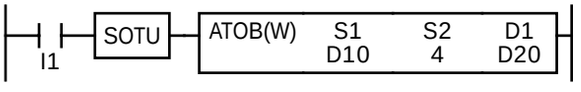
Examples: ATOB

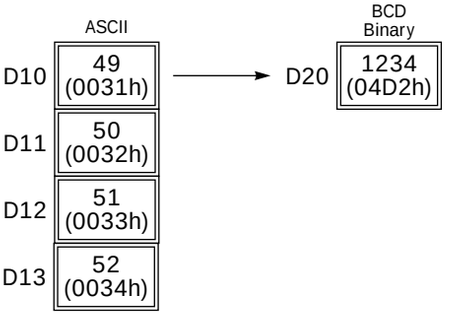
- **Quantity of Digits: 5**



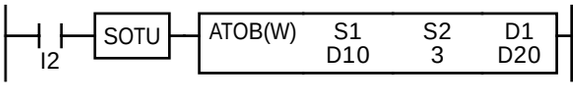


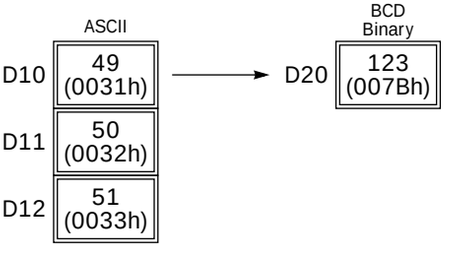
- **Quantity of Digits: 4**



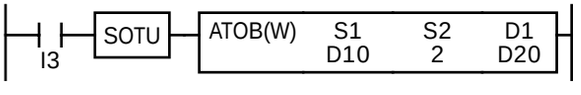


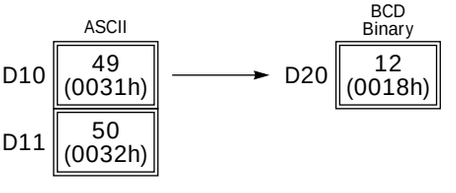
- **Quantity of Digits: 3**



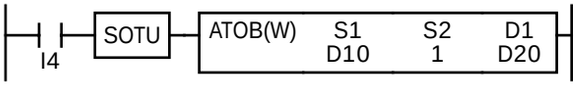


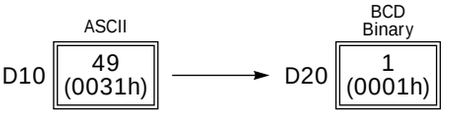
- **Quantity of Digits: 2**



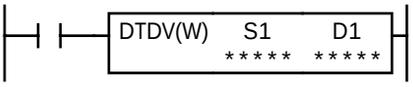


- **Quantity of Digits: 1**





DTDV (Data Divide)



S1 → D1, D1+1

When input is on, the 16-bit binary data designated by S1 is divided into upper and lower bytes.

When a data register is selected as destination operand, the upper byte data is stored to the destination designated by operand D1. The lower byte data is stored to the operand next to D1.

When a link register is selected as destination operand, the lower byte data is stored to the destination designated by operand D1. The upper byte data is stored to the operand next to D1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Binary data to divide	X	X	X	X	X	X	X	X	X	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S1, the timer/counter current value is read out.

Since the DTDV instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

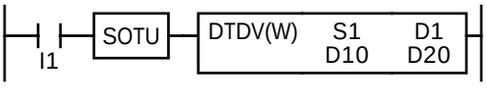
W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

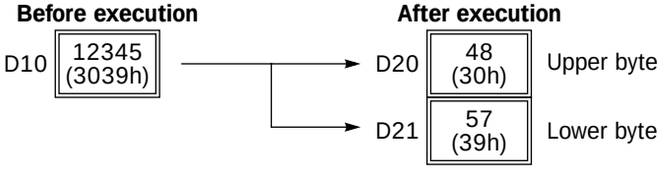
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

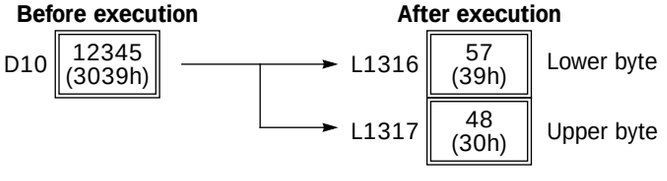
Examples: DTDV

- **Destination Operand: Data Register**

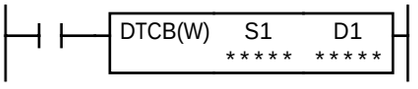




- **Destination Operand: Link Register**



DTCB (Data Combine)



S1, S1+1 → D1

When input is on, the lower-byte data is read out from 2 consecutive sources starting with operand designated by S1 and combined to make 16-bit data.

When a data register is selected as source operand, the lower byte data from the first source operand is moved to the upper byte of the destination designated by operand D1, and the lower byte data from the next source operand is moved to the lower byte of the destination.

When a link register is selected as source operand, the lower byte data from the first source operand is moved to the lower byte of the destination designated by operand D1, and the lower byte data from the next source operand is moved to the upper byte of the destination.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Binary data to combine	—	—	—	—	—	—	X	X	—	—
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

Since the DTCB instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Valid Data Types

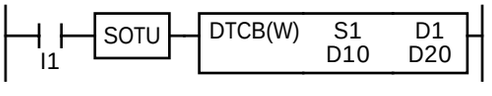
W (word)	I (integer)	D (double word)	L (long)
X	—	—	—

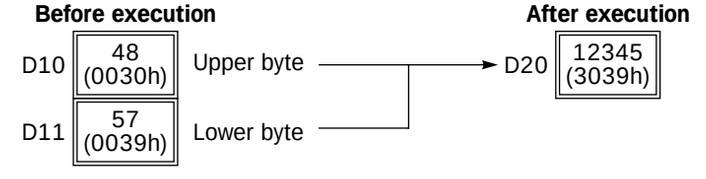
When a bit operand such as Q (output), M (internal relay), or R (shift register) is designated as the destination, 16 points (word data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word data type) is used.

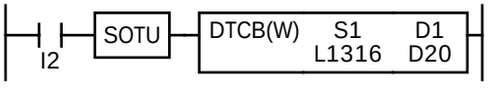
Example: DTCB

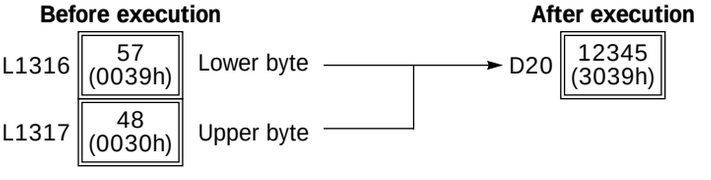
- **Source Operand: Data Register**





- **Source Operand: Link Register**





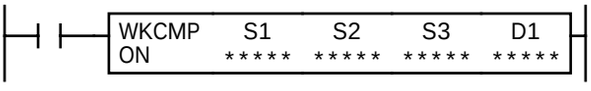
15: WEEK PROGRAMMER INSTRUCTIONS

Introduction

WKCMP instructions can be used as many as required to turn on and off designated output and internal relays at predetermined times and days of the week.

Once the internal calendar/clock is set, the WKCMP ON and OFF instructions compare the predetermined time with the internal clock. When the preset time is reached, internal relay or output designated as destination operand is turned on or off as scheduled.

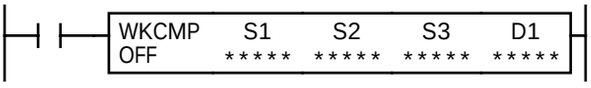
WKCMP ON (Week Compare ON)



When input is on, the WKCMP ON compares the S1 and S2 preset data with the current day and time.

When the current day and time reach the presets, an output or internal relay designated by operand D1 is turned on, depending on the week table output control designated by S3.

WKCMP OFF (Week Compare OFF)



When input is on, the WKCMP OFF compares the S1 and S2 preset data with the current day and time.

When the current day and time reach the presets, an output or internal relay designated by operand D1 is turned off, depending on the week table output control designated by S3.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Day of week comparison data	X	X	X	X	X	X	X	X	0-127	—
S2 (Source 2)	Hour/minute comparison data	X	X	X	X	X	X	X	X	0-2359	—
S3 (Source 3)	Week table output control	X	X	X	X	X	X	X	X	0-2	—
D1 (Destination 1)	Comparison ON output (WKCMP ON) Comparison OFF output (WKCMP OFF)	—	X	▲	—	—	—	—	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1. When T (timer) or C (counter) is used as S1, S2, or S3, the timer/counter current value is read out.

S1 — Day of week comparison data (0 through 127)

Specify the days of week to turn on (WKCMP ON) or to turn off (WKCMP OFF) the output or internal relay designated by D1.

Day of Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Bit Position	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6
ON/OFF Value	1	2	4	8	16	32	64

Designate the total of the ON/OFF values as operand S1 to turn on or off the output or internal relay.

Example: To turn on the output on Mondays through Fridays, designate 62 as S1 because 2 + 4 + 8 + 16 + 32 = 62.

S2 — Hour/minute comparison data

Specify the hours and minutes to turn on (WKCMP ON) or to turn off (WKCMP OFF) the output or internal relay designated by D1.

See the table on the next page.

Hour	Minute
00 through 23	00 through 59

Example: To turn on the output or internal relay at 8:30 a.m. using the WKCMP ON instruction, designate 830 as S2. To turn off the output or internal relay at 5:05 p.m. using the WKCMP OFF instruction, designate 1705 as S2.

S3 — Week table output control (0 through 2)

0: Disable the week table

When the current day and time reach the presets for S1 and S2, the designated output or internal relay is turned on (WKCMP ON) or turned off (WKCMP OFF). Set 0 for S3 when the WKTBL is not used; the WKTBL instruction is ignored even if it is programmed.

1: Additional days in the week table

When the current time reaches the hour/minute comparison data set for S2 on the special day programmed in the WKTBL, the designated output or internal relay is turned on (WKCMP ON) or turned off (WKCMP OFF).

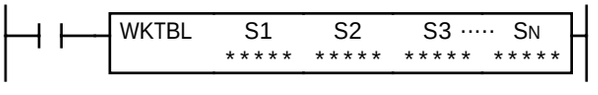
2: Skip days in the week table

On the special day programmed in the WKTBL, the designated output or internal relay is not turned on or off, even when the current day and time reach the presets for S1 and S2.

Note: When 1 or 2 is set for S3, program special days in the week table using the WKTBL instruction. If the WKTBL instruction is not programmed when 1 or 2 is set for S3 in the WKCMP ON or WKCMP OFF instruction, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Make sure that the values set for S1, S2, and S3 are within the valid ranges. If any data is over the valid value, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

WKTBL (Week Table)



S1, S2, S3, ... , SN → Week Table

When input is on, N blocks of special month/day data in operands designated by S1, S2, S3, ... , SN are set to the week table.

The quantity of special days can be up to 50.

The special days stored in the week table are used to add or skip days to turn on or off the comparison outputs programmed in subsequent WKCMP ON or WKCMP OFF instructions.

The WKTBL must precede the WKCMP instructions.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Special month/day data	X	X	X	X	X	X	X	X	101-1231	—

For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S1 through SN, the timer/counter current value is read out.

S1 through SN — Special month/day data

Specify the months and days to add or skip days to turn on or off the comparison outputs programmed in WKCMP ON or WKCMP OFF instructions.

Month	Day
01 through 12	01 through 31

Example: To set July 4 as a special day, designate 704 as S1.

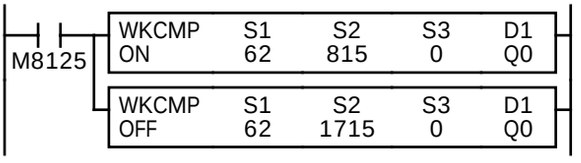
Make sure that the values set for S1 through SN are within the valid ranges. If any data is over the valid value, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Examples: WKCMP ON / OFF

• Without Special Days (S3 = 0)

This example is the basic program for week programmer application without using the WKTBL (week table) instruction. While the CPU is running, the WKCMP ON and WKCMP OFF compare the S1 and S2 preset data with the current day and time.

When the current day and time reach the presets, an output designated by operand D1 is turned on and off.



M8125 is the in-operation output special internal relay.

S1 (62) specifies Monday through Friday.

The WKCMP ON turns on output Q0 at 8:15 on Monday through Friday.

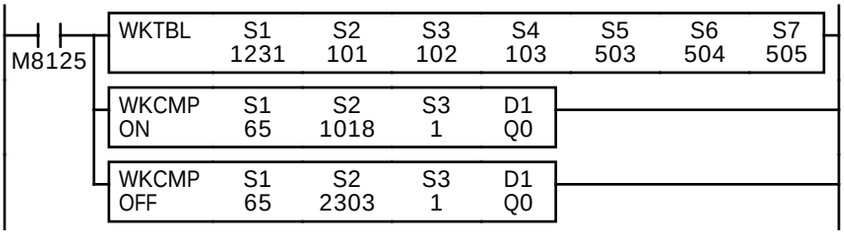
The WKCMP OFF turns off output Q0 at 17:15 on Monday through Friday.

• With Additional Days in the Week Table (S3 = 1)

When the current time reaches the hour/minute preset time on the special days programmed in the WKTBL, the designated output is turned on (WKCMP ON) or turned off (WKCMP OFF). In addition, the designated output is turned on and off every week as designated by operand S1 of WKCMP.

In normal execution, when the current day and time coincide with the preset day (S1) and time (S2), the designated output is turned on or off. Execution on the special days has precedence over execution on normal days.

This example demonstrates operation on special days in addition to regular weekends. The output is turned on from 10:18 a.m. to 11:03 p.m. on every Saturday and Sunday. Without regard to the day of week, the output is also turned on December 31 through January 3, and May 3 through May 5.



WKTBL designates Dec. 31 to Jan. 3 and May 3 to May 5 as special days.

S1 (65) specifies Saturday and Sunday. S3 (1) adds special days.

WKCMP ON turns on output Q0 at 10:18 on every Saturday, Sunday, and special days.

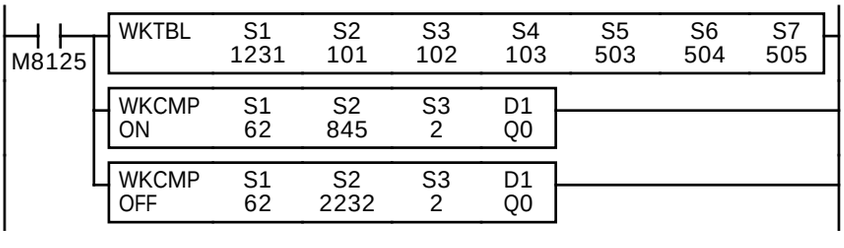
The WKCMP OFF turns off output Q0 at 23:03 on the same days.

• With Skip Days in the Week Table (S3 = 2)

On the special days programmed in the WKTBL, the designated output is *not* turned on or off, while the designated output is turned on and off every week as designated by operand S1 of WKCMP.

In normal execution, when the current day and time coincide with the preset day (S1) and time (S2), the designated output is turned on or off. Execution on the special days has precedence over execution on normal days.

This example is demonstrates operation aborted on special days. The output is turned on from 8:45 a.m. to 10:32 p.m. on every Monday through Friday, but is not turned on December 31 through January 3, and May 3 through May 5.



WKTBL designates Dec. 31 to Jan. 3 and May 3 to May 5 as special days.

S1 (62) specifies Monday to Friday. S3 (2) skips special days.

WKCMP ON turns on output Q0 at 8:45 on every Monday through Friday except on special days.

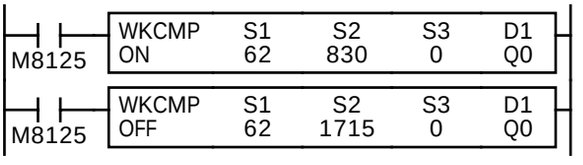
The WKCMP OFF turns off output Q0 at 22:32 on the same days.

Interval Comparison in WKCMP ON/OFF Instructions

The WKCMP ON/OFF instructions compare the current day and time with the preset values designated by operands S1 and S2. When the current day and time reach the presets, the WKCMP turns on or off the output or internal relay designated by destination operand D1. When the WKCMP ON/OFF instructions are programmed as described below, interval comparison among the current day/time and presets is performed to reflect the comparison result on the comparison output. With the WKCMP ON/OFF instructions programmed for interval comparison, the comparison output status is ensured when the CPU restarts operation after interruption; the output is turned on or off as appropriate.

⚠ Caution

- The program shown below does not make an interval comparison because the WKCMP ON and WKCMP OFF instruction have separate input contacts.



We strongly recommend the use of the interval comparison to ensure outputs as programmed when the CPU is restarted.

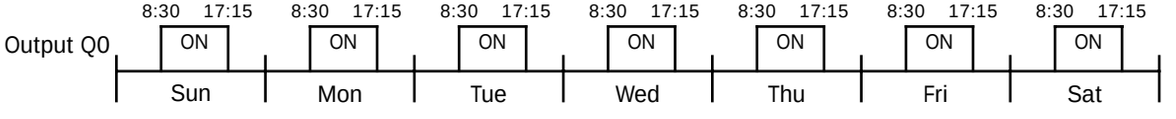
Conditions for Interval Comparison with ON/OFF Times on the Same Day

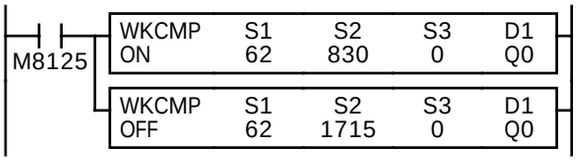
When the three conditions shown below are satisfied, the interval comparison is enabled. Otherwise, the instructions work as ordinary clock data comparison instructions.

1. WKCMP ON is followed by WKCMP OFF immediately, which has the same input contact.
2. The matching WKCMP ON and WKCMP OFF instructions have the same values for the day of week comparison data (S1: constant), week table output control (S3), and comparison output operand (D1).
3. Hour/minute comparison data (S2: constant) has a relationship: ON time < OFF time.

Example: Interval comparison with ON/OFF times on the same day

When the current day and time reach the presets, the output designated by operand D1 is turned on and off.





S1: Same constant value
S2: Constant values; ON time < OFF time
S3: Same constant value
D1: Same operand

M8125 is the in-operation output special internal relay.

S1 (62) specifies Monday through Friday.

WKCMP ON turns on output Q0 at 8:30 on Monday through Friday.

WKCMP OFF turns off output Q0 at 17:15 on the same day.

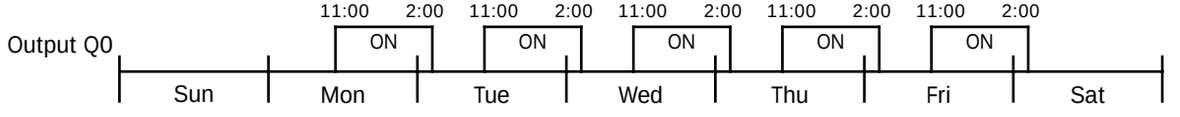
Conditions for Interval Comparison with ON / OFF Times on Different Days

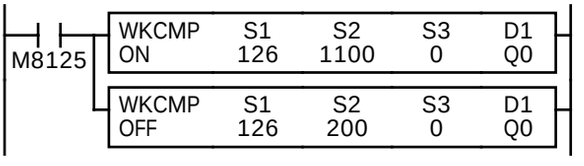
When WKCMP ON and WKCMP OFF instructions are programmed to turn on and off the output on different days, the five conditions shown below are needed to enable the interval comparison. Otherwise, the instructions work as ordinary clock data comparison instructions.

1. WKCMP ON is followed by WKCMP OFF immediately, which has the same input contact.
2. The matching WKCMP ON and WKCMP OFF instructions have the same values for the day of week comparison data (S1: constant). When S1 is set to 0, the instructions work without designation of day of week. Set S1 to 0 or a value to designate consecutive days, such as 6 for Monday and Tuesday, 56 for Wednesday through Friday, or 65 for Saturday and Sunday. Do not set S1 to a value to designate a single day, such as 32 for Friday only, or 127 to designate all days.
3. Hour/minute comparison data (S2: constant) has a relationship: ON time > OFF time.
4. The matching WKCMP ON and WKCMP OFF instructions have 0 set for the week table output control (S3) to disable use of the week table.
5. The matching WKCMP ON and WKCMP OFF instructions have the same comparison output operand (D1).

Example: Interval comparison with ON / OFF times on different days — 1

The output is turned on at 11:00 a.m. on Monday through Friday, and is turned off at 2:00 a.m. on the following day.





S1: Same constant value to designate consecutive days
S2: Constant values; ON time > OFF time
S3: Same constant value 0
D1: Same operand

M8125 is the in-operation output special internal relay.

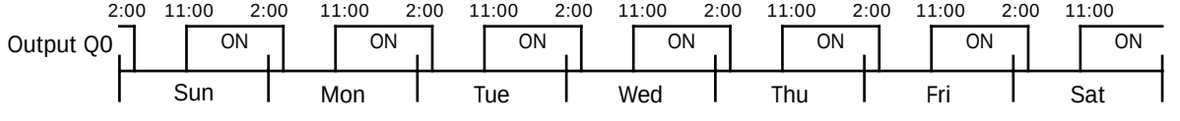
S1 (126) specifies Monday through Saturday.

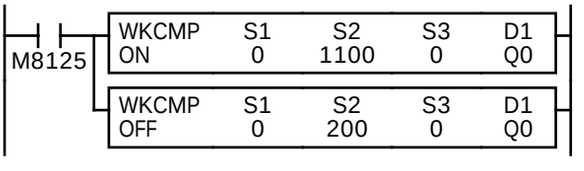
WKCMP ON turns on output Q0 at 11:00 a.m. on Monday through Friday.

WKCMP OFF turns off output Q0 at 2:00 a.m. on the next day.

Example: Interval comparison with ON / OFF times on different days — 2

The output is turned on at 11:00 a.m. every day, and is turned off at 2:00 a.m. on the following day.





S1: Same constant value to designate consecutive days
S2: Constant values; ON time > OFF time
S3: Same constant value 0
D1: Same operand

M8125 is the in-operation output special internal relay.

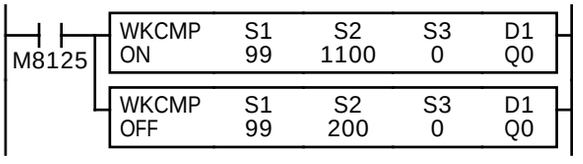
S1 (0) specifies all days.

WKCMP ON turns on output Q0 at 11:00 a.m. everyday.

WKCMP OFF turns off output Q0 at 2:00 a.m. on the next day.

Example: Interval comparison with ON/OFF times on different days — 3

The output is turned on at 11:00 a.m. on Friday through Sunday, and is turned off at 2:00 a.m. on the following day.



S1: Same constant value to designate consecutive days
S2: Constant values; ON time > OFF time
S3: Same constant value 0
D1: Same operand

M8125 is the in-operation output special internal relay.

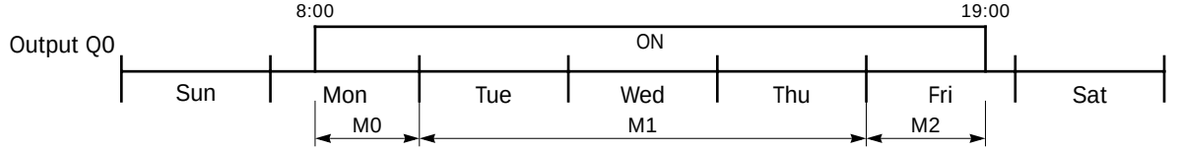
S1 (99) specifies Friday through Monday.

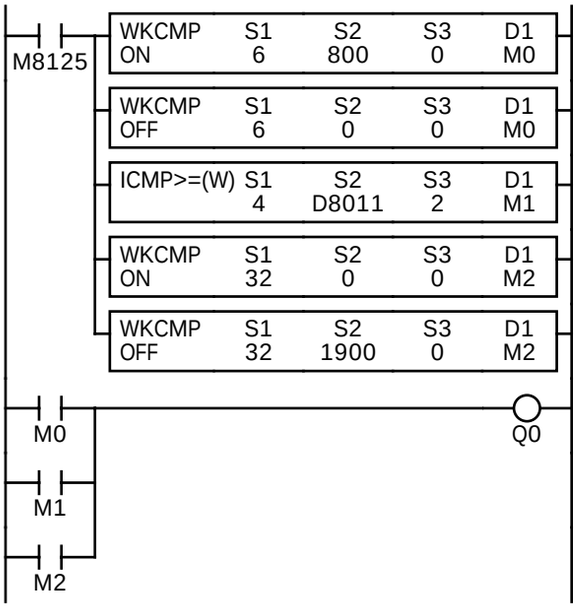
WKCMP ON turns on output Q0 at 11:00 a.m. on Friday through Sunday.

WKCMP OFF turns off output Q0 at 2:00 a.m. on the next day.

Example: Interval comparison with ON/OFF times extending over three days

To keep the output on for more than two days, use the ICMP≥ (interval compare greater than or equal to) instruction in combination with the WKCMP ON/OFF instructions. This example turns on the output at 8:00 a.m. on Monday and turn it off at 7:00 p.m. on Friday.





M8125 is the in-operation output special internal relay.

S1 (6) specifies Monday and Tuesday.

WKCMP ON turns on M0 at 8:00 a.m. on Monday.

WKCMP OFF turns off M0 at 0:00 a.m. on Tuesday.

D8011 contains the current day of week data. S1 (4) specifies Thursday. S3 (2) specifies Tuesday. See page 15-7. M1 remains on from Tuesday through Thursday.

S1 (32) specifies Friday.

WKCMP ON turns on M2 at 0:00 a.m. on Friday.

WKCMP OFF turns off M2 at 19:00 on Friday.

While M0, M1, or M2 is on, output Q0 is turned on.

Setting Calendar / Clock Using WindLDR

Before using the week programmer instructions for the first time, the internal calendar/clock must be set using WindLDR or executing a user program to transfer correct calendar/clock data to special data registers allocated to the calendar/clock. Once the calendar/clock data is stored, the data is held by the backup battery while the CPU power is turned off.

1. Select **Online** from the WindLDR menu bar, then select **Monitor**. The screen display changes to the monitor window.
2. From the **Online** menu, select **PLC Status**. The OpenNet PLC Status dialog box is displayed. The current calendar/clock data is read out from the OpenNet Controller CPU and displayed in the Calendar box.
3. Click the **Change** button in the Calendar box. The Set Calendar and Time dialog box comes up with the date and time values read from the computer internal clock.

4. Click the **Down Arrow** button on the right of **Calendar**, then the calendar is displayed where you can change the year, month, and date. Enter or select new values.
5. To change hours and minutes, click in the **Time** box, and type a new value or use the up/down keys. When new values are entered, click the **OK** button to transfer the new values to the CPU.

Setting Calendar / Clock Using a User Program

Another way of setting the calendar/clock data is to move the values to special data registers dedicated to the calendar and clock and to turn on special internal relay M8020 by executing a user program. Data registers D8015 through D8021 do not hold the current values of the calendar/clock data but hold unknown values before executing a user program.

Calendar / Clock Special Data Registers

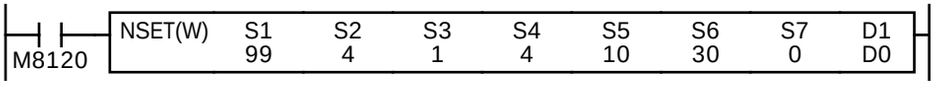
Data Register No.	Data	Value	Read / Write	Updated
D8008	Year (current data)	0 to 99	Read only	100 msec or one scan time whichever is larger
D8009	Month (current data)	1 to 12		
D8010	Day (current data)	1 to 31		
D8011	Day of week (current data)	0 to 6 (Note)		
D8012	Hour (current data)	0 to 23		
D8013	Minute (current data)	0 to 59		
D8014	Second (current data)	0 to 59		
D8015	Year (new data)	0 to 99	Write only	Not updated
D8016	Month (new data)	1 to 12		
D8017	Day (new data)	1 to 31		
D8018	Day of week (new data)	0 to 6 (Note)		
D8019	Hour (new data)	0 to 23		
D8020	Minute (new data)	0 to 59		
D8021	Second (new data)	0 to 59		

Note: The day of week value is assigned for both current and new data as follows:

0	1	2	3	4	5	6
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

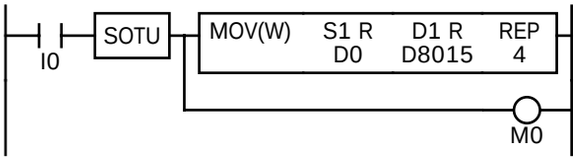
Example: Setting Calendar / Clock Data

This example demonstrates how to set calendar/clock data using a ladder program. After storing new calendar/clock data into data registers D8015 through D8021, special internal relay M8020 (calendar/clock data write flag) must be turned on to set the new calendar/clock data to the CPU.

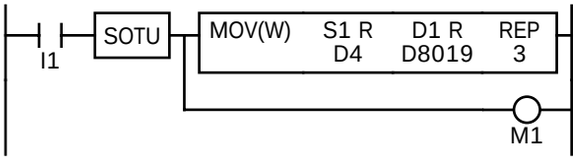


M8120 is the initialize pulse special internal relay.

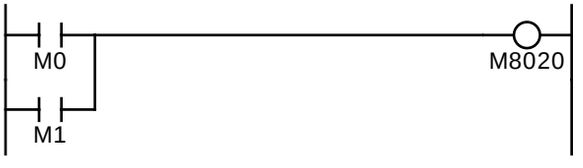
When the CPU starts, the NSET moves calendar/clock data to data registers D0 through D6.



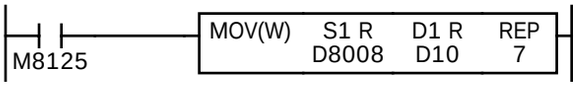
When input I0 turns on, new calendar data (year, month, day, and day of week) are moved to data registers D8015 through D8018, and internal relay M0 is turned on for 1 scan time.



When input I1 turns on, new clock data (hour, minute, and second) are moved to data registers D8019 through D8021, and internal relay M1 is turned on for 1 scan time.



When either M0 or M1 is turned on, calendar/clock data write flag special internal relay M8020 is turned on to set the new calendar/clock data to the CPU.



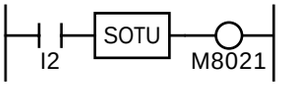
M8125 is the in-operation output special internal relay.

While the CPU is running, the MOV(W) moves current calendar/clock data to data registers D10 through D16.

Adjusting Clock Using a User Program

Special internal relay M8021 (clock data adjust flag) is provided for adjusting the clock data. When M8021 is turned on, the clock is adjusted with respect to seconds. If *seconds* are between 0 and 29 for current time, adjustment for *seconds* will be set to 0 and minutes remain the same. If *seconds* are between 30 and 59 for current time, adjustment for *seconds* will be set to 0 and *minutes* are incremented one. M8021 is useful for precise timing which starts at zero seconds.

Example: Adjusting Calendar / Clock Data



When input I2 turns on, clock data adjust flag special internal relay M8021 is turned on and the clock is adjusted with respect to seconds.

16: INTERFACE INSTRUCTIONS

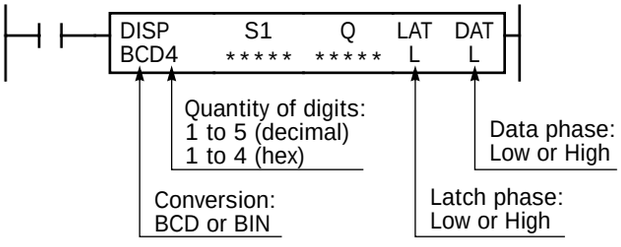
Introduction

The DISP (display) instruction is used to display 1 through 5 digits of timer/counter current values and data register data on 7-segment display units.

The DGRD (digital read) instruction is used to read 1 through 5 digits of digital switch settings to a data register. This instruction is useful to change preset values for timers and counters using digital switches.

The CDISP (character display) instruction is used to display a maximum of 16 characters on dot matrix display units.

DISP (Display)



When input is on, data designated by source operand S1 is set to outputs or internal relays designated by operand Q. This instruction is used to output 7-segment data to display units.

Eight DISP instructions can be used in a user program.

Display data can be 0 through 65535 (FFFFh).

Note: The DISP instruction can be used on transistor output modules only.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data to display	—	—	—	—	X	X	X	—	—	—
Q (Output)	First output number to display data	—	X	▲	—	—	—	—	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as Q. Special internal relays cannot be designated as Q. When T (timer) or C (counter) is used as S1, the timer/counter current value is read out.

Conversion

BCD: To connect BCD (decimal) display units
BIN: To connect BIN (hexadecimal) display units

Latch Phase and Data Phase

Select the latch and data phases to match the phases of the display units in consideration of sink or source output of the OpenNet Controller output module.

Output Points

The quantity of required output points is 4 plus the quantity of digits to display. When displaying 4 digits with output Q0 designated as the first output number, 8 consecutive output points must be reserved starting with Q0 through Q7.

Display Processing Time

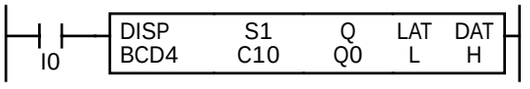
Displaying numerical data requires the following time after the input to the DISP instruction is turned on. Keep the input to the DISP instruction for the period of time shown below to process the display data.

Scan Time	Display Processing Time
5 msec or more	3 scan times × Quantity of digits

When the scan time is less than 5 msec, the data cannot be displayed correctly. When the scan time is too short to ensure normal display, set a value of 6 or more (in msec) to special data register D8022 (constant scan time preset value). See page 5-20.

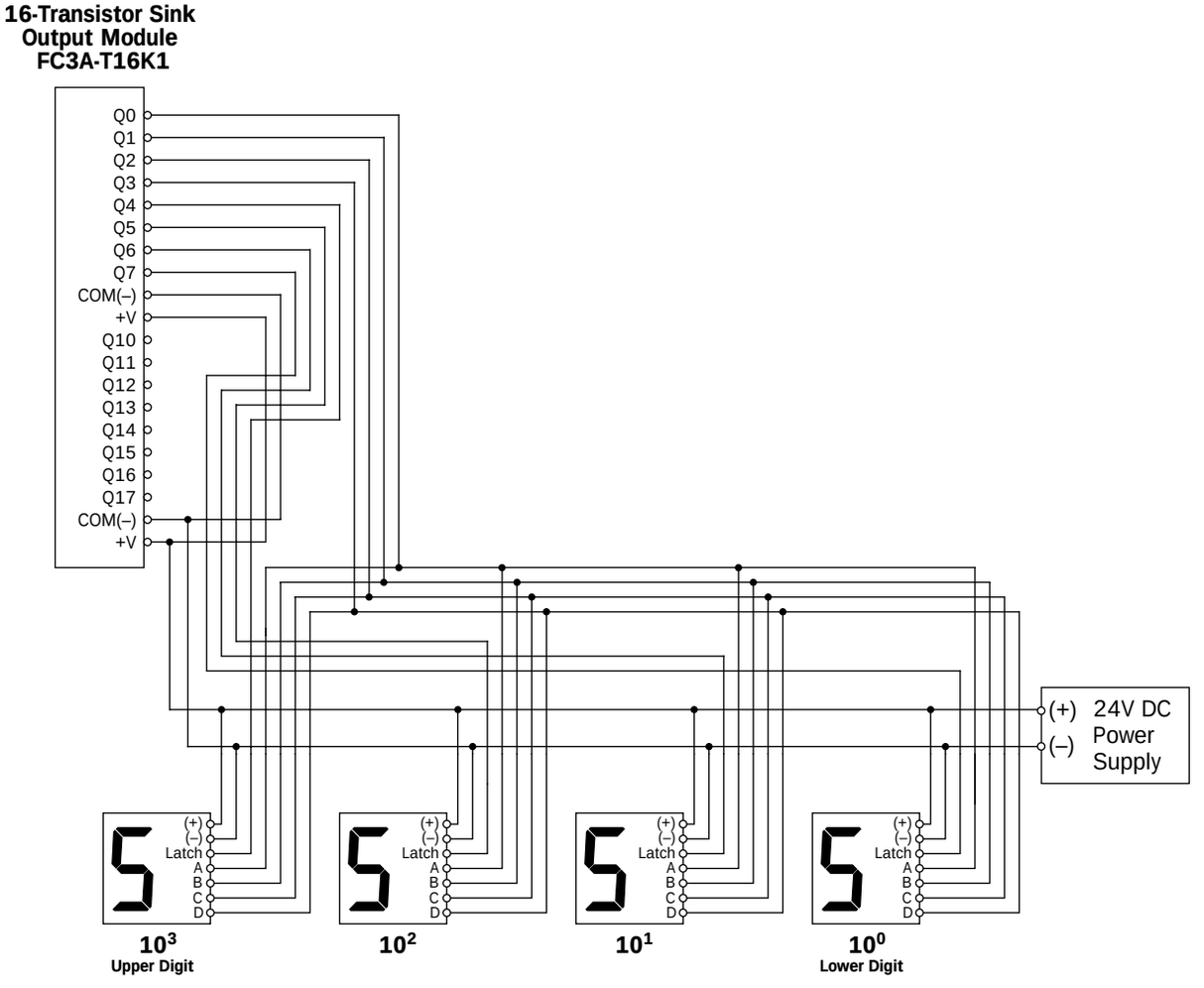
Example: DISP

The following example demonstrates a program to display the 4-digit current value of counter CNT10 on 7-segment display units (IDEC's DD3S-F31N) connected to the transistor sink output module.

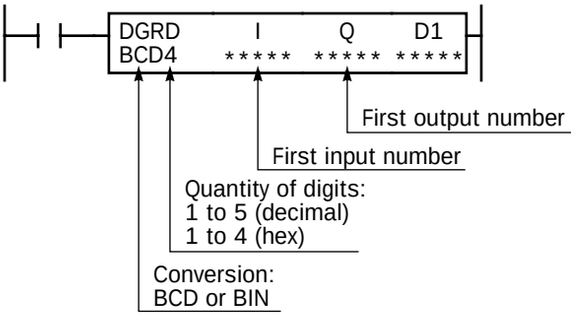


When input I0 is on, the 4-digit current value of counter C10 is displayed on 7-segment digital display units.

Output Wiring Diagram



DGRD (Digital Read)



When input is on, data designated by operands I and Q is set to a data register or link register designated by destination operand D1.

This instruction can be used to change preset values for timer and counter instructions using digital switches. The data that can be read using this instruction is 0 through 65535 (5 digits), or FFFFh.

Note: The DGRD instruction can be used on DC input and transistor output modules only.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
I	First input number to read	X	—	—	—	—	—	—	—	—	—
Q	First output number for digit selection	—	X	—	—	—	—	—	—	—	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	X	—	—

For the valid operand number range, see page 6-2.

The DGRD instruction can read 65535 (5 digits) at the maximum. When the read value exceeds 65535 with the quantity of digits set to 5, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Note: The DGRD instruction can be used up to 16 times in a user program. When transferring a user program containing more than 16 DGRD instructions to the CPU, a user program syntax error occurs, turning on the ERROR LED. The user program cannot be executed.

Conversion

BCD: To connect BCD (decimal) digital switches
BIN: To connect BIN (hexadecimal) digital switches

Input Points

Inputs are used to read the data from digital switches. The quantity of required input points is always 4. Four input points must be reserved starting with the input number designated by operand I. For example, when input I0 is designated as operand I, inputs I0 through I3 are used.

Output Points

Outputs are used to select the digits to read. The quantity of required output points is equal to the quantity of digits to read. When connecting the maximum of 5 digital switches, 5 output points must be reserved starting with the output number designated by operand Q. For example, when output Q0 is designated as operand Q to read 3 digits, outputs Q0 through Q2 are used.

Digital Switch Data Reading Time

Reading digital switch data requires the following time after the input to the DGRD instruction is turned on. Keep the input to the DGRD instruction for the period of time shown below to read the digital switch data. For example, when reading data from 5 digital switches to the destination operand, 14 scans are required

Digital Switch Data Reading Time
2 scan times × (Quantity of digits + 2)

Adjusting Scan Time

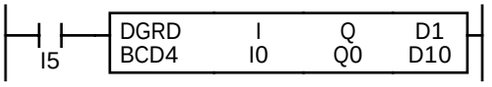
The DGRD instruction requires a scan time longer than the filter time plus 4 msec.

Minimum Required Scan Time
(Scan time) ≥ (Filter time) + 4 msec

When the actual scan time is too short to execute the DGRD instruction, use the constant scan function. The default value of the input filter is 4 msec. When the input filter time is set to default, set a value of 8 or more (in msec) to special data register D8022 (constant scan time preset value). See page 5-20. When the input filter time is changed, set a proper value to D8022 to make sure of the minimum required scan time shown above.

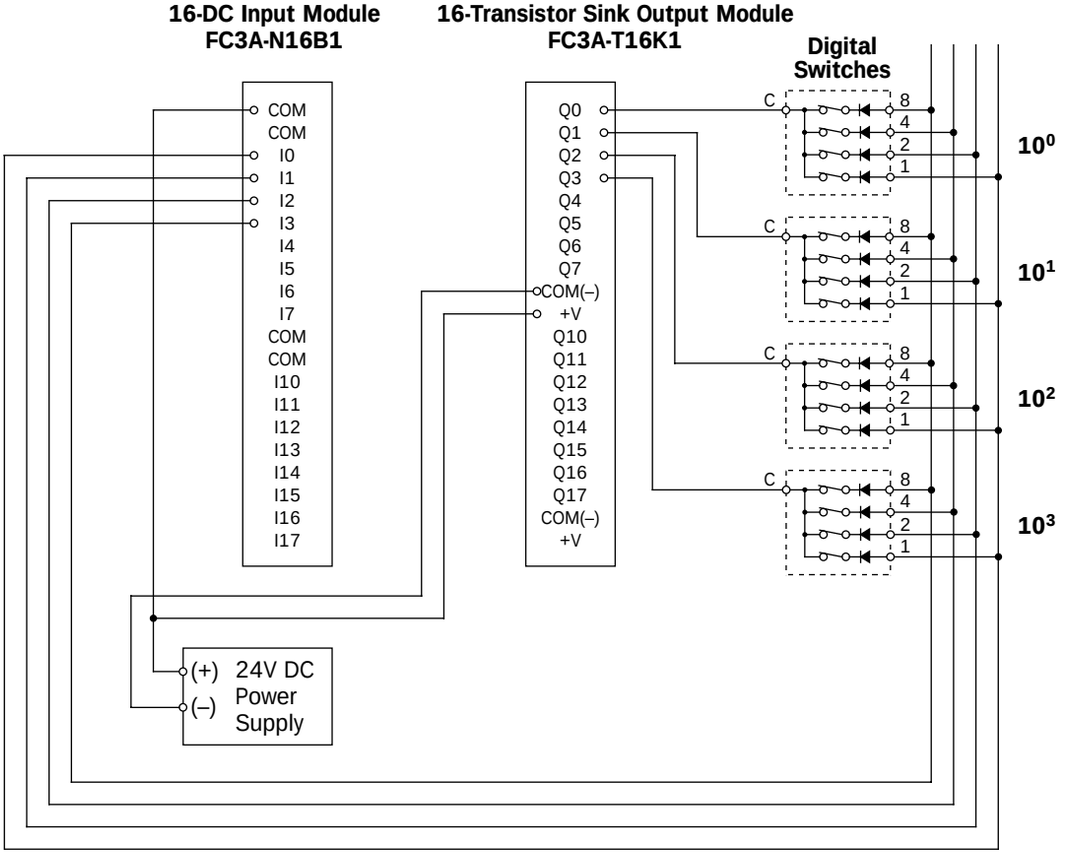
Example: DGRD

The following example demonstrates a program to read data from four digital switches (IDEC's DF**-031D(K)) to a data register in the OpenNet Controller CPU module.

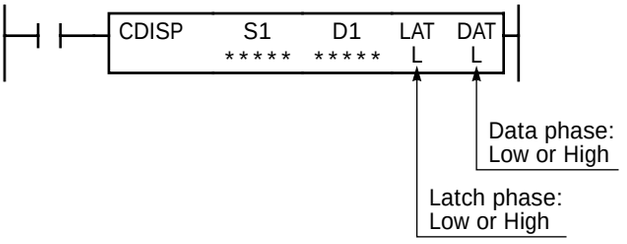


When input I5 is on, the 4-digit value from BCD digital switches is read to data register D10.

I/O Wiring Diagram



CDISP (Character Display)



When input is on, data designated by source operand S1 is set to outputs designated by operand D1.

One CDISP instruction can send data to 16 character display units at the maximum.

The CDISP instruction can be used up to 8 times in a user program.

Note: The CDISP instruction can be used on transistor output modules only.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Data to display	—	—	—	—	X	X	X	—	X	1-16
D1 (Destination 1)	First output number to display data	—	X	▲	—	—	—	—	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1. When T (timer) or C (counter) is used as S1, the timer/counter current value is read out.

Note: The CDISP instruction can be used up to 8 times in a user program. When transferring a user program containing more than 8 CDISP instructions to the CPU, a user program syntax error occurs, turning on the ERROR LED. The user program cannot be executed.

S1 — Data to Display

Operand	Conversion Type	Display Digits	Repeat
Timer	Binary to ASCII	1 to 4	1 to 16
Counter	BCD to ASCII	1 to 5	
Data Register	No conversion	1 to 2	
Constant	No conversion	1	—

D1 — First Output Number to Display Data

Connect the data signals starting with operand designated by D1 through the last destination operand, followed by latch signals. The quantity of required output points is 8 plus the quantity of digits to display. When displaying 4 digits with output Q0 designated as the first output number, 12 consecutive output points must be reserved starting with Q0 through Q13.

LAT — Latch Phase

Select the latch phase for the digit select signal.

L: Low latch
H: High latch

DAT — Data Phase

Select the phase for the data signal.

L: Negative logic
H: Positive logic

Display Processing Time

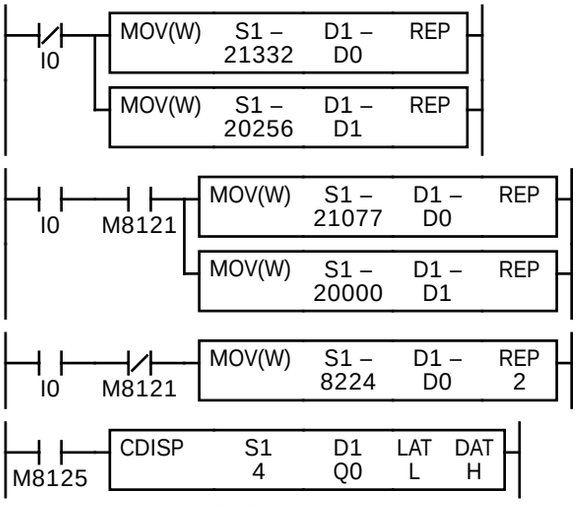
Displaying character data requires the following time after the input to the CDISP instruction is turned on. Keep the input to the CDISP instruction for the period of time shown below to process the display data.

Scan Time	Display Processing Time
5 msec or more	3 scan times × Quantity of digits

When the scan time is less than 5 msec, the data cannot be displayed correctly. When the scan time is too short to ensure normal display, set a value of 6 or more (in msec) to special data register D8022 (constant scan time preset value). See page 5-20.

Example: CDISP

The following example demonstrates a program to display “STOP” on character display units when input I0 is off. When input I0 of on, “RUN” flashes on the display units.



When input I0 is off, decimal values for ASCII character codes are moved to data registers D0 and D1.

21332 = 5354h “ST”
20256 = 4F20h “OP”

M8121 is the 1-sec clock pulse special internal relay.

When input I0 and M8121 are on, decimal values for ASCII character codes are moved to data registers D0 and D1.

21077 = 5255h “RU”
20000 = 4E20h “N (space)”

8224 = 2020h “(space)(space)”

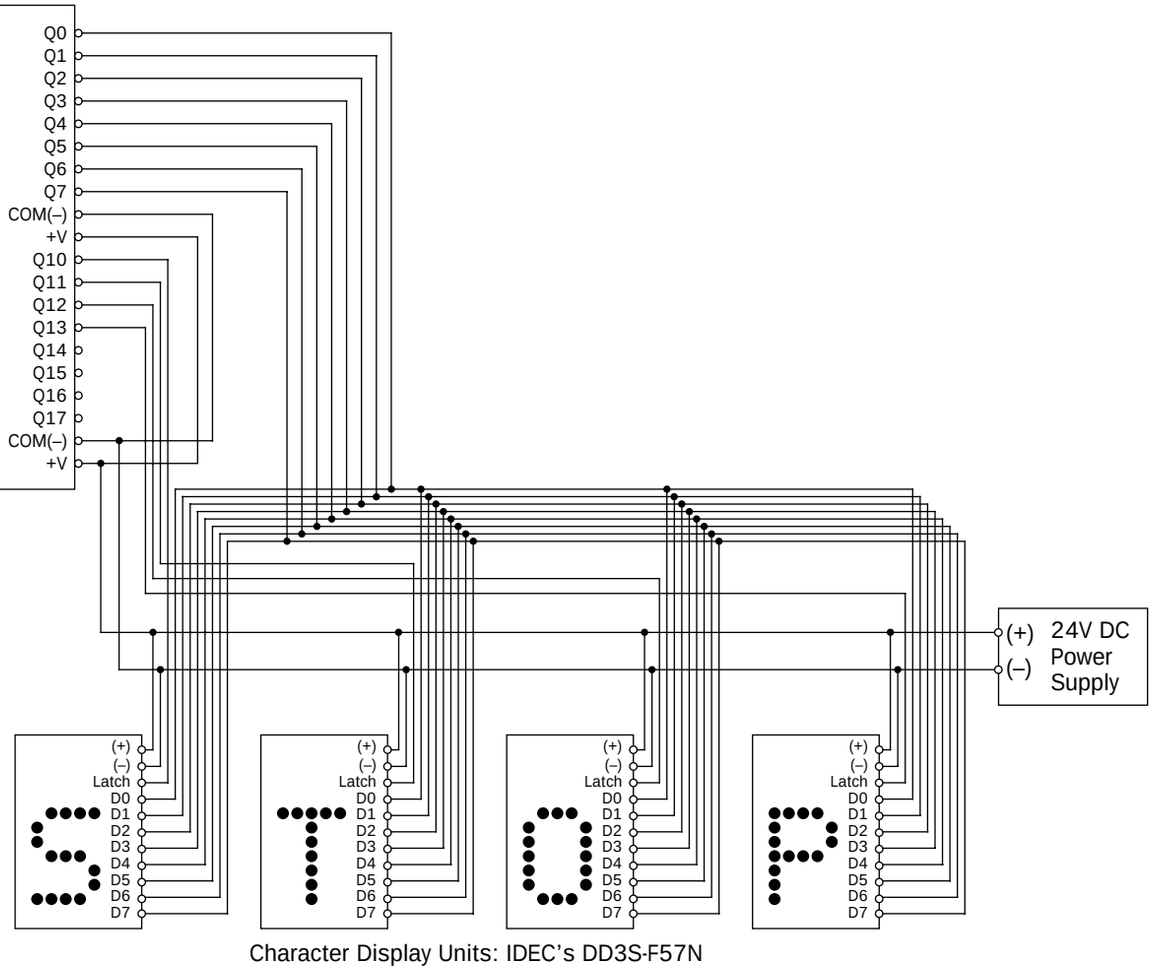
M8125 is the in-operation output special internal relay.

S1 specifies data register D0, no conversion, 2 digits, 2 repeats.

The CDISP sends out data from D0 upper byte, D0 lower byte, D1 upper byte, and D1 lower byte, in this order.

Output Wiring Diagram

16-Transistor Sink Output Module
FC3A-T16K1



Character Display Units: IDEC’s DD3S-F57N

Character Codes for IDEC DD3S Character Display Unit

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0																
	0			0	@	P	`	p	°F	○					|	•
Decimal	0	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
1																
	1		!	1	A	Q	a	q	°C	●					/	›
Decimal	1	17	33	49	65	81	97	113	129	145	161	177	193	209	225	241
2																
	2		"	2	B	R	b	r	Ω	▷					⁄	›
Decimal	2	18	34	50	66	82	98	114	130	146	162	178	194	210	226	242
3																
	3		#	3	C	S	c	s	ʊ	◁					⁄	›
Decimal	3	19	35	51	67	83	99	115	131	147	163	179	195	211	227	243
4																
	4		$	4	D	T	d	t	µ	▒					—	›
Decimal	4	20	36	52	68	84	100	116	132	148	164	180	196	212	228	244
5																
	5		%	5	E	U	e	u	√	▒					¬	›
Decimal	5	21	37	53	69	85	101	117	133	149	165	181	197	213	229	245
6																
	6		&	6	F	V	f	v	π	♡					\	›
Decimal	6	22	38	54	70	86	102	118	134	150	166	182	198	214	230	246
7																
	7		'	7	G	W	g	w	×	♥					\	`
Decimal	7	23	39	55	71	87	103	119	135	151	167	183	199	215	231	247
8																•
	8		(	8	H	X	h	x	÷	▵						•
Decimal	8	24	40	56	72	88	104	120	136	152	168	184	200	216	232	248
9																
	9		)	9	I	Y	i	y	ᶜH	▽					•	‹
Decimal	9	25	41	57	73	89	105	121	137	153	169	185	201	217	233	249
A																
			*	:	J	Z	j	z	\						●	‹
Decimal	10	26	42	58	74	90	106	122	138	154	170	186	202	218	234	250
B																
			+	;	K	[	k	{	‾						■	‹
Decimal	11	27	43	59	75	91	107	123	139	155	171	187	203	219	235	251
C																
			,	<	L	¥	l	|	↑						◆	‹
Decimal	12	28	44	60	76	92	108	124	140	156	172	188	204	220	236	252
D																
			–	=	M	]	m	}	↓						●	‹
Decimal	13	29	45	61	77	93	109	125	141	157	173	189	205	221	237	253
E																
		y	.	>	N	^	n	→	▲						■	‹
Decimal	14	30	46	62	78	94	110	126	142	158	174	190	206	222	238	254
F																
			/	?	O	_	o	←	▼						■	‹
Decimal	15	31	47	63	79	95	111	127	143	159	175	191	207	223	239	255

Note: These character codes are used with IDEC DD3S series character display units. Those codes left blank are reserved for Japanese characters.

17: USER COMMUNICATION INSTRUCTIONS

Introduction

This chapter describes the user communication function for communication between the OpenNet Controller and external devices with an RS232C port. The OpenNet Controller uses user communication instructions for transmitting and receiving communication to and from external devices.

User Communication Overview

The user communication mode is used for linking the OpenNet Controller to an RS232C communication device such as a computer, modem, printer, or barcode reader.

All OpenNet Controller CPU modules feature two RS232C ports to communicate with two external devices simultaneously.

User communication transmit and receive instructions can be programmed to match the communication protocol of the equipment to communicate with. Possibility of communication using the user communication mode can be determined referring to the user communication mode specifications described below.

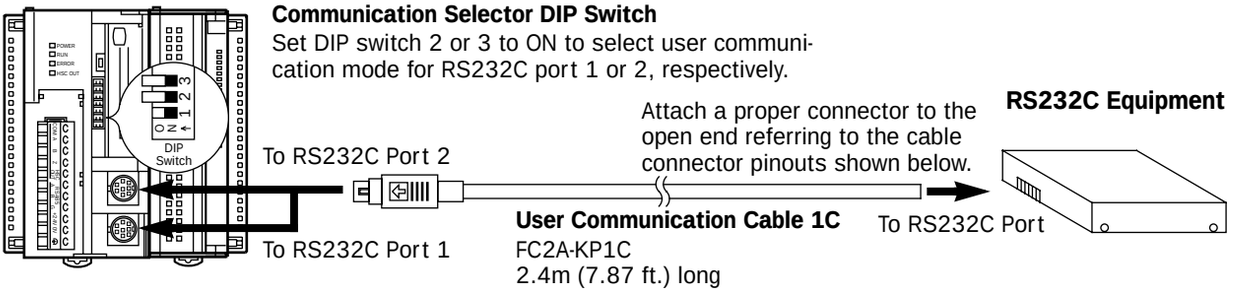
User Communication Mode Specifications

Standards	EIA RS232C
Control Signal	DSR, DTR, RTS
Baud Rate	1200, 2400, 4800, 9600, 19200 bps
Data Bits	7 or 8 bits
Parity	Odd, Even, None
Stop Bits	1 or 2 bits
Receive Timeout	10 to 2540 msec (10-msec increments) or none (Receive timeout is disabled when 2550 msec is selected.) The receive timeout has an effect when using RXD1/RXD2 instructions.
Communication Method	Start-stop synchronization system half-duplex
Maximum Transmit Data	200 bytes
Maximum Receive Data	200 bytes

Connecting RS232C Equipment through RS232C Port 1 or 2

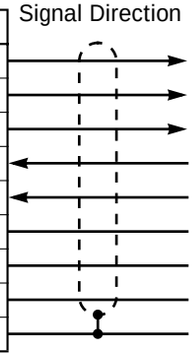
To connect equipment with an RS232C communication port to the RS232C port 1 or 2 on the OpenNet Controller, use the user communication cable 1C (FC2A-KP1C). One end of the user communication cable 1C is not provided with a connector, and it can be terminated with a proper connector to plug in to communicate with the RS232C port. See the figure on page 17-2.

User Communication System Setup



Cable Connector Pinouts

Pin	Description		AWG#		Color
1	RTS	Request to Send	28	Twisted	Black
2	DTR	Data Terminal Ready	28		Yellow
3	TXD	Transmit Data	28		Blue
4	RXD	Receive Data	28		Green
5	DSR	Data Set Ready	28		Brown
6	SG	Signal Ground	28		Gray
7	SG	Signal Ground	26	Twisted	Red
8	NC	No Connection	26		White
Cover	—	Shield	—		—



Setting RS232C Port Communication Mode Selection Special Data Registers D8200 and D8300

When using the user communication mode for the RS232C port 1, set 0 to special data register D8200.
When using the user communication mode for the RS232C port 2, set 0 to special data register D8300.

When the modem mode is not used for the RS232C port 1 or 2, make sure that special data register D8200 or D8300 is set to 0.

Setting Communication Selector DIP Switches

The communication selector DIP switch is used to select communication modes for the RS232C ports 1 and 2. When the CPU is powered up, the selected communication modes are enabled automatically. If the communication selector DIP switch setting is changed after the CPU is powered up, the new setting does not take effect until the communication enable button is depressed.

Set DIP switch 2 or 3 to ON to enable the user communication mode for the RS232C port 1 or 2, respectively.

Communication Mode for RS232C Ports

Communication Selector DIP Switch	Port	ON	OFF
2	RS232C port 1	User communication mode	Maintenance mode
3	RS232C port 2	User communication mode	Maintenance mode

User communication mode: Used for user communication instructions
Maintenance mode: Used for communication between the CPU and WindLDR on computer.

Communication Enable Button

To enable the new settings of the communication selector DIP switches, press the communication enable button for 4 seconds.

While the CPU is powered up, pressing the communication enable button for more than 4 seconds until the ERROR LED blinks once makes the CPU read the settings on the communication selector DIP switches. Then the CPU updates the communication mode for the RS232C ports 1 and 2. This button is useful when you want to change the communication mode without turning power off.

IMPORTANT: Do not power up while the communication enable button is depressed, and do not press the button unless it is necessary to do so.

Setting Communication Parameters Using WindLDR

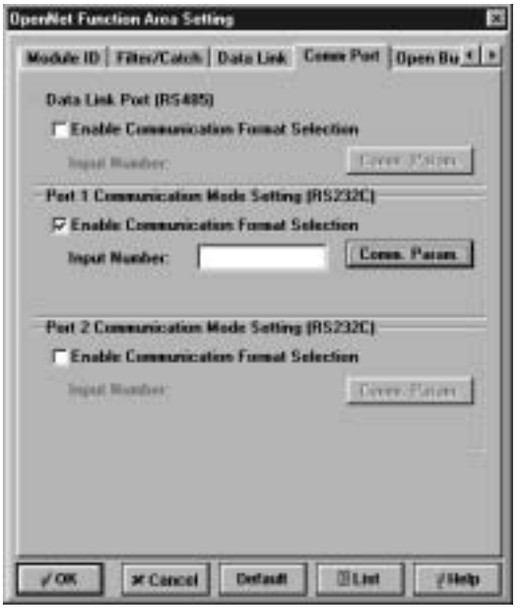
When using the user communication function to communicate with an external RS232C device, set the communication parameters for the OpenNet Controller to match those of the external device

Note: Since communication parameters in the Function Area Settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

1. Select **Configure** from the WindLDR menu bar, then select **Function Area Settings**.

The Function Area Setting dialog box appears.

2. Click the **Comm Port** tab.

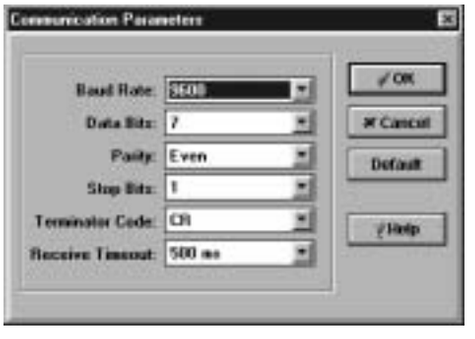


Click the check box to the left of **Enable Communication Format Selection** for the **Port 1** or **Port 2 Communication Mode Setting (RS232C)**.

Leave the **Input Number** box blank.

3. Click the **Comm. Param.** button.

The Communication Parameter dialog box appears.



When 2550 ms is selected in the **Receive Timeout** box, the receive timeout function is disabled.

4. Select communication parameters to the same values for the device to communicate with.

The terminator code selected in this dialog box has no effect in the user communication mode. Instead, end delimiter codes are used for the user communication. The terminator code is used for the maintenance communication.

TXD1 (Transmit 1)

When input is on, data designated by S1 is converted into a specified format and transmitted through the RS232C port 1 to a remote terminal with an RS232C port.

TXD2 (Transmit 2)

When input is on, data designated by S1 is converted into a specified format and transmitted through the RS232C port 2 to a remote terminal with an RS232C port.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Transmit data	—	—	—	—	—	—	X	—	X	—
D1 (Destination 1)	Transmit completion output	—	X	▲	—	—	—	—	—	—	—
D2 (Destination 2)	Transmit status register	—	—	—	—	—	—	X	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

Transmit data designated by operand S1 can be a maximum of 200 bytes.

When transmission is complete, an output or internal relay, designated by operand D1, is turned on.

Destination 2 occupies two consecutive data registers starting with the operand designated by D2. The transmit status data register, D0 through D7998, stores the status of transmission and error code. The next data register stores the byte count of transmitted data. The same data registers should not be used as transmit status registers for TXD1/TXD2 instructions and receive status registers for RXD1/RXD2 instructions.

Precautions for Programming TXD Instruction

- The OpenNet Controller has five formatting areas each for executing TXD1 and TXD2 instructions, so five TXD1 and five TXD2 instructions can be processed at the same time. If inputs to more than five TXD1 or TXD2 instructions are turned on at the same time, an error code is set to the transmit status data register, designated by operand D2, in the excessive TXD instructions that cannot be executed.
- If the input for a TXD instruction is turned on while another TXD instruction is executed, the subsequent TXD instruction is executed 2 scan times after the preceding TXD instruction is completed.
- Since TXD instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

User Communication Transmit Instruction Dialog Box in WindLDR

Selections and Operands in Transmit Instruction Dialog Box

Type	**TXD**	Transmit instruction
	RXD	Receive instruction
Port	**Port 1**	Transmit user communication through RS232C port 1 (TXD1)
	Port 2	Transmit user communication through RS232C port 2 (TXD2)
S1	**Source 1**	Enter the data to transmit in this area. Transmit data can be constant values (character or hexadecimal), data registers, or BCC.
D1	**Destination 1**	Transmit completion output can be an output or internal relay.
D2	**Destination 2**	Transmit status register can be data register D0 through D7998. The next data register stores the byte count of transmitted data.

Transmit Data

Transmit data is designated by source operand S1 using constant values or data registers. BCC code can also be calculated automatically and appended to the transmit data. One TXD instruction can transmit 200 bytes of data at the maximum.

S1 (Source 1)

Transmit Data	Operand	Conversion Type	Transmit Digits (Bytes)	Repeat	Calculation	Calculation Start Position
Constant	00h-FFh (7Fh)	No conversion	1	—	—	—
Data Register	D0-D7999	A: Binary to ASCII B: BCD to ASCII –: No conversion	1-4 1-5 1-2	1-99	—	—
BCC	—	A: Binary to ASCII –: No conversion	1-2	—	X: XOR A: ADD	1-15

Designating Constant as S1

When a constant value is designated as source operand S1, one-byte data is transmitted without conversion. The valid transmit data value depends on the data bits selected in **Configure** > **Fun Area Settings** > **Comm Port** > **Port 1 or 2 Communication Mode Setting (RS232C)** > **Communication Parameters** dialog box. When 8 data bits are selected, 00h through FFh is transmitted. When 7 data bits are selected as default, 00h through 7Fh is transmitted. Constant values are entered in character or hexadecimal notation into the source data.

Constant (Character)

Any character available on the computer keyboard can be entered. One character is counted as one byte.

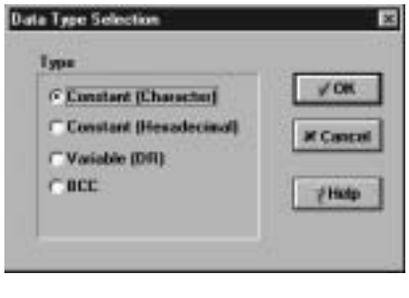
Constant (Hexadecimal)

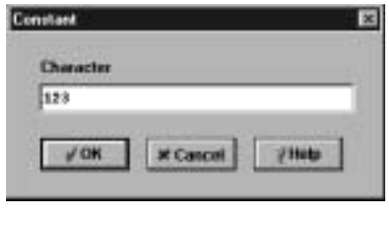
Use this option to enter the hexadecimal code of any ASCII character. ASCII control codes NUL (00h) through US (1Fh) can also be entered using this option.

Example:

The following example shows two methods to enter 3-byte ASCII data “1” (31h), “2” (32h), “3” (33h).

(1) Constant (Character)





(2) Constant (Hexadecimal)

Designating Data Register as S1

When a data register is designated as source operand S1, conversion type and transmit digits must also be designated. The data stored in the designated data register is converted and a designated quantity of digits of the resultant data is transmitted. Conversion types are available in Binary to ASCII, BCD to ASCII, and no conversion.

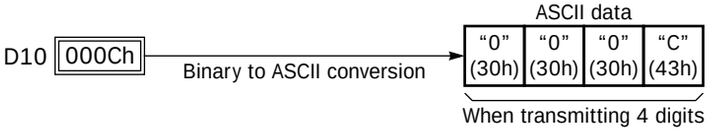
When repeat is designated, data of data registers as many as the repeat cycles are transmitted, starting with the designated data register. Repeat cycles can be up to 99.

Conversion Type

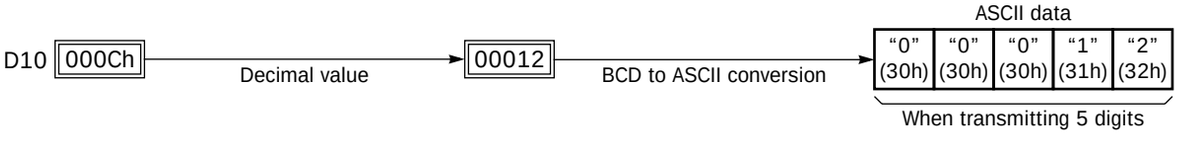
The transmit data is converted according to the designated conversion type as described below:

Example: D10 stores 000Ch (12)

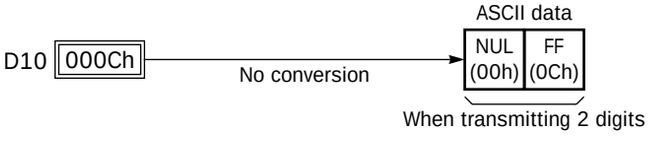
(1) Binary to ASCII conversion



(2) BCD to ASCII conversion



(3) No conversion

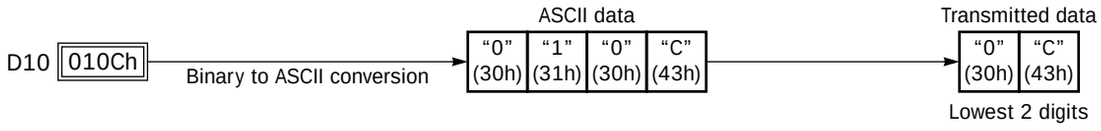


Transmit Digits (Bytes)

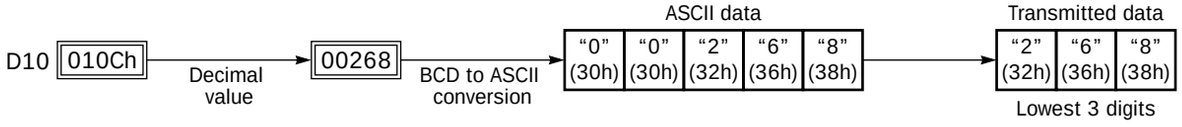
After conversion, the transmit data is taken out in specified digits. Possible digits depend on the selected conversion type.

Example: D10 stores 010Ch (268)

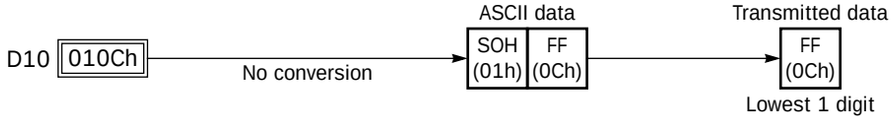
(1) Binary to ASCII conversion, Transmit digits = 2



(2) BCD to ASCII conversion, Transmit digits = 3



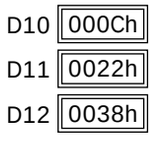
(3) No conversion, Transmit digits = 1



Repeat Cycles

When a data register is designated to repeat, consecutive data registers, as many as the repeat cycles, are used for transmit data in the same conversion type and transmit digits.

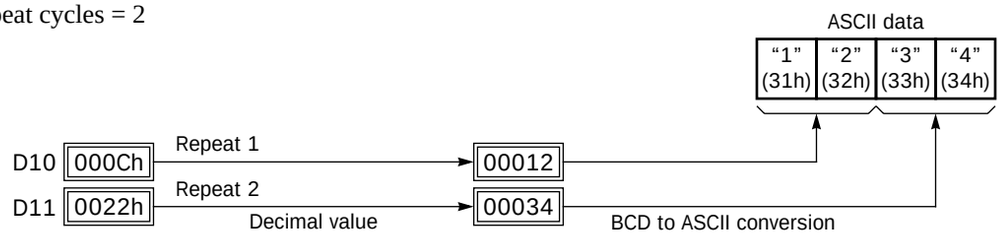
Example:



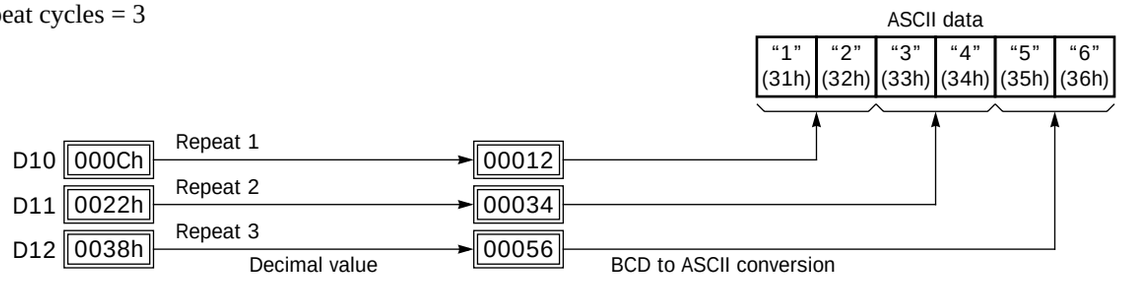
Data register No.: D10
Transmit digits: 2
Conversion type: BCD to ASCII

Data of data registers starting with D10 is converted in BCD to ASCII and is transmitted according to the designated repeat cycles.

(1) Repeat cycles = 2

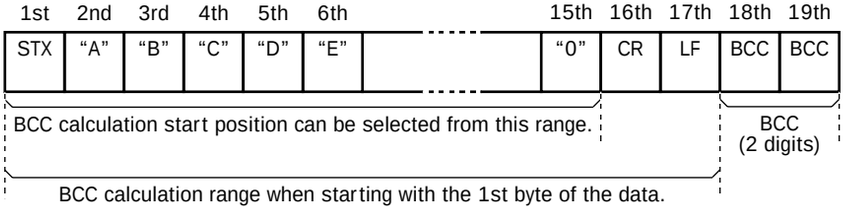


(2) Repeat cycles = 3



BCC (Block Check Character)

Block check characters can be appended to the transmit data. The start position for the BCC calculation can be selected from the first byte through the 15th byte. The BCC, calculated in either XOR or ADD, can be 1 or 2 digits.

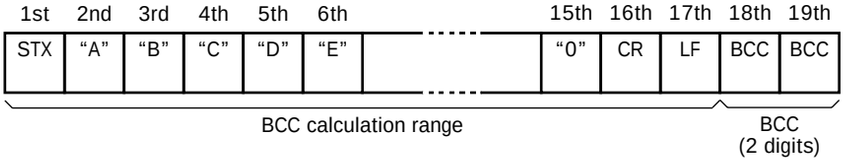


BCC Calculation Start Position

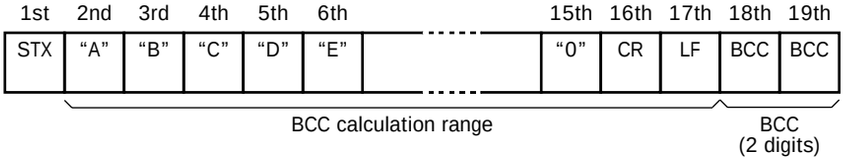
The start position for the BCC calculation can be specified from the first byte through the 15th byte. The BCC is calculated for the range starting at the designated position up to the byte immediately before the BCC of the transmit data.

Example: Transmit data consists of 17 bytes plus 2 BCC digits.

(1) Calculation start position = 1



(2) Calculation start position = 2



BCC Calculation Formula

BCC calculation formula can be selected from XOR (exclusive OR) or ADD (addition) operation.

Example: Conversion results of transmit data consist of 41h, 42h, 43h, 44h, and 45h.

ASCII data				
"A" (41h)	"B" (42h)	"C" (43h)	"D" (44h)	"E" (45h)

(1) BCC calculation formula = XOR

$41h \oplus 42h \oplus 43h \oplus 44h \oplus 45h = 41h$

(2) BCC calculation formula = ADD

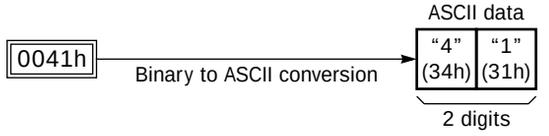
$41h + 42h + 43h + 44h + 45h = 14Fh \rightarrow 4Fh$ (Only the last 1 or 2 digits are used as BCC.)

Conversion Type

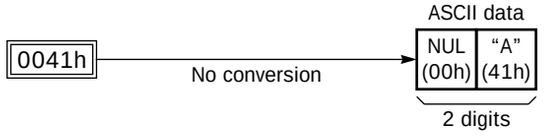
The BCC calculation result can be converted or not according to the designated conversion type as described below:

Example: BCC calculation result is 0041h.

(1) Binary to ASCII conversion



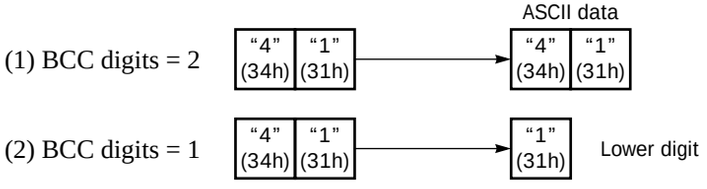
(2) No conversion



BCC Digits (Bytes)

The quantity of digits (bytes) of the BCC code can be selected from 1 or 2.

Example:



Transmit Completion Output

Designate an output, Q0 through Q597, or an internal relay, M0 through M2557, as an operand for the transmit completion output. Special internal relays cannot be used.

When the start input for a TXD instruction is turned on, preparation for transmission is initiated, followed by data transmission. When a sequence of all transmission operation is complete, the designated output or internal relay is turned on.

Transmit Status

Designate a data register, D0 through D7998, as an operand to store the transmit status information including a transmission status code and a user communication error code.

Transmit Status Code

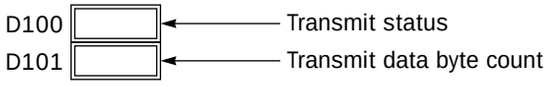
Transmit Status Code	Status	Description
16	Preparing transmission	From turning on the start input for a TXD instruction, until the transmit data is stored in the internal transmit buffer
32	Transmitting data	From enabling data transmission by an END processing, until all data transmission is completed
48	Data transmission complete	From completing all data transmission, until the END processing is completed for the TXD instruction
64	Transmit instruction complete	All transmission operation is completed and the next transmission is made possible

If the transmit status code is other than shown above, an error of transmit instruction is suspected. See User Communication Error Code on page 17-25.

Transmit Data Byte Count

The data register next to the operand designated for transmit status stores the byte count of data transmitted by the TXD instruction. When BCC is included in the transmit data, the byte count of the BCC is also included in the transmit data byte count.

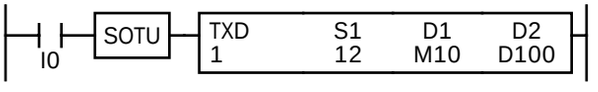
Example: Data register D100 is designated as an operand for transmit status.



Programming TXD Instruction Using WindLDR

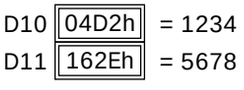
The following example demonstrates how to program a TXD instruction including a start delimiter, BCC, and end delimiter using WindLDR.

TXD sample program:

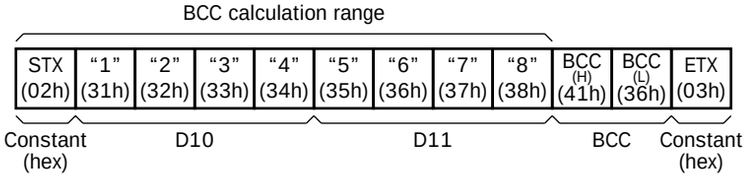


Communication port:	RS232C port 1
Transmit completion output:	M10
Transmit status register:	D100
Transmit data byte count:	D101

Data register contents:



Transmit data example:



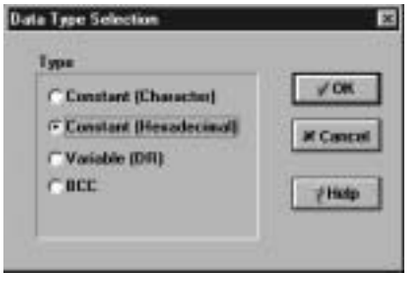
1. Start to program a TXD instruction. Move the cursor where you want to insert the TXD instruction, and type **TXD**. You can also insert the TXD instruction by clicking the User Communication icon in the menu bar and clicking where you want to insert the TXD instruction in the program edit area.

The Transmit instruction dialog box appears.

2. Check that **TXD** is selected in the Type box and click **Port 1** in the Port box. Then, click **Insert**.

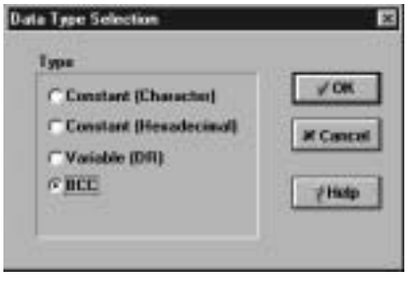
The Data Type Selection dialog box appears. You will program source operand S1 using this dialog box.

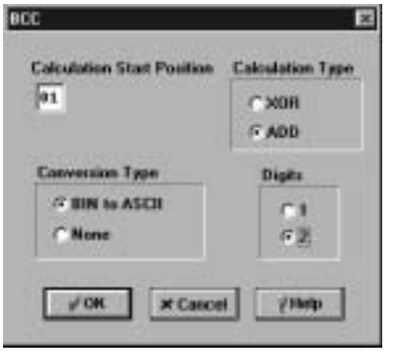
3. Click **Constant (Hexadecimal)** in the Type box and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **02** to program the start delimiter STX (02h). When finished, click **OK**.



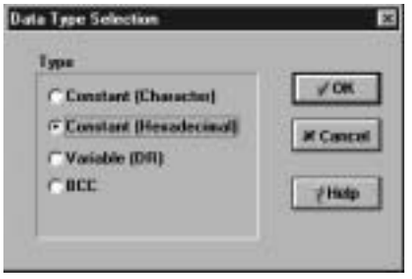
4. Since the Transmit instruction dialog box reappears, repeat the above procedure. In the Data Type Selection dialog box, click **Variable (DR)** and click **OK**. Next, in the Variable (Data Register) dialog box, type **D10** in the DR No. box and click **BCD to ASCII** to select the BCD to ASCII conversion. Enter **4** in the Digits box (4 digits) and **2** in the REP box (2 repeat cycles). When finished, click **OK**.

5. Again in the Data Type Selection dialog box, click **BCC** and click **OK**. Next, in the BCC dialog box, enter **1** in the Calculation Start Position box, click **ADD** for the Calculate Type, click **BIN to ASCII** for the Conversion Type, and click **2** for the Digits. When finished, click **OK**.

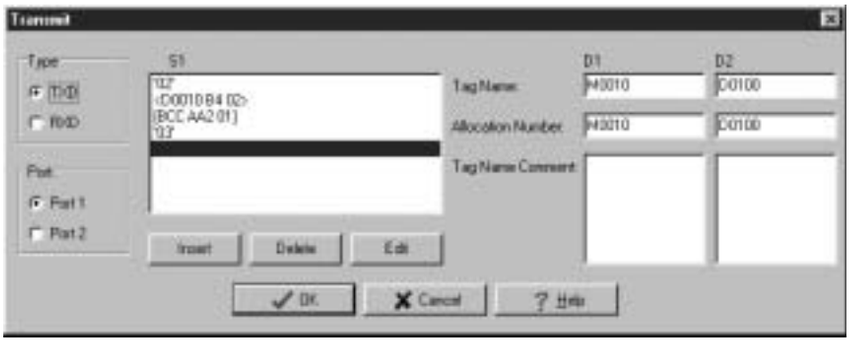




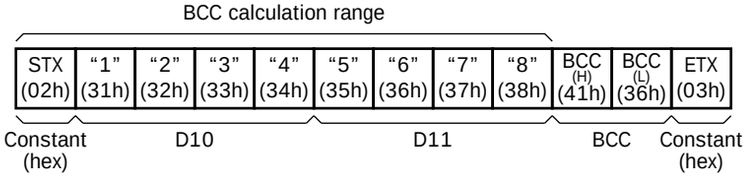
6. Once again in the Data Type Selection dialog box, click **Constant (Hexadecimal)** and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **03** to program the end delimiter ETX (03h). When finished, click **OK**.



7. In the Transmit instruction dialog box, type **M10** in the destination D1 box and type **D100** in the destination D2 box. When finished, click **OK**.



Programming of the TXD1 instruction is complete and the transmit data is specified as follows:



RXD1 (Receive 1)

When input is on, data received through the RS232C port 1 from a remote terminal is converted and stored in data registers according to the receive format designated by S1.

RXD2 (Receive 2)

When input is on, data received through the RS232C port 2 from a remote terminal is converted and stored in data registers according to the receive format designated by S1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Receive format	—	—	—	—	—	—	X	—	X	—
D1 (Destination 1)	Receive completion output	—	X	▲	—	—	—	—	—	—	—
D2 (Destination 2)	Receive status	—	—	—	—	—	—	X	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

Receive format designated by operand S1 can be a maximum of 200 bytes.

When data receive is complete, an output or internal relay, designated by operand D1, is turned on.

Destination 2 occupies two consecutive data registers starting with the operand designated by D2. The receive status data register, D0 through D7998, stores the status of data receive and error code. The next data register stores the byte count of received data. The same data registers should not be used as transmit status registers for TXD1/TXD2 instructions and receive status registers for RXD1/RXD2 instructions.

While RXD1/RXD2 instructions are ready for receiving data after a receive format is complete, turning on the user communication receive instruction cancel flag M8022 or M8023 cancels all RXD1/RXD2 instructions.

Precautions for Programming the RXD Instruction

- The OpenNet Controller can execute a maximum of five RXD1 and five RXD2 instructions that have a start delimiter at the same time. If a start delimiter is not programmed in RXD1/RXD2 instructions, the OpenNet Controller can execute only one RXD1 and one RXD2 instructions at a time. If the start input for a RXD1/RXD2 instruction is turned on while another RXD1/RXD2 instruction without a start delimiter is executed, a user communication error occurs.
- Since RXD instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.
- Once the input to the RXD instruction is turned on, the RXD is activated and ready for receiving incoming communication even after the input is turned off. When the RXD completes data receiving, the RXD is deactivated if the input to the RXD is off. Or, if the input is on, the RXD is made ready for receiving another communication. M8022/M8023 deactivate all RXD instructions waiting for incoming communication.

User Communication Receive Instruction Dialog Box in WindLDR

Selections and Operands in Receive Instruction Dialog Box

Type	**TXD**	Transmit instruction
	RXD	Receive instruction
Port	**Port 1**	Receive user communication through RS232C port 1 (RXD1)
	Port 2	Receive user communication through RS232C port 2 (RXD2)
S1	**Source 1**	Enter the receive format in this area. The receive format can include a start delimiter, data register to store incoming data, end delimiter, BCC, and skip.
D1	**Destination 1**	Receive completion output can be an output or internal relay.
D2	**Destination 2**	Receive status register can be data register D0 through D7998. The next data register stores the byte count of received data.

Receive Format

Receive format, designated by source operand S1, specifies data registers to store received data, data digits for storing data, data conversion type, and repeat cycles. A start delimiter and an end delimiter can be included in the receive format to discriminate valid incoming communication. When some characters in the received data are not needed, “skip” can be used to ignore a specified number of characters. BCC code can also be appended to the receive format to verify the received data. One RXD instruction can receive 200 bytes of data at the maximum.

S1 (Source 1)

Receive Format	Operand	Receive Digits (Bytes)	Conversion Type	Repeat	Calculation	Calculation Start Position	Skip Bytes
Data Register	D0-D7999	1-4 1-5 1-2	A: ASCII to Binary B: ASCII to BCD –: No conversion	1-99	—	—	—
Start Delimiter	00h-FFh (7Fh)	—	No conversion	—	—	—	—
End Delimiter	00h-FFh (7Fh)	—	No conversion	—	—	—	—
BCC	—	1-2	A: Binary to ASCII –: No conversion	—	X: XOR A: ADD	1-15	—
Skip	—	—	—	—	—	—	1-99

Designating Data Register as S1

When a data register is designated as source operand S1, receive digits and conversion type must also be designated. The received data is divided into a block of specified receive digits, converted in a specified conversion type, and stored to the designated data register. Conversion types are available in ASCII to Binary, ASCII to BCD, and no conversion.

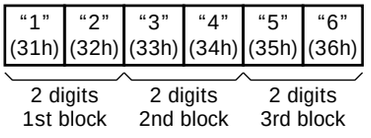
When repeat is designated, received data is divided, converted, and stored into data registers as many as the repeat cycles, starting with the designated data register. Repeat cycles can be up to 99.

Receive Digits

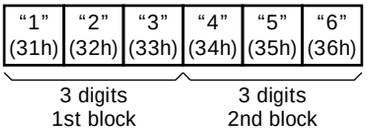
The received data is divided into a block of specified receive digits before conversion as described below:

Example: Received data of 6 bytes are divided in different receive digits. (Repeat is also designated.)

(1) Receive digits = 2



(2) Receive digits = 3

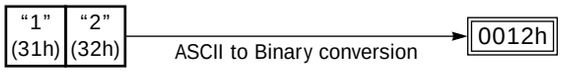


Conversion Type

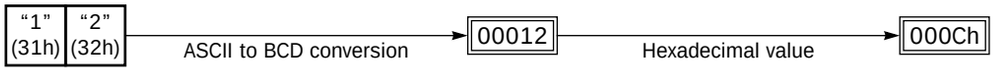
The data block of the specified receive digits is then converted according to the designated conversion type as described below:

Example: Received data has been divided into a 2-digit block.

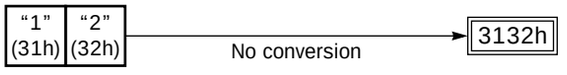
(1) ASCII to Binary conversion



(2) ASCII to BCD conversion



(3) No conversion

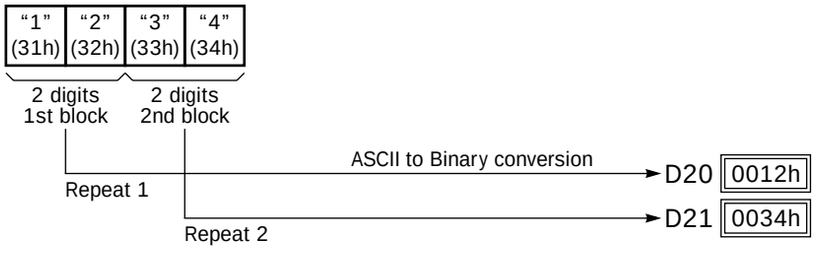


Repeat Cycles

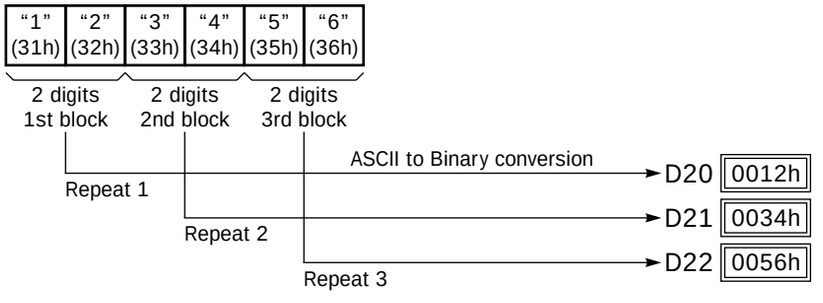
When a data register is designated to repeat, the received data is divided and converted in the same way as specified, and the converted data is stored to consecutive data registers as many as the repeat cycles.

Example: Received data of 6 bytes is divided into 2-digit blocks, converted in ASCII to Binary, and stored to data registers starting at D20.

(1) Repeat cycles = 2



(2) Repeat cycles = 3



Designating Constant as Start Delimiter

A start delimiter can be programmed at the first byte in the receive format of a RXD1/RXD2 instruction; the OpenNet Controller will recognize the beginning of valid communication, although a RXD1/RXD2 instruction without a start delimiter can also be executed.

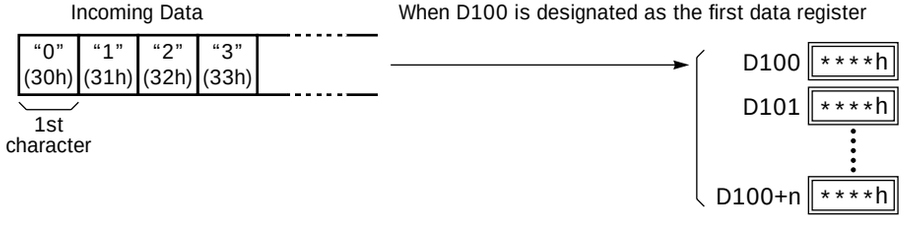
When a constant value is designated at the first byte of source operand S1, the one-byte data serves as a start delimiter to start the processing of the received data. The valid start delimiter value depends on the data bits selected in **Configure** > **Function Area Settings** > **Comm Port** > **Port 1 or 2 Communication Mode Setting (RS232C)** > **Communication Parameters** dialog box. When 8 data bits are selected, start delimiters can be 00h through FFh. When 7 data bits are selected as default, start delimiters can be 00h through 7Fh. Constant values are entered in character or hexadecimal notation into the source data.

A maximum of five RXD1 and five RXD2 instructions with different start delimiters can be executed at the same time. When the first byte of the incoming data matches the start delimiter of a RXD1/RXD2 instruction, the received data is processed and stored according to the receive format specified in the RXD1/RXD2 instruction. If the first byte of the incoming data does not match the start delimiter of any RXD1/RXD2 instruction that is executed, the OpenNet Controller discards the incoming data and waits for the next communication.

While a RXD1/RXD2 instruction without a start delimiter is executed, any incoming data is processed continuously according to the receive format. Only one RXD1 and one RXD2 instructions without a start delimiter can be executed at a time. If start inputs to two or more RXD1/RXD2 instructions without a start delimiter are turned on simultaneously, one at the smallest address is executed and the corresponding completion output is turned on.

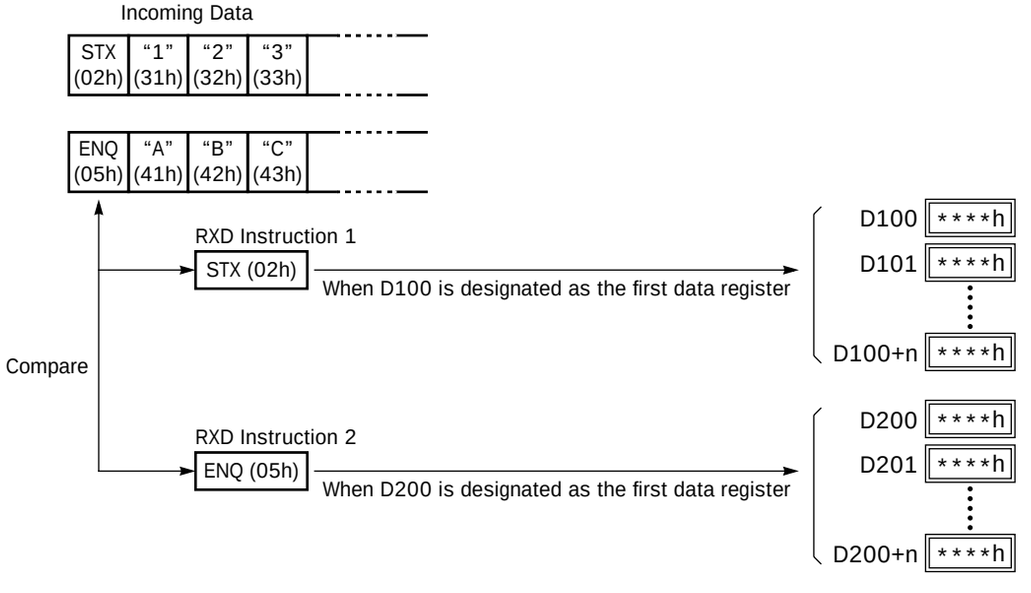
Example:

(1) When a RXD1/RXD2 instruction without a start delimiter is executed



The incoming data is divided, converted, and stored to data registers according to the receive format.

(2) When RXD1/RXD2 instructions with start delimiters STX (02h) and ENQ (05h) are executed



The incoming data is divided, converted, and stored to data registers according to the receive format.

Start delimiters are not stored to data registers.

Designating Constant as End Delimiter

An end delimiter can be programmed at other than the first byte in the receive format of a RXD instruction; the OpenNet Controller will recognize the end of valid communication, although RXD instructions without an end delimiter can also be executed.

When a constant value is designated at other than the first byte of source operand S1, the one- or multiple-byte data serves as an end delimiter to end the processing of the received data. The valid end delimiter value depends on the data bits selected in **Configure** > **Function Area Settings** > **Comm Port** > **Port 1 or 2 Communication Mode Setting (RS232C)** > **Communication Parameters** dialog box. See page 17-3. When 8 data bits are selected, end delimiters can be 00h through FFh. When 7 data bits are selected as default, end delimiters can be 00h through 7Fh. Constant values are entered in character or hexadecimal notation into the source data.

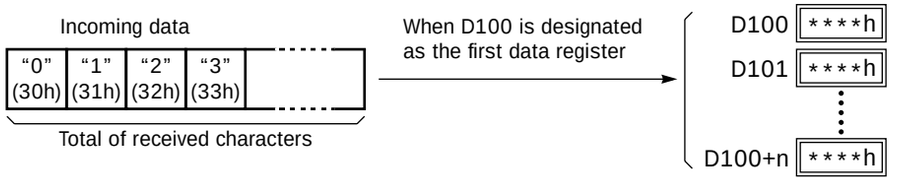
If a character in incoming data matches the end delimiter, the RXD instruction ends receiving data at this point and starts subsequent receive processing as specified. Even if a character matches the end delimiter at a position earlier than expected, the RXD instruction ends receiving data there.

If a BCC code is included in the receive format of a RXD instruction, an end delimiter can be positioned immediately before or after the BCC code. If a data register or skip is designated between the BCC and end delimiter, correct receiving is not ensured.

When a RXD instruction without an end delimiter is executed, data receiving ends when the specified bytes of data in the receive format, such as data registers and skips, have been received. In addition, data receiving also ends when the interval between incoming data characters exceeds the receive timeout value specified in the **Communication Parameters** dialog box whether the RXD has an end delimiter or not. The character interval timer is started when the first character of incoming communication is received and restarted each time the next character is received. When a character is not received within a predetermined period of time, timeout occurs and the RXD ends data receive operation.

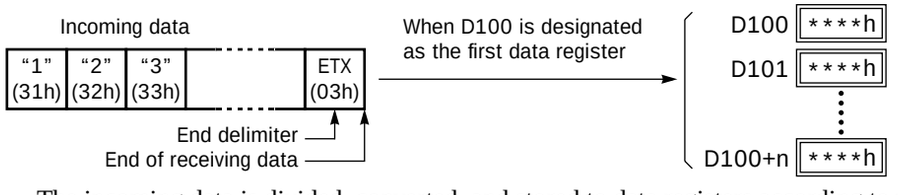
Example:

(1) When a RXD instruction without an end delimiter is executed



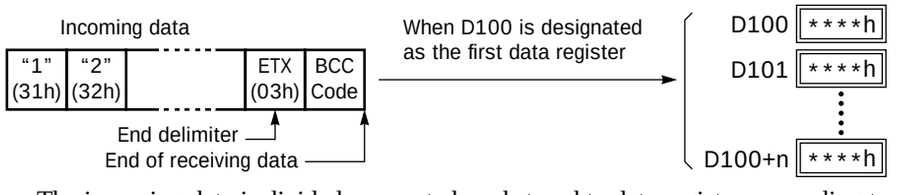
The incoming data is divided, converted, and stored to data registers according to the receive format.
Receive operation is completed when the total characters programmed in RXD are received.

(2) When a RXD instruction with end delimiter ETX (03h) and without BCC is executed



The incoming data is divided, converted, and stored to data registers according to the receive format.
The end delimiter is not stored to a data register.
Any data arriving after the end delimiter is discarded.

(3) When a RXD instruction with end delimiter ETX (03h) and one-byte BCC is executed

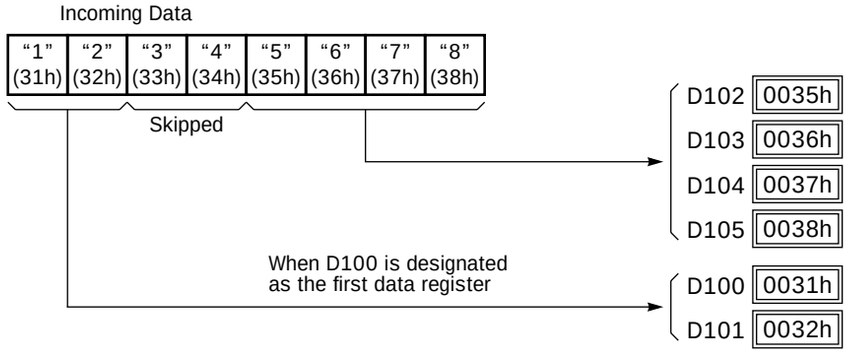


The incoming data is divided, converted, and stored to data registers according to the receive format.
The end delimiter and BCC code are not stored to data registers.
After receiving the end delimiter, the OpenNet Controller receives only the one-byte BCC code.

Skip

When "skip" is designated in the receive format, a specified quantity of digits in the incoming data are skipped and not stored to data registers. A maximum of 99 digits (bytes) of characters can be skipped continuously.

Example: When a RXD instruction with skip for 2 digits starting at the third byte is executed



BCC (Block Check Character)

The OpenNet Controller has an automatic BCC calculation function to detect a communication error in incoming data. If a BCC code is designated in the receive format of a RXD instruction, the OpenNet Controller calculates a BCC value for a specified starting position through the position immediately preceding the BCC and compares the calculation result with the BCC code in the received incoming data. The start position for the BCC calculation can be specified from the first byte through the 15th byte. The BCC, calculated in either XOR or ADD, can be 1 or 2 digits.

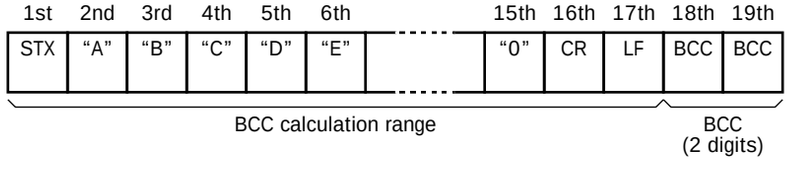
When an end delimiter is not used in the RXD instruction, the BCC code must be positioned at the end of the receive format designated in Source 1 operand. When an end delimiter is used, the BCC code must be immediately before or after the end delimiter. The OpenNet Controller reads a specified number of BCC digits in the incoming data according to the receive format to calculate and compare the received BCC code with the BCC calculation results.

BCC Calculation Start Position

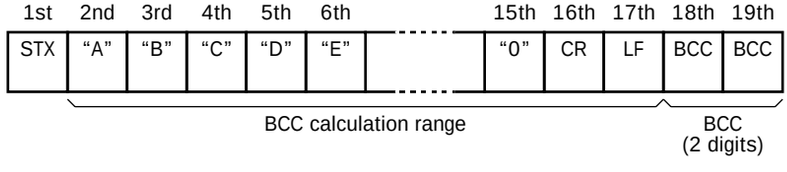
The start position for the BCC calculation can be specified from the first byte through the 15th byte. The BCC is calculated for the range starting at the designated position up to the byte immediately before the BCC of the receive data.

Example: Received data consists of 17 bytes plus 2 BCC digits.

(1) Calculation start position = 1



(2) Calculation start position = 2



BCC Calculation Formula

BCC calculation formula can be selected from XOR (exclusive OR) or ADD (addition) operation.

Example: Incoming data consists of 41h, 42h, 43h, 44h, and 45h.

(1) BCC Calculation Formula = XOR

$41h \oplus 42h \oplus 43h \oplus 44h \oplus 45h = 41h$

(2) BCC Calculation Formula = ADD

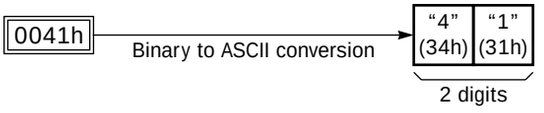
$41h + 42h + 43h + 44h + 45h = 14Fh \rightarrow 4Fh$ (Only the last 1 or 2 digits are used as BCC.)

Conversion Type

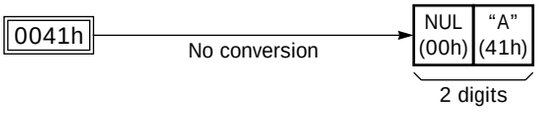
The BCC calculation result can be converted or not according to the designated conversion type as described below:

Example: BCC calculation result is 0041h.

(1) Binary to ASCII conversion



(2) No conversion

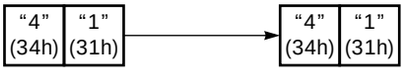


BCC Digits (Bytes)

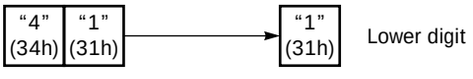
The quantity of digits (bytes) of the BCC code can be selected from 1 or 2.

Example:

(1) BCC digits = 2



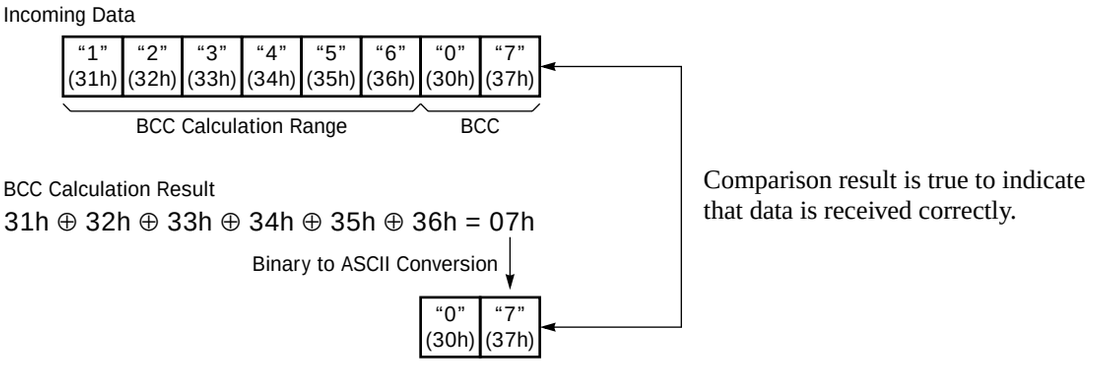
(2) BCC digits = 1



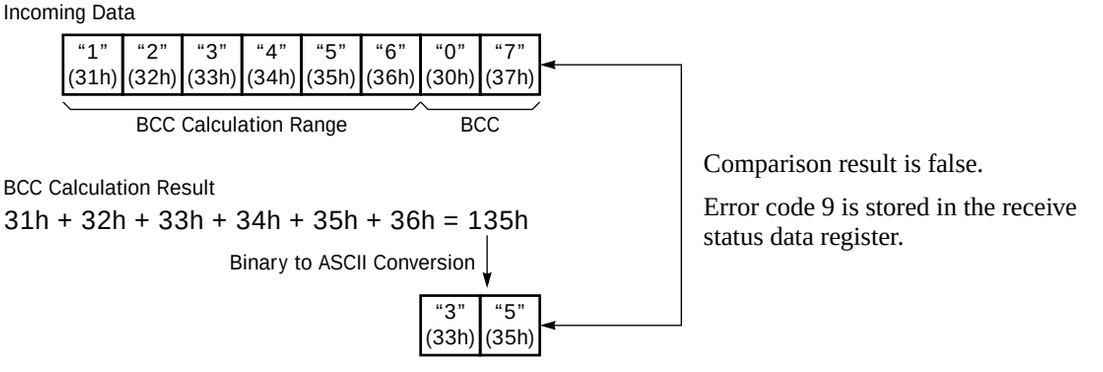
Comparing BCC Codes

The OpenNet Controller compares the BCC calculation result with the BCC code in the received incoming data to check for any error in the incoming communication due to external noises or other causes. If a disparity is found in the comparison, an error code is stored in the data register designated as receive status in the RXD instruction. For user communication error code, see page 17-25.

Example 1: BCC is calculated for the first byte through the sixth byte using the XOR format, converted in binary to ASCII, and compared with the BCC code appended to the seventh and eighth bytes of the incoming data.



Example 2: BCC is calculated for the first byte through the sixth byte using the ADD format, converted in binary to ASCII, and compared with the BCC code appended to the seventh and eighth bytes of the incoming data.



Receive Completion Output

Designate an output, Q0 through Q597, or internal relay, M0 through M2557, as an operand for the receive completion output.

When the start input for a RXD instruction is turned on, preparation for receiving data is initiated, followed by data conversion and storage. When a sequence of all data receive operation is complete, the designated output or internal relay is turned on.

Conditions for Completion of Receiving Data

After starting to receive data, the RXD instruction can be completed in three ways:

- When an end delimiter is received (except when a BCC exists immediately after the end delimiter).
- When receive timeout occurs.
- When a specified byte count of data has been received.

Data receiving is completed when one of the above three conditions is met. To abort a RXD instruction, use the user communication receive instruction cancel flag M8022 or M8023. See page 17-21.

Receive Status

Designate a data register, D0 through D7998, as an operand to store the receive status information including a receive status code and a user communication error code.

Receive Status Code

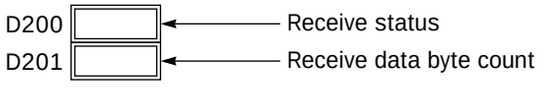
Receive Status Code	Status	Description
16	Preparing data receive	From turning on the start input for a RXD instruction to read the receive format, until the RXD instruction is enabled by an END processing
32	Receiving data	From enabling the RXD instruction by an END processing, until incoming data is received
48	Data receive complete	From receiving incoming data, until the received data is converted and stored in data registers according to the receive format
64	Receive instruction complete	All data receive operation is completed and the next data receive is made possible
128	User communication receive instruction cancel flag active	RXD instructions are cancelled by special internal relay M8022 or M8023

If the receive status code is other than shown above, an error of receive instruction is suspected. See User Communication Error Code on page 17-25.

Receive Data Byte Count

The data register next to the operand designated for receive status stores the byte count of data received by the RXD instruction. When a start delimiter, end delimiter, and BCC are included in the received data, the byte counts for these codes are also included in the receive data byte count.

Example: Data register D200 is designated as an operand for receive status.



User Communication Receive Instruction Cancel Flag

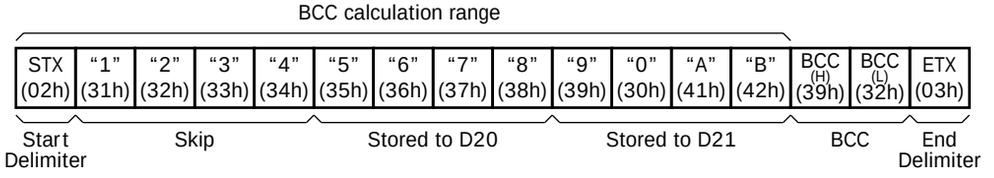
Special internal relays M8022 and M8023 are used to cancel all RXD1 and RXD2 instructions, respectively. While the OpenNet Controller has completed receive format and is ready for receiving incoming data, turning on M8022 or M8023 cancels all receive instructions for RS232C port 1 or port 2, respectively. This function is useful to cancel receive instructions only, without stopping the OpenNet Controller.

To make the cancelled RXD instructions active, turn off the flag and turn on the input to the RXD instruction again.

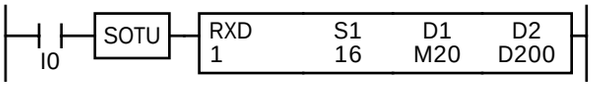
Programming RXD Instruction Using WindLDR

The following example demonstrates how to program a RXD instruction including a start delimiter, skip, BCC, and end delimiter using WindLDR. Converted data is stored to data registers D20 and D21. Internal relay M20 is used as destination D1 for the receive completion output. Data register D200 is used as destination D2 for the receive status, and data register D201 is used to store the receive data byte count.

Receive data example:



RXD sample program:



Communication port:	RS232C port 1
Receive completion output:	M20
Receive status register:	D200
Receive data byte count:	D201

1. Start to program a RXD instruction. Move the cursor where you want to insert the RXD instruction, and type **RXD**. You can also insert the RXD instruction by clicking the User Communication icon in the menu bar and clicking where you want to insert the RXD instruction in the program edit area, then the Transmit dialog box appears. Click **RXD** to change the dialog box to the Receive dialog box.

The Receive instruction dialog box appears.

2. Check that **RXD** is selected in the Type box and click **Port 1** in the Port box. Then, click **Insert**.

The Data Type Selection dialog box appears. You will program source operand S1 using this dialog box.

3. Click **Constant (Hexadecimal)** in the Type box and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **02** to program the start delimiter STX (02h). When finished, click **OK**.

4. Since the Receive instruction dialog box reappears, repeat the above procedure. In the Data Type Selection dialog box, click **Skip** and click **OK**. Next, in the Skip dialog box, type **4** in the Digits box and click **OK**.

5. Again in the Data Type Selection dialog box, click **Variable (DR)** and click **OK**. Next, in the Variable (Data Register) dialog box, type **D20** in the DR No. box and click **ASCII to BIN** to select ASCII to binary conversion. Enter **4** in the Digits box (4 digits) and **2** in the REP box (2 repeat cycles). When finished, click **OK**.

6. Again in the Data Type Selection dialog box, click **BCC** and click **OK**. Next, in the BCC dialog box, enter **1** in the Calculation Start Position box, click **ADD** for the Calculation Type, click **BIN to ASCII** for the Conversion Type, and click **2** for the Digits. When finished, click **OK**.

7. Once again in the Data Type Selection dialog box, click **Constant (Hexadecimal)** and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **03** to program the end delimiter ETX (03h). When finished, click **OK**.

8. In the Receive instruction dialog box, type **M20** in the destination D1 box and type **D200** in the destination D2 box. When finished, click **OK**.

Programming of the RXD1 instruction is complete and the receive data will be stored as follows:

D20 | 5678h | = 22136
D21 | 90ABh | = 37035

User Communication Error

When a user communication error occurs, a user communication error code is stored in the data register designated as a transmit status in the TXD instruction or as a receive status in the RXD instruction. When multiple errors occur, the final error code overwrites all preceding errors and is stored in the status data register.

The status data register also contains transmit/receive status code. To extract a user communication error code from the status data register, divide the value by 16. The remainder is the user communication error code. See pages 17-9 and 17-21.

To correct the error, correct the user program by referring to the error causes described below:

User Communication Error Code

User Communication Error Code	Error Cause	Transmit / Receive Completion Output
1	Start inputs to more than 5 TXD instructions are on simultaneously.	Transmit completion outputs of the first 5 TXD instructions from the top of the ladder diagram are turned on.
2	Transmission destination busy timeout	Goes on after busy timeout.
3	Start inputs to more than 5 RXD instructions with a start delimiter are on simultaneously.	Among the first 5 RXD instructions from the top of the ladder diagram, receive completion outputs of RXD instructions go on if the start delimiter matches the first byte of the received data.
4	While a RXD instruction without a start delimiter is executed, another RXD instruction with or without a start delimiter is executed.	The receive completion output of the RXD instruction at a smaller address goes on.
5	— Reserved —	—
6	— Reserved —	—
7	The first byte of received data does not match the specified start delimiter.	No effect on the receive completion output. If incoming data with a matching start delimiter is received subsequently, the receive completion output goes on.
8	When ASCII to binary or ASCII to BCD conversion is specified in the receive format, any code other than 0 to 9 and A to F is received. (These codes are regarded as 0 during conversion.)	The receive completion output goes on.
9	BCC calculated from the RXD instruction does not match the BCC appended to the received data.	The receive completion output goes on.
10	The end delimiter code specified in the RXD instruction does not match the received end delimiter code.	The receive completion output goes on.
11	Receive timeout between characters (After receiving one byte of data, the next byte is not received in the period specified for the receive timeout value.)	The receive completion output goes on.
12	Overrun error (Before the receive processing is completed, the next data is received.)	The receive completion output goes on.
13	Framing error (Detection error of start bit or stop bit)	No effect on the completion output.
14	Parity check error (Error is found in the parity check.)	No effect on the completion output.
15	TXD1/RXD1 (or TXD2/RXD2) instruction is executed while the communication selector DIP switch is not set to select user communication mode for the RS232C port 1 (or RS232C port 2).	No effect on the completion output.

ASCII Character Code Table

Upper Bit / Lower Bit	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	$^{N}U_{L}$	$^{D}L_{E}$	SP	0	@	P	`	p								
Decimal	0	16	32	48	64	80	96	112	128	144	160	176	192	208	224	240
1	$^{S}O_{H}$	$^{D}C_{1}$	!	1	A	Q	a	q								
Decimal	1	17	33	49	65	81	97	113	129	145	161	177	193	209	225	241
2	$^{S}T_{X}$	$^{D}C_{2}$	”	2	B	R	b	r								
Decimal	2	18	34	50	66	82	98	114	130	146	162	178	194	210	226	242
3	$^{E}T_{X}$	$^{D}C_{3}$	#	3	C	S	c	s								
Decimal	3	19	35	51	67	83	99	115	131	147	163	179	195	211	227	243
4	$^{E}O_{T}$	$^{D}C_{4}$	$	4	D	T	d	t								
Decimal	4	20	36	52	68	84	100	116	132	148	164	180	196	212	228	244
5	$^{E}N_{Q}$	$^{N}A_{K}$	%	5	E	U	e	u								
Decimal	5	21	37	53	69	85	101	117	133	149	165	181	197	213	229	245
6	$^{A}C_{K}$	$^{S}Y_{N}$	&	6	F	V	f	v								
Decimal	6	22	38	54	70	86	102	118	134	150	166	182	198	214	230	246
7	$^{B}E_{L}$	$^{E}T_{B}$	’	7	G	W	g	w								
Decimal	7	23	39	55	71	87	103	119	135	151	167	183	199	215	231	247
8	BS	$^{C}A_{N}$	(	8	H	X	h	x								
Decimal	8	24	40	56	72	88	104	120	136	152	168	184	200	216	232	248
9	HT	EM	)	9	I	Y	i	y								
Decimal	9	25	41	57	73	89	105	121	137	153	169	185	201	217	233	249
A	LF	$^{S}U_{B}$	*	:	J	Z	j	z								
Decimal	10	26	42	58	74	90	106	122	138	154	170	186	202	218	234	250
B	VT	$^{E}S_{C}$	+	;	K	[	k	{								
Decimal	11	27	43	59	75	91	107	123	139	155	171	187	203	219	235	251
C	FF	FS	,	<	L	\	l	|								
Decimal	12	28	44	60	76	92	108	124	140	156	172	188	204	220	236	252
D	CR	GS	-	=	M	]	m	}								
Decimal	13	29	45	61	77	93	109	125	141	157	173	189	205	221	237	253
E	SO	RS	.	>	N	^	n	~								
Decimal	14	30	46	62	78	94	110	126	142	158	174	190	206	222	238	254
F	SI	US	/	?	O	_	o									
Decimal	15	31	47	63	79	95	111	127	143	159	175	191	207	223	239	255

RS232C Line Control Signals

While the OpenNet Controller is in the user communication mode, special data registers can be used to enable or disable DSR, DTR, and RTS control signal options for the RS232C port 1 and port 2.

To use the control signals on the RS232C port 1 or port 2 in the user communication mode, enter 0 to D8200 (RS232C port 1 communication mode selection) or to D8300 (RS232C port 2 communication mode selection), respectively.

Special Data Registers for RS232C Line Control Signals

Special data registers D8204 through D8207 and D8304 through D8307 are allocated for RS232C line control signals.

RS232C Port	DR No.	Data Register Function	DR Value Updated	R/W
Port 1	D8204	Control signal status	Every scan	R
	D8205	DSR input control signal option	When sending/receiving data	R/W
	D8206	DTR output control signal option	When sending/receiving data	R/W
	D8207	RTS output control signal option	When sending/receiving data	R/W
Port 2	D8304	Control signal status	Every scan	R
	D8305	DSR input control signal option	When sending/receiving data	R/W
	D8306	DTR output control signal option	When sending/receiving data	R/W
	D8307	RTS output control signal option	When sending/receiving data	R/W

Control Signal Status D8204/D8304

Special data registers D8204 and D8304 store a value to show that RTS, DSR, and DTR are on or off at RS232C port 1 or port 2, respectively. The data of D8204 and D8304 is updated at every END processing.

D8204/D8304 Value	RTS	DSR	DTR	Description
0	OFF	OFF	OFF	All RTS, DSR, and DTR are off
1	ON	OFF	OFF	RTS is on
2	OFF	ON	OFF	DSR is on
3	ON	ON	OFF	RTS and DSR are on
4	OFF	OFF	ON	DTR is on
5	ON	OFF	ON	RTS and DTR are on
6	OFF	ON	ON	DSR and DTR are on
7	ON	ON	ON	All RTS, DSR, and DTR are on

Control Signal Statuses in RUN Mode

Communication Mode	DR Value	DSR (Input) D8205/D8305	DTR (Output) D8206/D8306	RTS (Output) D8207/D8307
User Communication Mode	0 (default)	No effect	ON	While transmitting: OFF Not transmitting: ON
	1	ON: Enable TXD/RXD OFF: Disable TXD/RXD	OFF	While transmitting: ON Not transmitting: OFF
	2	ON: Disable TXD/RXD OFF: Enable TXD/RXD	RXD enabled: ON RXD disabled: OFF	ON
	3	ON: Enable TXD OFF: Disable TXD	ON	OFF
	4	ON: Disable TXD OFF: Enable TXD	ON	While transmitting: OFF Not transmitting: ON
	5 or more	No effect	ON	While transmitting: OFF Not transmitting: ON
Maintenance Mode	—	No effect	ON	While transmitting: OFF Not transmitting: ON

Control Signal Statuses in STOP Mode

Communication Mode	DR Value	DSR (Input) D8205/D8305	DTR (Output) D8206/D8306	RTS (Output) D8207/D8307
User Communication Mode	0 (default)	No effect TXD/RXD disabled	OFF	ON
	1	No effect TXD/RXD disabled	OFF	OFF
	2	No effect TXD/RXD disabled	OFF	OFF
	3	No effect TXD/RXD disabled	OFF	OFF
	4	No effect TXD/RXD disabled	OFF	ON
	5 or more	No effect TXD/RXD disabled	OFF	ON
Maintenance Mode	—	No effect	ON	While transmitting: OFF Not transmitting: ON

DSR Input Control Signal Option D8205/D8305

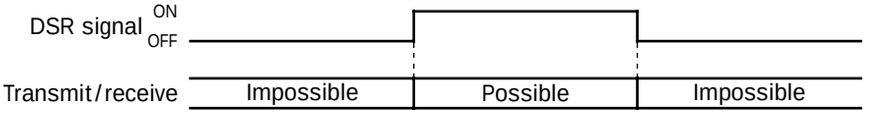
Special data registers D8205 and D8305 are used to control data flow between the OpenNet Controller RS232C port 1 or port 2 and the remote terminal depending on the DSR (data set ready) signal sent from the remote terminal. The DSR signal is an input to the OpenNet Controller to determine the status of the remote terminal. The remote terminal informs the OpenNet Controller using DSR whether the remote terminal is ready for receiving data or is sending valid data.

The DSR control signal option can be used only for the user communication through the RS232C port 1 or port 2.

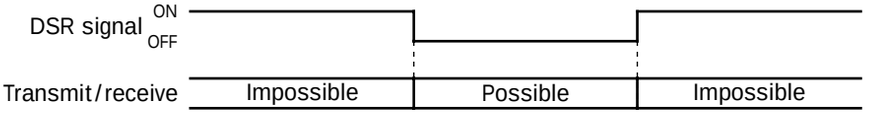
D8205/D8305 = 0 (system default):

DSR is not used for data flow control. When DSR control is not needed, set 0 to D8205 or D8305.

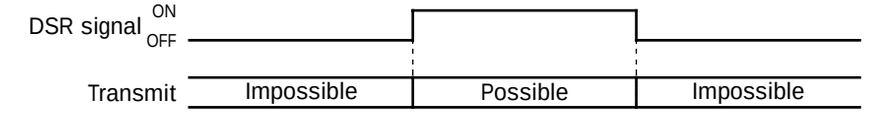
D8205/D8305 = 1: When DSR is on, the OpenNet Controller can transmit and receive data.



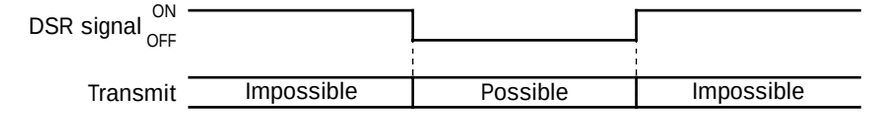
D8205/D8305 = 2: When DSR is off, the OpenNet Controller can transmit and receive data.



D8205/D8305 = 3: When DSR is on, the OpenNet Controller can transmit data. This function is usually called "Busy Control" and is used for controlling transmission to a remote terminal with a slow processing speed, such as a printer. When the remote terminal is busy, data input to the remote terminal is restricted.



D8205/D8305 = 4: When DSR is off, the OpenNet Controller can transmit data.



D8205/D8305 = 5 or more: Same as D8205/D8305 = 0. DSR is not used for data flow control.

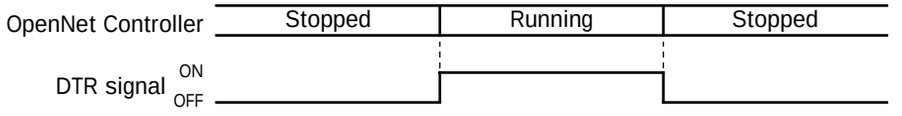
DTR Output Control Signal Option D8206/D8306

Special data registers D8206 and D8306 are used to control the DTR (data terminal ready) signal to indicate the OpenNet Controller operating status or transmitting/receiving status.

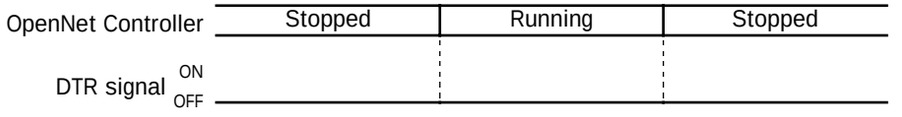
The DTR control signal option can be used only for the user communication through the RS232C port 1 or port 2.

D8206/D8306 = 0 (system default):

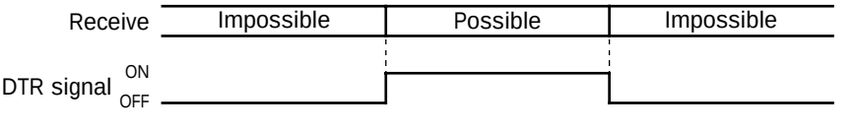
While the OpenNet Controller is running, DTR is on whether the OpenNet Controller is transmitting or receiving data. While the OpenNet Controller is stopped, DTR remains off. Use this option to indicate the OpenNet Controller operating status.



D8206/D8306 = 1: Whether the OpenNet Controller is running or stopped, DTR remains off.



D8206/D8306 = 2: While the OpenNet Controller can receive data, DTR is turned on. While the OpenNet Controller can not receive data, DTR remains off. Use this option when flow control of receive data is required.



D8206/D8306 = 3 or more: Same as D8206/D8306 = 0.

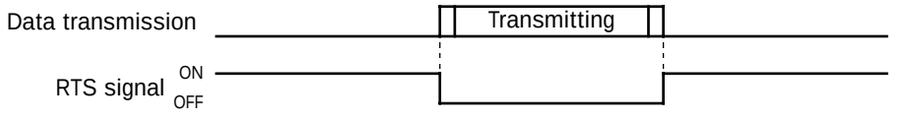
RTS Output Control Signal Option D8207/D8307

D8207 and D8307 are used to control the RTS (request to send) signal to indicate the OpenNet Controller transmission status or operating status.

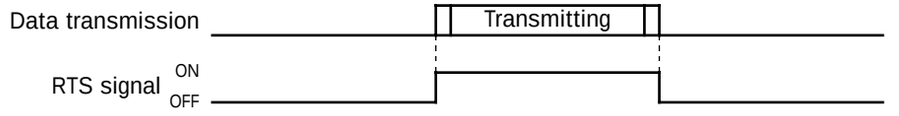
The RTS control signal option can be used only in the user protocol to communicate through the RS232C port 1 or port 2.

D8207/D8307 = 0 (system default):

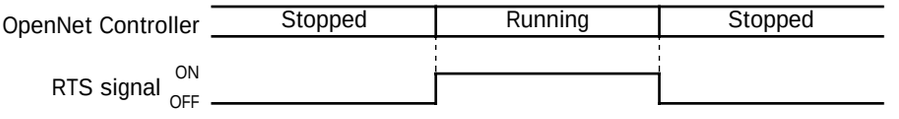
While the OpenNet Controller is transmitting data, RTS remains off. While the OpenNet Controller is not transmitting data, RTS is turned on. Use this option for communication with a remote terminal in the half-duplex mode since RTS goes on or off according to the data transmission from the OpenNet Controller.



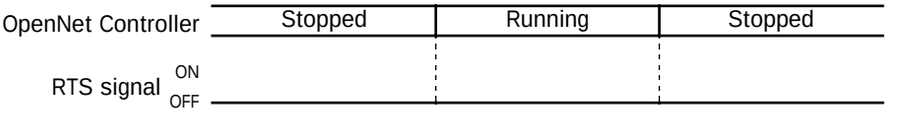
D8207/D8307 = 1: While the OpenNet Controller is transmitting data, RTS is turned on. While the OpenNet Controller is not transmitting data, RTS remains off. Use this option for communication with a remote terminal in the half-duplex mode since RTS goes on or off according to the data transmission from the OpenNet Controller.



D8207/D8307 = 2: While the OpenNet Controller is running, RTS remains on whether the OpenNet Controller is transmitting or receiving data. While the OpenNet Controller is stopped, RTS remains off. Use this option to indicate the OpenNet Controller operating status.



D8207/D8307 = 3: Whether the OpenNet Controller is running or stopped, RTS remains off.

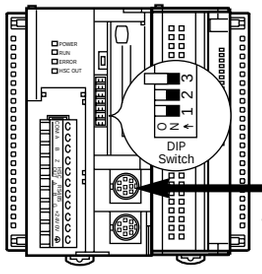


D8207/D8307 = 4 or more: Same as D8207/8307 = 0.

Sample Program – User Communication TXD

This example demonstrates a program to send data to a printer using the user communication TXD2 (transmit) instruction.

System Setup



Communication Selector DIP Switch
Set DIP switch 3 to ON to select user communication mode for RS232C port 2.

To RS232C Port 2

User Communication Cable 1C
FC2A-KP1C
2.4m (7.87 ft.) long

To RS232C Port

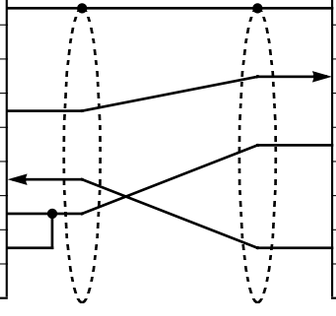
Printer

Attach a proper connector to the open end of the cable referring to the cable connector pinouts shown below.

Cable Connection and Pinouts

Mini DIN Connector Pinouts

Description		Color	Pin
Shield		—	**Cover**
NC	No Connection	Black	**1**
NC	No Connection	Yellow	**2**
TXD	Transmit Data	Blue	**3**
NC	No Connection	Green	**4**
DSR	Data Set Ready	Brown	**5**
SG	Signal Ground	Gray	**6**
SG	Signal Ground	Red	**7**
NC	No Connection	White	**8**



D-sub 9-pin Connector Pinouts

Pin	Description	
1	NC	No Connection
2	NC	No Connection
3	DATA	Receive Data
4	NC	No Connection
5	GND	Ground
6	NC	No Connection
7	NC	No Connection
8	BUSY	Busy Signal
9	NC	No Connection

The name of BUSY terminal differs depending on printers, such as DTR. The function of this terminal is to send a signal to remote equipment whether the printer is ready to print data or not. Since the operation of this signal may differ depending on printers, confirm the operation before connecting the cable.

Caution • Do not connect any wiring to the NC (no connection) pins; otherwise, the OpenNet Controller and the printer may not work correctly and may be damaged.

Description of Operation

The data of counter C2 and data register D30 are printed every minute. A printout example is shown on the right.

Printout Example

```
--- PRINT TEST ---

11H 00M

CNT2...0050
D030...3854

--- PRINT TEST ---

11H 01M

CNT2...0110
D030...2124
```

Programming Special Data Register

Special data register D8305 is used to monitor the BUSY signal and to control the transmission of print data.

Special DR	Value	Description
D8300	0	User communication mode (not modem mode)
D8305	3	While DSR is on (not busy), the CPU sends data. While DSR is off (busy), the CPU stops data transmission. If the off duration exceeds a limit (approx. 5 sec), a transmission busy timeout error will occur, and the remaining data is not sent. The transmit status data register stores an error code. See pages 17-9 and 17-25.

The OpenNet Controller monitors the DSR signal to prevent the receive buffer of the printer from overflowing. For the DSR signal, see page 17-28.

Setting Communication Selector DIP Switch

Since this example uses the RS232C port 2, turn on communication selector DIP switch 3 to select the user communication mode. See page 17-2.

Setting Communication Parameters

Set the communication parameters to match those of the printer. See page 17-3. For details of the communication parameters of the printer, see the user's manual for the printer. An example is shown below:

Communication Parameters:

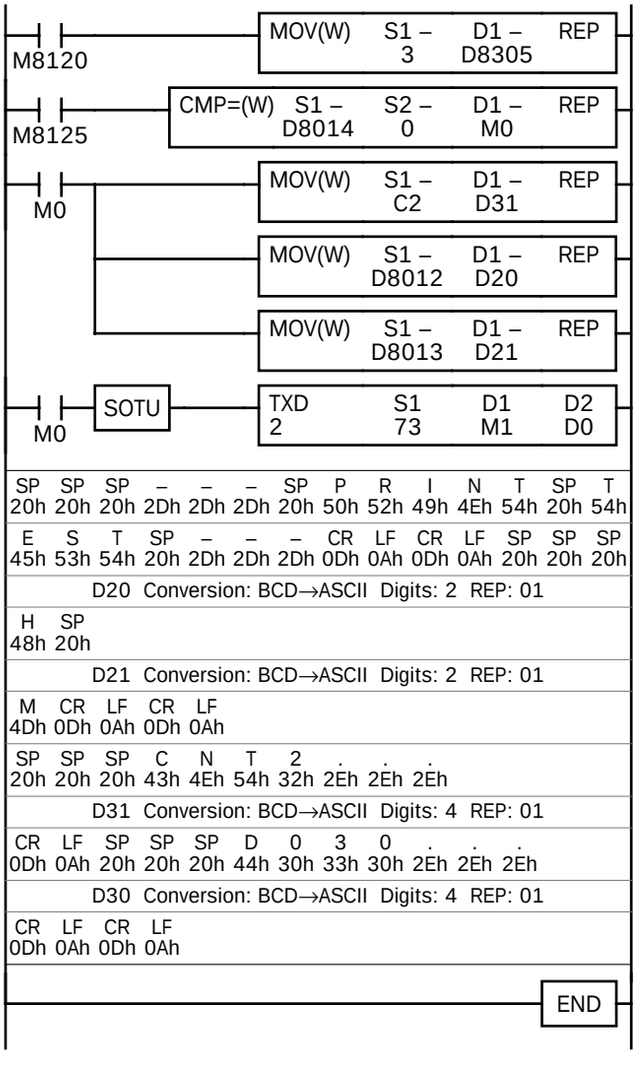
Baud rate	9600 bps
Data bits	8
Parity check	None
Stop bits	1

Note 1: In the user communication mode, communication is based on the end delimiter code specified in the TXD or RXD instruction.

Note 2: The receive timeout value is used for the RXD instruction in the user communication mode. Since this example uses only the TXD instruction, the receive timeout value has no effect.

Ladder Diagram

The second data stored in special data register D8014 is compared with 0 using the CMP= (compare equal to) instruction. Each time the condition is met, the TXD2 instruction is executed to send the C2 and D30 data to the printer. A counting circuit for counter C2 is omitted from this sample program.



M8120 is the initialize pulse special internal relay.

3 → D8305 to enable the DSR option for busy control.

M8125 is the in-operation output special internal relay.

CMP=(W) compares the D8014 second data with 0.

When the D8014 data equals 0 second, M0 is turned on.

Counter C2 current value is moved to D31.

D8012 hour data is moved to D20.

D8013 minute data is moved to D21.

TXD2 is executed to send 73-byte data through the RS232C port 2 to the printer.

D20 hour data is converted from BCD to ASCII, and 2 digits are sent.

D21 minute data is converted from BCD to ASCII, and 2 digits are sent.

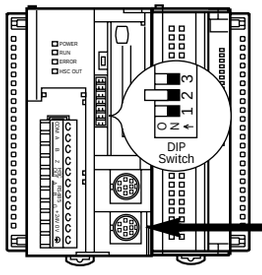
D31 counter C2 data is converted from BCD to ASCII, and 4 digits are sent.

D30 data is converted from BCD to ASCII, and 4 digits are sent.

Sample Program – User Communication RXD

This example demonstrates a program to receive data from a barcode reader with a RS232C port using the user communication RXD1 (receive) instruction.

System Setup



Communication Selector DIP Switch
Set DIP switch 2 to ON to select user communication mode for RS232C port 1.

To RS232C Port 1

User Communication Cable 1C
FC2A-KP1C
2.4m (7.87 ft.) long

To RS232C Port

Barcode Reader

Attach a proper connector to the open end of the cable referring to the cable connector pinouts shown below.

Mini DIN Connector Pinouts

Description		Color	Pin
Shield		—	**Cover**
RTS	Request to Send	Black	**1**
DTR	Data Terminal Ready	Yellow	**2**
TXD	Transmit Data	Blue	**3**
RXD	Receive Data	Green	**4**
DSR	Data Set Ready	Brown	**5**
SG	Signal Ground	Gray	**6**
SG	Signal Ground	Red	**7**
NC	No Connection	White	**8**

D-sub 25-pin Connector Pinouts

Pin	Description	
1	FG	Frame Ground
2	TXD1	Transmit Data
3	RXD1	Receive Data
7	GND	Ground

Caution

- Do not connect any wiring to the NC (no connection) pins; otherwise, the OpenNet Controller and the barcode reader may not work correctly and may be damaged.

Description of Operation

A barcode reader is used to scan barcodes of 8 numerical digits. The scanned data is sent to the OpenNet Controller through the RS232C port 1 and stored to data registers. The upper 8 digits of the data are stored to data register D20 and the lower 8 digits are stored to data register D21.

Programming Special Data Register

Special DR	Value	Description
D8200	0	RS232C port 1 user communication mode (not modem mode)

Setting Communication Selector DIP Switch

Since this example uses the RS232C port 1, turn on communication selector DIP switch 2 to select the user communication mode. See page 17-2.

Setting Communication Parameters

Set the communication parameters to match those of the barcode reader. See page 17-3. For details of the communication parameters of the barcode reader, see the user's manual for the barcode reader. An example is shown below:

Communication Parameters:

Baud rate	9600 bps
Data bits	7
Parity check	Even
Stop bits	1

Configuring Barcode Reader

The values shown below are an example of configuring a barcode reader. For actual settings, see the user's manual for the barcode reader.

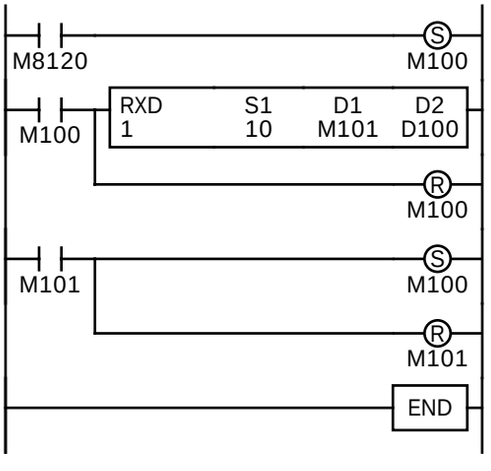
Synchronization mode	Auto			
Read mode	Single read or multiple read			
Communication parameter	Baud rate: Parity check:	9600 bps Even	Data bits: Stop bit:	7 1
Other communication settings	Header: Data echo back: Output timing: Data output filter: Sub serial:	02h No Output priority 1 No No	Terminator: BCR data output: Character suppress: Main serial input:	03h Yes No No
Comparison preset mode	Not used			

Allocation Numbers

M100	Input to start receiving barcode data
M101	Receive completion output for barcode data
M8120	Initialize pulse special internal relay
D20	Store barcode data (upper 4 digits)
D21	Store barcode data (lower 4 digits)
D100	Receive status data register for barcode data
D101	Receive data byte count data register

Ladder Diagram

When the OpenNet Controller starts operation, the RXD1 instruction is executed to wait for incoming data. When data receive is complete, the data is stored to data registers D20 and D21. The receive completion signal is used to execute the RXD1 instruction to wait for another incoming data.



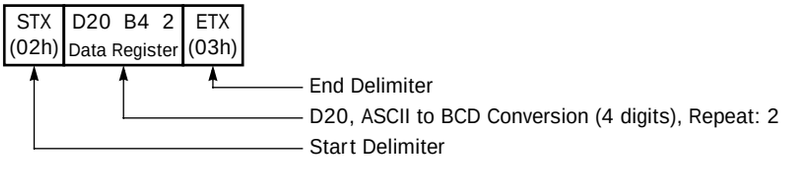
M8120 is the initialize pulse special internal relay used to set M100.

At the rising edge of M100, RXD1 is executed to be ready for receiving data.

Even after M100 is reset, RXD1 still waits for incoming data.

When data receive is complete, M101 is turned on, then M100 is set to execute RXD1 to receive the next incoming data.

RXD1 Data



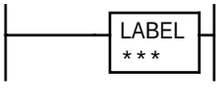
18: PROGRAM BRANCHING INSTRUCTIONS

Introduction

The program branching instructions reduce execution time by making it possible to bypass portions of the program whenever certain conditions are not satisfied.

The basic program branching instructions are LABEL and LJMP, which are used to tag an address and jump to the address which has been tagged. Programming tools include "either/or" options between numerous portions of a program and the ability to call one of several subroutines which return execution to where the normal program left off.

LABEL (Label)



This is the label number, from 0 to 255, used at the program address where the execution of program instructions begins for a program branch.

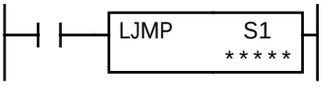
An END instruction may be used to separate a tagged portion of the program from the main program. In this way, scan time is minimized by *not* executing the program branch unless input conditions are satisfied.

Note: The same label number cannot be used more than once. When a user program including duplicate label numbers is downloaded to the CPU, a user program syntax error will result, turning on the ERROR LED.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
Label number	Tag for LJMP, LCAL, and DJNZ	—	—	—	—	—	—	—	—	0-255	—

LJMP (Label Jump)



When input is on, jump to the address with label 0 through 255 designated by S1.

When input is off, no jump takes place, and program execution proceeds with the next instruction.

The LJMP instruction is used as an "either/or" choice between two portions of a program. Program execution does *not* return to the instruction following the LJMP instruction, after the program branch.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Label number to jump to	X	X	X	X	X	X	X	X	0-255	—

For the valid operand number range, see page 6-2.

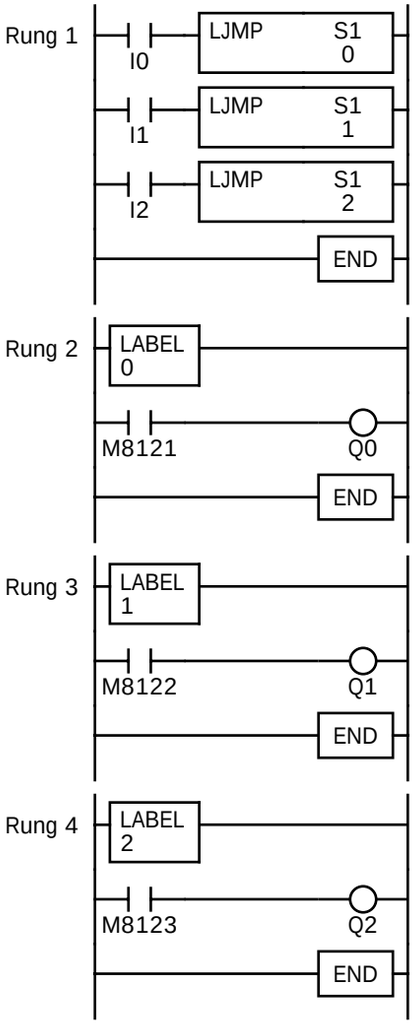
When T (timer) or C (counter) is used as S1, the timer/counter current value is read out.

Since the LJMP instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Note: Make sure that a LABEL instruction of the label number used for a LJMP instruction is programmed. If a matching label does not exist, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Example: LJMP and LABEL

The following example demonstrates a program to jump to three different portions of program depending on the input.



When input I0 is on, program execution jumps to label 0.

When input I1 is on, program execution jumps to label 1.

When input I2 is on, program execution jumps to label 2.

M8121 is the 1-sec clock special internal relay.

When jump occurs to label 0, output Q0 oscillates in 1-sec increments.

M8122 is the 100-msec clock special internal relay.

When jump occurs to label 1, output Q1 oscillates in 100-msec increments.

M8123 is the 10-msec clock special internal relay.

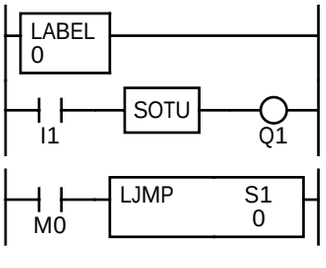
When jump occurs to label 2, output Q2 oscillates in 10-msec increments.

Using the Timer Instruction with Program Branching

When the timer start input of the TML, TIM, TMH or TMS instruction is already on, timedown begins immediately at the location jumped to, starting with the timer current value. When using a program branch, it is important to make sure that timers are initialized when desired, after the jump. If it is necessary to initialize the timer instruction (set to the preset value) after the jump, the timer's start input should be kept off for one or more scan cycles before initialization. Otherwise, the timer input on will not be recognized.

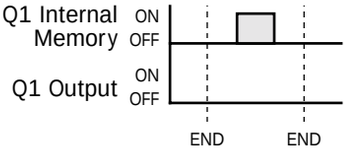
Using the SOTU / SOTD Instructions with Program Branching

Check that pulse inputs of counters and shift registers, and input of single outputs (SOTU and SOTD) are maintained during the jump, if required. Hold the input off for one or more scan cycles after the jump for the rising or falling edge transition to be recognized.



Although normally, the SOTU instruction produces a pulse for one scan, when used in a program branch the SOTU pulse will last only until the next time the same SOTU instruction is executed.

In the example on the left, the program branch will loop as long as internal relay M0 remains on. However, the SOTU produces a pulse output only during the first loop.



Since the END instruction is not executed as long as M0 remains on, output Q1 is not turned on even if input I1 is on.

LCAL (Label Call)

When input is on, the address with label 0 through 255 designated by S1 is called. When input is off, no call takes place, and program execution proceeds with the next instruction.

The LCAL instruction calls a subroutine, and returns to the main program after the branch is executed. A LRET instruction (see below) must be placed at the end of a program branch which is called, so that normal program execution resumes by returning to the instruction following the LCAL instruction.

Note: The END instruction must be used to separate the main program from any subroutines called by the LCAL instruction.

A maximum of 10 LCAL instructions can be nested.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Label number to call	X	X	X	X	X	X	X	X	0-255	—

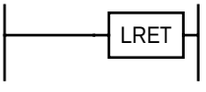
For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S1, the timer/counter current value is read out.

When designating S1 using other than a constant, the value for the label is a variable. When using a variable for a label, make sure that all probable LABEL numbers are included in the user program.

Since the LCAL instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

LRET (Label Return)



This instruction is placed at the end of a subroutine called by the LCAL instruction. When the subroutine is completed, normal program execution resumes by returning to the instruction following the LCAL instruction.

The LRET must be placed at the end of the subroutine starting with a LABEL instruction. When the LRET is programmed at other places, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Valid Operands

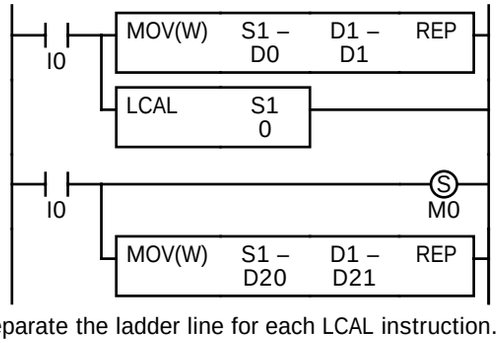
Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
—	—	—	—	—	—	—	—	—	—	—	—

Correct Structure for Calling Subroutine

When a LCAL instruction is executed, the remaining program instructions on the same rung may not be executed upon return, if input conditions are changed by the subroutine. After the LRET instruction of a subroutine, program execution begins with the instruction following the LCAL instruction, depending on current input condition.

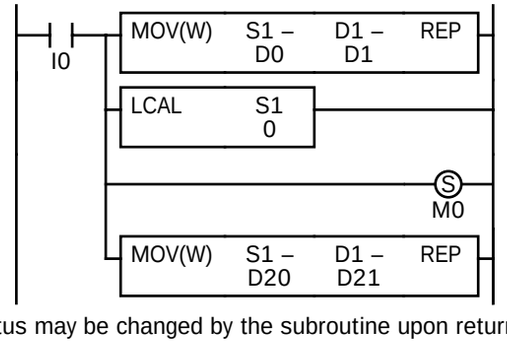
When instructions following a LCAL instruction must be executed after the subroutine is called, make sure the subroutine does not change input conditions unfavorably. In addition, include subsequent instructions in a new line, separated from the LCAL instruction.

Correct



Separate the ladder line for each LCAL instruction.

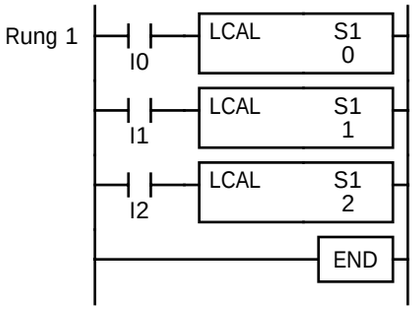
Incorrect



I0 status may be changed by the subroutine upon return.

Example: LCAL and LRET

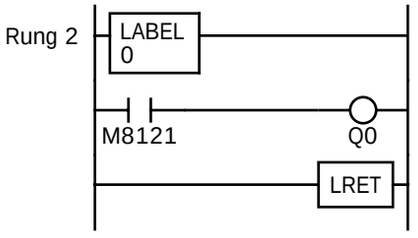
The following example demonstrates a program to call three different portions of program depending on the input. When the subroutine is complete, program execution returns to the instruction following the LCAL instruction.



When input I0 is on, program execution jumps to label 0.

When input I1 is on, program execution jumps to label 1.

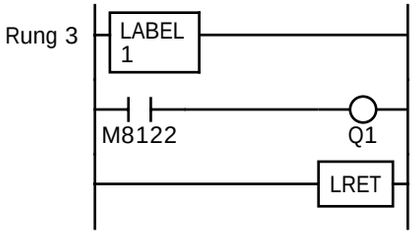
When input I2 is on, program execution jumps to label 2.



M8121 is the 1-sec clock special internal relay.

When jump occurs to label 0, output Q0 oscillates in 1-sec increments.

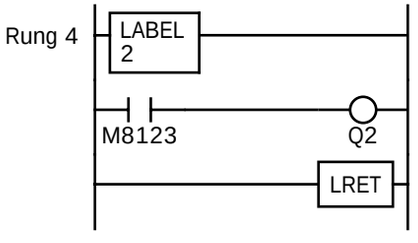
Program execution returns to rung 1, input I1.



M8122 is the 100-msec clock special internal relay.

When jump occurs to label 1, output Q1 oscillates in 100-msec increments.

Program execution returns to rung 1, input I2.

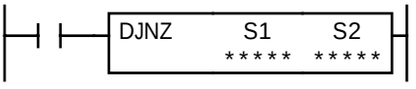


M8123 is the 10-msec clock special internal relay.

When jump occurs to label 2, output Q2 oscillates in 10-msec increments.

Program execution returns to rung 1, END.

DJNZ (Decrement Jump Non-zero)



When input is on, the value stored in the data register or link register designated by S1 is checked. When the value is 0, no jump takes place. When the value is not 0, the value is decremented by one. If the result is not 0, jump to address with label 0 through 255 designated by S2. If the decrement results in 0, no jump takes place, and program execution proceeds with the next instruction.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Decrement value	—	—	—	—	—	—	X	X	—	—
S2 (Source 2)	Label number to jump to	X	X	X	X	X	X	X	X	0-255	—

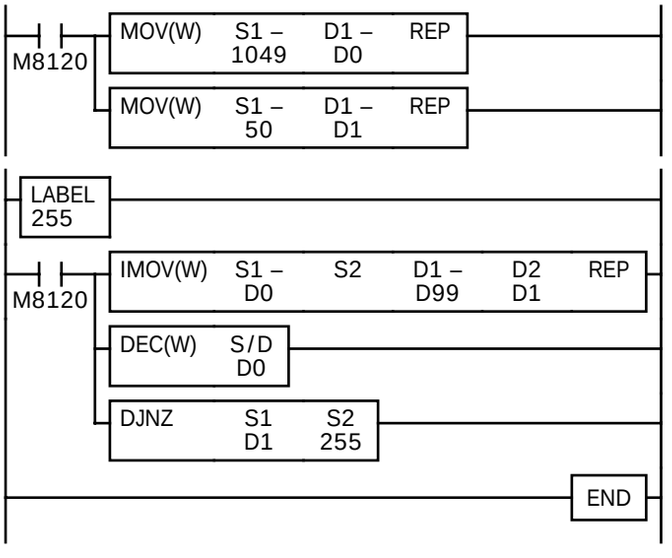
For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as S2, the timer/counter current value is read out.

Since the DJNZ instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used as required.

Example: DJNZ and LABEL

The following example demonstrates a program to store consecutive values 1000 through 1049 to data registers D100 through D149, respectively.



M8120 is the initialize pulse special internal relay.

At startup, MOV instructions store initial data.

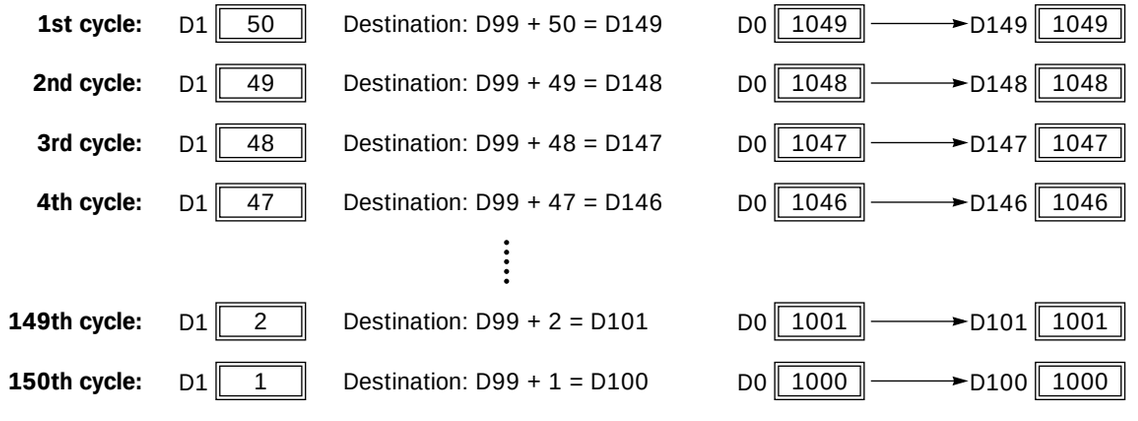
1049 → D0 to store the value for the first cycle.

50 → D1 to determine the jump cycles.

IMOV moves D0 data 1049 to D149 in the first cycle.

DEC decrements D0 data to 1048.

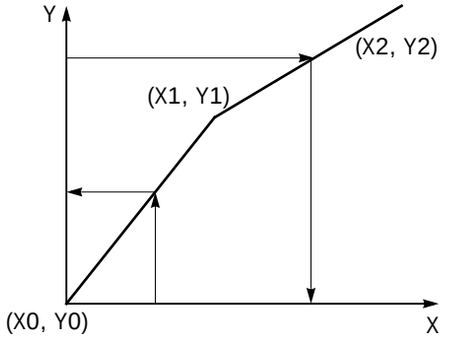
DJNZ jumps to label 255 until D1 value reduces to 0.



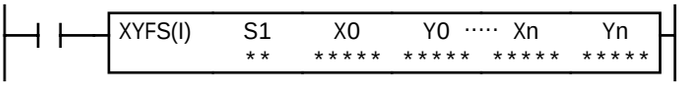
19: COORDINATE CONVERSION INSTRUCTIONS

Introduction

The coordinate conversion instructions convert one data point to another value, using a linear relationship between values of X and Y.



XYFS (XY Format Set)



When input is on, the format for XY conversion is set. The number of XY coordinates, defining the linear relationship between X and Y, can be 2 to 32 points. ($0 \leq n \leq 31$)

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Format number	—	—	—	—	—	—	—	—	0 to 29	—
X0 through Xn	X value	X	X	X	X	X	X	X	X	0 to 32767	—
Y0 through Yn	Y value	X	X	X	X	X	X	X	X	–32768 to 32767	—

For the valid operand number range, see page 6-2.

When T (timer) or C (counter) is used as X0 through Xn or Y0 through Yn, the timer/counter current value is read out.

S1 — Format number

Select a format number 0 through 29. A maximum of 30 formats for XY conversion can be set.

Xn — X value

Enter a value for the X coordinate. The integer value can be 0 through +32767. If the X value becomes negative, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

Yn — Y value

Enter a value for the Y coordinate. The integer value can be –32768 through +32767.

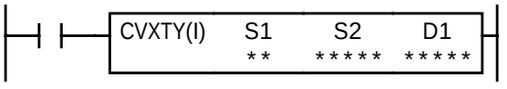
Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
—	X	—	—

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as Xn or Yn, 16 points (integer data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as Xn or Yn, 1 point (integer data type) is used.

CVXTY (Convert X to Y)



When input is on, the X value designated by operand S2 is converted into corresponding Y value according to the linear relationship defined in the XYFS instruction. Operand S1 selects a format from a maximum of 30 XY conversion formats. The conversion result is set to the operand designated by D1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Format number	—	—	—	—	—	—	—	—	0 to 29	—
S2 (Source 2)	X value	X	X	X	X	X	X	X	X	0 to 32767	—
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S2, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

S1 — Format number

Select a format number 0 through 29 which have been set using the XYFS instruction. When an XYFS instruction with the corresponding format number is not programmed, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

S2 — X value

Enter a value for the X coordinate to convert, within the range specified in the XYFS instruction. Although the integer value can be 0 through +32767, any value out of the range specified in the XYFS results in a user program execution error, turning on special internal relay M8004 and the ERROR LED.

D1 — Destination to store results

The conversion results of the Y value is stored to the destination. The integer value of the conversion results can be –32768 through +32767.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
—	X	—	—

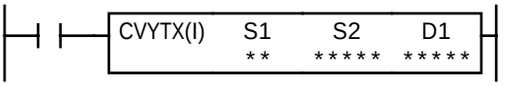
When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as S2 or D1, 16 points (integer data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as S2 or D1, 1 point (integer data type) is used.

Data Conversion Error

The data conversion error is ±0.5.

CVYTX (Convert Y to X)



When input is on, the Y value designated by operand S2 is converted into corresponding X value according to the linear relationship defined in the XYFS instruction. Operand S1 selects a format from a maximum of 30 XY conversion formats. The conversion result is set to the operand designated by D1.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Format number	—	—	—	—	—	—	—	—	0 to29	—
S2 (Source 2)	Y value	X	X	X	X	X	X	X	X	–32768 to 32767	—
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	X	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S2, the timer/counter current value is read out. When T (timer) or C (counter) is used as D1, the data is written in as a preset value which can be 0 through 65535.

S1 — Format number

Select a format number 0 through 29 which have been set using the XYFS instruction. When an XYFS instruction with the corresponding format number is not programmed, a user program execution error will result, turning on special internal relay M8004 and the ERROR LED.

S2 — Y value

Enter a value for the Y coordinate to convert, within the range specified in the XYFS instruction. Although the integer value can be –32768 through +32767, any value out of the range specified in the XYFS results in a user program execution error, turning on special internal relay M8004 and the ERROR LED.

D1 — Destination to store results

The conversion results of the X value is stored to the destination. The integer value of the conversion results can be 0 through +32767.

Valid Data Types

W (word)	I (integer)	D (double word)	L (long)
—	X	—	—

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as S2 or D1, 16 points (integer data type) are used.

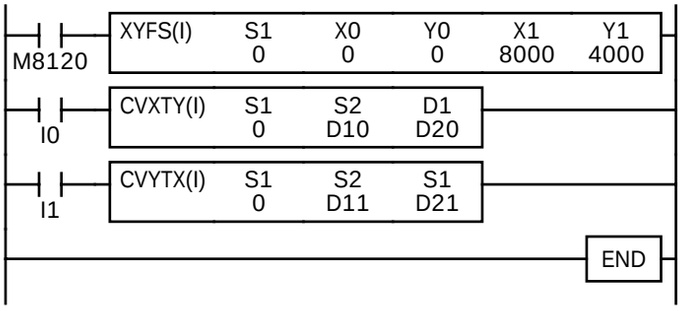
When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as S2 or D1, 1 point (integer data type) is used.

Data Conversion Error

The data conversion error is ±0.5.

Example: Linear Conversion

The following example demonstrates setting up two coordinate points to define the linear relationship between X and Y. The two points are (X0, Y0) = (0, 0) and (X1, Y1) = (8000, 4000). Once these are set, there is an X to Y conversion, as well as a Y to X conversion.

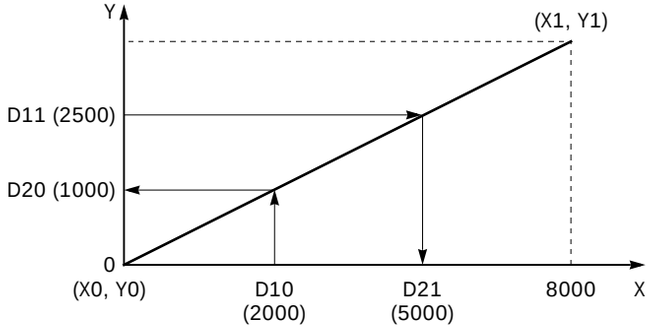


M8120 is the initialize pulse special internal relay.

At startup, XYFS specifies two points.

When input I0 is on, CVXTY converts the value in D10 and stores the result in D20.

When input I1 is on, CVYTX converts the value in D11 and stores the result in D21.



The graph shows the linear relationship that is defined by the two points:

$$Y = \frac{1}{2}X$$

If the value in data register D10 is 2000, the value assigned to D20 is 1000.

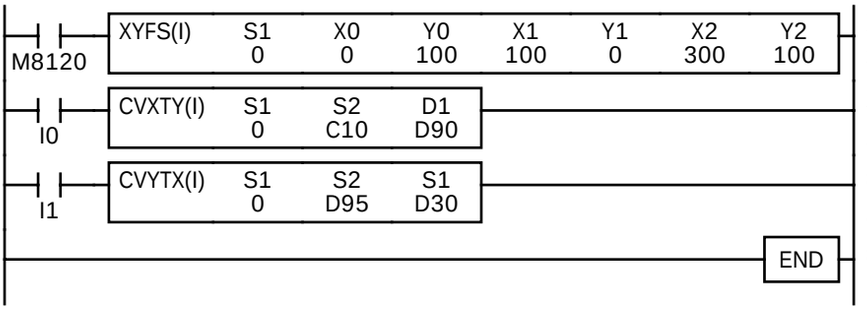
For Y to X conversion, the following equation is used:

$$X = 2Y$$

If the value in data register D11 is 2500, the value assigned to D21 is 5000.

Example: Overlapping Coordinates

In this example, the XYFS instruction sets up three coordinate points, which define two different linear relationships between X and Y. The three points are: (X0, Y0) = (0, 100), (X1, Y1) = (100, 0), and (X2, Y2) = (300, 100). The two line segments define overlapping coordinates for X. That is, for each value of Y within the designated range, there would be two X values assigned.

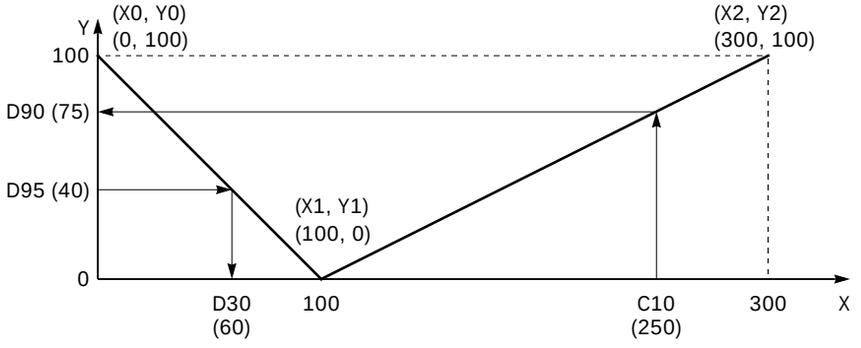


M8120 is the initialize pulse special internal relay.

At startup, XYFS specifies three points.

CVXTY converts the value in C10 and stores the result in D90.

CVYTX converts the value in D95 and stores the result in D30.



The first line segment defines the following relationship for X to Y conversion:

$$Y = -X + 100$$

The second line segment defines another relationship for X to Y conversion:

$$Y = \frac{1}{2}X - 50$$

For X to Y conversion, each value of X has only one corresponding value for Y. If the current value of counter C10 is 250, the value assigned to D90 is 75.

For Y to X conversion, the XYFS instruction assigns two possible values of X for each value of Y. The relationship defined by the first two points has priority in these cases. The line between points (X0, Y0) and (X1, Y1), that is, the line between (0, 100) and (100, 0), has priority in defining the relationship for Y to X conversion (X = –Y + 100).

Therefore, if the value in data register D95 is 40, the value assigned to D30 is 60, not 180.

Exactly the same two line segments might also be defined by the XYFS instruction, except that the point (300, 100) could be assigned first, as (X0, Y0), and the point (100, 0) could be defined next, as (X1, Y1). In this case, this linear relationship would have priority.

In this case, if the value in data register D95 is 40, the value assigned to D30 is 180, not 60.

AVRG (Average)

When input is on, sampling data designated by operand S1 is processed according to sampling conditions designated by operands S2 and S3.

When sampling is complete, average, maximum, and minimum values are stored to 3 consecutive operands starting with operand designated by D1, then sampling completion output designated by operand D2 is turned on.

This instruction is effective for data processing of analog input values. A maximum of 10 AVRG instructions can be programmed in a user program.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant	Repeat
S1 (Source 1)	Sampling data	X	X	X	X	X	X	X	X	—	—
S2 (Source 2)	Sampling end input	X	X	X	X	—	—	—	—	—	—
S3 (Source 3)	Sampling cycles	X	X	X	X	X	X	X	X	0-65535	—
D1 (Destination 1)	First operand number to store results	—	—	—	—	—	—	X	X	—	—
D2 (Destination 2)	Sampling completion output	—	X	▲	—	—	—	—	—	—	—

For the valid operand number range, see page 6-2.

▲ Internal relays M0 through M2557 can be designated as D2. Special internal relays cannot be designated as D2. When T (timer) or C (counter) is used as S1 or S3, the timer/counter current value is read out.

While input is on, the AVRG instruction is executed in each scan. When the quantity of sampling cycles designated by operand S3 is 1 through 65535, sampling data designated by operand S1 is processed in each scan. When the designated sampling cycles have been completed, the average value of the sampling data is set to operand designated by D1. The maximum value of the sampling data is set to the next operand, D1+1. The minimum value of the sampling data is set to the next operand, D1+2. The sampling completion output designated by operand D2 is turned on.

When the quantity of sampling cycles designated by operand S3 is 0, sampling is started when the input to the AVRG instruction is turned on, and stopped when the sampling end input designated by operand S2 is turned on. Then, the average, maximum, and minimum values are set to 3 operands starting with operand designated by D1.

When the sampling exceeds 65535 cycles, the average, maximum, and minimum values at this point are set to 3 operands starting with operand designated by D1, and sampling continues.

When the sampling end input is turned on before the sampling cycles designated by operand S3 have not been completed, sampling is stopped and the results at this point are set to 3 operands starting with operand designated by D1.

The average value is calculated to units, rounding the fractions of one decimal place.

When the sampling end input is not used, designate an internal relay or another valid operand as a dummy for source operand S2.

Valid Data Types

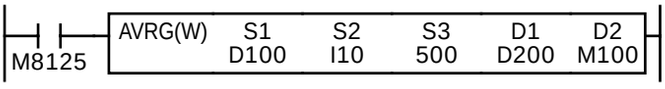
W (word)	I (integer)	D (double word)	L (long)
X	X	—	—

When a bit operand such as I (input), Q (output), M (internal relay), or R (shift register) is designated as the source or destination, 16 points (word or integer data type) are used.

When a word operand such as T (timer), C (counter), D (data register), or L (link register) is designated as the source or destination, 1 point (word or integer data type) is used.

Example: AVRG

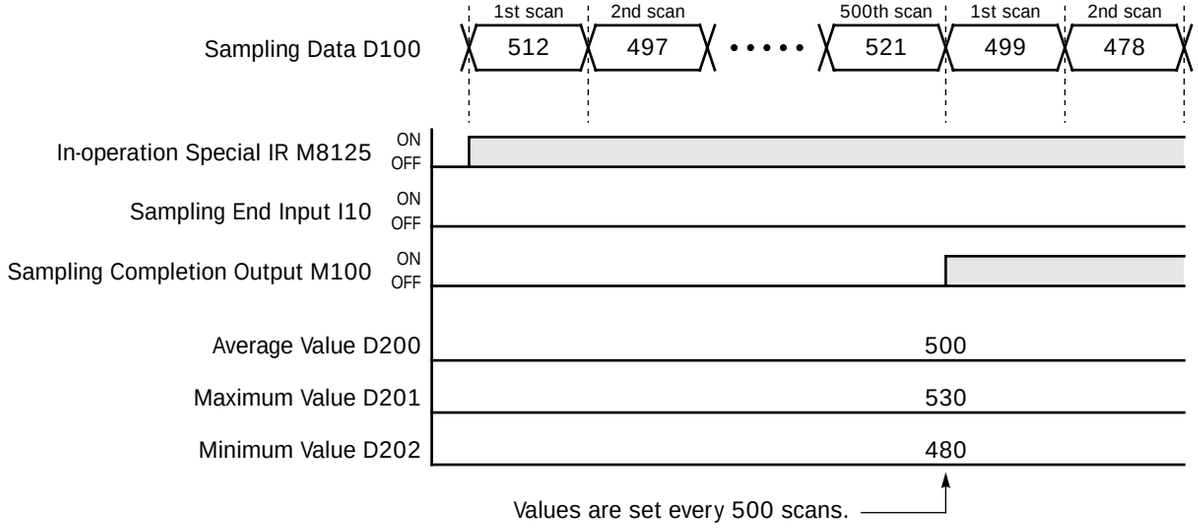
The following example demonstrates a program to calculate average values of the data register D100 and store the result to data register D200 in every 500 scans.



M8125 is the in-operation output special internal relay.

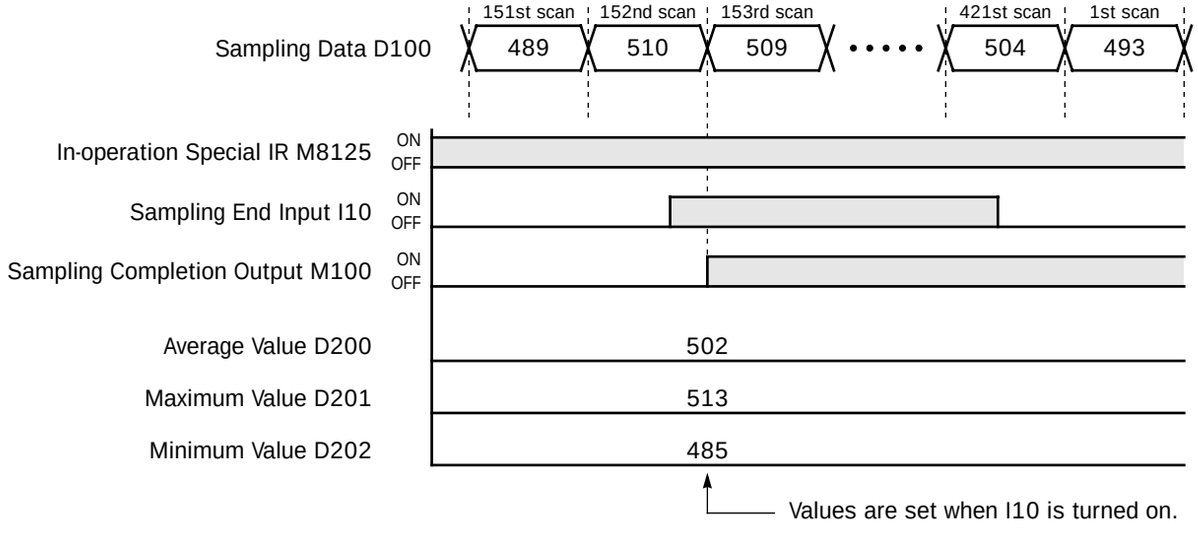
When the sampling end input does not turn on

While sampling end input I10 is off, the average, maximum, and minimum values are calculated in every 500 scans and stored to data registers D200, D201, and D202, respectively. Sampling completion output M100 is set every 500 scans.



When the sampling end input turns on

When sampling end input I10 turns on, the average, maximum, and minimum values at this point are stored to data registers D200, D201, and D202, respectively. Sampling completion output M100 is also set. When sampling end input I10 turns off, sampling resumes starting at the first scan.



20: PID INSTRUCTION

Introduction

The PID instruction implements a PID (proportional, integral, and derivative) algorithm with built-in auto tuning to determine PID parameters, such as proportional gain, integral time, derivative time, and control action automatically. The PID instruction is primarily designed for use with an analog I/O module to read analog input data, and turns on and off a designated output to perform PID control in applications such as temperature control described in the application example on page 20-14. In addition, when the output manipulated variable is converted, the PID instruction can also generate an analog output using an analog I/O module.

⚠ Warning

- Special technical knowledge about the PID control is required to use the PID function of the OpenNet Controller. Use of the PID function without understanding the PID control may cause the OpenNet Controller to perform unexpected operation, resulting in disorder of the control system, damage, or accidents.
- When using the PID instruction for feedback control, emergency stop and interlocking circuits must be configured outside the OpenNet Controller. If such a circuit is configured inside the OpenNet Controller, failure of inputting the process variable may cause equipment damage or accidents.

PID (PID Control)

When input is on, auto tuning and/or PID action is executed according to the value (0 through 2) stored in a data register operand assigned for operation mode.

A maximum of 42 PID instructions can be used in a user program.

Valid Operands

Operand	Function	I	Q	M	R	T	C	D	L	Constant
S1 (Source 1)	Control register	—	—	—	—	—	—	D0-D7973	—	—
S2 (Source 2)	Control relay	—	Q0-Q590	M0-M2550	—	—	—	—	—	—
S3 (Source 3)	Set point	—	—	—	—	—	—	D0-D7999	—	0-4000
S4 (Source 4)	Process variable (before conversion)	—	—	—	—	—	—	D0-D7999	L100-L705	—
D1 (Destination 1)	Manipulated variable	—	—	—	—	—	—	D0-D7999	—	—

Source operand S1 (control register) uses 27 data registers starting with the operand designated by S1. Data registers D0 through D7973 can be designated by S1. For details, see the following pages.

Source operand S2 (control relay) uses 8 points of outputs or internal relays starting with the operand designated by S2. Outputs Q0 through Q590 or internal relays M0 through M2550 can be designated by S2. For details, see page 20-10.

Source operand S3 (set point): When the linear conversion is disabled (S1+4 set to 0), the valid range of the set point (S3) is 0 through 4000 which can be designated using a data register or constant. When the linear conversion is enabled (S1+4 set to 1), the valid range is –32768 to 32767 that is a value after linear conversion. Use a data register to designate a negative value for a set point when the linear conversion is used. For details, see page 20-12.

Source operand S4 (process variable) is designated using a data register or link register. When reading input data from an analog input module, designate a proper link register number depending on the slot position of the analog input module and the channel number connected to the analog input. For details, see page 20-12.

Destination operand D1 (manipulated variable) stores –32768 through 32767 that is a calculation result of the PID action. For details, see page 20-13.

Source Operand S1 (Control Register)

Store appropriate values to data registers starting with the operand designated by S1 before executing the PID instruction as required, and make sure that the values are within the valid range. Operands S1+0 through S1+2 are for read only, and operands S1+23 through S1+26 are reserved for the system program.

Operand	Function	Description	R/W
S1+0	Process variable (after conversion)	When S1+4 (linear conversion) = 1 (enable linear conversion): Stores the process variable after conversion. When S1+4 (linear conversion) = 0 (disable linear conversion): Stores the process variable without conversion.	R
S1+1	Output manipulated variable	Stores the output manipulated variable (manual mode output variable and AT output manipulated variable) in percent. 0 to 100 (0% to 100%)	R
S1+2	Operating status	Stores the operating or error status of the PID instruction.	R
S1+3	Operation mode	0: PID action 1: AT (auto tuning) + PID action 2: AT (auto tuning)	R/W
S1+4	Linear conversion	0: Disable linear conversion 1: Enable linear conversion	R/W
S1+5	Linear conversion maximum value	–32768 to +32767	R/W
S1+6	Linear conversion minimum value	–32768 to +32767	R/W
S1+7	Proportional gain	1 to 10000 (0.01% to 100.00%) 0 designates 0.01%, ≥10001 designates 100.00%	R/W
S1+8	Integral time	1 to 65535 (0.1 sec to 6553.5 sec), 0 disables integral action	R/W
S1+9	Derivative time	1 to 65535 (0.1 sec to 6553.5 sec), 0 disables derivative action	R/W
S1+10	Integral start coefficient	1 to 100 (1% to 100%), 0 and ≥101 (except 200) designate 100% 200 executes integral action within the proportional range	R/W
S1+11	Input filter coefficient	0 to 99 (0% to 99%), ≥100 designates 99%	R/W
S1+12	Sampling period	1 to 10000 (0.01 sec to 100.00 sec) 0 designates 0.01 sec, ≥10001 designates 100.00 sec	R/W
S1+13	Control period	1 to 500 (0.1 sec to 50.0 sec) 0 designates 0.1 sec, ≥501 designates 50.0 sec	R/W
S1+14	High alarm value	When S1+4 (linear conversion) = 0: 0 to 4000 (≥4001 designates 4000) When S1+4 = 1: Linear conversion min. ≤ High alarm ≤ Linear conversion max. When S1+14 < S1+6 (linear conversion min.), S1+6 becomes high alarm. When S1+14 > S1+5 (linear conversion max.), S1+5 becomes high alarm.	R/W
S1+15	Low alarm value	When S1+4 (linear conversion) = 0: 0 to 4000 (≥4001 designates 4000) When S1+4 = 1: Linear conversion min. ≤ Low alarm ≤ Linear conversion max. When S1+15 < S1+6 (linear conversion min.), S1+6 becomes low alarm. When S1+15 > S1+5 (linear conversion max.), S1+5 becomes low alarm.	R/W
S1+16	Output manipulated variable upper limit	0 to 100, 10001 to 10099 (other values designate 100)	R/W
S1+17	Output manipulated variable lower limit	0 to 100 (≥101 designates 100)	R/W
S1+18	Manual mode output manipulated variable	0 to 100 (≥101 designates 100)	R/W
S1+19	AT sampling period	1 to 10000 (0.01 sec to 100.00 sec) 0 designates 0.01 sec, ≥10001 designates 100.00 sec	R/W
S1+20	AT control period	1 to 500 (0.1 sec to 50.0 sec) 0 designates 0.1 sec, ≥501 designates 50.0 sec	R/W
S1+21	AT set point	When S1+4 (linear conversion) = 0: 0 to 4000 (≥4001 designates 4000) When S1+4 = 1: Linear conversion min. ≤ AT set point ≤ Linear conversion max.	R/W
S1+22	AT output manipulated variable	0 to 100 (≥101 designates 100)	R/W
S1+23 S1+24 S1+25 S1+26	— Reserved for processing the PID instruction —		

Note: The value stored in the data register designated by S1+3 (operation mode) is checked only when the start input for the PID instruction is turned on. Values in all other control registers are refreshed in every scan.

S1+0 Process Variable (after conversion)

When the linear conversion is enabled (S1+4 set to 1), the data register designated by S1+0 stores the linear conversion result of the process variable (S4). The process variable (S1+0) takes a value between the linear conversion minimum value (S1+6) and the linear conversion maximum value (S1+5).

When the linear conversion is disabled (S1+4 is set to 0), the data register designated by S1+0 stores the same value as the process variable (S4).

S1+1 Output Manipulated Variable

While the PID action is in progress, the data register designated by S1+1 holds 0 through 100 read from the manipulated variable, –32768 through 32767, stored in the data register designated by D1, omitting values less than 0 and greater than 100. The percent value in S1+1 determines the ON duration of the control output (S2+6) in proportion to the control period (S1+13).

While manual mode is enabled with the auto/manual mode control relay (S2+1) set to on, S1+1 stores 0 through 100 read from the manual mode output manipulated variable (S1+18).

While auto tuning (AT) is in progress, S1+1 stores 0 through 100 read from the AT output manipulated variable (S1+22).

S1+2 Operating Status

The data register designated by S1+2 stores the operating or error status of the PID instruction.

Status codes 1X through 6X contain the time elapsed after starting auto tuning or PID action. X changes from 0 through 9 in 10-minute increments to represent 0 through 90 minutes. The time code remains 9 after 90 minutes has elapsed. When the operation mode (S1+3) is set to 1 (AT+PID), the time code is reset to 0 at the transition from AT to PID.

Status codes 100 and above indicate an error, stopping the auto tuning or PID action. When these errors occur, a user program execution error will result, turning on the ERR LED and special internal relay M8004 (user program execution error). To continue operation, enter correct parameters and turn on the start input for the PID instruction.

Status Code	Description	Operation
1X	AT in progress	AT is normal.
2X	AT completed	
5X	PID action in progress	PID action is normal.
6X	PID set point (S3) is reached. Status code changes from 5X to 6X once the PID set point is reached.	
100	The operation mode (S1+3) is set to a value over 2.	PID action or AT is stopped because of incorrect parameter settings.
101	The linear conversion (S1+4) is set to a value over 1.	
102	When the linear conversion is enabled (S1+4 to 1), the linear conversion maximum value (S1+5) and the linear conversion minimum value (S1+6) are set to the same value.	
103	The output manipulated variable upper limit (S1+16) is set to a value smaller than the output manipulated variable lower limit (S1+17).	
104	When the linear conversion is enabled (S1+4 set to 1), the AT set point (S1+21) is set to a value larger than the linear conversion maximum value (S1+5) or smaller than the linear conversion minimum value (S1+6).	
105	When the linear conversion is disabled (S1+4 set to 0), the AT set point (S1+21) is set to a value larger than 4000.	
106	When the linear conversion is enabled (S1+4 set to 1), the set point (S3) is set to a value larger than the linear conversion maximum value (S1+5) or smaller than the linear conversion minimum value (S1+6).	
107	When the linear conversion is disabled (S1+4 set to 0), the set point (S3) is set to a value larger than 4000.	
200	The current control action (S2+0) differs from that determined at the start of AT. To restart AT, set correct parameters referring to the probable causes listed below: • The manipulated variable (D1) or the control output (S2+6) is not outputted to the control target correctly. • The process variable is not stored to the operand designated by S4. • The AT output manipulated variable (S1+22) is not set to a large value so that the process variable (S4) can change sufficiently. • A large disturbance occurred.	AT is stopped because of AT execution error.
201	AT failed to complete normally because the process variable (S4) fluctuated excessively. To restart AT, set the AT sampling period (S1+19) or the input filter coefficient (S1+11) to a larger value.	

S1+3 Operation Mode

When the start input for the PID instruction is turned on, the CPU module checks the value stored in the data register designated by S1+3 and executes the selected operation. The selection cannot be changed while executing the PID instruction.

0: PID action
The PID action is executed according to the designated PID parameters such as proportional gain (S1+7), integral time (S1+8), derivative time (S1+9), and control action (S2+0).

1: AT (auto tuning) + PID action
Auto tuning is first executed according to the designated AT parameters such as AT sampling period (S1+19), AT control period (S1+20), AT set point (S1+21), and AT output manipulated variable (S1+22). As a result of auto tuning, PID parameters are determined such as proportional gain (S1+7), integral time (S1+8), derivative time (S1+9), and control direction (S2+0), then PID action is executed according to the derived PID parameters.

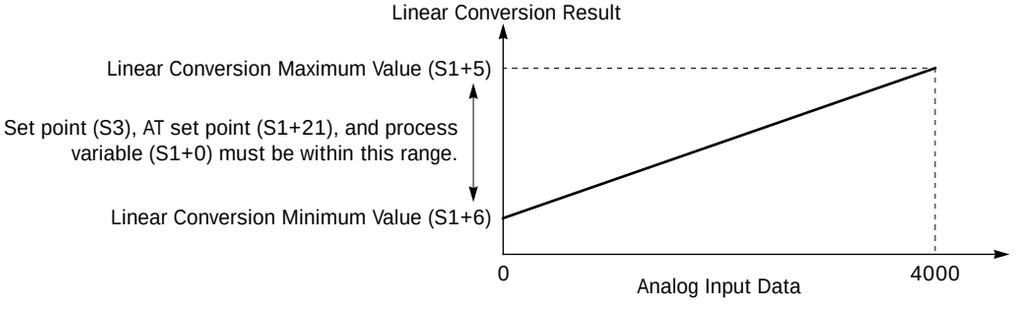
2: AT (auto tuning)
Auto tuning is executed according to designated AT parameters to determine PID parameters such as proportional gain (S1+7), integral time (S1+8), derivative time (S1+9), and control direction (S2+0); PID action is not executed.

S1+4 Linear Conversion

0: Disable linear conversion
Linear conversion is not executed. When the linear conversion is disabled (S1+4 set to 0), the analog input data (0 through 4000) from the analog I/O module is stored to the process variable (S4), and the same value is stored to the process variable (S1+0) without conversion.

1: Enable linear conversion
The linear conversion function is useful for scaling the process variable to the actual measured value in engineering units.

When the linear conversion is enabled (S1+4 set to 1), the analog input data (0 through 4000) from the analog I/O module is linear-converted, and the result is stored to the process variable (S1+0). When using the linear conversion, set proper values to the linear conversion maximum value (S1+5) and linear conversion minimum value (S1+6) to specify the linear conversion output range. When using the linear conversion function in a temperature control application, temperature values can be used to designate the set point (S3), high alarm value (S1+14), low alarm value (S1+15), and AT set point (S1+21), and also to read the process variable (S1+0).



S1+5 Linear Conversion Maximum Value

When the linear conversion is enabled (S1+4 set to 1), set the linear conversion maximum value to the data register designated by S1+5. Valid values are –32768 through 32767, and the linear conversion maximum value must be larger than the linear conversion minimum value (S1+6). Select an appropriate value for the linear conversion maximum value to represent the maximum value of the input signal to the analog I/O module.

When the linear conversion is disabled (S1+4 set to 0), you don't have to set the linear conversion maximum value (S1+5).

S1+6 Linear Conversion Minimum Value

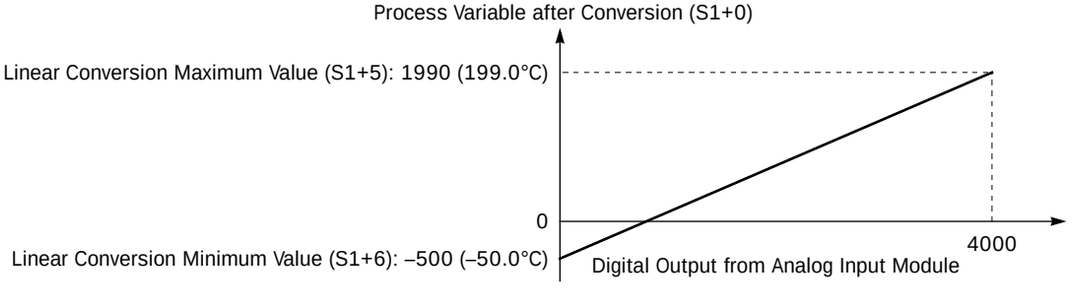
When the linear conversion is enabled (S1+4 set to 1), set the linear conversion minimum value to the data register designated by S1+6. Valid values are –32768 through 32767, and the linear conversion minimum value must be smaller than the linear conversion maximum value (S1+5). Select an appropriate value for the linear conversion minimum value to represent the minimum value of the input signal to the analog I/O module.

When the linear conversion is disabled (S1+4 set to 0), you don't have to set the linear conversion minimum value (S1+6).

Example:

When the transducer connected to the analog input module has an input range of –50°C through +199°C, set the following values. The temperature values are multiplied by 10 to calculate the process variable.

Control mode (S1+4):	1 (enable linear conversion)
Linear conversion maximum value (S1+5):	1990 (199.0°C)
Linear conversion minimum value (S1+6):	–500 (–50.0°C)



S1+7 Proportional Gain

The proportional gain is a parameter to determine the amount of proportional action in the proportional band.

When auto tuning is used by setting the operation mode (S1+3) to 1 (AT+PID) or 2 (AT), a proportional gain is determined automatically and does not have to be specified by the user.

When auto tuning is not used by setting the operation mode (S1+3) to 0 (PID), set a required value of 1 through 10000 to specify a proportional gain of 0.01% through 100.00% to the data register designated by S1+7. When S1+7 stores 0, the proportional gain is set to 0.01%. When S1+7 stores a value larger than 10000, the proportional gain is set to 100.00%.

When the proportional gain is set to a large value, the proportional band becomes small and the response becomes fast, but overshoot and hunching will be caused. In contrast, when the proportional gain is set to a small value, overshoot and hunching are suppressed, but response to disturbance will become slow.

While the PID action is in progress, the proportional gain value can be changed by the user.

S1+8 Integral Time

When only the proportional action is used, a certain amount of difference (offset) between the set point (S3) and the process variable (S1+0) remains after the control target has reached a stable state. An integral action is needed to reduce the offset to zero. The integral time is a parameter to determine the amount of integral action.

When auto tuning is used by setting the operation mode (S1+3) to 1 (AT+PID) or 2 (AT), an integral time is determined automatically and does not have to be specified by the user.

When auto tuning is not used by setting the operation mode (S1+3) to 0 (PID), set a required value of 1 through 65535 to specify an integral time of 0.1 sec through 6553.5 sec to the data register designated by S1+8. When S1+8 is set to 0, the integral action is disabled.

When the integral time is too short, the integral action becomes too large, resulting in hunching of a long period. In contrast, when the integral time is too long, it takes a long time before the process variable (S1+0) reaches the set point (S3).

While the PID action is in progress, the integral time value can be changed by the user.

S1+9 Derivative Time

The derivative action is a function to adjust the process variable (S1+0) to the set point (S3) by increasing the manipulated variable (D1) when the set point (S3) is changed or when the difference between the process variable (S1+0) and the set point (S3) is increased due to disturbance. The derivative time is a parameter to determine the amount of derivative action.

When auto tuning is used by setting the operation mode (S1+3) to 1 (AT+PID) or 2 (AT), a derivative time is determined automatically and does not have to be specified by the user.

When auto tuning is not used by setting the operation mode (S1+3) to 0 (PID), set a required value of 1 through 65535 to specify a derivative time of 0.1 sec through 6553.5 sec to the data register designated by S1+9. When S1+9 is set to 0, the derivative action is disabled.

When the derivative time is set to a large value, the derivative action becomes large. When the derivative action is too large, hunching of a short period is caused.

While the PID action is in progress, the derivative time value can be changed by the user.

S1+10 Integral Start Coefficient

The integral start coefficient is a parameter to determine the point, in percent of the proportional term, where to start the integral action. Normally, the data register designated by S1+10 (integral start coefficient) stores 0 to select an integral start coefficient of 100% and the integral start coefficient disable control relay (S2+3) is turned off to enable integral start coefficient. When the PID action is executed according to the PID parameters determined by auto tuning, proper control is ensured with a moderate overshoot and no offset.

It is also possible to set a required value of 1 through 100 to start the integral action at 1% through 100% to the data register designated by S1+10. When S1+10 stores 0 or a value larger than 100 (except for 200), the integral start coefficient is set to 100%.

When 200 is set to S1+10, the integral action is enabled only while the process variable (S4) is within the proportional band. When the process variable runs off the proportional band due to disturbance or changing of the set point, the integral action is disabled, so that adjustment of the output manipulated variable (S1+1) is improved with little overshoot and undershoot.

To enable the integral start coefficient, turn off the integral start coefficient disable control relay (S2+3). When S2+3 is turned on, the integral start coefficient is disabled and the integral term takes effect at the start of the PID action.

When the integral term is enabled at the start of the PID action, a large overshoot is caused. The overshoot can be suppressed by delaying the execution of the integral action in coordination with the proportional term. The PID instruction is designed to achieve proper control with a small or moderate overshoot when the integral start coefficient is set to 100%. Overshoot is most suppressed when the integral start coefficient is set to 1% and is least suppressed when the integral start coefficient is set to 100%. When the integral start coefficient is too small, overshoot is eliminated but offset is caused.

S1+11 Input Filter Coefficient

The input filter has an effect to smooth out fluctuations of the process variable (S4). Set a required value of 0 through 99 to specify an input filter coefficient of 0% through 99% to the data register designated by S1+11. When S1+11 stores a value larger than 99, the input filter coefficient is set to 99%. The larger the coefficient, the larger the input filter effect.

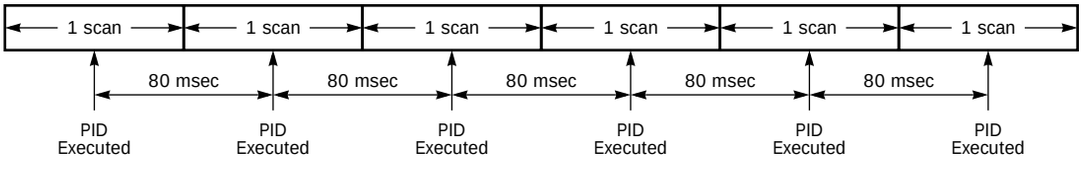
The input filter is effective for reading a process variable (S4) such as temperature data when the value changes at each sampling time. The input filter coefficient is in effect during auto tuning and PID action.

S1+12 Sampling Period

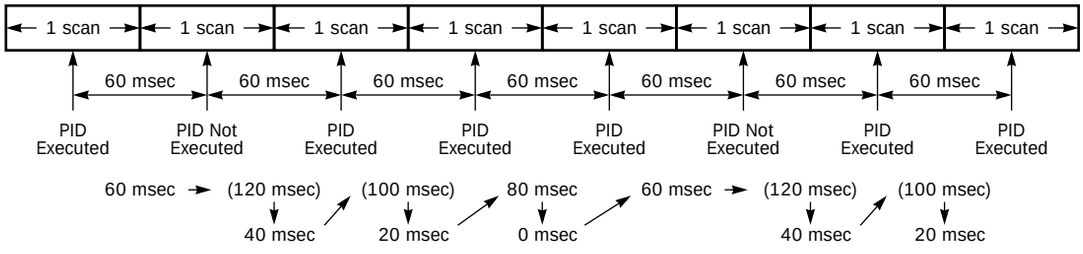
The sampling period determines the interval to execute the PID instruction. Set a required value of 1 through 10000 to specify a sampling period of 0.01 sec through 100.00 sec to the data register designated by S1+12. When S1+12 stores 0, the sampling period is set to 0.01 sec. When S1+12 stores a value larger than 10000, the sampling period is set to 100.00 sec.

When a sampling period is set to a value smaller than the scan time, the PID instruction is executed every scan.

Example – Sampling period: 40 msec, Scan time: 80 msec (Sampling period ≤ Scan time)



Example – Sampling period: 80 msec, Scan time: 60 msec (Sampling period > Scan time)

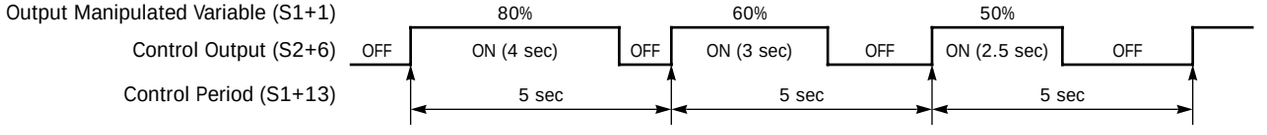


S1+13 Control Period

The control period determines the duration of the ON/OFF cycle of the control output (S2+6) that is turned on and off according to the output manipulated variable (S1+1) calculated by the PID action or derived from the manual mode output manipulated variable (S1+18). Set a required value of 1 through 500 to specify a control period of 0.1 sec through 50.0 sec to the data register designated by S1+13. When S1+13 stores 0, the control period is set to 0.1 sec. When S1+13 is set to a value larger than 500, the control period is set to 50.0 sec.

The ON pulse duration of the control output (S2+6) is determined by the product of the control period (S1+13) and the output manipulated variable (S1+1).

Example – Control period: 5 sec (S1+13 is set to 50)



S1+14 High Alarm Value

The high alarm value is the upper limit of the process variable (S1+0) to generate an alarm. When the process variable is higher than or equal to the high alarm value while the start input for the PID instruction is on, the high alarm output control relay (S2+4) is turned on. When the process variable is lower than the high alarm value, the high alarm output control relay (S2+4) is turned off.

When the linear conversion is disabled (S1+4 set to 0), set a required high alarm value of 0 through 4000 to the data register designated by S1+14. When S1+14 stores a value larger than 4000, the high alarm value is set to 4000.

When the linear conversion is enabled (S1+4 set to 1), set a required high alarm value of –32768 through 32767 to the data register designated by S1+14. The high alarm value must be larger than or equal to the linear conversion minimum value (S1+6) and must be smaller than or equal to the linear conversion maximum value (S1+5). If the high alarm value is set to a value smaller than the linear conversion minimum value (S1+6), the linear conversion minimum value will become the high alarm value. If the high alarm value is set to a value larger than the linear conversion maximum value (S1+5), the linear conversion maximum value will become the high alarm value.

S1+15 Low Alarm Value

The low alarm value is the lower limit of the process variable (S1+0) to generate an alarm. When the process variable is lower than or equal to the low alarm value while the start input for the PID instruction is on, the low alarm output control relay (S2+5) is turned on. When the process variable is higher than the low alarm value, the low alarm output control relay (S2+5) is turned off.

When the linear conversion is disabled (S1+4 set to 0), set a required low alarm value of 0 through 4000 to the data register designated by S1+15. When S1+15 stores a value larger than 4000, the low alarm value is set to 4000.

When the linear conversion is enabled (S1+4 set to 1), set a required low alarm value of –32768 through 32767 to the data register designated by S1+15. The low alarm value must be larger than or equal to the linear conversion minimum value (S1+6) and must be smaller than or equal to the linear conversion maximum value (S1+5). If the low alarm value is set to a value smaller than the linear conversion minimum value (S1+6), the linear conversion minimum value will become the low alarm value. If the low alarm value is set to a value larger than the linear conversion maximum value (S1+5), the linear conversion maximum value will become the low alarm value.

S1+16 Output Manipulated Variable Upper Limit

The value contained in the data register designated by S1+16 specifies the upper limit of the output manipulated variable (S1+1) in two ways: direct and proportional.

S1+16 Value 0 through 100

When S1+16 contains a value 0 through 100, the value directly determines the upper limit of the output manipulated variable (S1+1). If the manipulated variable (D1) is greater than or equal to the upper limit value (S1+1), the upper limit value is outputted to the output manipulated variable (S1+1). Set a required value of 0 through 100 for the output manipulated variable upper limit to the data register designated by S1+16. When S1+16 stores a value larger than 100 (except 10001 through 10099), the output manipulated variable upper limit (S1+16) is set to 100. The output manipulated variable upper limit (S1+16) must be larger than the output manipulated variable lower limit (S1+17).

To enable the manipulated variable upper limit, turn on the output manipulated variable limit enable control relay (S2+2). When S2+2 is turned off, the output manipulated variable upper limit (S1+16) has no effect.

S1+16 Value 10001 through 10099 (disables Output Manipulated Variable Lower Limit S1+17)

When S1+16 contains a value 10001 through 10099, the value minus 10000 determines the ratio of the output manipulated variable (S1+1) in proportion to the manipulated variable (D1) of 0 through 100. The output manipulated variable (S1+1) can be calculated by the following equation:

$$\text{Output manipulated variable (S1+1)} = \text{Manipulated variable (D1)} \times (N - 10000)$$

where N is the value stored in the output manipulated variable upper limit (S1+16), 10001 through 10099.

If the manipulated variable (D1) is greater than or equal to 100, 100 multiplied by (N – 10000) is outputted to the output manipulated variable (S1+1). If D1 is less than or equal to 0, 0 is outputted to S1+1.

To enable the manipulated variable upper limit, turn on the output manipulated variable limit enable control relay (S2+2). When S2+2 is turned off, the output manipulated variable upper limit (S1+16) has no effect.

When S1+16 is set to a value 10001 through 10099, the output manipulated variable lower limit (S1+17) is disabled.

S1+17 Output Manipulated Variable Lower Limit

The value contained in the data register designated by S1+17 specifies the lower limit of the output manipulated variable (S1+1). Set a required value of 0 through 100 for the output manipulated variable lower limit to the data register designated by S1+17. When S1+17 stores a value larger than 100, the output manipulated variable lower limit is set to 100. The output manipulated variable lower limit (S1+17) must be smaller than the output manipulated variable upper limit (S1+16).

To enable the output manipulated variable lower limit, turn on the output manipulated variable limit enable control relay (S2+2), and set the output manipulated variable upper limit (S1+16) to a value other than 10001 through 10099. When the manipulated variable (D1) is smaller than or equal to the specified lower limit, the lower limit value is outputted to the output manipulated variable (S1+1).

When the output manipulated variable limit enable control relay (S2+2) is turned off, the output manipulated variable lower limit (S1+17) has no effect.

S1+18 Manual Mode Output Manipulated Variable

The manual mode output manipulated variable specifies the output manipulated variable (0 through 100) for manual mode. Set a required value of 0 through 100 for the manual mode output manipulated variable to the data register designated by S1+18. When S1+18 stores a value larger than 100, the manual mode output manipulated variable is set to 100.

To enable the manual mode, turn on the auto/manual mode control relay (S2+1). While in manual mode, the PID action is disabled. The specified value of the manual mode output manipulated variable (S1+18) is outputted to the output manipulated variable (S1+1), and the control output (S2+6) is turned on and off according to the control period (S1+13) and the manual mode output manipulated variable (S1+18).

S1+19 AT Sampling Period

The AT sampling period determines the interval of sampling during auto tuning. When using auto tuning, set a required value of 1 through 10000 to specify an AT sampling period of 0.01 sec through 100.00 sec to the data register designated by S1+19. When S1+19 stores 0, the AT sampling period is set to 0.01 sec. When S1+19 stores a value larger than 10000, the AT sampling period is set to 100.00 sec.

Set the AT sampling period to a long value to make sure that the current process variable is smaller than or equal to the previous process variable during direct control action (S2+0 is on) or that the current process variable is larger than or equal to the previous process variable during reverse control action (S2+0 is off).

S1+20 AT Control Period

The AT control period determines the duration of the ON/OFF cycle of the control output (S2+6) during auto tuning. For operation of the control output, see Control Period on page 20-7.

When using auto tuning, set a required value of 1 through 500 to specify an AT control period of 0.1 sec through 50.0 sec to the data register designated by S1+20. When S1+20 stores 0, the AT control period is set to 0.1 sec. When S1+20 stores a value larger than 500, the AT control period is set to 50.0 sec.

S1+21 AT Set Point

While auto tuning is executed, the AT output manipulated variable (S1+22) is outputted to the output manipulated variable (S1+1) until the process variable (S1+0) reaches the AT set point (S1+21). When the process variable (S1+0) reaches the AT set point (S1+21), auto tuning is complete and the output manipulated variable (S1+1) is reduced to zero. When PID action is selected with operation mode (S1+3) set to 1 (AT+PID), the PID action follows immediately.

When the linear conversion is disabled (S1+4 set to 0), set a required AT set point of 0 through 4000 to the data register designated by S1+21. When S1+21 stores a value larger than 4000, the AT set point is set to 4000.

When the linear conversion is enabled (S1+4 set to 1), set a required AT set point of –32768 through 32767 to the data register designated by S1+21. The AT set point must be larger than or equal to the linear conversion minimum value (S1+6) and must be smaller than or equal to the linear conversion maximum value (S1+5).

In the direct control action (see page 20-10), set the AT set point (S1+21) to a value sufficiently smaller than the process variable (S4) at the start of the auto tuning. In the reverse control action, set the AT set point (S1+21) to a value sufficiently larger than the process variable (S4) at the start of the auto tuning.

S1+22 AT Output Manipulated Variable

The AT output manipulated variable specifies the amount of the output manipulated variable (0 through 100) during auto tuning. When using auto tuning, set a required AT output manipulated variable of 0 through 100 to the data register designated by S1+22. When S1+22 stores a value larger than 100, the AT output manipulated variable is set to 100.

While auto tuning is executed, the specified value of the AT output manipulated variable (S1+22) is outputted to the output manipulated variable (S1+1), and the control output (S2+6) is turned on and off according to the AT control period (S1+20) and the AT output manipulated variable (S1+22). To keep the control output (S2+6) on during auto tuning, set 100 to S1+22.

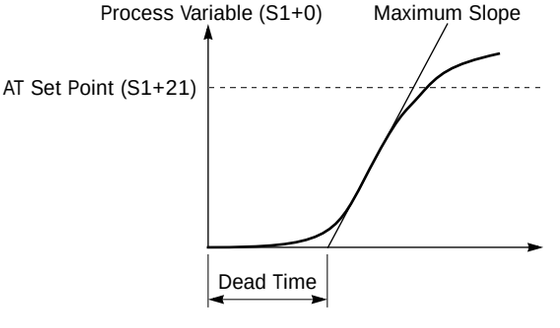
Auto Tuning (AT)

When auto tuning is selected with the operation mode (S1+3) set to 1 (AT+PID) or 2 (AT), the auto tuning is executed before starting PID control to determine PID parameters, such as proportional gain (S1+7), integral time (S1+8), derivative time (S1+9), and control action (S2+0) automatically. The OpenNet Controller uses the step response method to execute auto tuning. To enable auto tuning, set four parameters for auto tuning before executing the PID instruction, such as AT sampling period (S1+19), AT control period (S1+20), AT set point (S1+21), and AT output manipulated variable (S1+22).

Step Response Method

The OpenNet Controller uses the step response method to execute auto tuning and determine PID parameters such as proportional gain (S1+7), integral time (S1+8), derivative time (S1+9), and control action (S2+0) automatically. The auto tuning is executed in the following steps:

1. Calculate the maximum slope of the process variable (S1+0) before the process variable reaches the AT set point (S1+21).
2. Calculate the dead time based on the derived maximum slope.
3. Based on the maximum slope and dead time, calculate the four PID parameters.



Source Operand S2 (Control Relay)

Turn on or off appropriate outputs or internal relays starting with the operand designated by S2 before executing the PID instruction as required. Operands S2+4 through S2+7 are for read only to reflect the PID and auto tuning statuses.

Operand	Function	Description	R/W
S2+0	Control action	ON: Direct control action OFF: Reverse control action	R/W
S2+1	Auto/manual mode	ON: Manual mode OFF: Auto mode	R/W
S2+2	Output manipulated variable limit enable	ON: Enable output manipulated variable upper and lower limits (S1+16 and S1+17) OFF: Disable output manipulated variable upper and lower limits (S1+16 and S1+17)	R/W
S2+3	Integral start coefficient disable	ON: Disable integral start coefficient (S1+10) OFF: Enable integral start coefficient (S1+10)	R/W
S2+4	High alarm output	ON: When process variable (S1+0) ≥ high alarm value (S1+14) OFF: When process variable (S1+0) < high alarm value (S1+14)	R
S2+5	Low alarm output	ON: When process variable (S1+0) ≤ low alarm value (S1+15) OFF: When process variable (S1+0) > low alarm value (S1+15)	R
S2+6	Control output	Goes on and off according to the AT parameters or PID calculation results	R
S2+7	AT complete output	Goes on when AT is complete or failed, and remains on until reset	R

S2+0 Control Action

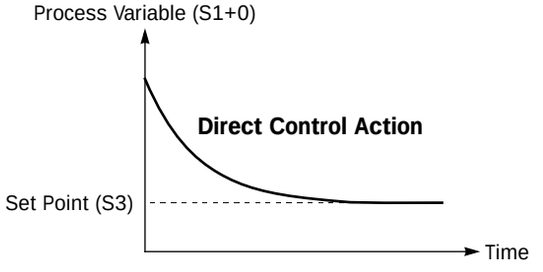
When auto tuning is executed with the operation mode (S1+3) set to 1 (AT+PID) or 2 (AT), the control action is determined automatically. When auto tuning results in a direct control action, the control action control relay designated by S2+0 is turned on. When auto tuning results in a reverse control action, the control action control relay designated by S2+0 is turned off. The PID action is executed according to the derived control action, which remains in effect during the PID action.

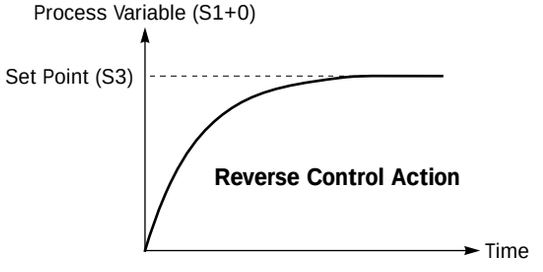
When auto tuning is not executed with the operation mode (S1+3) set to 0 (PID), turn on or off the control action control relay (S2+0) to select a direct or reverse control action, respectively, before executing the PID instruction.

In the direct control action, the manipulated variable (D1) is increased while the process variable (S1+0) is larger than the set point (S3). Temperature control for cooling is executed in the direct control action.

In the reverse control action, the manipulated variable (D1) is increased while the process variable (S1+0) is smaller than the set point (S3). Temperature control for heating is executed in the reverse control action.

In either the direct or reverse control action, the manipulated variable (D1) is increased while the difference between the process variable (S1+0) and the set point (S3) increases.





S2+1 Auto/Manual Mode

To select auto mode, turn off the auto/manual mode control relay designated by S2+1 before or after starting the PID instruction. In auto mode, the PID action is executed and the manipulated variable (D1) stores the PID calculation result. The control output (S2+6) is turned on and off according to the control period (S1+13) and the output manipulated variable (S1+1).

To select manual mode, turn on the auto/manual mode control relay (S2+1). When using manual mode, set a required value to the manual mode output manipulated variable (S1+18) before enabling manual mode. In manual mode, the output manipulated variable (S1+1) stores the manual mode output manipulated variable (S1+18), and the control output (S2+6) is turned on and off according to the control period (S1+13) and the manual mode output manipulated variable (S1+18).

While auto tuning is in progress, manual mode cannot be enabled. Only after auto tuning is complete, auto or manual mode can be enabled. Auto/manual mode can also be switched while executing the PID instruction.

S2+2 Output Manipulated Variable Limit Enable

The output manipulated variable upper limit (S1+16) and the output manipulated variable lower limit (S1+17) are enabled or disabled using the output manipulated variable limit enable control relay (S2+2).

To enable the output manipulated variable upper/lower limits, turn on S2+2.

To disable the output manipulated variable upper/lower limits, turn off S2+2.

S2+3 Integral Start Coefficient Disable

The integral start coefficient (S1+10) is enabled or disabled using the integral start coefficient disable control relay (S2+3).

To enable the integral start coefficient (S1+10), turn off S2+3; the integral term is enabled as specified by the integral start coefficient (S1+10).

To disable the integral start coefficient (S1+10), turn on S2+3; the integral term is enabled at the start of the PID action.

S2+4 High Alarm Output

When the process variable (S1+0) is higher than or equal to the high alarm value (S1+14) while the start input for the PID instruction is on, the high alarm output control relay (S2+4) goes on. When S1+0 is lower than S1+14, S2+4 is off.

S2+5 Low Alarm Output

When the process variable (S1+0) is lower than or equal to the low alarm value (S1+15) while the start input for the PID instruction is on, the low alarm output control relay (S2+5) goes on. When S1+0 is higher than S1+15, S2+5 is off.

S2+6 Control Output

During auto tuning in auto mode with the auto/manual mode control relay (S2+1) set to off, the control output (S2+6) is turned on and off according to the AT control period (S1+20) and AT output manipulated variable (S1+22).

During PID action in auto mode with the auto/manual mode control relay (S2+1) set to off, the control output (S2+6) is turned on and off according to the control period (S1+13) and the output manipulated variable (S1+1) calculated by the PID action.

In manual mode with the auto/manual mode control relay (S2+1) set to on, the control output (S2+6) is turned on and off according to the control period (S1+13) and the manual mode output manipulated variable (S1+18).

S2+7 AT Complete Output

The AT complete output control relay (S2+7) goes on when auto tuning is complete or failed, and remains on until reset. Operating status codes are stored to the operating status control register (S1+2). See page 20-3.

Source Operand S3 (Set Point)

The PID action is executed to adjust the process variable (S1+0) to the set point (S3).

When the linear conversion is disabled (S1+4 set to 0), set a required set point value of 0 through 4000 to the operand designated by S3. Valid operands are data register and constant.

When the linear conversion is enabled (S1+4 set to 1), designate a data register as operand S3 and set a required set point value of –32768 through 32767 to the data register designated by S3. Since the PID instruction uses the word data type, negative constants cannot be entered directly to operand S3. Use the MOV instruction with the integer (I) data type to store a negative value to a data register. The set point value (S3) must be larger than or equal to the linear conversion minimum value (S1+6) and smaller than or equal to the linear conversion maximum value (S1+5).

When an invalid value is designated as a set point, the PID action is stopped and an error code is stored to the data register designated by S1+2. See Operating Status on page 20-3.

Source Operand S4 (Process Variable before Conversion)

The analog output from the transducer is inputted to the analog input module, which converts the input data to a digital value of 0 through 4000. The digital value is stored to a link register L100 through L705 depending on the mounting position of the analog input module and the analog input channel connected to the transducer. Designate a link register as source operand S4 to store the process variable.

For example, when the analog input module is mounted in the first slot from the CPU module among all functional modules such as analog I/O and OpenNet interface modules (not including digital I/O modules) and when the analog input is connected to channel 0 of the analog input module, designate link register L100 as source operand S4. When the analog input module is mounted in the third slot and the analog input is connected to channel 4, designate link register L304 as source operand S4.

Link Register Allocation Numbers for Source Operand S4

Analog Input Module Position	Analog Input Channel					
	0	1	2	3	4	5
Functional Module 1	L100	L101	L102	L103	L104	L105
Functional Module 2	L200	L201	L202	L203	L204	L205
Functional Module 3	L300	L301	L302	L303	L304	L305
Functional Module 4	L400	L401	L402	L403	L404	L405
Functional Module 5	L500	L501	L502	L503	L504	L505
Functional Module 6	L600	L601	L602	L603	L604	L605
Functional Module 7	L700	L701	L702	L703	L704	L705

When an analog input module is not used, a data register can also be designated by source operand S4 (process variable). When designating a data register as S4, make sure that the S4 data takes a value between 0 and 4000. When S4 stores a value larger than 4000, the process variable is set to 4000.

Destination Operand D1 (Manipulated Variable)

The data register designated by destination operand D1 stores the manipulated variable of –32768 through 32767 calculated by the PID action. When the calculation result is less than –32768, D1 stores –32768. When the calculation result is greater than 32767, D1 stores 32767. While the calculation result is less than –32768 or greater than 32767, the PID action still continues.

When the output manipulated variable limit is disabled (S2+2 set to off) while the PID action is in progress, the data register designated by S1+1 holds 0 through 100 of the manipulated variable (D1), omitting values less than 0 and greater than 100. The percent value in S1+1 determines the ON duration of the control output (S2+6) in proportion to the control period (S1+13).

When the output manipulated variable limit is enabled (S2+2 set to on), the manipulated variable (D1) is stored to the output manipulated variable (S1+1) according to the output manipulated variable upper limit (S1+16) and the output manipulated variable lower limit (S1+17) as summarized in the table below.

While manual mode is enabled with the auto/manual mode control relay (S2+1) set to on, S1+1 stores 0 through 100 of the manual mode output manipulated variable (S1+18), and D1 stores an indefinite value.

While auto tuning is in progress, S1+1 stores 0 through 100 of the AT output manipulated variable (S1+22), and D1 stores an indefinite value.

Examples of Output Manipulated Variable Values

Output Manipulated Variable Limit Enable (S2+2)	Output Manipulated Variable Upper Limit (S1+16)	Output Manipulated Variable Lower Limit (S1+17)	Manipulated Variable (D1)	Output Manipulated Variable (S1+1)
OFF (disabled)	—	—	≥ 100	100
			1 to 99	1 to 99
			≤ 0	0
ON (enabled)	50	25	≥ 50	50
			26 to 49	26 to 49
			≤ 25	25
	10050	—	≥ 100	50
			1 to 99	(1 to 99) × 0.5
			≤ 0	0

Application Example

This application example demonstrates a PID control for a heater to keep the temperature at 200°C.

In this example, when the program is started, the PID instruction first executes auto tuning according to the designated AT parameters, such as AT sampling period, AT control period, AT set point, and AT output manipulated variable, and also the temperature data inputted to the analog input module. The control output remains on to keep the heater on until the temperature reaches the AT set point of 150°C. Auto tuning determines PID parameters such as proportional gain, integral time, derivative time, and control action.

When the temperature reaches 150°C, PID action starts to control the temperature to 200°C using the derived PID parameters. The heater is turned on and off according to the output manipulated variable calculated by the PID action. When the heater temperature is higher than or equal to 250°C, an alarm light is turned on by the high alarm output.

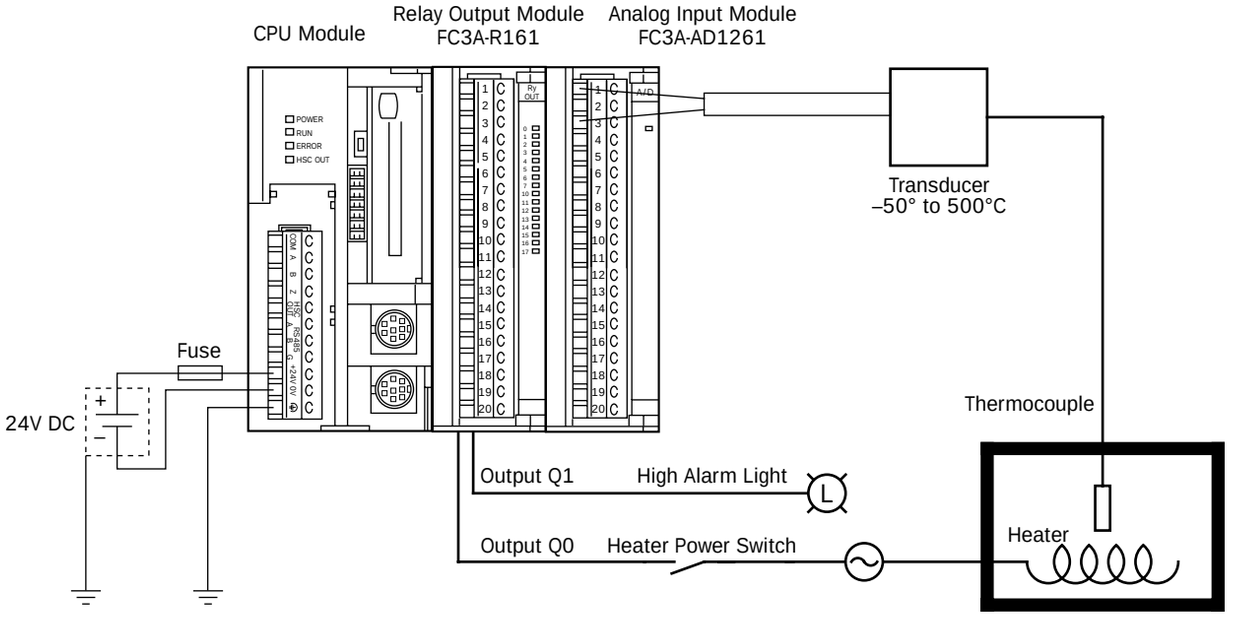
The analog input module data is also monitored to force off the heater power switch.

Operand Settings

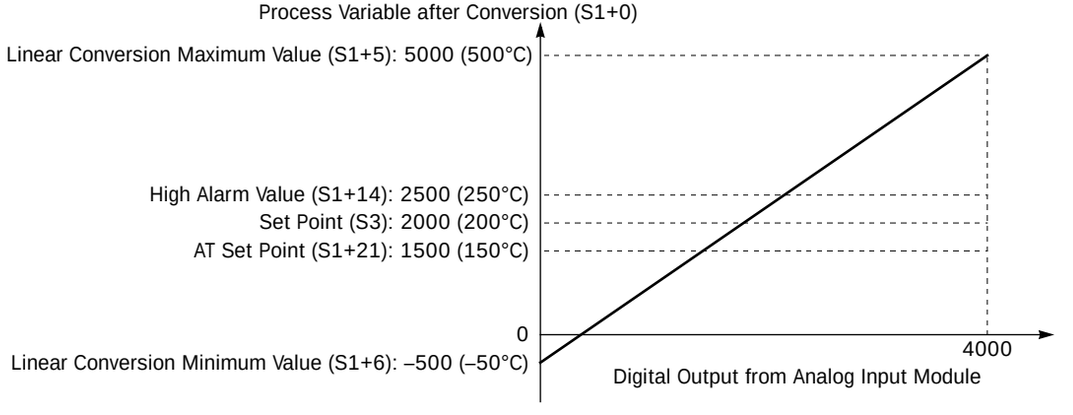
Operand	Function	Description	Allocation No. (Value)
S1+3	Operation mode	AT (auto tuning) + PID action	D3 (1)
S1+4	Linear conversion	Enable linear conversion	D4 (1)
S1+5	Linear conversion maximum value	500°C	D5 (5000)
S1+6	Linear conversion minimum value	–50°C	D6 (–500)
S1+10	Integral start coefficient	100%	D10 (0)
S1+11	Input filter coefficient	70%	D11 (70)
S1+12	Sampling period	500 msec	D12 (50)
S1+13	Control period	1 sec	D13 (10)
S1+14	High alarm value	250°C	D14 (2500)
S1+19	AT sampling period	1.5 sec	D19 (150)
S1+20	AT control period	3 sec	D20 (30)
S1+21	AT set point	150°C	D21 (1500)
S1+22	AT output manipulated variable	100% (Note)	D22 (100)
S2+1	Auto/manual mode	Auto mode	M1 (OFF)
S2+2	Output manipulated variable limit enable	Disable output manipulated variable limits	M2 (OFF)
S2+3	Integral start coefficient disable	Enable integral start coefficient (S1+10)	M3 (OFF)
S2+4	High alarm output	ON: When temperature ≥ 250°C OFF: When temperature < 250°C	M4
S2+6	Control output	Remains on during auto tuning; Goes on and off according to the control period (S1+13) and output manipulated variable (S1+1) during PID action	M6
S3	Set point	200°C	D100 (2000)
S4	Process variable	Analog input module is mounted at the first slot among functional modules and the analog input is connected to channel 0 of the analog input module; stores 0 through 4000	L100
D1	Manipulated variable	Stores PID calculation result (–32768 to 32767)	D102
	PID start input	Starts to execute the PID instruction	I0
	Monitor input	Starts to monitor the analog input module data for high alarm	I1
	Heater power switch	Turned on and off by control output M6	Q0
	High alarm light	Turned on and off by high alarm output M4	Q1

Note: The output manipulated variable during auto tuning is a constant value. In this example, the AT output manipulated variable is set to the maximum value of 100 (100%), so the control output (S2+6) remains on during auto tuning.

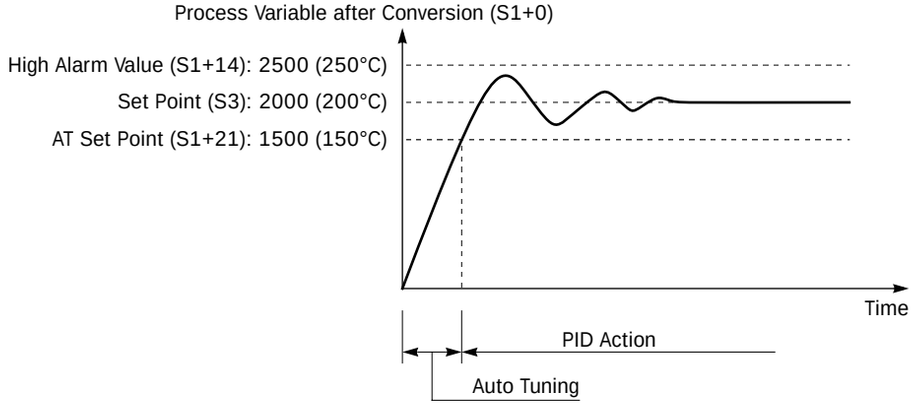
System Setup



Digital Output from Analog Input Module vs. Process Variable after Conversion

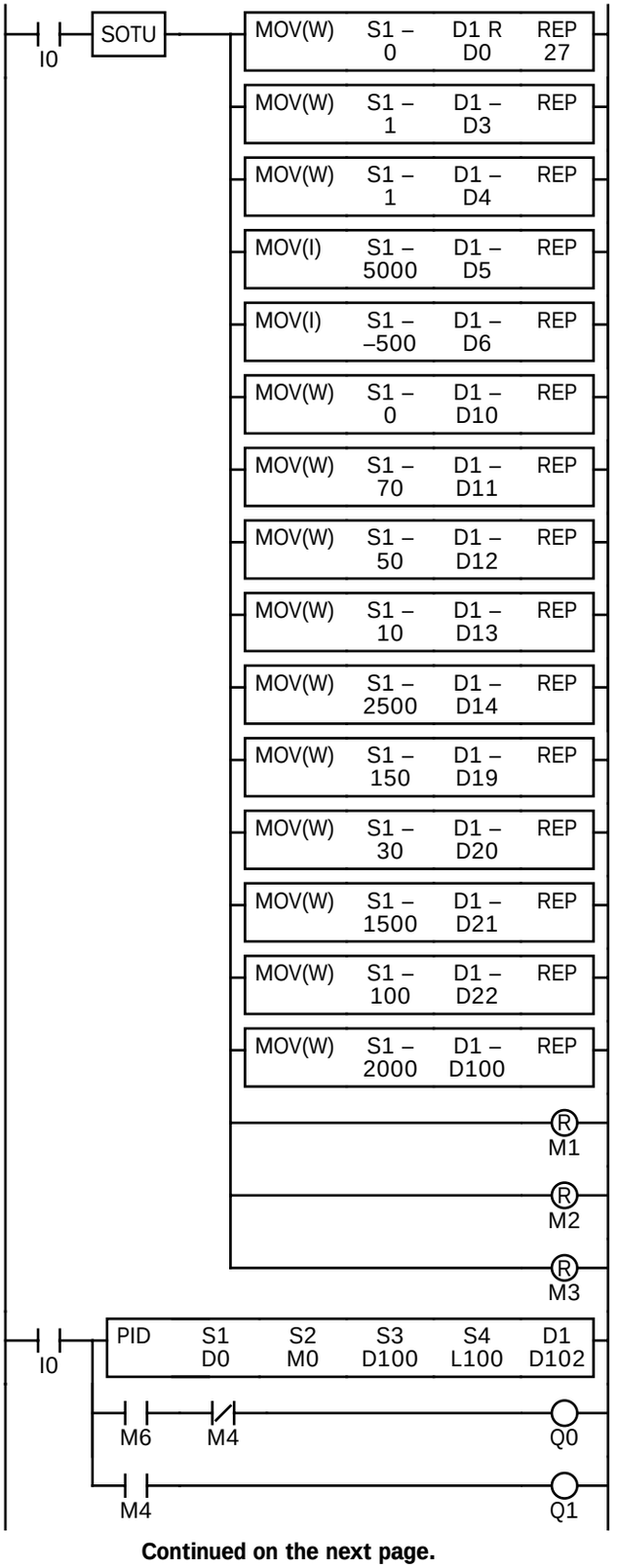


Temperature Control by Auto Tuning and PID Action



Ladder Program

The ladder diagram shown below describes an example of using the PID instruction. The user program must be modified according to the application and simulation must be performed before actual operation.



Continued on the next page.

When input I0 is turned on, 0 is stored to 27 data registers D0 through D26 designated as control registers.

D3 (operation mode): 1 (AT+PID)

D4 (linear conversion): 1 (enable linear conversion)

D5 (linear conversion maximum value): 5000 (500°C)

D6 (linear conversion minimum value): –500 (–50°C)

D10 (integral start coefficient): 0 (100%)

D11 (input filter coefficient): 70 (70%)

D12 (sampling period): 50 (500 msec)

D13 (control period): 10 (1 sec)

D14 (high alarm value): 2500 (250°C)

D19 (AT sampling period): 150 (1.5 sec)

D20 (AT control period): 30 (3 sec)

D21 (AT set point): 1500 (150°C)

D22 (AT output manipulated variable): 100 (100%)

D100 (set point): 2000 (200°C)

When input I0 is turned on, 3 internal relays M1 through M3 designated as control relays are turned off.

M1 (auto/manual mode): Auto mode
M2 (output manipulated variable limit enable): Disable
M3 (integral start coefficient disable): Enable

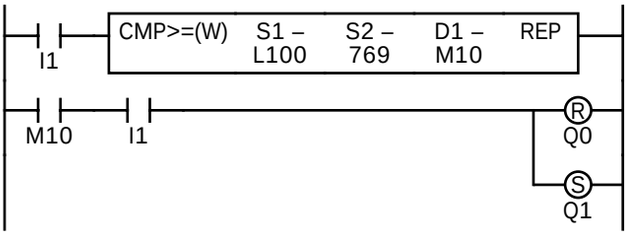
While input I0 is on, the PID instruction is executed.

D0-D26: control registers
M0-M7: control relays
D100: set point
L100: process variable
D102: manipulated variable

When internal relay M6 (control output) is turned on, output Q0 (heater power switch) is turned on.

When internal relay M4 (high alarm output) is turned on, output Q1 (high alarm light) is turned on.

Ladder Program (continued)



While monitor input I1 is on, the temperature is monitored. When the temperature is higher than or equal to 250°C, M10 is turned on.

$$4000 \times 250/1300 = 769.23$$

When M10 is on while monitor input I1 is on, Q0 (heater power switch) is forced off and Q1 (high alarm light) is forced on.

Notes for Using the PID Instruction:

- Since the PID instruction requires continuous operation, keep on the start input for the PID instruction.
- The high alarm output (S2+4) and the low alarm output (S2+5) work while the start input for the PID instruction is on. These alarm outputs, however, do not work when a PID instruction execution error occurs (S1+2 stores 100 through 107) due to data error in control data registers S1+0 through S1+26 or while the start input for the PID instruction is off. Provide a program to monitor the process variable (S4) separately.
- When a PID execution error occurs (S1+2 stores 100 through 107) or when auto tuning is completed, the manipulated variable (D1) stores 0 and the control output (S2+6) turns off.
- Do not use the PID instruction in program branching instructions: LABEL, LJMP, LCAL, LRET, JMP, JEND, MCS, and MCR. The PID instruction may not operate correctly in these instructions.
- The PID instruction, using the difference between the set point (S3) and process variable (S4) as input, calculates the manipulated variable (D1) according to the PID parameters, such as proportional gain (S1+7), integral time (S1+8), and derivative time (S1+9). When the set point (S3) or process variable (S4) is changed due to disturbance, overshoot or undershoot will be caused. Before putting the PID control into actual application, perform simulation tests by changing the set point and process variable (disturbance) to anticipated values in the application.
- The PID parameters, such as proportional gain (S1+7), integral time (S1+8), and derivative time (S1+9), determined by the auto tuning may not always be the optimum values depending on the actual application. To make sure of the best results, adjust the parameters. Once the best PID parameters are determined, perform only the PID action in usual operation unless the control object is changed.
- When a feedback control is executed using the control output (S2+6), the optimum control may not be achieved depending on the controlled object. If this is the case, use of the manipulated variable (D1) in the feedback control is recommended.

21: DATA LINK COMMUNICATION

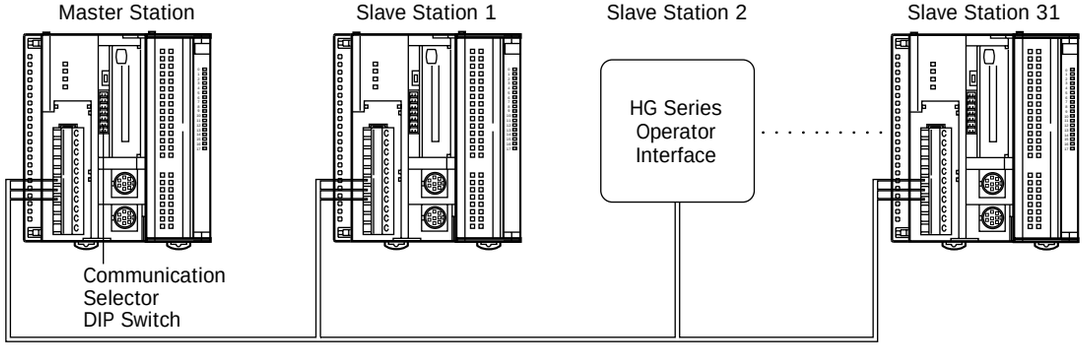
Introduction

This chapter describes the data link communication function used to set up a distributed control system.

A data link communication system consists of one master station and a maximum of 31 slave stations, each station comprising an OpenNet Controller CPU module and I/O modules. When the data link communication is enabled, the master station has 20 data registers assigned for each slave station, and each slave station has 20 data registers for communication with the master station. Using these data registers, the master station can send and receive data of 10 data registers to and from each slave station. Any particular program is not required for sending or receiving data in the data link communication system.

When data of inputs, outputs, internal relays, timers, counters, or shift registers are moved to data registers using the move instructions in the user program, these data can also be exchanged between the master and slave stations.

The MICRO^3, MICRO^{3}C, FA-3S series PLCs and HG2A series operator interfaces can also be connected to the data link communication system.



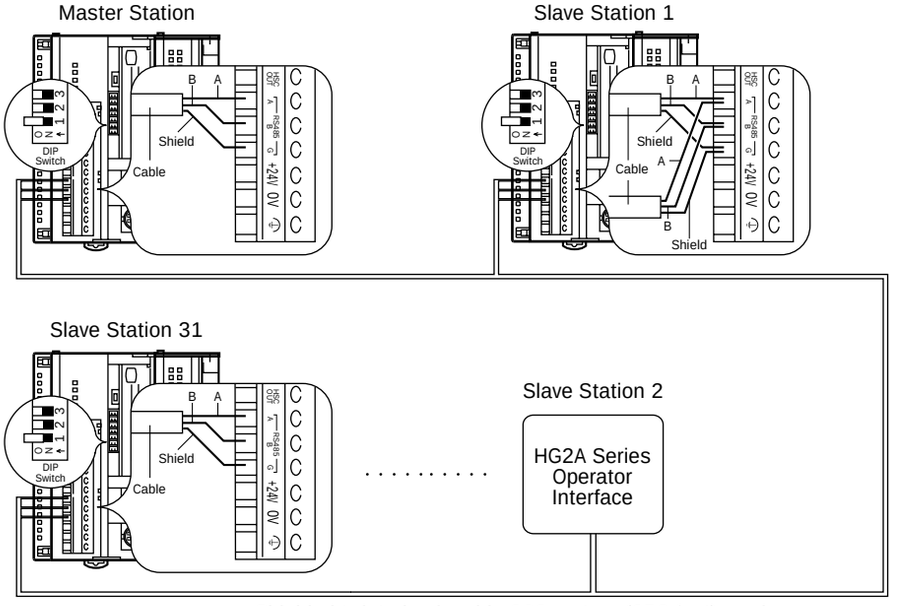
Data Link Specifications

Electric Specifications	Compliance with EIA-RS485
Baud Rate	19,200 or 38,400 bps
Synchronization	Start-stop synchronization Start bit: 1 Data bits: 7 Parity: Even Stop bit: 1
Communication Cable	Shielded twisted pair cable, core wire diameter 0.9 mm (0.035”) minimum
Maximum Cable Length	200m (656 feet) total
Maximum Slave Stations	31 slave stations
Refresh Mode	Separate or simultaneous refresh
Transmit / Receive Data	0 through 10 words each for transmission and receiving per slave station
Special Internal Relay	M8005-M8007: communication control and error M8140-M8176: communication completion for each slave station M8177: communication completion for all slave stations
Data Register	D7000-D7619 for transmit/receive data
Special Data Register	D8400-D8430 for communication error code

Data Link System Setup

To set up a data link system, connect the RS485 terminals A, B, and G on every OpenNet Controller CPU module using a shielded twisted pair cable as shown below. The total length of the cable for the data link system can be extended up to 200 meters (656 feet).

Set communication selector DIP switch 1 to ON at all master and slave stations to select the data link mode for the RS485 port.



Shielded twisted pair cable 200 meters (656 feet) maximum
Core wire diameter 0.9 mm (0.035") minimum

Setting Communication Selector DIP Switch

The communication selector DIP switch is used to select the communication protocol for the RS485 and RS232C ports, and also to select the device number for the CPU module used in a data link or computer link communication system. When using the OpenNet Controllers in a data link system, set communication selector DIP switches 1 and 4 through 8.

Selecting Data Link Communication Mode

To select the data link communication mode, set communication selector DIP switch 1 to ON at master and slave stations.

DIP Switch No.	Function	Setting	
1	RS485 port communication mode	ON: Data link mode	OFF: Maintenance mode

Selecting Master and Slave Station Numbers

Set communication selector DIP switches 4 through 8 to assign master station 0 and slave station numbers 1 through 31. The slave station numbers do not have to be consecutive.

DIP Switch No.	Master	Slave Station Number														
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
4	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**
5	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**
6	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**
7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

DIP Switch No.	Slave Station Number															
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
4	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**
5	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**
6	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**
7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
8	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**

Data Register Allocation for Transmit / Receive Data

The master station has 20 data registers assigned for data communication with each slave station. Each slave station has 20 data registers assigned for data communication with the master station. When data is set in data registers at the master station assigned for data link communication, the data is sent to the corresponding data registers at a slave station. When data is set in data registers at a slave station assigned for data link communication, the data is sent to the corresponding data registers at the master station.

Master Station

Slave Station Number	Data Register	Transmit / Receive Data	Slave Station Number	Data Register	Transmit / Receive Data
Slave 1	D7000-D7009	Transmit data to slave 1	Slave 17	D7320-D7329	Transmit data to slave 17
	D7010-D7019	Receive data from slave 1		D7330-D7339	Receive data from slave 17
Slave 2	D7020-D7029	Transmit data to slave 2	Slave 18	D7340-D7349	Transmit data to slave 18
	D7030-D7039	Receive data from slave 2		D7350-D7359	Receive data from slave 18
Slave 3	D7040-D7049	Transmit data to slave 3	Slave 19	D7360-D7369	Transmit data to slave 19
	D7050-D7059	Receive data from slave 3		D7370-D7379	Receive data from slave 19
Slave 4	D7060-D7069	Transmit data to slave 4	Slave 20	D7380-D7389	Transmit data to slave 20
	D7070-D7079	Receive data from slave 4		D7390-D7399	Receive data from slave 20
Slave 5	D7080-D7089	Transmit data to slave 5	Slave 21	D7400-D7409	Transmit data to slave 21
	D7090-D7099	Receive data from slave 5		D7410-D7419	Receive data from slave 21
Slave 6	D7100-D7109	Transmit data to slave 6	Slave 22	D7420-D7429	Transmit data to slave 22
	D7110-D7119	Receive data from slave 6		D7430-D7439	Receive data from slave 22
Slave 7	D7120-D7129	Transmit data to slave 7	Slave 23	D7440-D7449	Transmit data to slave 23
	D7130-D7139	Receive data from slave 7		D7450-D7459	Receive data from slave 23
Slave 8	D7140-D7149	Transmit data to slave 8	Slave 24	D7460-D7469	Transmit data to slave 24
	D7150-D7159	Receive data from slave 8		D7470-D7479	Receive data from slave 24
Slave 9	D7160-D7169	Transmit data to slave 9	Slave 25	D7480-D7489	Transmit data to slave 25
	D7170-D7179	Receive data from slave 9		D7490-D7499	Receive data from slave 25
Slave 10	D7180-D7189	Transmit data to slave 10	Slave 26	D7500-D7509	Transmit data to slave 26
	D7190-D7199	Receive data from slave 10		D7510-D7519	Receive data from slave 26
Slave 11	D7200-D7209	Transmit data to slave 11	Slave 27	D7520-D7529	Transmit data to slave 27
	D7210-D7219	Receive data from slave 11		D7530-D7539	Receive data from slave 27
Slave 12	D7220-D7229	Transmit data to slave 12	Slave 28	D7540-D7549	Transmit data to slave 28
	D7230-D7239	Receive data from slave 12		D7550-D7559	Receive data from slave 28
Slave 13	D7240-D7249	Transmit data to slave 13	Slave 29	D7560-D7569	Transmit data to slave 29
	D7250-D7259	Receive data from slave 13		D7570-D7579	Receive data from slave 29
Slave 14	D7260-D7269	Transmit data to slave 14	Slave 30	D7580-D7589	Transmit data to slave 30
	D7270-D7279	Receive data from slave 14		D7590-D7599	Receive data from slave 30
Slave 15	D7280-D7289	Transmit data to slave 15	Slave 31	D7600-D7609	Transmit data to slave 31
	D7290-D7299	Receive data from slave 15		D7610-D7619	Receive data from slave 31
Slave 16	D7300-D7309	Transmit data to slave 16	—		
	D7310-D7319	Receive data from slave 16			

If any slave stations are not connected, master station data registers which are assigned to the vacant slave stations can be used as ordinary data registers.

Slave Station

Data	Data Register	Transmit / Receive Data
Slave Station Data	D7000-D7009	Transmit data to master station
	D7010-D7019	Receive data from master station

Slave station data registers D7020 through D7619 can be used as ordinary data registers.

Special Data Registers for Data Link Communication Error

In addition to data registers assigned for data communication, the master station has 31 special data registers and each slave station has one special data register to store data link communication error codes. If any communication error occurs in the data link system, communication error codes are set to a corresponding data register for link communication error at the master station and to data register D8400 at the slave station. For details of link communication error codes, see below.

If a communication error occurs in the data link communication system, the data is resent three times. If the error still exists after three attempts, then the error code is set to the data registers for data link communication error. Since the error code is not communicated between the master and slave stations, error codes must be cleared individually.

Master Station

Special Data Register	Data Link Communication Error Data	Special Data Register	Data Link Communication Error Data
D8400	Slave station 1 communication error	D8416	Slave station 17 communication error
D8401	Slave station 2 communication error	D8417	Slave station 18 communication error
D8402	Slave station 3 communication error	D8418	Slave station 19 communication error
D8403	Slave station 4 communication error	D8419	Slave station 20 communication error
D8404	Slave station 5 communication error	D8420	Slave station 21 communication error
D8405	Slave station 6 communication error	D8421	Slave station 22 communication error
D8406	Slave station 7 communication error	D8422	Slave station 23 communication error
D8407	Slave station 8 communication error	D8423	Slave station 24 communication error
D8408	Slave station 9 communication error	D8424	Slave station 25 communication error
D8409	Slave station 10 communication error	D8425	Slave station 26 communication error
D8410	Slave station 11 communication error	D8426	Slave station 27 communication error
D8411	Slave station 12 communication error	D8427	Slave station 28 communication error
D8412	Slave station 13 communication error	D8428	Slave station 29 communication error
D8413	Slave station 14 communication error	D8429	Slave station 30 communication error
D8414	Slave station 15 communication error	D8430	Slave station 31 communication error
D8415	Slave station 16 communication error	—	—

If any slave stations are not connected, master station data registers which are assigned to the vacant slave stations can be used as ordinary data registers.

Slave Station

Special Data Register	Data Link Communication Error Data
D8400	Slave station communication error

Note: Slave station data registers D8401 through D8430 can be used as ordinary data registers.

Data Link Communication Error Code

The data link error code is stored in the special data register allocated to indicate a communication error in the data link system. When this error occurs, special internal relay M8005 (data link communication error) is also turned on at both master and slave stations. The detailed information of general errors can be viewed using WindLDR. Select **Online** > **Monitor**, then select **Online** > **PLC Status** > **Error Status: Details**.

Error Code	Error Details
1h	Overrun error (data is received when the receive data registers are full)
2h	Framing error (failure to detect start or stop bit)
4h	Parity error (an error was found by the parity check)
8h	Receive timeout (line disconnection)
10h	BCC (block check character) error (disparity with data received up to BCC)
20h	Retry cycle over (error occurred in all 3 trials of communication)
40h	I/O definition quantity error (discrepancy of transmit/receive station number or data quantity)

When more than one error is detected in the data link system, the total of error codes is indicated. For example, when framing error (error code 2h) and BCC error (error code 10h) are found, error code 12 is stored.

Data Link Communication between Master and Slave Stations

The master station has 10 data registers assigned to transmit data to a slave station and 10 data registers assigned to receive data from a slave station. The quantity of data registers for data link can be selected from 0 through 10 using WindLDR. The following examples illustrate how data is exchanged between the master and slave stations when 2 or 10 data registers are used for data link communication with each slave station.

Example 1: Transmit Data 2 Words and Receive Data 2 Words

Master Station

D8400	Communication Error
D7000 - D7001	Transmit Data
D7010 - D7011	Receive Data
D8401	Communication Error
D7020 - D7021	Transmit Data
D7030 - D7031	Receive Data
D8402	Communication Error
D7040 - D7041	Transmit Data
D7050 - D7051	Receive Data
D8403	Communication Error
D7060 - D7061	Transmit Data
D7070 - D7071	Receive Data
⋮	⋮
D8429	Communication Error
D7580 - D7581	Transmit Data
D7590 - D7591	Receive Data
D8430	Communication Error
D7600 - D7601	Transmit Data
D7610 - D7611	Receive Data

Slave Stations

D8400	Communication Error	Slave Station 1
D7000 - D7001	Transmit Data	
D7010 - D7011	Receive Data	
D8400	Communication Error	Slave Station 2
D7000 - D7001	Transmit Data	
D7010 - D7011	Receive Data	
D8400	Communication Error	Slave Station 3
D7000 - D7001	Transmit Data	
D7010 - D7011	Receive Data	
D8400	Communication Error	Slave Station 4
D7000 - D7001	Transmit Data	
D7010 - D7011	Receive Data	
⋮	⋮	⋮
D8400	Communication Error	Slave Station 30
D7000 - D7001	Transmit Data	
D7010 - D7011	Receive Data	
D8400	Communication Error	Slave Station 31
D7000 - D7001	Transmit Data	
D7010 - D7011	Receive Data	

Example 2: Transmit Data 10 Words and Receive Data 10 Words

Master Station

D8400	Communication Error
D7000 - D7009	Transmit Data
D7010 - D7019	Receive Data
D8401	Communication Error
D7020 - D7029	Transmit Data
D7030 - D7039	Receive Data
D8402	Communication Error
D7040 - D7049	Transmit Data
D7050 - D7059	Receive Data
D8403	Communication Error
D7060 - D7069	Transmit Data
D7070 - D7079	Receive Data
⋮	⋮
D8429	Communication Error
D7580 - D7589	Transmit Data
D7590 - D7599	Receive Data
D8430	Communication Error
D7600 - D7609	Transmit Data
D7610 - D7619	Receive Data

Slave Stations

D8400	Communication Error	Slave Station 1
D7000 - D7009	Transmit Data	
D7010 - D7019	Receive Data	
D8400	Communication Error	Slave Station 2
D7000 - D7009	Transmit Data	
D7010 - D7019	Receive Data	
D8400	Communication Error	Slave Station 3
D7000 - D7009	Transmit Data	
D7010 - D7019	Receive Data	
D8400	Communication Error	Slave Station 4
D7000 - D7009	Transmit Data	
D7010 - D7019	Receive Data	
⋮	⋮	⋮
D8400	Communication Error	Slave Station 30
D7000 - D7009	Transmit Data	
D7010 - D7019	Receive Data	
D8400	Communication Error	Slave Station 31
D7000 - D7009	Transmit Data	
D7010 - D7019	Receive Data	

Special Internal Relays for Data Link Communication

Special internal relays M8005 through M8007 and M8140 through M8177 are assigned for the data link communication.

M8005 Data Link Communication Error

When an error occurs during communication in the data link system, M8005 turns on. The M8005 status is maintained when the error is cleared and remains on until M8005 is reset using WindLDR or until the CPU is turned off. The cause of the data link communication error can be checked using **Online** > **Monitor**, followed by **Online** > **PLC Status** > **Error Status: Details**. See page 21-4.

M8006 Data Link Communication Prohibit Flag (Master Station)

When M8006 at the master station is turned on in the data link system, data link communication is stopped. When M8006 is turned off, data link communication resumes. The M8006 status is maintained when the CPU is turned off and remains on until M8006 is reset using WindLDR.

When M8006 is on at the master station, M8007 is turned on at slave stations in the data link system.

M8007 Data Link Communication Initialize Flag (Master Station) Data Link Communication Stop Flag (Slave Station)

M8007 has a different function at the master or slave station of the data link communication system.

Master station: Data link communication initialize flag

When M8007 at the master station is turned on during operation, the link configuration is checked to initialize the data link system. When a slave station is powered up after the master station, turn M8007 on to initialize the data link system. After a data link system setup is changed, M8007 must also be turned on to ensure correct communication.

Slave station: Data link communication stop flag

When a slave station does not receive communication data from the master station for 10 seconds or more in the data link system, M8007 turns on. When a slave station does not receive data in 10 seconds after initializing the data link system, M8007 also turns on at the slave station. When the slave station receives correct communication data, M8007 turns off.

M8140-M8176 Slave Station Communication Completion Relay for Separate Refresh Mode

Special internal relays M8140 through M8176 are used to indicate the completion of data refresh when the data link communication is performed in the separate refresh mode. When data link communication with a slave station is complete, a special internal relay assigned for the slave station is turned on for one scan time at both the master and slave station.

Special Internal Relay	Slave Station Number	Special Internal Relay	Slave Station Number
M8140	Slave Station 1	**M8160**	Slave Station 17
M8141	Slave Station 2	**M8161**	Slave Station 18
M8142	Slave Station 3	**M8162**	Slave Station 19
M8143	Slave Station 4	**M8163**	Slave Station 20
M8144	Slave Station 5	**M8164**	Slave Station 21
M8145	Slave Station 6	**M8165**	Slave Station 22
M8146	Slave Station 7	**M8166**	Slave Station 23
M8147	Slave Station 8	**M8167**	Slave Station 24
M8150	Slave Station 9	**M8170**	Slave Station 25
M8151	Slave Station 10	**M8171**	Slave Station 26
M8152	Slave Station 11	**M8172**	Slave Station 27
M8153	Slave Station 12	**M8173**	Slave Station 28
M8154	Slave Station 13	**M8174**	Slave Station 29
M8155	Slave Station 14	**M8175**	Slave Station 30
M8156	Slave Station 15	**M8176**	Slave Station 31
M8157	Slave Station 16	**—**	—

M8177 All Slave Station Communication Completion Relay

When data link communication with all slave stations is complete in either separate or simultaneous refresh mode, special internal relay M8177 at the master station is turned on for one scan time. M8177 at slave stations does not go on.

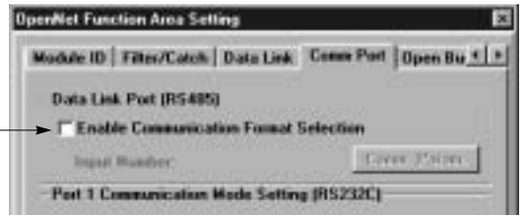
Programming WindLDR

The Data Link page in the Function Area Settings must be programmed for the data link master station. Only when baud rate of 38400 bps is used, the baud rate must also be selected for slave stations on the Data Link page of WindLDR. Any other settings are not needed for slave stations.

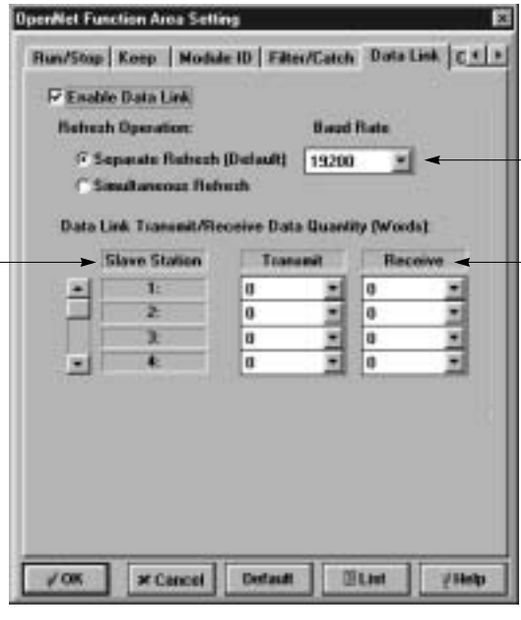
Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.

2. Click the **Comm Port** tab and make sure that the check box to the left of **Enable Communication Format Selection** for the **Data Link Port (RS485)** is unchecked. If the check box is on, click the check box to delete the check mark so that you can proceed with the following procedures.



3. Select the **Data Link** tab.



Enable Data Link — Click the check box on the left to use the data link communication.

Refresh Operation — Click the button for separate refresh (default) or simultaneous refresh. See page 21-8.

Baud Rate — Select 19200 or 38400 bps.
When the data link system consists of only OpenNet Controllers and FA-3S serial interface module PF3S-SIF4, select 38400 bps for faster communication.
When the data link system includes the MICRO^3 or MICRO^{3}C, select 19200 bps.

Data Link Transmit / Receive Data Quantity (Words)
Scroll the slave station number using the up and down buttons on the left. Select the quantity of data registers used for transmit and receive data per slave station. The data words can be selected from 0 through 10 words.

Refresh Modes

In the data link communication, the master station sends data to a slave station and receives data from the slave station one after another. After receiving data from slave stations, the master station stores the data into data registers allocated to each slave station. The process of updating data into data registers is called refresh. The master station refreshes the received data in two ways; separate refresh or simultaneous refresh mode. Differences of these two refresh modes are listed below:

Mode	Separate Refresh Mode	Simultaneous Refresh Mode
Master Station Scan Time	Since the master station refreshes received data at the END processing of the user program, the scan time in the master station is affected.	Since the master station uses an interrupt processing to refresh received data while executing the user program, the scan time in the master station is not affected.
Transmit Frame	All data of fixed data lengths are transmitted as selected in the Function Area Settings.	Only data that has been changed is transmitted.
Master Station Refresh Timing	Data received from one slave station is refreshed at each END processing.	Data received from all slave stations is refreshed at the END processing after completing communication with all slave stations.
Applicable Master Station	OpenNet Controller, MICRO^3, MICRO^{3}C	OpenNet Controller
Applicable Slave Station	OpenNet Controller, MICRO^3, MICRO^{3}C	OpenNet Controller, MICRO^3, MICRO^{3}C

When the data link system contains the OpenNet Controller and MICRO^3/MICRO^{3}C, set the baud rate to 19200 bps and transmit/receive data quantity to 2 words in the Function Area Settings for the OpenNet Controller to communicate with MICRO^3/MICRO^{3}C stations.

When the MICRO^3/MICRO^{3}C is used as a slave station in the simultaneous refresh mode, the transmit frame from the master station will be of a fixed data length. The OpenNet Controller master station in the simultaneous refresh mode automatically checks if slave stations connected in the data link system are MICRO^3/MICRO^{3}C or not.

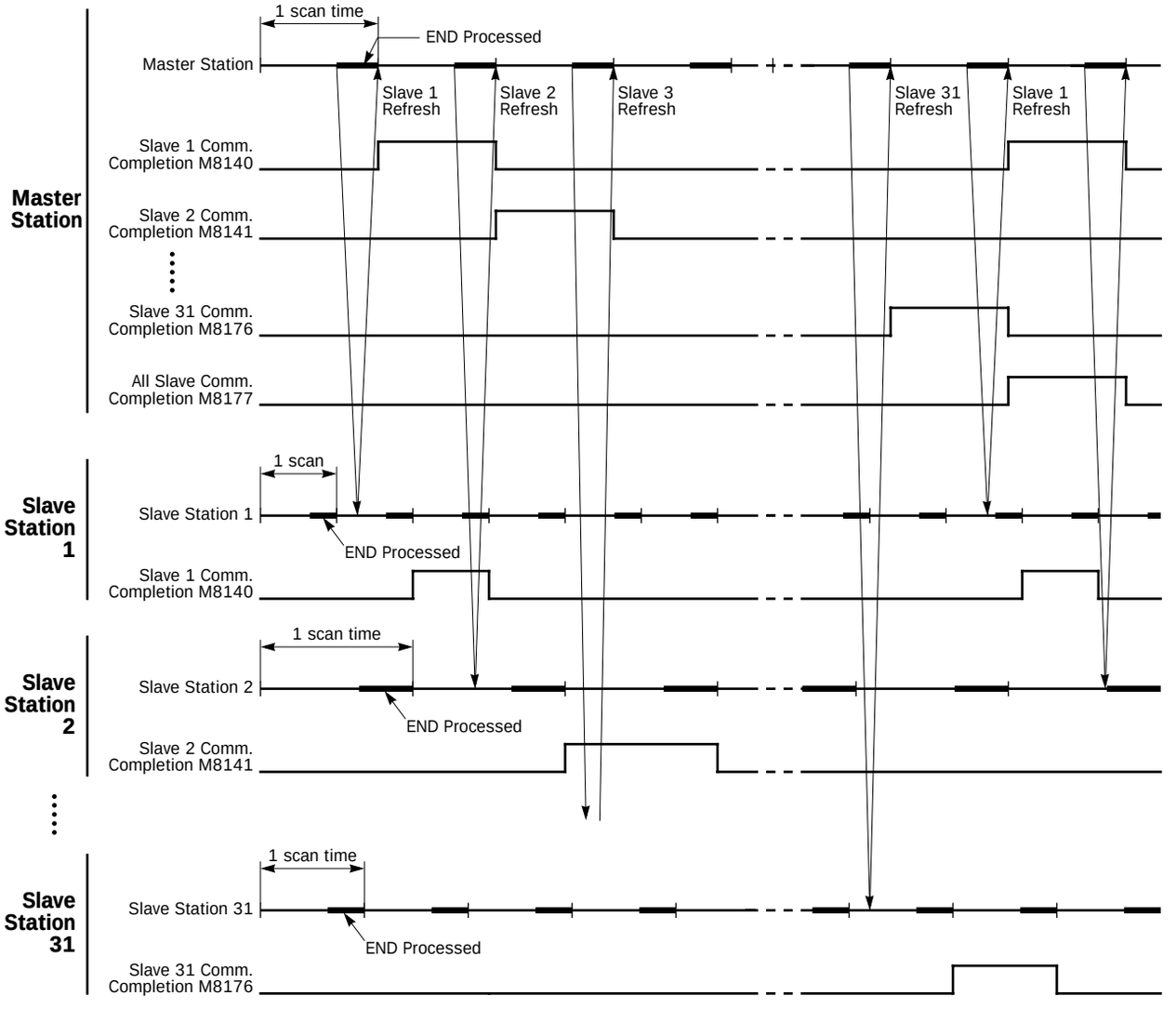
Separate Refresh Mode Communication Sequence

The master station can communicate with only one slave station in one scan time. When a slave station receives a communication from the master station, the slave station returns data stored in data registers assigned for data link communication. When the maximum 31 slave stations are connected, the master station requires 31 scans to communicate with all slave stations.

Both master and slave stations refresh communication data in the END processing at each station. When data refresh is complete, communication completion special internal relays M8140 through M8176 (slave station communication completion relay) go on at the master and slave stations for one scan time after the data refresh.

When the master station completes communication with all slave stations, special internal relay M8177 (all slave station communication completion relay) goes on at the master station.

The communication sequence in the separate refresh mode is shown below:



Separate Refresh Time at Master Station for Communication with One Slave Station (Trf)

When the baud rate is set at 19200 bps, the master station requires the following time to refresh the transmit and receive data for communication with one slave station.

$$Trf = 2.083\ \text{msec} \times (\text{Transmit Words} + \text{Receive Words}) + 3.125\ \text{msec} + 1\ \text{scan time}$$

Total Separate Refresh Time at Master Station for Communication with All Slave Stations (Trfn)

When the baud rate is set at 19200 bps, the master station requires the following time to refresh the transmit and receive data for communication with all slave stations, that is the total of refresh times.

$$Trfn = \sum Trf = \sum \{2.083\ \text{msec} \times (\text{Transmit Words} + \text{Receive Words}) + 3.125\ \text{msec} + 1\ \text{scan time}\}$$

Example: Refresh Time in Separate Refresh Mode

When data link communication is performed with such parameters as transmit words 10, receive words 10, slave stations 8, average scan time 20 msec, and baud rate 19200 bps, then the total refresh time Trf8 for communication with all eight slave stations in the separate refresh mode will be:

$$Trf8 = \{2.083\ \text{msec} \times (10 + 10) + 3.125\ \text{msec} + 20\ \text{msec}\} \times 8 = 518.28\ \text{msec}$$

When the baud rate is 38400 bps, the total refresh time will be:

$$Trf8 = 518.28\ \text{msec} \div 2 = 259.14\ \text{msec}$$

Simultaneous Refresh Mode Communication Sequence

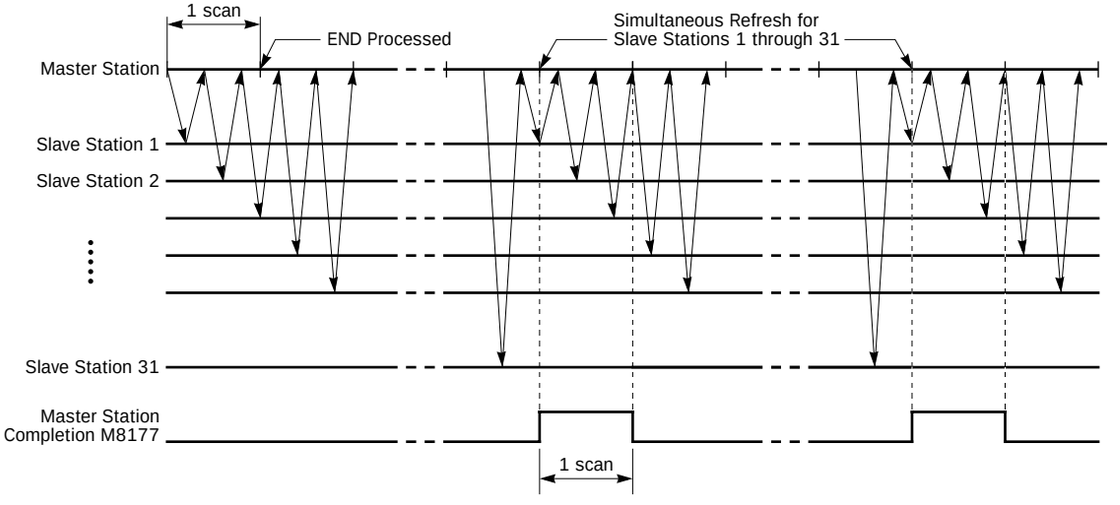
Unlike the separate refresh mode, the master station performs data link communication using an interrupt processing during normal scanning. When communication with all slave stations is complete, the master station refreshes all received data simultaneously.

As with the separate refresh, when a slave station receives a communication from the master station, the slave station returns data stored in data registers assigned for data link communication to the master station.

Data refresh at the master and slave stations is done in the END processing at the respective station.

When the master station completes data refresh, special internal relay M8177 (all slave station communication completion relay) goes on at the master station. Special internal relays M8140 through M8176 (slave station communication completion relay) do not go on at the master and slave stations in the simultaneous refresh mode.

The communication sequence in the simultaneous refresh mode is shown below:



Simultaneous Refresh Time at Master Station for Communication with One Slave Station (Trf)

When no transmit/receive data has been changed during communication at 19200 bps, the master station requires the following time to refresh data for communication with one slave station.

$Trf = 3.125 \text{ msec}$

When N words of transmit/receive data have been changed during communication at 19200 bps:

$Trf = 4.167 \text{ msec} \times (2 + N)$

Total Simultaneous Refresh Time at Master Station for Communication with All Slave Stations (Trfn)

When the baud rate is set at 19200 bps, the master station requires the following time to refresh the transmit and receive data for communication with all slave stations, that is the total of refresh times.

$Trfn = \sum Trf = \sum 4.167 \text{ msec} \times (2 + N)$

Example: Refresh Time in Simultaneous Refresh Mode

When data link communication is performed with such parameters as transmit words 10, receive words 10, slave stations 8, average scan time 20 msec, and baud rate 19200 bps, then the total refresh time Trf8 for communication with all eight slave stations in the simultaneous refresh mode will be as follows:

When no transmit/receive data has been changed,

$Trf8 = 3.125 \text{ msec} \times 8 = 25 \text{ msec}$

When one word of transmit data has been changed at all eight slave stations,

$Trf8 = \{4.167 \text{ msec} \times (2 + 1)\} \times 8 = 100.0 \text{ msec}$

When 10 words of all transmit data have been changed at all eight slave stations,

$Trf8 = \{4.167 \text{ msec} \times (2 + 10)\} \times 8 = 400.0 \text{ msec}$

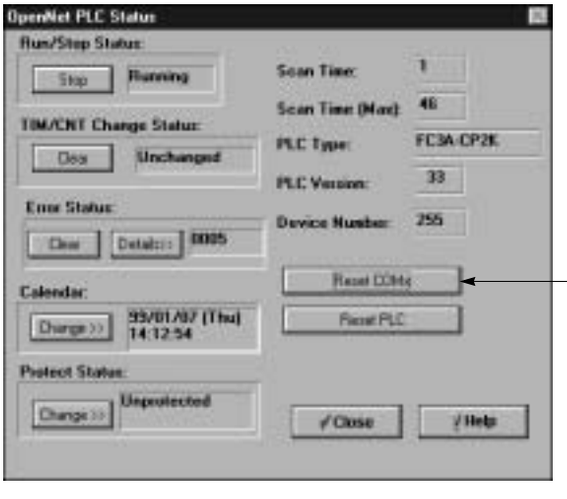
When the baud rate is 38400 bps, Trf8 for all slave stations is $400.0 \div 2 = 200.0$ msec

Operating Procedure for Data Link System

To set up and use a data link system, complete the following steps:

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. First determine the assignments for the master station and slave stations.
3. Connect the OpenNet Controller CPU modules at the master station and all slave stations as illustrated on page 21-2.
4. Set communication selector DIP switch 1 to ON at all master and slave stations to select the data link mode for the RS485 port.
5. Set communication selector DIP switches 4 through 8 to select master station number 0 and slave station numbers 1 through 31 as many as required. The slave station numbers do not have to be consecutive.
6. Create user programs for the master and slave stations. Different programs are used for the master and slave stations.
7. Using WindLDR, enter settings to **Configure** > **Function Area Settings** > **Data Link** for the master station. Only when a baud rate of 38400 bps is used, enter the setting to the **Data Link** page in WindLDR for the slave station. For programming WindLDR, see page 21-7.
8. Power up all OpenNet Controller CPU modules at the same time, and download the user programs to the master and slave stations.
9. Monitor the data registers used for data link at the master and slave stations.

Note: To enable data link communication, power up all OpenNet Controller modules at the same time, or power up slave stations first. If a slave station is powered up later than the master station, the master station does not recognize the slave station. To make the master station recognize the slave station in this case, turn on special internal relay M8007 (data link communication initialize flag) at the master station (see page 21-6), or in WindLDR select **Online** > **Monitor**, followed by **Online** > **PLC Status** and click the **Reset COMx** button.



Reset COMx
Initializes data link communication

When the CPU is powered up, the CPU checks the settings of the communication selector DIP switch and enables the selected communication mode and device number automatically. After changing the settings of the communication selector DIP switch while the CPU is powered up, press the communication enable button for more than 4 seconds until the ERROR LED blinks once; then the new communication mode takes effect. You have to press the communication enable button only when you change the communication mode while the CPU is powered up.

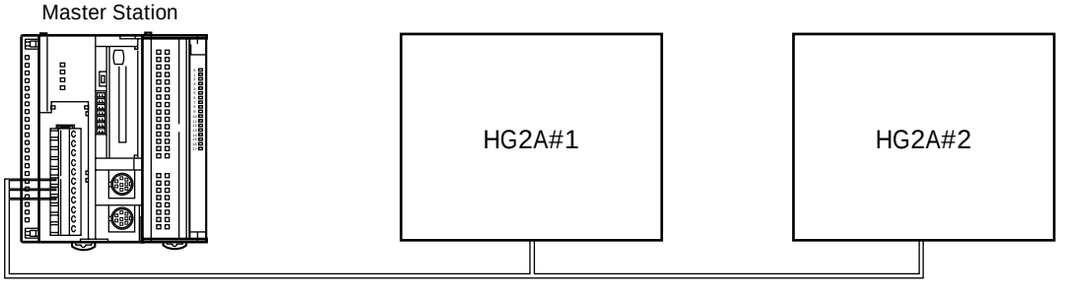
Do not power up the CPU while the communication enable button is depressed and do not press the button unless it is necessary.

Data Link with Other Equipment (Separate Refresh Mode)

The data link communication system can include IDEC's HG2A operator interfaces, MICRO^3/MICRO^{3}C micro programmable controllers, and FA-3S programmable controllers using serial interface modules.

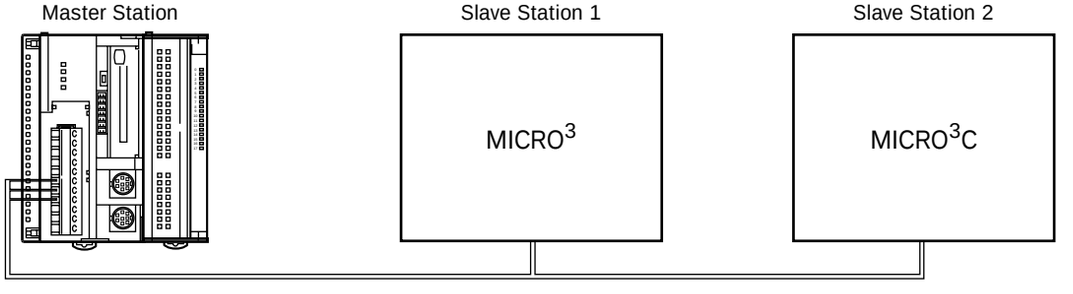
Data Link with HG2A Operator Interface

OpenNet Controller Settings	HG2A Settings	HG2A Settings
Transmit data: 2 words × 6 Receive data: 2 words × 6 Baud rate: 19200 bps	First slave station number: 1 (6 slave stations)	First slave station number: 7 (6 slave stations)



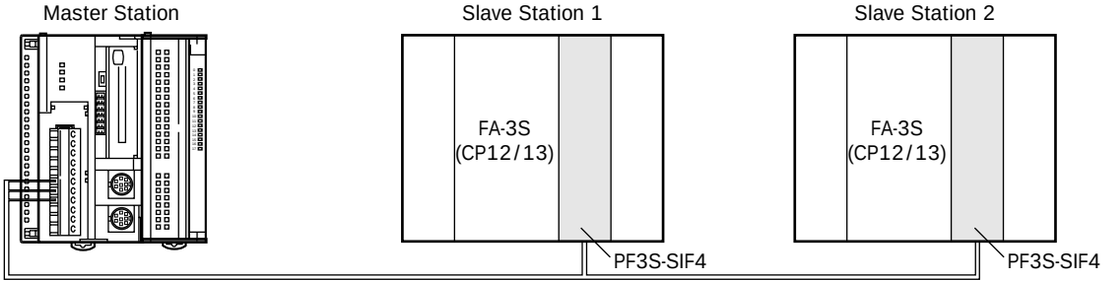
Data Link with MICRO^3 / MICRO^{3}C

OpenNet Controller Settings	MICRO^3 Settings	MICRO^{3}C Settings
Transmit data: 2 words Receive data: 2 words Baud rate: 19200 bps	Function selector switch: 1	Function selector switch: 2



Data Link with FA-3S High-performance CPU using Serial Interface Module PF3S-SIF4

OpenNet Controller Settings	PF3S-SIF4 Settings	PF3S-SIF4 Settings
Transmit data: 6 words Receive data: 6 words Baud rate: 19200 or 38400 bps	Data link slave station mode Slave station number: 1	Data link slave station mode Slave station number: 2



22: COMPUTER LINK COMMUNICATION

Introduction

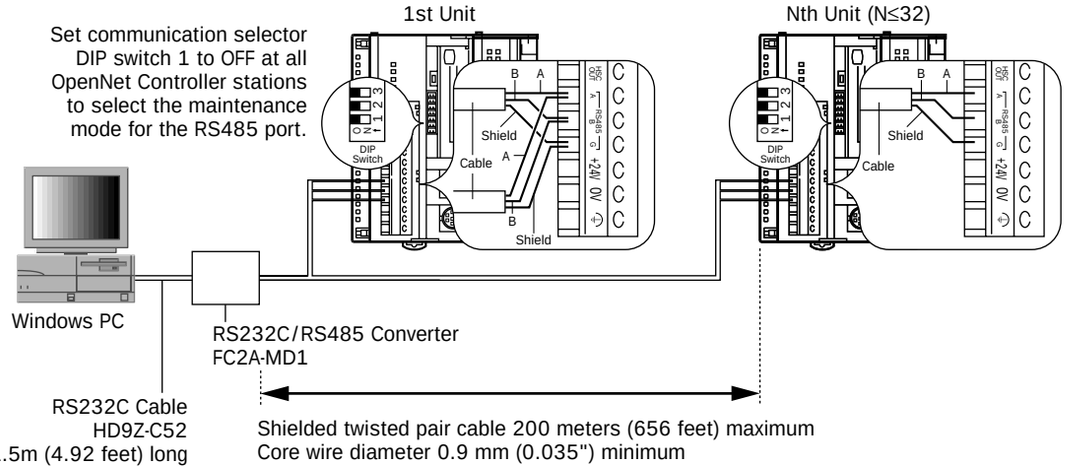
When the OpenNet Controller is connected to a computer, operating status and I/O status can be monitored on the computer, data in the CPU can be monitored or updated, and user programs can be downloaded and uploaded. The OpenNet Controller can also be started or stopped from the computer. A maximum of 32 OpenNet Controller CPUs can be connected to one computer in the 1:N computer link system.

This chapter describes the 1:N computer link system. For the 1:1 computer link system, see page 4-1.

Computer Link System Setup (1:N Computer Link System)

To set up a 1:N communication computer link system, connect the RS232C/RS485 converter to the RS485 terminals A, B, and G on every OpenNet Controller CPU module using a shielded twisted pair cable as shown below. The total length of the cable for the computer link system can be extended up to 200 meters (656 feet).

Connect the RS232C port on the computer to the RS232C/RS485 converter using the RS232C cable HD9Z-C52. The RS232C cable has a D-sub 9-pin female connector for connection with a computer.



Setting Communication Selector DIP Switch

The communication selector DIP switch is used to select the communication protocol for the RS485 and RS232C ports, and also to select the device number for the OpenNet Controller CPU module used in a data link or computer link communication system. When using the OpenNet Controllers in a 1:N computer link system, set communication selector DIP switches 1 and 4 through 8.

When the CPU is powered up, the CPU checks the settings of the communication selector DIP switch and enables the selected communication mode and device number automatically. After changing the settings of the communication selector DIP switch while the CPU is powered up, press the communication enable button for more than 4 seconds until the ERROR LED blinks once; then the new communication mode takes effect. You have to press the communication enable button only when you change the communication mode while the CPU is powered up.

Do not power up the CPU while the communication enable button is depressed and do not press the button unless it is necessary.

Selecting Maintenance Mode

To select the maintenance mode, set communication selector DIP switch 1 to OFF at all OpenNet Controller CPU modules in the 1:N computer link network.

DIP Switch No.	Function	Setting	
1	RS485 port communication mode	ON: Data link mode	OFF: Maintenance mode

Selecting Device Numbers

Set communication selector DIP switches 4 through 8 to assign a unique device number of 0 through 31 to each CPU in the computer link network. The device numbers do not have to be consecutive.

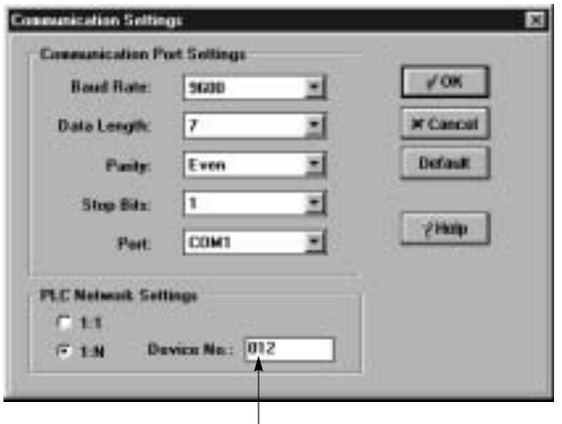
DIP Switch No.	Device Number															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**
5	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**
6	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**
7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

DIP Switch No.	Device Number															
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
4	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF	**ON**
5	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**
6	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**
7	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**
8	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**

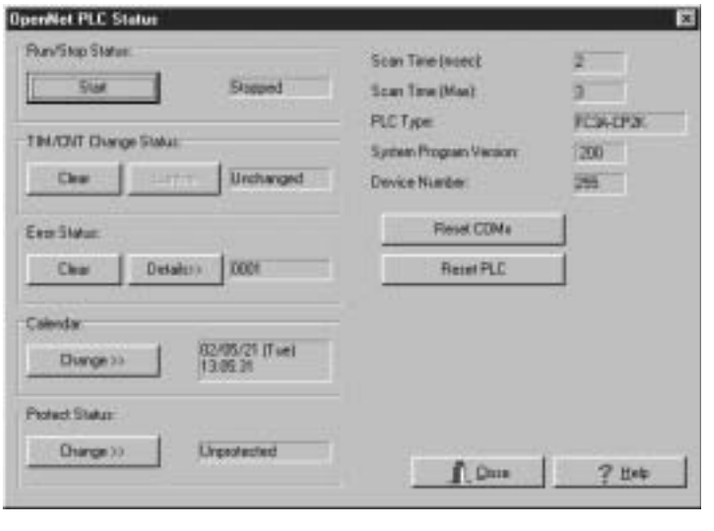
Monitoring PLC Status

The following example describes the procedures to monitor the operating status of the OpenNet Controller assigned with device number 12 in a 1:N communication computer link system.

1. From the WindLDR menu bar, select **Configure** > **Communication Settings**. The Communication Settings dialog box appears.
2. Under PLC Network Setting, click the **1:N** button to select 1:N communication, and enter 12 to the **Device No.** field.
3. From the WindLDR menu bar, select **Online** > **Monitor**. The ladder diagram on the screen enters the monitor mode.
4. From the WindLDR menu bar, select **Online** > **PLC Status**. The OpenNet PLC Status dialog box appears.



Device No.:
Enter 12 to select a device number to communicate with.



23: MODEM MODE

Introduction

This chapter describes the modem mode designed for communication between the OpenNet Controller and another OpenNet Controller or any data terminal equipment through telephone lines. Using the modem mode, the OpenNet Controller can initialize a modem, dial a telephone number, send an AT command, enable the answer mode to wait for an incoming call, and disconnect the telephone line. All of these operations can be performed simply by turning on a start internal relay dedicated to each operation.

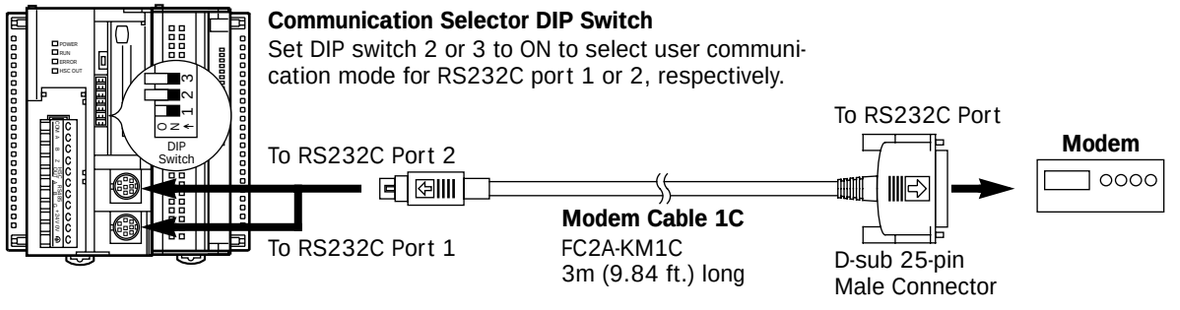
⚠ Caution

- The modem mode provides for a simple modem control function so that the OpenNet Controller can initialize a modem, dial a destination telephone number, or answer an incoming call. The performance of the modem communication using the modem mode depends on the modem functions and telephone line situations. The modem mode does not prevent intrusion or malfunctions of other systems. For practical applications, confirm the communication function using the actual system setup and include safety provisions.
- While communicating through modems, the telephone line may be disconnected unexpectedly or receive data errors may occur. Provisions against such errors must be included in the user program.

System Setup

To connect a modem to the RS232C port 1 or 2 on the OpenNet Controller, use the modem cable 1C (FC2A-KM1C). To enable the modem mode, make the two settings described below:

1. Set communication selector DIP switch 2 or 3 to ON to select user communication mode for RS232C port 1 or 2, respectively. (See page 2-2.) Both RS232C port 1 and 2 can be used for modem communication at the same time.
2. Enter 1 to data register D8200 or D8300 (RS232C port communication mode selection) to enable the modem mode for RS232C port 1 or 2, respectively. (See page 23-3.)



Mini DIN Connector Pinouts

Description		Pin
Shield		Cover
RTS	Request to Send	1
DTR	Data Terminal Ready	2
TXD	Transmit Data	3
RXD	Receive Data	4
DSR	Data Set Ready	5
SG	Signal Ground	6
SG	Signal Ground	7
NC	No Connection	8

D-sub 25-pin Connector Pinouts

Pin	Description	
1	FG	Frame Ground
2	TXD	Transmit Data
3	RXD	Receive Data
4	RTS	Request to Send
5	—	—
6	—	—
7	SG	Signal Ground
8	DCD	Data Carrier Detect
20	DTR	Data Terminal Ready

⚠ Caution

- Do not connect the NC (no connection) pin to any line; otherwise, the OpenNet Controller and modem may be damaged.
- Modem cables for Apple Macintosh computers cannot be used for the OpenNet Controller.

Applicable Modems

Any Hayes compatible modem can be used. Modems with a communications rate of 9600 bps or more between modems are recommended. Use modems of the same make and model at both ends of the communication line.

Internal Relays for Modem Mode

When the modem mode is enabled, internal relays M8050 through M8107 are allocated to special functions. M8050-M8056 (RS232C port 1) and M8080-M8086 (RS232C port 2) are used to send an AT command or disconnect the telephone line. M8060-M8066 and M8070-M8076 (RS232C port 1) and M8090-M8096 and M8100-M8106 (RS232C port 2) turn on to indicate the results of the command. M8057, M8067, and M8077 (RS232C port 1) and M8087, M8097, and M8107 (RS232C port 2) are used to indicate the status of the RS232C port.

All completion and failure internal relays are turned off at the first scan in the modem mode.

Start and Result Internal Relays for RS232C Port 1

Mode	Command	Start IR	Completion IR	Failure IR	Data Registers
Originate Mode	Initialization String	M8050	M8060	M8070	D8245-D8269
	ATZ	M8051	M8061	M8071	—
	Dialing	M8052	M8062	M8072	D8270-D8299
Disconnect Mode	Disconnect Line	M8053	M8063	M8073	—
AT General Command Mode	AT Command	M8054	M8064	M8074	D8230-D8244
Answer Mode	Initialization String	M8055	M8065	M8075	D8245-D8269
	ATZ	M8056	M8066	M8076	—

Start and Result Internal Relays for RS232C Port 2

Mode	Command	Start IR	Completion IR	Failure IR	Data Registers
Originate Mode	Initialization String	M8080	M8090	M8100	D8345-D8369
	ATZ	M8081	M8091	M8101	—
	Dialing	M8082	M8092	M8102	D8370-D8399
Disconnect Mode	Disconnect Line	M8083	M8093	M8103	—
AT General Command Mode	AT Command	M8084	M8094	M8104	D8330-D8344
Answer Mode	Initialization String	M8085	M8095	M8105	D8345-D8369
	ATZ	M8086	M8096	M8106	—

When one of start internal relays M8050-M8056 or M8080-M8086 is turned on, a corresponding command is executed once. To repeat the command, reset the start internal relay and turn the internal relay on again.

Completion or failure of a command is determined as described below:

Completion: The command is transmitted repeatedly as many as the retry cycles specified in data register D8209 or D8309. When the command is completed successfully, the completion IR is turned on and the command is not executed for the remaining cycles.

Failure: The command is transmitted repeatedly but failed in all trials as many as the retry cycles specified in data register D8209 or D8309.

Status Internal Relays for RS232C Port 1 and Port 2

Port 1	Port 2	Status	Description
M8057	**M8087**	AT Command Execution	ON: AT command is in execution (start IR is on) OFF: AT command is not in execution (completion or failure IR is on) (Note)
M8067	**M8097**	Operational State	ON: Command mode OFF: On-line mode
M8077	**M8107**	Line Connection	ON: Telephone line connected OFF: Telephone line disconnected

Note: While M8057/M8087 (AT command execution) is on, the OpenNet Controller cannot send and receive communication.

Data Registers for Modem Mode

When the modem mode is enabled, data registers D8200 through D8399 are allocated to special functions. At the first scan in the modem mode, D8209/D8309 and D8210/D8310 store the default values, then D8245-D8269 and D8345-D8369 store an initialization string depending on the value in D8201/D8301, respectively.

Port 1	Port 2	Stored Data	Description
D8200	**D8300**	RS232C Port Communication Mode Selection	Communication mode for RS232C port 1 or 2 is selected. 0 (other than 1): User communication mode 1: Modem mode Enter 1 to D8200/D8300 to enable the modem mode after setting DIP switch 2 or 3 to ON. When 1 is stored to D8200/D8300, the modem mode is initialized at the next END processing.
D8201	**D8301**	Modem Initialization String Selection	Depending on the value stored in D8201/D8301, a modem initialization string is stored to D8245-D8269 or D8345-D8369. When D8201/D8301 value is changed, a corresponding initialization string is stored. See page 23-4. Valid values: 0 to 5, 10 to 15, 20 to 25 When D8201/D8301 stores any value other than above, the initialization string for value 0 is stored.
D8203	**D8303**	On-line Mode Protocol Selection	The D8203/D8303 value selects the protocol for the RS232C port after telephone line is connected. 0 (other than 1): Maintenance protocol 1: User protocol
D8209	**D8309**	Retry Cycles (default = 3)	The D8209/D8309 value selects how many retries will be made until the operation initiated by a start internal relay M8050-M8056 or M8080-M8086 is completed. (See Note.) 0: No retry 1-65535: Executes a specified number of retries
D8210	**D8310**	Retry Interval (default = 90 sec)	The D8210/D8310 value specifies the interval to start a retry of dialing when a dialing fails with the retry cycles set to a value more than 1. (Other start commands are repeated continuously as many as the retry cycles.) (See Note.) Valid value: 0 to 65535 (seconds) If a telephone line is not connected within the retry interval, the OpenNet Controller starts a retry. Consequently, if the retry interval is set to a too small value, the telephone line can not be connected correctly.
D8211	**D8311**	Modem Mode Status	Modem mode status is stored (see page 23-8). When not in the modem mode, D8211/D8311 stores 0.
D8215-D8229	**D8315-D8329**	AT Command Result Code	AT command result codes returned from modem are stored. When the result code exceeds 30 bytes, first 30 bytes are stored.
D8230-D8244	**D8330-D8344**	AT Command String	AT command string for the AT general command mode is stored. Enter an AT command string to these data registers to send by turning on M8054/M8084 (AT command start internal relay). "AT" and LF (0Ah) are appended automatically.
D8245-D8269	**D8345-D8369**	Initialization String	Initialization string for the originate and answer modes is stored depending on the D8201/D8301 value. To change the initialization string, enter a new value without changing the value of D8201/D8301. The new value is sent by turning on M8050/M8080 or M8055/M8085. "AT" and LF (0Ah) are appended automatically.
D8270-D8299	**D8370-D8399**	Telephone Number	Telephone number for dialing in the originate mode is stored. "ATD" and LF (0Ah) are appended automatically.

Note: To change the D8209/D8309 or D8210/D8310 value, enter a new value in the next scan after entering 1 to D8200/D8300.

Originate Mode

The originate mode is used to send an initialization string to the modem, issue the ATZ command to reset the modem, and dial the telephone number. To execute a command, turn on one of start internal relays M8050-M8052 (RS232C port 1) or M8080-M8082 (RS232C port 2). If two or more start internal relays are turned on simultaneously, an error will result and error code 61 is stored in modem mode status data register D8211/D8311 (see page 23-8). When a start internal relay is turned on, a corresponding sequence of commands is executed once as described below. When the start command fails, the same command is repeated as many as the retry cycles specified by D8209/D8309.

M8050/M8080: Send an initialization string, send the ATZ command, and dial the telephone number

M8051/M8081: Send the ATZ command and dial the telephone number

M8052/M8082: Dial the telephone number

Initialization String in Originate Mode

When the modem mode is enabled as described on page 23-1 and the OpenNet Controller is started to run, an initialization string is stored to data registers D8245-D8269 (RS232C port 1) or D8345-D8369 (RS232C port 2) at the END processing of the first scan, depending on the value stored in data register D8201/D8301 (modem initialization string selection). To send the initialization string from the OpenNet Controller to the modem, turn M8050/M8080 on; then the ATZ command is issued and the telephone number is dialed successively.

When the D8200/D8300 value is changed to 1 to enable modem mode or when the D8201/D8301 value is changed, an initialization string is stored to D8245-D8269 or D8345-D8369, depending on the value stored in D8201/D8301.

Modem Initialization String

D8201/D8301 Value	Initialization String (D8245-D8269 or D8345-D8369)	Applicable Modem
0	ATE0Q0V1&D2&C1\V0X4\Q3\J0\A0&M5\N2S0=2&W	AIWA (33.6 Kbps or less)
1	ATE0Q0V1&D2&C1\V0X4\Q2\J0\A0&M5\N2S0=2&W	OMRON
2	ATE0Q0V1&D2&C1\V0X4\Q3\A0&M5\N2S0=2&W	AIWA (56 Kbps)
3	ATE0Q0V1&D2&C1&A0X4&H1&I0&B1&M5S0=2&W	OMRON (56 Kbps)
4	ATE0Q0V1&D2&C1\V0X4&K3\A0\N3S0=2&W	Sun Corporation, Micro Research
5	ATE0Q0V1&D2&C1\V0X4&K3\A0\N3S0=2&W0	Seiko Instruments
10	ATE0Q0V1&D2&C1\V0X3\Q3\J0\A0&M5\N2S0=2&W	
11	ATE0Q0V1&D2&C1\V0X3\Q2\J0\A0&M5\N2S0=2&W	
12	ATE0Q0V1&D2&C1\V0X3\Q3\A0&M5\N2S0=2&W	
13	ATE0Q0V1&D2&C1&A0X3&H1&I0&B1&M5S0=2&W	
14	ATE0Q0V1&D2&C1\V0X3&K3\A0\N3S0=2&W	
15	ATE0Q0V1&D2&C1\V0X3&K3\A0\N3S0=2&W0	
20	ATE0Q0V1&D2&C1\V0X0\Q3\J0\A0&M5\N2S0=2&W	
21	ATE0Q0V1&D2&C1\V0X0\Q2\J0\A0&M5\N2S0=2&W	
22	ATE0Q0V1&D2&C1\V0X0\Q3\A0&M5\N2S0=2&W	
23	ATE0Q0V1&D2&C1&A0X0&H1&I0&B1&M5S0=2&W	
24	ATE0Q0V1&D2&C1\V0X0&K3\A0\N3S0=2&W	
25	ATE0Q0V1&D2&C1\V0X0&K3\A0\N3S0=2&W0	

Default Initialization String: ATE0Q0V1&D2&C1\V0X4\Q3\J0\A0&M5\N2S0=2&W[CR][LF]

When D8201/D8301 (modem initialization string selection) stores 0, the default initialization string shown above is stored to data registers D8245-D8269 or D8345-D8369. AT and [LF] are appended at the beginning and end of the initialization string automatically by the system program and are not stored in data registers.

	DR 8245	8246	8247	8248	8249	8250	8251	8252	8253	8254	8255	8256	8257	8258	8259	8260	8261	8262	8263	8264
	DR 8345	8346	8347	8348	8349	8350	8351	8352	8353	8354	8355	8356	8357	8358	8359	8360	8361	8362	8363	8364
AT	E0	Q0	V1	&D	2&	C1	\V	0X	4\	Q3	\J	0\	A0	&M	5\	N2	S0	=2	&W	0D00	[LF]

This initialization string is used for AIWA's modems. Depending on your modem and telephone line, the initialization string may have to be modified. To select another initialization string from the table above, set another value to data register D8201/D8301 (modem initialization string selection).

More changes can also be made by entering required values to data registers D8245-D8269 or D8345-D8369. Store two characters in one data register; the first character at the upper byte and the second character at the lower byte in the data register. AT and [LF] need not be stored in data registers. Use the MACRO instruction on WindLDR to set the initialization string characters and ASCII value 0Dh for [CR] at the end. Program the MACRO to replace the default values in D8245-D8269 or D8345-D8369 stored in the first scan and execute the MACRO in a subsequent scan. For essential commands which must be included in the initialization string, see page 23-9. After the new values are stored, do not change the values stored in D8201/D8301 (modem initialization string selection). Turn on M8050/M8080 to send the new initialization string to the modem.

When the initialization string has been sent successfully, internal relay M8060/M8090 is turned on. If the initialization string fails, internal relay M8070/M8100 is turned on. When the subsequent commands of ATZ and dialing are also completed successfully, M8061/M8091 and M8062/M8092 will also be turned on.

The default initialization string or the modified initialization string stored in D8245-D8269 or D8345-D8369 is also used for the initialization in the answer mode.

ATZ (Resetting the Modem) in Originate Mode

The default initialization string specifies to be stored in the non-volatile memory of the modem, using the &W command. The initialization string is restored when the modem is powered up or when the ATZ command is issued. The OpenNet Controller sends the ATZ command to the modem, following the initialization string when M8050/M8080 is turned on. The ATZ command can also be issued separately by turning M8051/M8081 on, followed by the dial command to be executed automatically.

ATZ Command: ATZ[CR][LF]

When the ATZ command has been completed successfully, internal relay M8061/M8091 is turned on. If the ATZ command fails, internal relay M8071/M8101 is turned on. When the subsequent dialing is also completed successfully, M8062/M8092 will also be turned on.

If the initialization string has been stored in the non-volatile memory of the modem, M8050/M8080 may be skipped. Start with M8051/M8081 to send the ATZ command.

Dialing the Telephone Number

When the modem mode is enabled, data registers D8270-D8299 or D8370-D8399 are allocated to the telephone number. Before turning on one of the start internal relays M8050-M8052 or M8080-M8082 for the originate mode, store the telephone number in data registers starting with D8270/D8370. One data register stores two characters: the first character at the upper byte and the second character at the lower byte in the data register. Since 30 data registers are allocated to the telephone number, up to 60 characters can be stored, as many as the modem capacity allows. Use the MACRO instruction on WindLDR to set the telephone number and execute the MACRO instruction before turning on start internal relays M8050-M8052 or M8080-M8082.

Example of Dial Command: ATDT123[CR][LF]

ATD and [LF] are appended at the beginning and end of the dial command automatically by the system program and need not be stored in data registers. To program the telephone number of the example above, store character T for touch-tone phone or P for pulse or rotary phone, followed by the telephone number and ASCII value 0Dh for [CR] to data registers starting with D8270.

D8270	5431h	54h = “T”	31h = “1”
D8271	3233h	32h = “2”	33h = “3”
D8272	0D00h	0Dh = [CR]	All characters subsequent to [CR] are ignored.

As described above, when start internal relay M8050/M8080 is turned on, the initialization string is sent, followed by the ATZ command and the dial command. When start internal relay M8051/M8081 is turned on, the ATZ command is sent, followed by the dial command. The dial command can also be sent separately by turning on start internal relay M8052/M8082.

If retry cycles are set to data register D8209/D8309, the dial command is repeated at retry intervals specified by D8210/D8310 (default 90 seconds) as many as the specified retry cycles (default 3 cycles) until the telephone line is connected.

When the dial command has been completed successfully, internal relay M8062/M8092 is turned on. If the dial command fails, internal relay M8072/M8102 is turned on.

The dial command is determined successful when the DCD signal is turned on.

Note: When the OpenNet Controller is powered down while the telephone line is connected, the telephone line is disconnected because the DTR signal is turned off. This method should not be used for disconnecting the telephone line. Always use M8053/M8083 to disconnect the telephone line as described below.

RS232C Port Communication Protocol

Before the telephone line is connected in the modem mode after power up, the RS232C port 1 or port 2 can only send out an AT command by turning on a start internal relay M8050-M8056 or M8080-M8086. The communication protocol for the RS232C port after the telephone line is connected is selected by the value stored in data register D8203/D8303.

D8203/D8303	RS232C Port Communication Protocol in the On-Line Mode
0 (other than 1)	Maintenance protocol
1	User protocol

When the telephone line is disconnected, the RS232C port restores the state as before the telephone line is connected, whether D8203/D8303 is set to 0 or 1.

When using a TXD or RXD instruction in the user communication mode while the telephone line is connected, insert internal relay M8077/M8107 (line connection) as an input condition for the TXD or RXD instruction. After the telephone line is connected, make sure of an approximately 1-second interval before executing the TXD or RXD instruction until the telephone line connection stabilizes.

Note: When the OpenNet Controller is stopped while the telephone line is connected, the RS232C port protocol changes to the maintenance protocol even if D8203/D8303 is set to 1 (user protocol in the on-line mode); then the telephone line remains connected. When the OpenNet Controller is restarted, the user protocol is enabled again.

Disconnect Mode

The disconnect mode includes only one command to disconnect the telephone line. To disconnect the telephone line, turn on internal relay M8053/M8083. The telephone line is disconnected by turning off the DTR signal since the initialization string includes the &D2 command.

While a modem command is executed, another command cannot be executed. If two or more start internal relays are turned on simultaneously, an error will result and error code 61 is stored in modem mode status data register D8211/D8311 (see page 23-8).

When the disconnect command has been completed successfully, internal relay M8063/M8093 is turned on. If the disconnect command fails, internal relay M8073/M8103 is turned on.

The disconnect command is determined successful when the DCD signal is turned off.

After the telephone line is disconnected, the RS232C port restores the state as before the telephone line is connected whether D8203/D8303 is set to 0 or 1 so that the RS232C port can be controlled by turning on a start internal relay M8050-M8056 or M8080-M8086.

AT General Command Mode

When the modem mode is enabled, data registers D8230-D8244 or D8330-D8344 are allocated to the AT command string. Before turning on start internal relay M8054/M8084 for the AT general command mode, store an AT command string in data registers starting with D8230/D8330. One data register stores two characters: the first character at the upper byte and the second character at the lower byte in the data register. Use the MACRO instruction on WindLDR to set the AT command string and execute the MACRO instruction before turning M8054/M8084 on.

Example of AT Command: ATE0Q0V1[CR][LF]

AT and [LF] are appended at the beginning and end of the AT general command string automatically by the system program and need not be stored in data registers. To program the AT command string of the example above, store the command characters and ASCII value 0Dh for [CR] to data registers starting with D8230.

D8230	4530h	45h = "E"	30h = "0"
D8231	5130h	51h = "Q"	30h = "0"
D8232	5631h	56h = "V"	31h = "1"
D8233	0D00h	0Dh = CR	All characters subsequent to CR are ignored.

When the AT general command has been completed successfully, internal relay M8064/M8094 is turned on. If the AT general command fails, internal relay M8074/M8104 is turned on.

The AT general command is determined successful when result code CR LF OK CR LF returned from the modem is received.

Answer Mode

The answer mode is used to send an initialization string to the modem and to issue the ATZ command to reset the modem. To execute a command, turn on one of start internal relays M8055/M8056 (RS232C port 1) or M8085/M8086 (RS232C port 2). If two or more start internal relays are turned on simultaneously, an error will result and error code 61 is stored in modem mode status data register D8211/D8311 (see page 23-8). When a start internal relay is turned on, a corresponding sequence of commands is executed once as described below.

M8055/M8085: Send initialization string and send the ATZ command

M8056/M8086: Send the ATZ command

Initialization String in Answer Mode

When the modem mode is enabled as described on page 23-1 and the OpenNet Controller is started to run, the default initialization string is stored to data registers D8245-D8269 (RS232C port 1) or D8345-D8369 (RS232C port 2) at the END processing of the first scan. To send the initialization string from the data registers to the modem, turn M8055/M8085 on; then the ATZ command is issued subsequently.

Default Initialization String: ATE0Q0V1&D2&C1\V0X4\Q3\J0\A0&M5\N2S0=2&W CR LF

As described in the Originate Mode, the initialization string can be modified to match your modem. For details of modifying the initialization string, see page 23-4.

When the initialization string has been sent successfully, internal relay M8065/M8095 is turned on. If the initialization string fails, internal relay M8075/M8105 is turned on. When the subsequent ATZ command is also completed successfully, M8066/M8096 will also be turned on.

ATZ (Resetting the Modem) in Answer Mode

The default initialization string specifies to be stored in the non-volatile memory of the modem, using the &W command. The initialization string is restored when the modem is powered up or when the ATZ command is issued. The OpenNet Controller sends the ATZ command to the modem following the initialization string when M8055/M8085 is turned on. The ATZ command can also be issued separately by turning M8056/M8086 on.

ATZ Command: ATZ CR LF

When the ATZ command has been completed successfully, internal relay M8066/M8096 is turned on. If the ATZ command fails, internal relay M8076/M8106 is turned on.

If the initialization string has been stored in the non-volatile memory of the modem, M8055/M8085 may be skipped. Start with M8056/M8086 to send the ATZ command.

Modem Mode Status Data Register

When the modem mode is enabled, data register D8211 (RS232C port 1) or D8311 (RS232C port 2) stores a modem mode status or error code.

D8211/D8311 Value	Status	Description
0	Not in the modem mode	Modem mode is not enabled.
10	Ready for connecting line	Start internal relays except for disconnecting line can be turned on.
20	Sending initialization string (originate mode)	A start internal relay is in operation in the first try or subsequent retrial.
21	Sending ATZ (originate mode)	
22	Dialing	
23	Disconnecting line	
24	Sending AT command	
25	Sending initialization string (answer mode)	
26	Sending ATZ (answer mode)	
30	Waiting for resending initialization string (originate mode)	The command started by a start internal relay was not completed and is waiting for retrial.
31	Waiting for resending ATZ (originate mode)	
32	Waiting for re-dialing	
33	Waiting for re-disconnecting line	
34	Waiting for resending AT command	
35	Waiting for resending initialization string (answer mode)	
36	Waiting for resending ATZ (answer mode)	
40	Line connected	Telephone line is connected. Only M8053/M8083 (disconnect line) can be turned on.
50	AT command completed successfully	Command started by M8054-M8056 or M8084-M8086 is completed successfully.
60	AT command program error	Invalid character is included in the initialization string, dial number, or AT command string. Correct the program to include 0Dh in the AT command.
61	Simultaneous start of commands	Two or more start internal relays are on. Correct the user program so that only one start internal relay goes on at a time.
62	Invalid command in on-line mode	A start IR other than M8053/M8083 (disconnect line) is turned on while the telephone line is connected. Correct the program so that only the disconnect command is sent while the line is connected.
63	AT command execution error	Command failed in the first and all retry cycles.

Initialization String Commands

The built-in initialization strings (see page 23-4) include the commands shown below. The commands are divided into two groups by importance. For details of modem commands, see the user's manual for your modem. When you make an optional initialization string, include the commands in the first category to make sure of correct modem communication.

Commands included in all initialization strings

Commands in this category are essential to use the modem mode. Some modems have the same function by a different command name. When you make an optional initialization string, modify the initialization string to match your modem.

E0	Characters NOT echoed. The modem mode of the OpenNet Controller operates without echo back. Without the E0 command, the OpenNet Controller misunderstands an echo for a result code. An error will be caused although a command is executed correctly. This command must be included in the initialization string.
Q0	Result codes displayed. The modem mode of the OpenNet Controller is configured to use result codes. Without the Q0 command, a timeout error will be caused although a command is executed correctly. This command must be included in the initialization string.
V1	Word result code. The modem mode of the OpenNet Controller is configured to use word result codes. Without the V1 command, result codes are regarded as invalid and a timeout error will be caused although a command is executed correctly. This command must be included in the initialization string.
&D2	Hang up and disable auto-answer on DTR detection. When the DTR signal turns off, the telephone line is disconnected. The OpenNet Controller uses this function to disconnect the telephone line. This command must be included in the initialization string.
&C1	DCD ON with carrier from remote modem. DCD tracks the state of the data carrier from the remote modem. An ON condition of DCD indicates the presence of a carrier. This command must be included in the initialization string.
S0=2	Ring to answer ON. Specifies the ring on which the modem will pick up the telephone line. S0=2 specifies that the modem answers an incoming call when detecting 2 ring calls. S0=0 disables the auto-answer function.

Commands included in several initialization strings

Commands in this category are essential depending on the modem used for the OpenNet Controller.

\V0, &A0	MNP result codes disabled. Conventional result codes are used and reliable link result codes are not used.
\A0	Set MNP maximum block size to 64 bytes
X4, X3, X0	X4: Enables dial tone and busy detection X3: Enables busy tone detection X0: Disables telephone line monitor signal detection PBX systems and outside telephone lines often use different line monitor signals. When using the modem in the PBX environment, include X0 in the initialization string to disable the signal detection.
\Q3, \Q2, &K3, &H1&I0	Enables hardware flow control. The software flow control (XON/XOFF) cannot be used for the OpenNet Controller modem mode. Any of these commands must be included in the initialization string.
\J0, &B1	Set bps rate adjust off. The bps rate between the modem and the OpenNet Controller is constant and independent of the telephone line bps rate.
&M5	Enables auto-reliable link. The modems at both ends of the telephone line detect the best communication format for the modems and establish a link.
\N2, \N3	Enables reliable or auto-reliable mode. Error correction function is used to improve the communication reliability.
&W, &W0	Write active profile. The current configuration profile is saved to a non-volatile memory of the modem.

Preparation for Using Modem

Before using a modem, read the user's manual for your modem.

Determine commands for the initialization string

The required initialization string depends on the model and make of the modem. The OpenNet Controller contains 18 predetermined initialization strings. When D8200/8300 (RS232C port communication mode selection) value is changed to 1 or D8201/D8301 (modem initialization string selection) value is changed, one of the predetermined modem initialization strings is stored to D8245-D8269 (RS232C port 1) or D8345-D8369 (RS232C port 2), depending on the value stored in D8201 or D8301, respectively.

Modem Initialization String Selection

D8201/D8301 Value	Applicable Modem	Confirmed Operation on
0	AIWA (33.6 Kbps or less)	AIWA PV-BW3360
1	OMRON	
2	AIWA (56 Kbps)	
3	OMRON (56 Kbps)	OMRON ME5614
4	Sun Corporation Micro Research	Sun Corporation MS56KEF Micro Research MR-560XL
5	Seiko Instruments	Seiko Instruments MC-6630

In making this user's manual, the correct operation has been confirmed on five modems listed in the table above. When using other modems, set a proper initialization string by referring to page 23-4 and confirm operation

When using the modem in the PBX environment, enter a value listed in the table above plus 10 to D8201/D8301. Try this value to establish modem connection. If it does not work, enter a value listed above plus 20 to D8201/D8301.

Determine the type of the telephone line

Consult your local telephone company whether your telephone line is for touch tone phones or pulse dial phones. Determine the dial command according to the type of the telephone line.

ATDT Touch tone phones
ATDP Pulse dial phones

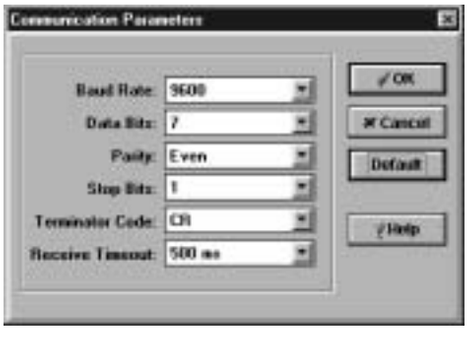
Setting Communication Parameters

The default communication parameters shown below are recommended.

RS232C Port Communication Parameter Default:

Baud rate	9600 bps
Start bit	1
Data bits	7
Parity	Even
Stop bit	1
Total	10 bits

Only when the DTE connected on the communication line uses different communication parameters than the default values of the OpenNet Controller, set the matching communication parameters in WindLDR menu bar > **Configure** > **Function Area Settings** > **Comm Port**. Click the check box for **Port 1** or **Port 2**, and click the **Comm. Param.** button. Since the total of modem communication parameters is 10 bits, set the value to a total of 10 bits.



Programming Data Registers and Internal Relays

To enable the modem mode and communicate through the telephone line, the following settings are needed.

1. Program to move 1 to data register D8200/D8300 (RS232C port communication mode selection) to enable the modem mode at RS232C port 1 or port 2, respectively.
2. Program to move a value 0 through 5, 10 through 15, or 20 through 25 to data register D8201/D8301 (modem initialization string selection) depending on your modem. For applicable modems, see page 23-4.
3. If the predetermined initialization strings do not match your modem, program a proper initialization string and enter the ASCII values to data registers starting with D8245/D8345 (initialization string). Make sure that the D8201/D8301 value is not changed after the new initialization string has been stored to data registers starting with D8245/D8345. To send out the new initialization string, turn on internal relay M8050/M8080 (initialization string start IR) after the new values have been stored to the data registers.
4. Program to move 0 or 1 to data register D8203/D8303 (on-line mode protocol selection) to select maintenance protocol or user protocol for the RS232C port after telephone line is connected.
5. Program the destination telephone number if dialing is required. Enter the ASCII values of the telephone number to data registers starting with D8270/D8370 (telephone number). Store two characters each in one data register. Enter 0Dh at the end of the telephone number. See page 23-5.
6. If you want to change the default value of 3 retry cycles, program to move a required value to data register D8209/D8309 (retry cycles) in the next scan after entering 1 to D8200/D8300.
7. Include internal relays M8050-M8077 (RS232C port 1) and M8080-M8107 (RS232C port 2) in the user program to control the modem communication as required.

Setting Up the CPU Module

1. Determine which RS232C port to use; port 1, port 2, or both. Connect the OpenNet Controller CPU module to a modem using the modem cable 1C (FC2A-KM1C) as shown on page 23-1.
2. Set communication selector DIP switch 2 or 3 to ON to select user communication mode for RS232C port 1 or 2, respectively.

DIP Switch No.	Function	Setting	
2	RS232C port 1 communication mode	ON: User communication mode	OFF: Maintenance mode
3	RS232C port 2 communication mode	ON: User communication mode	OFF: Maintenance mode

When the CPU is powered up, the CPU checks the settings of the communication selector DIP switch and enables the selected communication mode and device number automatically. You have to press the communication enable button only when you change the communication mode while the CPU is powered up. After changing the settings of the communication selector DIP switch while the CPU is powered up, press the communication enable button for more than 4 seconds until the ERROR LED blinks once; then the new communication mode takes effect.

Do not power up the CPU while the communication enable button is depressed and do not press the button unless it is necessary.

Operating Procedure

1. After completing the user program including the Function Area Settings, download the user program to the OpenNet Controller from a computer running WindLDR through the RS232C port or the data link terminals. To download the user program, the loader port or the data link terminals must be set to maintenance mode by setting communication selector DIP switches 1 through 3 to OFF.
2. After downloading the user program, set the communication selector DIP switch 2 or 3 to ON to select user communication mode for the RS232C port 1 or 2, respectively. Press the communication enable button for 4 seconds until the ERROR LED blinks once, if necessary.
3. Start the OpenNet Controller to run the user program.
4. Turn on start internal relay M8050/M8055 (port 1) or M8080/M8085 (port 2) to initialize the modem.

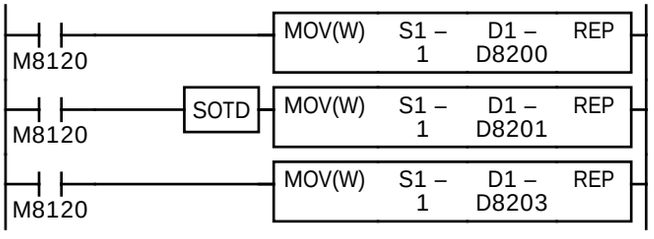
When originating the modem communication, turn on M8050/M8080 to send the initialization string, the ATZ command, and the dial command. If the initialization string has been stored in the non-volatile memory of the modem, turn on M8051/M8081 to start with the ATZ command followed by the dial command.

When answering an incoming call, turn on M8055/M8085 to send the initialization string and the ATZ command. If the initialization string has been stored in the non-volatile memory of the modem, turn on M8056/M8086 to send the ATZ command only.

5. Transmit or receive communication through the modem.
6. Turn on start internal relay M8053/M8083 to disconnect the telephone line.

Sample Program for Modem Originate Mode

This program demonstrates a user program for the modem originate mode to move values to data registers assigned to the modem mode at RS232C port 1, initialize the modem, dial the telephone number, and disconnect the telephone line. While the telephone line is connected, user communication instruction TXD1 sends a character string "Connect."



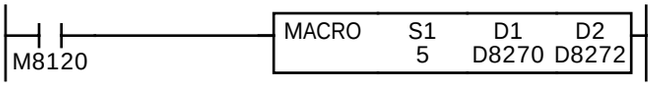
M8120 is the initialize pulse special internal relay.

MOV instructions store values to data registers for the modem mode at RS232C port 1.

1 → D8200 to enable the modem mode for port 1.

1 → D8201 to select a predetermined initialization string.

1 → D8203 to enable user protocol after telephone line is connected.

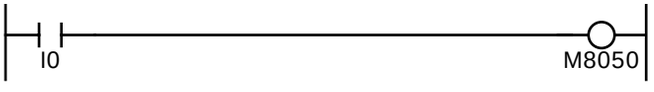


MACRO sets a dial command ATDT123 CR LF.

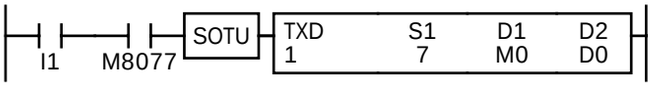
"T1" (5431h) → D8270 to designate touch tone and telephone number.

"23" (3233h) → D8271 to designate telephone number.

0D00h → D8272 to enter CR at the end of the telephone number.

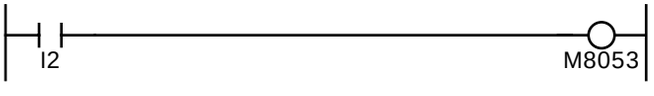


When input I0 is turned on, M8050 (initialization string) is turned on to send the initialization string, ATZ, and dial command to the modem.



M8077 (line connection status) is on while telephone line is connected.

When I1 is turned on, TXD1 sends seven characters "Connect." See the next page for the WindLDR dialog.



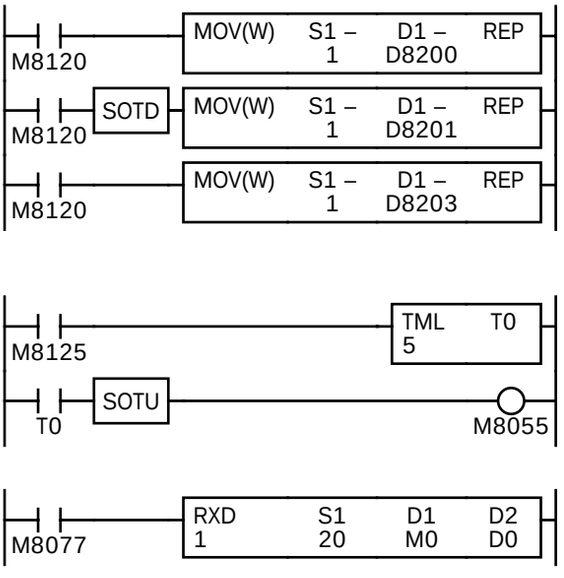
When input I2 is turned on, M8053 (disconnect line) is turned on to disconnect the telephone line.

Note: The MACRO instruction is not included in the OpenNet Controller instruction set, but can be programmed using WindLDR to move data to consecutive data registers using the MOV instructions.

The TXD1 instruction in the sample program for the modem originate mode is programmed using WindLDR with parameters shown below:

Sample Program for Modem Answer Mode

This program demonstrates a user program for the modem answer mode to move values to data registers assigned to the modem mode at RS232C port 1 and initialize the modem. While the telephone line is connected, user communication instruction RXD1 is executed to receive an incoming communication.



M8120 is the initialize pulse special internal relay.

MOV instructions store values to data registers for the modem mode at RS232C port 1.

1 → D8200 to enable the modem mode for port 1.

1 → D8201 to select a predetermined initialization string.

1 → D8203 to enable user protocol after telephone line is connected.

M8125 is the in-operation output special internal relay.

Timer T0 (1-sec timer TML) starts to time down when the OpenNet Controller is started to run.

When timer T0 times out 5 seconds, M8055 is turned on to send the initialization string for the modem answer mode.

M8077 (line connection status) is on while telephone line is connected.

RXD1 receives incoming communication and stores received data to data registers starting with D10.

The RXD1 instruction is programmed using WindLDR with parameters shown below:

Source S1: Data register D10, No conversion, 2 digits, Repeat 10

Troubleshooting in Modem Communication

When a start internal relay is turned on, the data of D8211/D8311 (modem mode status) changes, but the modem does not work.

Cause: A wrong cable is used or wiring is incorrect.

Solution: Use the modem cable 1C (FC2A-KM1C).

The DTR or ER indicator on the modem does not turn on.

Cause: A wrong cable is used or wiring is incorrect.

Solution: Use the modem cable 1C (FC2A-KM1C).

When a start internal relay is turned on, the data of D8211/D8311 (modem mode status) does not change.

Cause 1: D8200/D8300 does not store 1 and the modem mode is not enabled.

Solution 1: Store 1 to D8200 or D8300 when using RS232C port 1 or port 2, respectively.

Cause 2: Communication selector DIP switch setting is wrong and the modem mode is not enabled.

Solution 2: Set communication selector DIP switch 2 or 3 to ON when using RS232C port 1 or port 2, respectively

When an initialization string is sent, a failure occurs, but sending ATZ completes successfully.

Cause: The initialization string is not valid for the modem.

Solution: Refer to the user's manual for the modem and correct the initialization string.

When a dial command is sent, a result code "NO DIALTONE" is returned and the telephone line is not connected.

Cause 1: The modular cable is not connected.

Solution 1: Connect the modular cable to the modem.

Cause 2: The modem is used in a PBX environment.

Solution 2: Add 10 or 20 to the value stored in D8201/D8301 when using RS232C port 1 or port 2, respectively, and try initialization again.

Dialing completes successfully, but the telephone line is disconnected in a short period of time.

Cause 1: The modem settings at the both ends of the line are different.

Solution 1: Make the same settings for the modems at the both ends.

Cause 2: The model of the modems at the both ends of the line is different.

Solution 2: Use the same modems at the both ends.

Cause 3: The quality of the telephone line is low.

Solution 3: Decrease the baud rate of the OpenNet Controller to lower than 9600 bps.

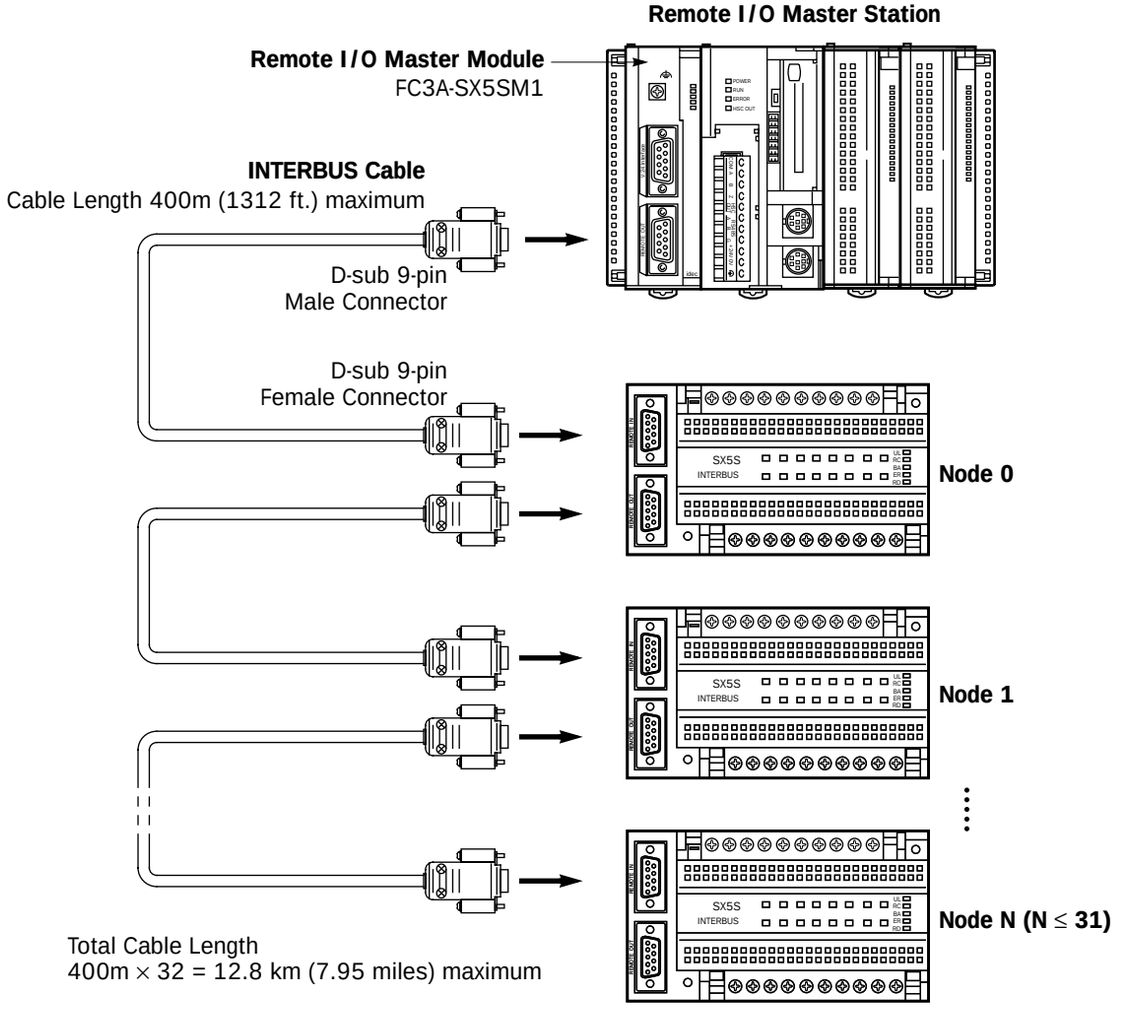
24: REMOTE I/O SYSTEM

Introduction

The OpenNet Controller uses the INTERBUS open network to set up a remote I/O system. Input data from a remote I/O slave station is stored to link registers allocated to input data in the OpenNet Controller. Output data is sent from the link registers allocated to output data in the OpenNet Controller. A remote I/O slave station can have a maximum of 128 I/O points (64 inputs and 64 outputs). When using 32 IDEC's SX5S modules with 16 input or output points, a total of 512 I/O points can be distributed to 32 remote slave stations at the maximum. The total cable length can be 12.8 km (7.95 miles) maximum. For the remote I/O master module parts description and specifications, see page 2-36.

Since I/O data is stored in link registers and transferred automatically, no communication program is required to send and receive I/O data between the master and slave stations. I/O connection is just as easy as ordinary digital I/O connection.

Remote I/O System Setup



Remote I/O Slave Stations
IDEC's SX5S Communication I/O Terminals for INTERBUS.

Other vendor's INTERBUS slave modules (remote bus stations) are also applicable. 64 input and 64 output points per slave station at the maximum.

For wiring INTERBUS cable, see page 24-15.

Specifications

Maximum Points per Node	128 points	The total I/O points per node is 128 points maximum. A node is allocated 4 link registers each for inputs (16 × 4 points) and outputs (16 × 4 points).
Maximum Quantity of Nodes	32 nodes	The maximum quantity of nodes includes bus stations without I/Os.
Maximum Total I/O Points	(4096 points)	When using SX5 communication I/O terminals as remote slave stations with 16 inputs or 16 outputs, a maximum of 512 I/O points can be connected to the remote I/O network.

Link Registers for Remote I/O System

I/O points at each node are allocated to predetermined link registers in the OpenNet Controller CPU module. Only read (InputData) and write (OutputData) functions can be used for the OpenNet Controller remote I/O communication. Nodes and link registers are allocated as listed below:

Node	Input Operand	Output Operand	Node	Input Operand	Output Operand
Node 0	L1000-L1003	L1004-L1007	**Node 16**	L1160-L1163	L1164-L1167
Node 1	L1010-L1013	L1014-L1017	**Node 17**	L1170-L1173	L1174-L1177
Node 2	L1020-L1023	L1024-L1027	**Node 18**	L1180-L1183	L1184-L1187
Node 3	L1030-L1033	L1034-L1037	**Node 19**	L1190-L1193	L1194-L1197
Node 4	L1040-L1043	L1044-L1047	**Node 20**	L1200-L1203	L1204-L1207
Node 5	L1050-L1053	L1054-L1057	**Node 21**	L1210-L1213	L1214-L1217
Node 6	L1060-L1063	L1064-L1067	**Node 22**	L1220-L1223	L1224-L1227
Node 7	L1070-L1073	L1074-L1077	**Node 23**	L1230-L1233	L1234-L1237
Node 8	L1080-L1083	L1084-L1087	**Node 24**	L1240-L1243	L1244-L1247
Node 9	L1090-L1093	L1094-L1097	**Node 25**	L1250-L1253	L1254-L1257
Node 10	L1100-L1103	L1104-L1107	**Node 26**	L1260-L1263	L1264-L1267
Node 11	L1110-L1113	L1114-L1117	**Node 27**	L1270-L1273	L1274-L1277
Node 12	L1120-L1123	L1124-L1127	**Node 28**	L1280-L1283	L1284-L1287
Node 13	L1130-L1133	L1134-L1137	**Node 29**	L1290-L1293	L1294-L1297
Node 14	L1140-L1143	L1144-L1147	**Node 30**	L1300-L1303	L1304-L1307
Node 15	L1150-L1153	L1154-L1157	**Node 31**	L1310-L1313	L1314-L1317

About INTERBUS

INTERBUS is a network originally developed for controlling sensors and actuators by Phoenix Contact, Germany, and the specifications were opened in 1987. Today, many major automobile manufacturers in the world use the INTERBUS network.

The INTERBUS system is a data ring with a central master-slave access method. It has the structure of a spatially distributed shift register. Every module forms with its registers a part of this shift register ring through which the data is shifted serially from the host controller board. The use of the ring topology in this way offers the possibility of sending and receiving data simultaneously (full duplex) and leads to better diagnostic possibilities when compared to a bus structure.

To simplify system installation, the ring is implemented within one cable line (go and return line within one cable). The system therefor appears as a bus system with branching lines (tree structure).

For detailed information about INTERBUS, read documents published by the INTERBUS CLUB or access the INTERBUS CLUB home page at www.interbusclub.com.

Data Communication between Remote I/O Master and Slave Stations

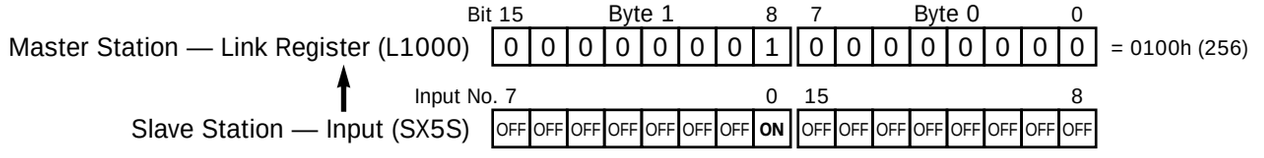
IDEC's SX5S communication I/O terminals for INTERBUS can be used as slave stations in the remote I/O communication system. When the SX5S is used with the remote I/O master module, the input and output data at the slave station are allocated to link registers in the OpenNet Controller CPU module as described below.

SX5S Communication I/O Terminals for INTERBUS

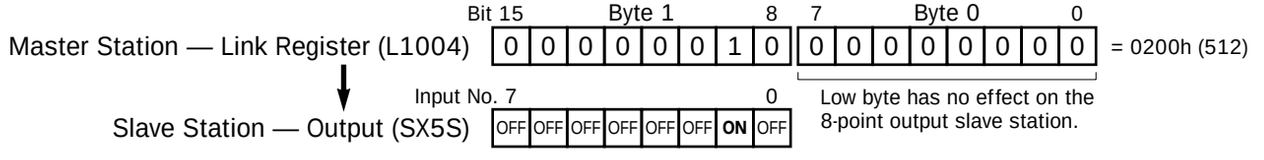
Type No.	ID Code	Station Type	Data Length
SX5S-SBN16S **SX5S-SBN16K**	02h	Remote Bus Station with Digital Inputs	1 word (16 inputs)
SX5S-SBR08	01h	Remote Bus Station with Digital Outputs	1 word (8 outputs)
SX5S-SBT16K **SX5S-SBT16P**	01h	Remote Bus Station with Digital Outputs	1 word (16 outputs)
SX5S-SBM16K **SX5S-SBM16P**	03h	Remote Bus Station with Digital I/Os	1 byte (8 in/8 out)

The following examples assume that the SX5S is connected at node 0.

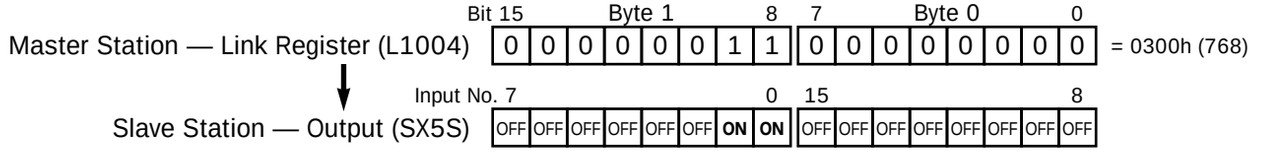
Communication of 1-word Input Data (SX5S-SBN16S or SX5S-SBN16K)



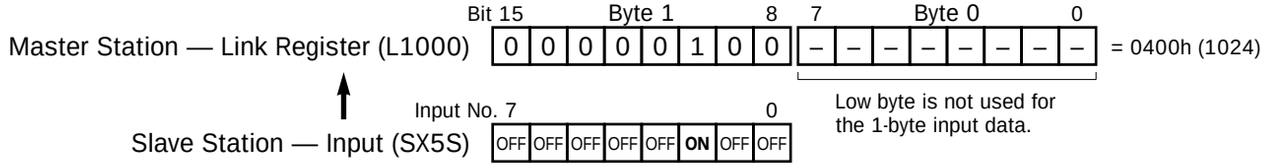
Communication of 1-word Output Data (SX5S-SBR08)

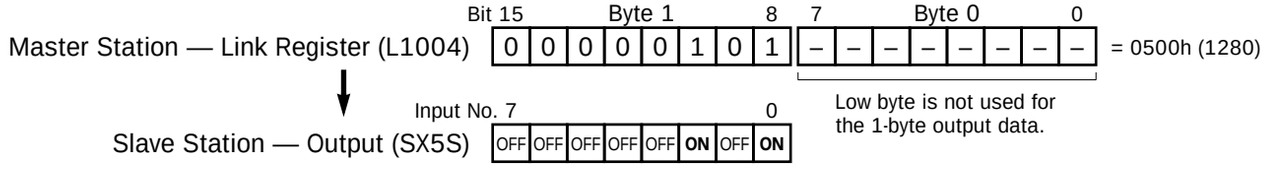


Communication of 1-word Output Data (SX5S-SBT16K or SX5S-SBT16P)



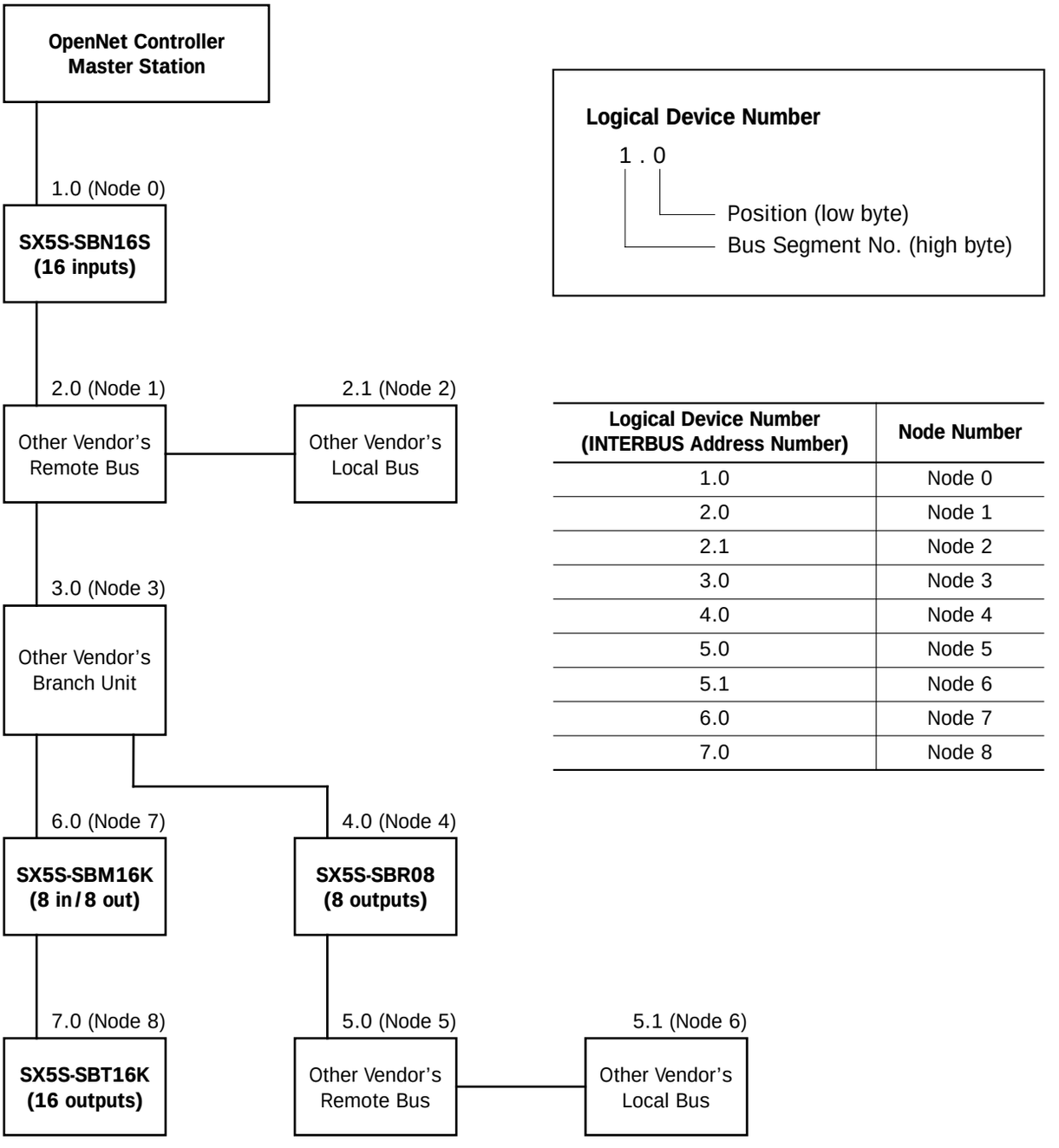
Communication of 1-byte Input/Output Data (SX5S-SBM16K or SX5S-SBM16P)





Logical Device Number and Node Number

Node addresses (logical device numbers) are assigned to each slave station by the remote I/O master module automatically according to the physical configuration of the remote I/O network. The following diagram illustrates an example of the OpenNet Controller remote I/O network.



Logical Device Number (INTERBUS Address Number)	Node Number
1.0	Node 0
2.0	Node 1
2.1	Node 2
3.0	Node 3
4.0	Node 4
5.0	Node 5
5.1	Node 6
6.0	Node 7
7.0	Node 8

Data Mapping

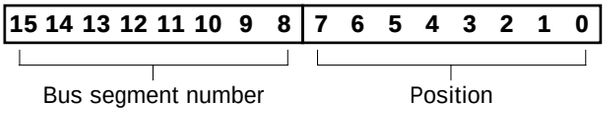
The data mapping for the remote I/O network configuration on the preceding page is shown in the table below.

Node No. (Logical Device No.)	Input			Output		
	Input Operand (Link Register)	Byte 1	Byte 0	Output Operand (Link Register)	Byte 1	Byte 0
Node 0 (1.0) 16-input module	**L1000** **L1001** **L1002** **L1003**	7--------- 0 Not used Not used Not used	15 -------- 8 Not used Not used Not used	**L1004** **L1005** **L1006** **L1007**	Not used	
Node 1 (2.0)	**L1010** **L1011** **L1012** **L1013**	Depends on the module specifications		**L1014** **L1015** **L1016** **L1017**	Depends on the module specifications	
Node 2 (2.1)	**L1020** **L1021** **L1022** **L1023**	Depends on the module specifications		**L1024** **L1025** **L1026** **L1027**	Depends on the module specifications	
Node 3 (3.0)	**L1030** **L1031** **L1032** **L1033**	Depends on the module specifications		**L1034** **L1035** **L1036** **L1037**	Depends on the module specifications	
Node 4 (4.0) 8-output module	**L1040** **L1041** **L1042** **L1043**	Not used		**L1044** **L1045** **L1046** **L1047**	7--------- 0 Not used Not used Not used	No data
Node 5 (5.0)	**L1050** **L1051** **L1052** **L1053**	Depends on the module specifications		**L1054** **L1055** **L1056** **L1057**	Depends on the module specifications	
Node 6 (5.1)	**L1060** **L1061** **L1062** **L1063**	Depends on the module specifications		**L1064** **L1065** **L1066** **L1067**	Depends on the module specifications	
Node 7 (6.0) 8-in / 8-out module	**L1070** **L1071** **L1072** **L1073**	7--------- 0 Not used Not used Not used	Not used	**L1074** **L1075** **L1076** **L1077**	7--------- 0 Not used Not used Not used	Not used
Node 8 (7.0) 16-output module	**L1080** **L1081** **L1082** **L1083**	Not used		**L1084** **L1085** **L1086** **L1087**	7--------- 0 Not used Not used Not used	15 -------- 8 Not used Not used Not used

Special Data Registers for Remote I/O Node Information

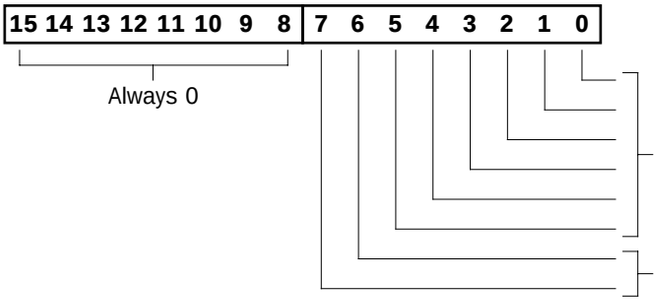
Four data registers are allocated to each node to store information of the slave station. The remote I/O node information is stored to special data registers D8050 through D8177 while the remote I/O communication is in normal operation. The remote I/O node information is not stored when special data register D8178 (INTERBUS master system error information) stores 6, 7, or 8 to indicate a data size error, ID code error, or maximum node quantity over, respectively. See page 24-10.

Logical Device No. (Bus Segment No. + Position)



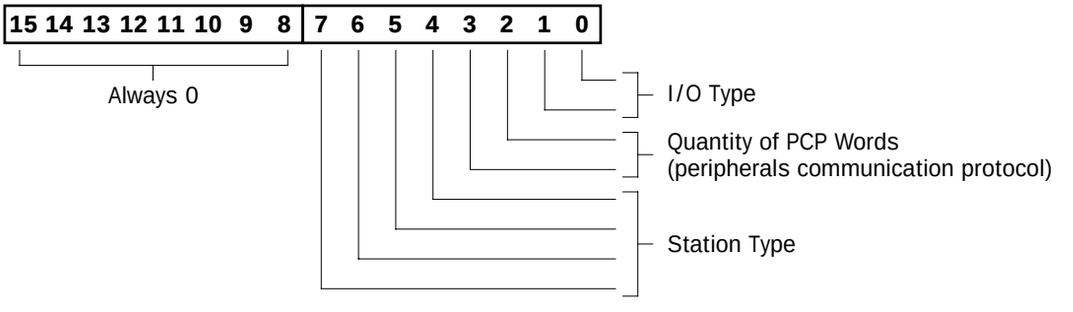
Length Code

Note: The data register assigned to the length code stores the quantity of the input or output points, whichever is larger, of the slave station. When using the SX5S as a slave, the length code can be 8 bits (1 byte) or 16 bits (2 bytes).



Bit 7	Bit 6	Unit
0	0	(reserved)
0	1	Nibbles
1	0	Bytes
1	1	Bits

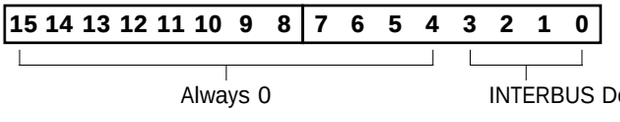
ID Code



ID Code Examples

ID Code (Low Byte)	Type
01h	Digital output remote bus station (example: SX5S-SBT16K)
02h	Digital input remote bus station (example: SX5S-SBN16S)
03h	Digital I/O remote bus station (example: SX5S-SBM16K)
31h	Analog output remote bus station
32h	Analog input remote bus station

Device Level



Special Data Register Numbers for Remote I/O Node Information

Allocation No.	Description		Remarks
D8050	**Node 0**	Logical Device No.	Bus Segment No. + Position
D8051		Length Code	High byte stores 0 (Note)
D8052		ID Code	High byte stores 0
D8053		Device Level	High byte stores 0
D8054	**Node 1**	Logical Device No.	Bus Segment No. + Position
D8055		Length Code	High byte stores 0 (Note)
D8056		ID Code	High byte stores 0
D8057		Device Level	High byte stores 0
D8058	**Node 2**	Logical Device No.	Bus Segment No. + Position
D8059		Length Code	High byte stores 0 (Note)
D8060		ID Code	High byte stores 0
D8061		Device Level	High byte stores 0
D8062	**Node 3**	Logical Device No.	Bus Segment No. + Position
D8063		Length Code	High byte stores 0 (Note)
D8064		ID Code	High byte stores 0
D8065		Device Level	High byte stores 0
D8066	**Node 4**	Logical Device No.	Bus Segment No. + Position
D8067		Length Code	High byte stores 0 (Note)
D8068		ID Code	High byte stores 0
D8069		Device Level	High byte stores 0
D8070	**Node 5**	Logical Device No.	Bus Segment No. + Position
D8071		Length Code	High byte stores 0 (Note)
D8072		ID Code	High byte stores 0
D8073		Device Level	High byte stores 0
D8074	**Node 6**	Logical Device No.	Bus Segment No. + Position
D8075		Length Code	High byte stores 0 (Note)
D8076		ID Code	High byte stores 0
D8077		Device Level	High byte stores 0
D8078	**Node 7**	Logical Device No.	Bus Segment No. + Position
D8079		Length Code	High byte stores 0 (Note)
D8080		ID Code	High byte stores 0
D8081		Device Level	High byte stores 0
D8082	**Node 8**	Logical Device No.	Bus Segment No. + Position
D8083		Length Code	High byte stores 0 (Note)
D8084		ID Code	High byte stores 0
D8085		Device Level	High byte stores 0
D8086	**Node 9**	Logical Device No.	Bus Segment No. + Position
D8087		Length Code	High byte stores 0 (Note)
D8088		ID Code	High byte stores 0
D8089		Device Level	High byte stores 0

Allocation No.	Description		Remarks
D8090	Node 10	Logical Device No.	Bus Segment No. + Position
D8091		Length Code	High byte stores 0 (Note)
D8092		ID Code	High byte stores 0
D8093		Device Level	High byte stores 0
D8094	Node 11	Logical Device No.	Bus Segment No. + Position
D8095		Length Code	High byte stores 0 (Note)
D8096		ID Code	High byte stores 0
D8097		Device Level	High byte stores 0
D8098	Node 12	Logical Device No.	Bus Segment No. + Position
D8099		Length Code	High byte stores 0 (Note)
D8100		ID Code	High byte stores 0
D8101		Device Level	High byte stores 0
D8102	Node 13	Logical Device No.	Bus Segment No. + Position
D8103		Length Code	High byte stores 0 (Note)
D8104		ID Code	High byte stores 0
D8105		Device Level	High byte stores 0
D8106	Node 14	Logical Device No.	Bus Segment No. + Position
D8107		Length Code	High byte stores 0 (Note)
D8108		ID Code	High byte stores 0
D8109		Device Level	High byte stores 0
D8110	Node 15	Logical Device No.	Bus Segment No. + Position
D8111		Length Code	High byte stores 0 (Note)
D8112		ID Code	High byte stores 0
D8113		Device Level	High byte stores 0
D8114	Node 16	Logical Device No.	Bus Segment No. + Position
D8115		Length Code	High byte stores 0 (Note)
D8116		ID Code	High byte stores 0
D8117		Device Level	High byte stores 0
D8118	Node 17	Logical Device No.	Bus Segment No. + Position
D8119		Length Code	High byte stores 0 (Note)
D8120		ID Code	High byte stores 0
D8121		Device Level	High byte stores 0
D8122	Node 18	Logical Device No.	Bus Segment No. + Position
D8123		Length Code	High byte stores 0 (Note)
D8124		ID Code	High byte stores 0
D8125		Device Level	High byte stores 0
D8126	Node 19	Logical Device No.	Bus Segment No. + Position
D8127		Length Code	High byte stores 0 (Note)
D8128		ID Code	High byte stores 0
D8129		Device Level	High byte stores 0
D8130	Node 20	Logical Device No.	Bus Segment No. + Position
D8131		Length Code	High byte stores 0 (Note)
D8132		ID Code	High byte stores 0
D8133		Device Level	High byte stores 0

Allocation No.	Description		Remarks
D8134	Node 21	Logical Device No.	Bus Segment No. + Position
D8135		Length Code	High byte stores 0 (Note)
D8136		ID Code	High byte stores 0
D8137		Device Level	High byte stores 0
D8138	Node 22	Logical Device No.	Bus Segment No. + Position
D8139		Length Code	High byte stores 0 (Note)
D8140		ID Code	High byte stores 0
D8141		Device Level	High byte stores 0
D8142	Node 23	Logical Device No.	Bus Segment No. + Position
D8143		Length Code	High byte stores 0 (Note)
D8144		ID Code	High byte stores 0
D8145		Device Level	High byte stores 0
D8146	Node 24	Logical Device No.	Bus Segment No. + Position
D8147		Length Code	High byte stores 0 (Note)
D8148		ID Code	High byte stores 0
D8149		Device Level	High byte stores 0
D8150	Node 25	Logical Device No.	Bus Segment No. + Position
D8151		Length Code	High byte stores 0 (Note)
D8152		ID Code	High byte stores 0
D8153		Device Level	High byte stores 0
D8154	Node 26	Logical Device No.	Bus Segment No. + Position
D8155		Length Code	High byte stores 0 (Note)
D8156		ID Code	High byte stores 0
D8157		Device Level	High byte stores 0
D8158	Node 27	Logical Device No.	Bus Segment No. + Position
D8159		Length Code	High byte stores 0 (Note)
D8160		ID Code	High byte stores 0
D8161		Device Level	High byte stores 0
D8162	Node 28	Logical Device No.	Bus Segment No. + Position
D8163		Length Code	High byte stores 0 (Note)
D8164		ID Code	High byte stores 0
D8165		Device Level	High byte stores 0
D8166	Node 29	Logical Device No.	Bus Segment No. + Position
D8167		Length Code	High byte stores 0 (Note)
D8168		ID Code	High byte stores 0
D8169		Device Level	High byte stores 0
D8170	Node 30	Logical Device No.	Bus Segment No. + Position
D8171		Length Code	High byte stores 0 (Note)
D8172		ID Code	High byte stores 0
D8173		Device Level	High byte stores 0
D8174	Node 31	Logical Device No.	Bus Segment No. + Position
D8175		Length Code	High byte stores 0 (Note)
D8176		ID Code	High byte stores 0
D8177		Device Level	High byte stores 0

Special Data Registers for INTERBUS Master Information

Six data registers are assigned to store the system error and status information.

Allocation No.	Description		Remarks
D8178	**INTERBUS Master System Error Information**		Occurred process
	0	Normal	Initialization process or recovering process from Bus NG
	1	INTERBUS master DPRAM is Not Ready (DPRAM fault, etc.)	
	2	INTERBUS master is Not Ready (master unit fault, etc.)	
	3	No response from INTERBUS master (timeout error)	
	4	System error (unexpected reply from INTERBUS master)	
	5	Entry count error (disparity of quantity of nodes between actual system setup and Function Area Settings value)	
	6	Data size error (bus station of invalid size is connected)	
	7	ID code error (bus station of invalid type is connected)	
	8	Maximum node quantity over (more than 32 nodes are connected)	
D8179	**INTERBUS Master Status Transition Number**		
	0	Power ON	
	1	DPRAM and master ready (ready for receiving service command)	
	2	Reading and identification of configuration complete	
	3	I/O logical addressing complete	
	4	Set the bus active	
	5	Set the bus to run (I/O data updated)	5 is stored during normal operation
	6	Bus NG occurred	
D8180	****h	INTERBUS Master Acknowledge Code Stores execution result of remote I/O master command request.	0 (normal completion) or error code is stored
D8181	****h	INTERBUS Master Additional Error Information Stores additional error information of D8180	
D8182	****h	INTERBUS Master Error Code	See page 24-16
D8183	****h	INTERBUS Master Error Location	See page 24-16

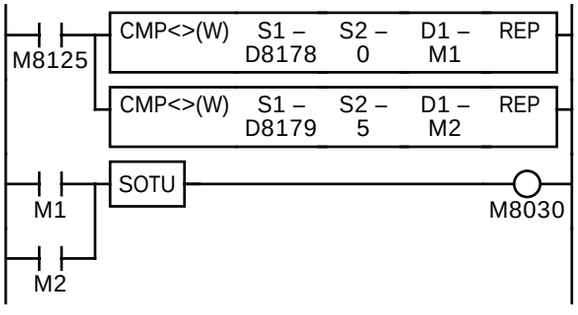
Special Internal Relays for INTERBUS Master Information

Three special internal relays are assigned for the INTERBUS master station control and status information.

Allocation No.	Description		R/W	CPU Stopped	Power OFF
M8030	INTERBUS Master Initialize	When M8030 is turned on, the INTERBUS master is initialized.	R/W	Maintained	Cleared
M8036	INTERBUS Master Bus NG	When the INTERBUS master detects a BUS NG, M8036 is turned on.	R	Maintained	Cleared
M8037	INTERBUS Master Peripheral Fault	When the INTERBUS master detects a peripheral fault, M8037 is turned on.	R	Maintained	Cleared
M8040	INTERBUS Master Error	When critical error is found in the INTERBUS master hardware/software and the master is initialized, M8040 or M8041 is turned on, depending on error contents.	R	Cleared	Cleared
M8041	INTERBUS Master Error		R	Cleared	Cleared

⚠ Caution

- When the remote I/O network is subjected to large noises, the remote I/O communication is affected. When such a trouble occurs, it is possible to initialize the remote I/O master module to restore normal operation. Include special data register D8178 (INTERBUS master system error information) in the user program to detect any error in the remote I/O system.
- When the CPU module at the remote I/O master station and the remote I/O slave modules are powered up simultaneously, the remote I/O master module may fail to recognize the slave modules. If this trouble occurs, include special data register D8179 (INTERBUS master status transition number) to detect failure to run.
- Include special internal relay M8030 (INTERBUS master initialize) in the user program and turn on M8030 to initialize the remote I/O master module.



M8125 is the in-operation output special internal relay.

D8178 stores 0 during normal operation.

When D8178 is not equal to 0, M1 is turned on.

D8179 stores 5 during normal operation.

When D8179 is not equal to 5, M2 is turned on.

When either M1 or M2 is turned on, M8030 is turned on for one scan to initialize the master module.

Note: When M8030 is turned on, outputs of the remote I/O slave modules are initialized. For example, when using IDEC's SX5S communication I/O terminals as slave modules, all outputs are turned off during initialization and restore normal operation to turn on or off according to the output data transmitted from the OpenNet Controller CPU module.

Calculation of the INTERBUS Cycle Time

The I/O data is refreshed continuously. The cycle time of the INTERBUS system depends on few factors and increases almost linearly with an increasing number of I/O points. Due to the high effectiveness of the protocol, the greater part of the cycle time is determined by the number of I/O points. However, it is also required to consider quantities such as the number of installed remote bus devices, the duration of the check sequence, the firmware runtime, and the signal runtime on the transmission medium.

Cycle Time Examples

I/O Points	Cycle Time
512	2.1 msec
1024	4.0 msec
2048	7.5 msec

Remote I/O slave stations have a specific data length depending on the I/O type. The data length (register width) is a factor to determine the cycle time.

SX5S Type No.	Slave Module Name	Inputs	Outputs	Register Width (user data bytes n)
SX5S-SBN16S/-SBN16K	16-input module	2 bytes	—	2 bytes
SX5S-SBR08	8-relay output module	—	2 bytes	2 bytes
SX5S-SBT16K/-SBT16P	16-output module	—	2 bytes	2 bytes
SX5S-SBM16K/-SBM16P	Mixed I/O module	1 byte	1 byte	1 byte

The cycle time (refresh time) can be calculated according to:

$$t_{cycle} = \{K \times 13 \times (6 + n) + 4 \times m\} \times t_{Bit} + t_{SW} + t_{PH} + r \times t_W$$

whereby

t_{cycle}	INTERBUS cycle time (1 scan time)
K	1.15
n	Number of user data bytes
m	Number of installed remote bus devices
t_{Bit}	Bit duration (0.002 msec)
t_{SW}	Firmware run time (1 msec)
t_{PH}	Signal run time on the transmission medium (0.016 msec/km)
r	1
t_W	13 × 2 µsec conversion time

Note: Data exchange between the OpenNet Controller CPU module and the remote I/O master module is asynchronous with the INTERBUS cycle time.

Start and Stop of Remote I/O Communication

The remote I/O master module is powered by the CPU module. The remote I/O communication is started and stopped by turning power on and off to the CPU module.

After connecting remote I/O slave modules to the remote I/O master module using INTERBUS cable, power up the slave modules first, followed by the CPU module at the remote I/O master station.

The start delay after power-up depends on the contents of the user program, remote I/O system setup, and data link configuration. A rough estimate of the start delay is the operation start time depending on the user program size plus approximately 4 seconds.

While the CPU module is powered up and program operation is stopped, the remote I/O network is in the run state but the data exchange between the CPU and the remote I/O master module is stopped.

Function Area Setting for Remote I/O Master Station

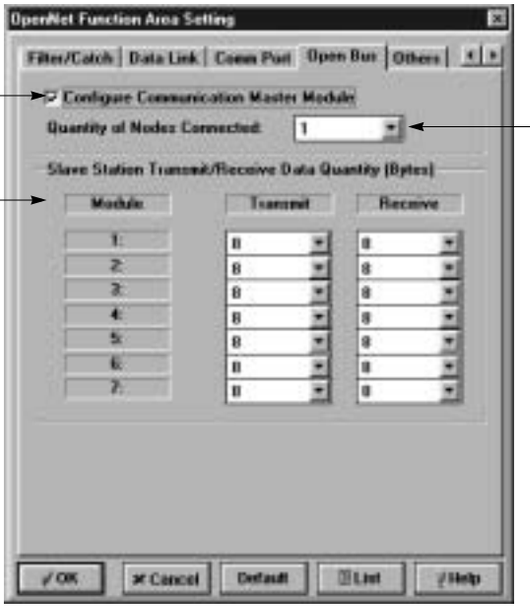
Normally, the remote I/O communication does not require the Function Area Settings. The CPU module at the remote I/O master station recognizes the remote I/O slave stations automatically at power-up and exchanges I/O data through the link registers allocated to each slave station (node).

You can also configure the remote I/O system setup in the master module. When the quantity of nodes is specified, the CPU communicates with slave stations as many as specified in the Function Area Settings. If the configuration in the Function Area Settings differs from the actual remote I/O system setup, the CPU does not start the remote I/O communication. For example, when any of the slave stations are removed or added or the INTERBUS cable is disconnected, the remote I/O communication is halted. To configure the remote I/O master module, make settings in the Function Area Settings for the user program.

Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Open Bus** tab.



Configure Communication Master Module Check Box

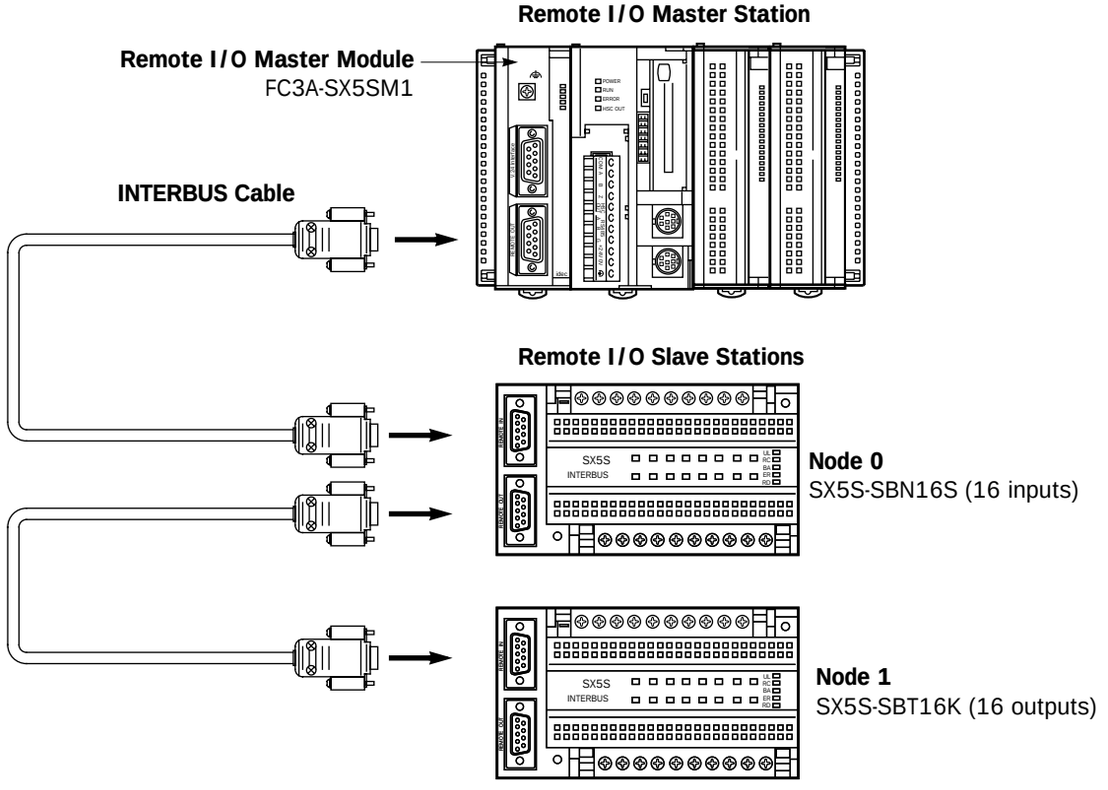
Slave Station Transmit / Receive Data Quantity (Bytes)
The remote I/O system does not require this setting. When using DeviceNet slave module or LONWORKS interface module, specify the data bytes to communicate through each slave or interface module.

Quantity of Nodes Connected
1 through 32

3. To specify the quantity of nodes connected, click the **Configure Communication Master Module** check box.
4. Select the quantity of slave stations 1 through 32 in the **Quantity of Nodes Connected** list box.
5. Click the **OK** button and download the user program to the OpenNet Controller.

Example 1: Reading and Writing I/O Data in Remote I/O System

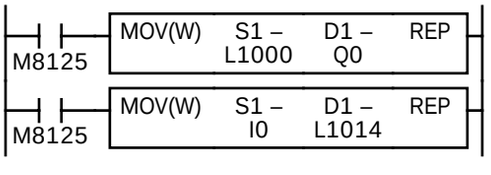
This example demonstrates a program to receive input data from the input slave module at node 0 and to send input data to the output slave module at node 1 in the remote I/O system shown below:



Nodes are numbered 0, 1, 2, and so forth starting with the node nearest to the remote I/O master module. In this example, the 16-point input module is allocated node 0 and the 16-point output module is allocated node 1. Consequently, I/O data of each slave station is stored in link registers shown below:

Node	Input Operand	Output Operand
Node 0	L1000-L1003	L1004-L1007
Node 1	L1010-L1013	L1014-L1017
Node 2	L1020-L1023	L1024-L1027
Node 3	L1030-L1033	L1034-L1037

L1000: Input data of the 16-point input module at node 0
L1014: Output data of the 16-point output module at node 1



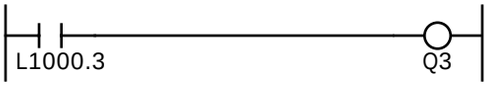
M8125 is the in-operation output special internal relay.

MOV instruction stores data of 16 inputs at the slave station of node 0 to 16 outputs Q0 through Q17 at the master station

MOV instruction stores data of 16 inputs I0 through I17 at the master station to 16 outputs at the slave station of node 1.

Example 2: Loading Bit Operand in Remote I/O System

One point of input or output can be loaded or outputted in the remote I/O system. This example demonstrates a program to load an input status at the slave station of node 0 and to send the status to output Q3 at the master station.



When the input at the slave station of node 0 is turned on, output Q3 at the master station is turned on.

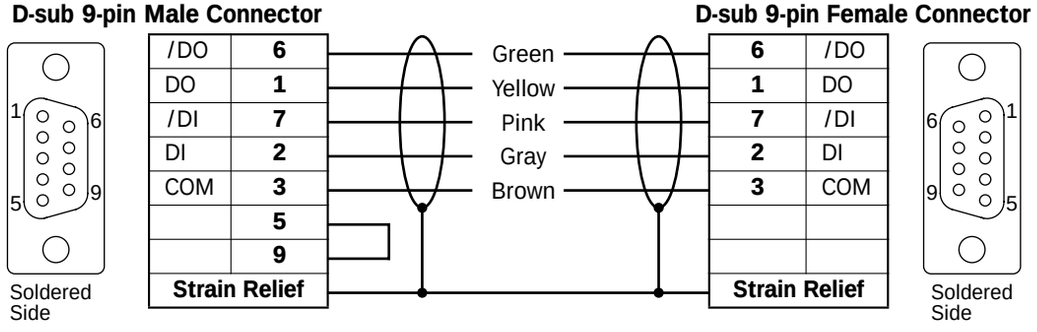
Precautions for Wiring INTERBUS Cable

For wiring the remote I/O master and slave modules, use the INTERBUS cable made of the remote bus cable with D-sub 9-position male and female connectors. The remote bus cable is available from Phoenix Contact. When ordering the remote bus cable from Phoenix Contact, specify the Order No. and cable length in meters.

Remote Bus Cable Type No.

Phoenix Type	Order No.	Specification	Used for
IBS RBC METER-T	28 06 28 6	Standard, 3 x 2 x 0.22 mm^2	Fixed routing
IBS RBC METER/F-T	27 23 12 3	Highly flexible, 3 x 2 x 0.25 mm^2	Flexible power conduits and machinery components which are frequently in motion
IBS RBC METER/E-T	27 23 14 9	Underground, 3 x 2 x 0.22 mm^2	Fixed routing indoors, outdoors or underground

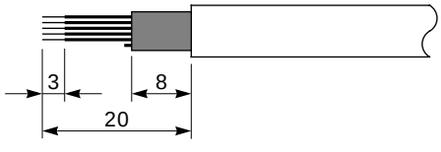
Cable Connector Pinouts



Bridge pins 5 and 9 inside the housing of the male connector.

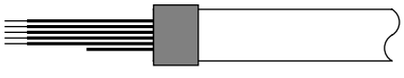
Use inch-sized screws (UNC4-40) to fasten the cable connectors to INTERBUS ports.

Stripping and Clamping Cable Ends



First, strip the cable sheath 20 mm from both ends of the cable and shorten the braided shield by 12 mm.

Bare the wire ends 3 mm. Trim the unused white wire.



Next, place the braided shield back over the cable sheath.

Clamp the shield under the strain relief in the connector housing for conductive connection with the housing.

- Do not install the INTERBUS cable in parallel with or close to motor lines. Keep the INTERBUS cable away from noise sources.
- Turn power off before wiring the INTERBUS cable. Make sure of correct wiring before turning power on.
- Use a special INTERBUS cable and connect the cable as shown above. Use D-sub connectors with metal or metal-coated housing. Connect the cable shield with the connector housing electrically.
- Leave open the remote out connector at the last station in the network.
- Supply power to each slave station or to each group of stations separately.
- Master and slave stations may be powered up in any order. But, if a slave station is not powered up while the master is in preparation for transmission, a network error will result.
- Causes of network errors include disconnection or short-circuit of the network cable, strong external noise, invalid command sent to the master station, momentary power voltage drop below the minimum power voltage, faulty transmission line, incorrect cable, and transmission longer than the rated distance.
- When a network error occurs, all outputs are turned off.

INTERBUS Error Codes

One of the useful features of INTERBUS is the powerful error detection function. This function makes it possible to detect cable disconnection, remote bus failures and also to locate the errors, so the system downtime can be minimized.

Two special data registers are assigned to store error information:

D8182 (INTERBUS master error code) stores an error code for user error, general bus error, remote or local bus error.

D8183 (INTERBUS master error location) stores the ADD_Error_Info to indicate the error location.

For example, when a peripheral fault is found at node 0 (logical device number 1.0), D8182 and D8183 store information as shown below:

D8182 [0BB1h] = Peripheral fault
D8183 [0100h] = Logical device number 1.0

Error Codes for User Errors (USER FAIL)

0BB1hex (PF)

Meaning	The specified INTERBUS device indicated a peripheral fault.
Remedy	Check the specified INTERBUS device.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BDFhex (LOOK FOR FAIL)

Meaning	The controller board has stopped data transmission and is searching for the error location and cause.
Cause	A bus error occurred.
Remedy	Wait until the search for the error has been completed. The controller board will inform you of the result.
Add_Error_Info	—

Error Codes for General Bus Errors (BUS FAIL)

0BE1hex (BUS FAIL)

Meaning	A serious error occurred causing the bus system to be switched off. However, no error was detected when checking the current configuration. This indicates that the error cause always occurs for a short time only.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	—

0BE2hex (BUS FAIL)

Meaning	The controller board detected changes in the configuration which do not permit to continue the data traffic over the bus.
Cause	– The maximum permissible number of INTERBUS words was exceeded. – The maximum number of INTERBUS devices was exceeded.
Add_Error_Info	—

0BE4hex (BUS FAIL)

Meaning	A serious error occurred when acquiring the bus configuration via the “Create_Configuration” (0710hex) service. This error caused the bus system to be switched off. The error location could not be detected. This indicates that the error cause always occurs for a short time only. The error rate can be very high.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	—

0BE6hex (BUS FAIL)

Meaning	A serious error occurred causing the bus system to be switched off. However, no error was detected when checking the current configuration. This indicates that the error cause always occurs for a short time only. The error affected data cycles but no ID cycles.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	—

0BE7hex (BUS FAIL)

Meaning	The controller board could not activate the services when the following services were processed: – “Activate_Configuration” (0711hex) or – “Control_Active_Configuration” (0713hex). The error location could not be detected.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	—

0BE8hex (BUS FAIL)

Meaning	A serious error occurred causing the bus system to be switched off. When checking the current configuration, the diagnostic algorithm detected errors but could not locate the precise error location. This indicates that the error cause always occurs for a short time only. The error rate can be very high.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	—

0BE9hex (BUS FAIL)

Meaning	A serious error occurred causing the bus system to be switched off. When checking the current configuration, the diagnostic algorithm detected errors but could not locate the precise error location. This indicates that the error cause always occurs for a short time only. The error rate can be very high.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	—

0BEAhex (BUS FAIL)

Meaning	The “Control_Device_Function” (0714hex) service could not be executed.
Cause	Fatal error.
Remedy	Repeat the service if the controller board is in the RUN or ACTIVE state. If diagnostics is active, you must wait for the result. Then, the indicated bus error specifies the error location.
Add_Error_Info	—

0BF0hex (BUS FAIL)

Meaning	The data transmission was temporarily interrupted. As a result, the controller board reset all outputs and stopped data transmission. The display shows the INTERBUS device number. The error can be found – in the preceding bus segment of a local bus, – in the preceding bus segment of a ST compact station, – in the bus segments of a preceding remote bus branch (e.g., installation remote bus), or – in the bus segment of the indicated INTERBUS device.
Cause	– Voltage reset of an INTERBUS device in the specified area. – Cable break in the specified bus segment. – The bridge (RBST or LBST) in the connector for the outgoing bus is defective for a device in the specified area.
Add_Error_Info	INTERBUS device number (Segment. Position) of the INTERBUS device.

0BF1hex (BUS FAIL)

Meaning	Data transmission is interrupted at a BK module.
Cause	– The connector for the outgoing remote bus branch has not been plugged in. – The bridge (LBST) in the connector for the outgoing remote bus branch is defective.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF2hex (BUS FAIL)

Meaning	Data transmission is interrupted at a BK module.
Cause	– The connector for the outgoing remote bus branch has not been plugged in. – The bridge (RBST) in the connector for the outgoing remote bus branch is defective.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF3hex (BUS FAIL)

Meaning	The data transmission is interrupted at a BK module, local bus devices or within an IB ST compact station.
Cause	Local bus – The connector for the outgoing local bus has not been plugged in. – The bridge (RBST or LBST) in the connector for the outgoing local bus is defective. ST compact station – The ST cable has not been plugged in. – The RBST connection led via the next module of the IB ST compact station is interrupted.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF4hex (BUS FAIL)

Meaning	Transmission error (CRC error) in the data forward path at the incoming bus interface (IN) of the specified INTERBUS device
Cause	Transmission errors.
Remedy	Check the specified INTERBUS segment for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF5hex (BUS FAIL)

Meaning	Transmission error (CRC error) in the data return path at the incoming bus interface (IN) of the specified INTERBUS device.
Remedy	Check the specified INTERBUS segment for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF6hex (BUS FAIL)

Meaning	Bus error. Data transmission was temporarily interrupted. As a result, the controller board reset all outputs and stopped data transmission. The display shows the INTERBUS device number. The error can be found – in the preceding bus segment of a local bus, – in the preceding bus segment of a ST compact station, – in the bus segments of a preceding remote bus branch (e.g., installation remote bus), or – in the bus segment of the indicated INTERBUS device.
Cause	– Voltage reset of an INTERBUS device in the specified area. – Cable break in the specified bus segment. – The bridge (RBST or LBST) in the connector for the outgoing bus is defective for a device in the specified area.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF8hex (BUS FAIL)

Meaning	Multiple errors when acquiring I/O data at the specified device. It was not possible to exactly locate the error.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Error location	The specified device, the preceding complete bus as well as all devices connected to OUT2 of the specified device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BF9hex (BUS FAIL)

Meaning	Multiple error at the specified device during quick diagnostics. It was not possible to exactly locate the error.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Error location	The specified device, the preceding complete bus as well as all devices connected to OUT2 of the specified device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

0BFAhex (BUS FAIL)

Meaning	Multiple errors at the specified device during startup or permanent diagnostics.
Cause	The error occurs due to – installation errors, – a defective INTERBUS device.
Error location	The specified device, the preceding complete bus as well as all devices connected to OUT2 of the specified device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

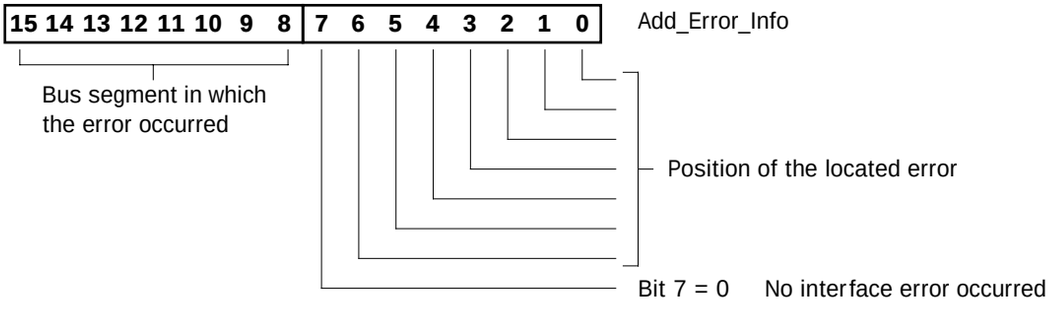
0BFBhex (BUS FAIL)

Meaning	Error detected by means of quick diagnostics.
Error location	The specified device, the preceding complete bus as well as all devices connected to OUT2 of the specified device.
Remedy	Check your system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – cable breaks in remote and local bus cabling, – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	INTERBUS device number (Segment . Position) of the INTERBUS device.

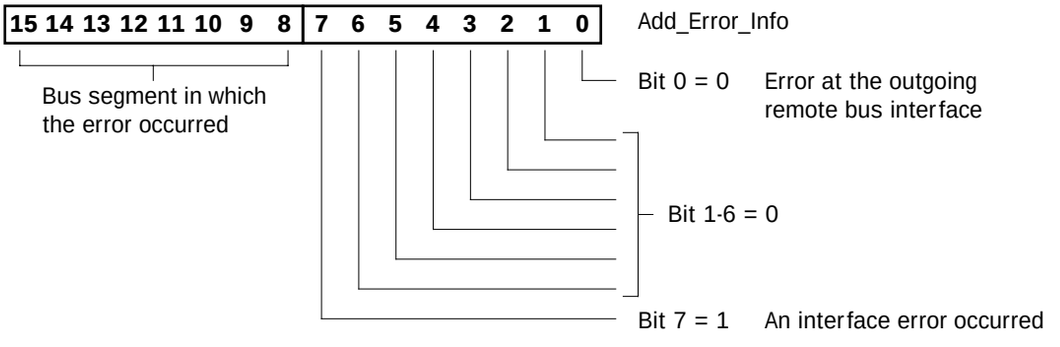
Error Codes for Remote Bus and Local Bus Errors

The Add_Error_Info provides the coded error location for remote or local bus errors. The exact error position is only indicated if no interface error occurred. In the case of an interface error, the defective bus segment will be indicated. Bit 7 indicates whether an interface error occurred. The meanings of bits 0 to 6 will also change. This results in three different states which have the following bit combinations in the Add_Error_Info.

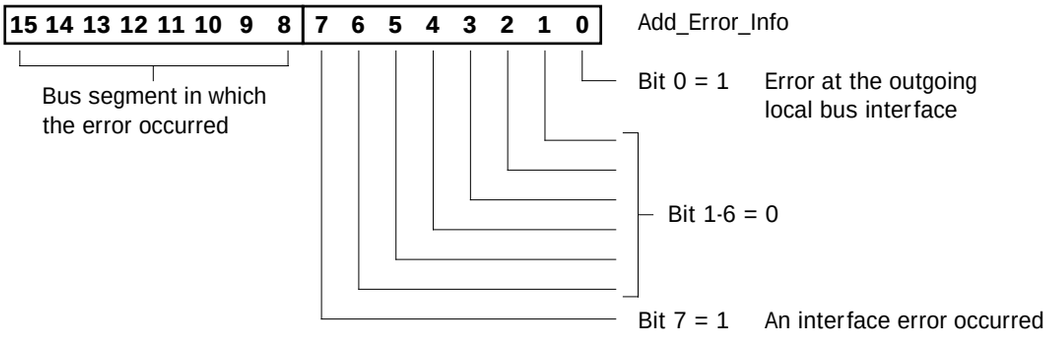
No interface error occurred



Error at the outgoing remote bus interface



Error at the outgoing local bus interface



0C10hex to 0C13hex (RB FAIL) or 0D10hex to 0D13hex (LB FAIL)

Meaning	An INTERBUS device is missing.
Cause	A device entered in the connected bus configuration and not marked as switched off is missing in the connected bus configuration. The active configuration is the quantity of INTERBUS devices connected to the INTERBUS system whose data is within the summation frame. The active configuration may differ from the connected bus configuration only when physically connected bus segments have been switched off.
Remedy	Compare the active configuration with the connected bus configuration, taking any disabled bus segments into account.
Add_Error_Info	Error location (Segment . Position).

0C14hex to 0C17hex (RB FAIL) or 0D14hex to 0D17hex (LB FAIL)

Meaning	Multiple errors in the segment of the connected INTERBUS device.
Cause	Transmission errors.
Remedy	Check the segment of the specified INTERBUS device for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	Error location (Segment . Position).

0C18hex to 0C1Bhex (RB FAIL) or 0D18hex to 0D1Bhex (LB FAIL)

Meaning	Multiple timeout in the segment of the specified INTERBUS device.
Cause	Transmission errors.
Remedy	Check the segment of the specified INTERBUS device for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	Error location (Segment . Position).

0C1Chex to 0C1Fhex (RB FAIL) or 0D1Chex to 0D1Fhex (LB FAIL)

Meaning	Transmission error (CRC error) in the forward data path at the incoming bus interface (IN) of the specified INTERBUS device.
Cause	Transmission errors.
Remedy	Check the segment of the specified INTERBUS device for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	Error location (Segment . Position).

0C20hex to 0C23hex (RB FAIL) or 0D20hex to 0D23hex (LB FAIL)

Meaning	The Medium Attachment Unit (MAU) firmware component diagnosed an interruption of the data transmission.
Cause	Interruption in the forward data path of the incoming bus interface (IN) of the specified INTERBUS device.
Remedy	Check the cables, male and female connectors on cables and devices for interruptions and repair them, if required.
Add_Error_Info	Error location (Segment . Position).

0C24hex to 0C27hex (RB FAIL) or 0D24hex to 0D27hex (LB FAIL)

Meaning	Transmission error (CRC error) in the return data path at the incoming bus interface (IN) of the specified INTERBUS device.
Cause	Transmission errors.
Remedy	Check the segment of the specified INTERBUS device for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	Error location (Segment . Position).

0C28hex to 0C2Bhex (RB FAIL) or 0D28hex to 0D2Bhex (LB FAIL)

Meaning	The Medium Attachment Unit (MAU) diagnosed an interruption of the data transmission.
Cause	Interruption in the return data path at the incoming bus interface (IN) of the specified INTERBUS device.
Remedy	Check the cables, male and female connectors on cables and devices for interruptions and repair them, if required.
Add_Error_Info	Error location (Segment . Position).

0C2Chex to 0C2Fhex (RB FAIL) or 0D2Chex to 0D2Fhex (LB FAIL)

Meaning	Unexpected change of the RBST or LBST signal.
Cause	Missing or defective bridge (loose contact, dry joint) in the outgoing bus connector of the preceding INTERBUS device.
Remedy	Check the segment of the specified INTERBUS device for interruptions in the connector (loose contact, dry joint). Solder a bridge or ensure the proper connection of the already existing bridge to generate an error-free RBST or LBST signal.
Add_Error_Info	Error location (Segment . Position).

0C40hex to 0C43hex (RB FAIL) or 0D40hex to 0D43hex (LB FAIL)

Meaning	The length code of the specified INTERBUS device is not identical with the entry in the configuration frame.
Add_Error_Info	Error location (Segment . Position).

0C44hex to 0C47hex (RB FAIL) or 0D44hex to 0D47hex (LB FAIL)

Meaning	The ID code of the specified INTERBUS device is not identical with the entry in the configuration frame.
Add_Error_Info	Error location (Segment . Position).

0C48hex to 0C4Bhex (RB FAIL) or 0D48hex to 0D4Bhex (LB FAIL)

Meaning	Only ID cycles but no data cycles can be run.
Cause	– The data register of the specified INTERBUS device has been interrupted. – The number of data registers of the specified INTERBUS is not identical with the length code entered in the configuration frame.
Add_Error_Info	Error location (Segment . Position).

0C4Chex to 0C4Fhex (RB FAIL) or 0D4Chex to 0D4Fhex (LB FAIL)

Meaning	The specified INTERBUS device has an invalid ID code.
Add_Error_Info	Error location (Segment . Position).

0D50hex to OD53hex (LB FAIL)

Meaning	The specified INTERBUS device has the ID code of a remote bus device.
Add_Error_Info	Error location (Segment . Position).

0C58hex to 0C5Bhex (RB FAIL) or 0D58hex to 0D5Bhex (LB FAIL)

Meaning	The data transmission is interrupted at the outgoing remote bus interface (OUT1) of the specified INTERBUS device.
Cause	– The connector has not been plugged in. – The bridge for connector identification (RBST or LBST) is defective.
Add_Error_Info	Error location (Segment . Position).

0C5Chex to 0C5Fhex (RB FAIL) or 0D5Chex to 0D5Fhex (LB FAIL)

Meaning	Data transmission is interrupted at the outgoing bus interface (OUT2) of the specified INTERBUS device.
Cause	– The connector has not been plugged in. – The bridge for connector identification (RBST or LBST) is defective.
Add_Error_Info	Error location (Segment . Position).

0C68hex to 0C6Bhex (RB FAIL) or 0D68hex to 0D6Bhex (LB FAIL)

Meaning	The SUPI 3 of the specified INTERBUS device detected an I/O timeout.
Add_Error_Info	Error location (Segment . Position).

0C6Chex to 0C6Fhex (RB FAIL) or 0D6Chex to 0D6Fhex (LB FAIL)

Meaning	The specified INTERBUS device carried out a reset.
Cause	The specified INTERBUS device is insufficiently supplied with power or is defective.
Remedy	– Check this INTERBUS device. – Check the supply voltage of this INTERBUS device whether it conforms to the rated value and whether the permissible AC voltage portion is exceeded. Refer to the relevant data sheet for the values. – Check the BK module's power supply unit for an overload condition. Refer to the relevant data sheets for the maximum permissible output current of the BK module and for the typical current consumption of the connected local bus devices.
Add_Error_Info	Error location (Segment . Position).

0C70hex to 0C73hex (RB FAIL) or 0D70hex to 0D73hex (LB FAIL)

Meaning	Data transmission was aborted. In an INTERBUS device whose SUPI is run in the microprocessor mode, the microprocessor failed to initialize the SUPI.
Cause	– The controller board tried to switch the bus into the *ACTIVE* state faster than the microprocessor of the INTERBUS device could initialize the SPUI. – The INTERBUS device is defective.
Remedy	– Delay the call of the "Activate_Configuration" (0711hex) service until the microprocessor has initialized the SUPI. – Replace the INTERBUS device.
Add_Error_Info	Error location (Segment . Position).

0C74hex to 0C77hex (RB FAIL) or 0D74hex to 0D77hex (LB FAIL)

Meaning	Data transmission was interrupted.
Cause	An invalid mode has been set on the INTERBUS protocol chip of an INTERBUS device.
Remedy	Set a valid operating mode or replace the device.
Add_Error_Info	Error location (Segment . Position).

0C80hex to 0C83hex (RB FAIL) or 0D80hex to 0D83hex (LB FAIL)

Meaning	Multiple errors at the outgoing bus interface (OUT1) of the specified INTERBUS device.
Cause	Defect of the bus cable connected to this bus interface, of the following INTERBUS device, or of a device on any subsequent local bus.
Remedy	Check this part of the system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	Error location (Segment . Position).

0C84hex to 0C87hex (RB FAIL) or 0D84hex to 0D87hex (LB FAIL)

Meaning	Multiple timeout of the outgoing bus interface (OUT1) of the specified INTERBUS device.
Cause	Defect of the bus cable connected to this bus interface, of the following INTERBUS device, or of a device on any subsequent local bus.
Remedy	Check this part of the system for: – missing or incorrect shielding of the bus cables (connectors), – missing or incorrect grounding/equipotential bonding, – poor connections in the connector (loose contact, dry joint), – voltage dips on the communication voltage supply of the remote bus devices.
Add_Error_Info	Error location (Segment . Position).

0C88hex to 0C8Bhex (RB FAIL) or 0D88hex to 0D8Bhex (LB FAIL)

Meaning	An unexpected device was found at the outgoing bus interface (OUT1) of the specified INTERBUS device.
Cause	– INTERBUS device connected without an entry in the active configuration. – INTERBUS cable connected without any further INTERBUS devices.
Add_Error_Info	Error location (Segment . Position).

0C8Chex to 0C8Fhex (RB FAIL) or 0D8Chex to 0D8Fhex (LB FAIL)

Meaning	Only ID cycles but no data cycles can be run.
Cause	– Interrupted data register of the INTERBUS device connected to the outgoing remote bus interface (OUT1). – The number of data registers of the specified INTERBUS that is connected to the outgoing remote bus interface (OUT1) of the specified INTERBUS device is not identical with the length code.
Add_Error_Info	Error location (Segment . Position).

0C90hex to 0C93hex (RB FAIL)

Meaning	The specified INTERBUS device could not activate the following bus segment.
Cause	The INTERBUS device connected to the outgoing interface (OUT1) of the specified INTERBUS device carried out a voltage reset or is defective.
Remedy	– Check this INTERBUS device. – Check the supply voltage of this INTERBUS device whether it conforms to the rated value and whether the permissible AC voltage portion is exceeded. Refer to the relevant data sheet for the values. – Check the BK module's power supply unit for an overload condition. Refer to the relevant data sheets for the maximum permissible output current of the BK module and for the typical current consumption of the connected local bus devices.
Add_Error_Info	Error location (Segment . Position).

0C94hex to 0C97hex (RB FAIL)

Meaning	An INTERBUS device with the ID code of a local bus device was found at the outgoing remote bus interface (OUT1) of the specified INTERBUS device.
Add_Error_Info	Error location (Segment . Position).

0C98hex to 0C9Bhex (RB FAIL) or 0D98hex to 0D9Bhex (LB FAIL)

Meaning	The INTERBUS device connected to the outgoing remote bus interface (OUT1) of the specified INTERBUS device has an invalid ID code.
Add_Error_Info	Error location (Segment . Position).

0D9Chex to 0D9Fhex (LB FAIL)

Meaning	The local bus connected directly to the controller board consists of more devices than have been entered in the active configuration.
Add_Error_Info	Error location (Segment . Position).

0CC0hex to 0CC3hex (RB FAIL) or 0DC0hex to 0DC3hex (LB FAIL)

Meaning	Multiple errors at the outgoing bus interface (OUT2) of the specified INTERBUS device.
Cause	– INTERBUS cable connected to the outgoing bus interface (OUT2) without any further INTERBUS device. – A local/remote bus cable is defective that belongs to the local/remote bus of the specified INTERBUS device. – Defective INTERBUS device connected to the local/remote bus of the specified INTERBUS device. – Failure of the supply voltage (communication voltage U_L) for the module electronics made available by the BK module. – Failure of the supply voltage (U_L) for the BK module.
Remedy	Check this local/remote bus.
Add_Error_Info	Error location (Segment . Position).

0CC4hex to 0CC7hex (RB FAIL) or 0DC4hex to 0DC7hex (LB FAIL)

Meaning	Multiple timeout at the outgoing bus interface (OUT2) of the specified INTERBUS device.
Cause	– Defective local/remote bus cable that belongs to the local/remote bus of the specified device. – Defective INTERBUS device connected to the local/remote bus of the specified INTERBUS device. – Failure of the supply voltage (communication voltage U_L) for the module electronics made available by the BK module. – Failure of the supply voltage (U_L) for the BK module.
Remedy	Check this local/remote bus.
Add_Error_Info	Error location (Segment . Position).

0CC8hex to 0CCBhex (RB FAIL) or 0DC8hex to 0DCBhex (LB FAIL)

Meaning	Unexpected devices were found at the outgoing bus interface (OUT2) of the specified INTERBUS device.
Cause	– INTERBUS device connected without an entry in the active configuration. – INTERBUS cable connected without any further INTERBUS devices.
Add_Error_Info	Error location (Segment . Position).

0CCChex to 0CCFhex (RB FAIL) or 0DCChex to 0DCFhex (LB FAIL)

Meaning	Only ID cycles but no data cycles can be run.
Cause	– Interrupted data register of the INTERBUS device connected to OUT2. – The number of data registers of the INTERBUS device connected to the outgoing interface (OUT2) of the specified INTERBUS device is not identical with the length code entered in the configuration frame.
Remedy	Replace the INTERBUS device which is connected to the outgoing bus interface (OUT2) of the specified INTERBUS device or adapt in the configuration frame the entry to the length code.
Add_Error_Info	Error location (Segment . Position).

0CD0hex to 0CD3hex (RB FAIL) or 0DD0hex to 0DD3hex (LB FAIL)

Meaning	After the outgoing bus interface (OUT2) of the specified INTERBUS device was opened, further devices in addition to a BK module were included in a data ring.
Cause	The INTERBUS device connected to the outgoing bus interface (OUT2) of the specified INTERBUS device carried out a voltage reset or is defective.
Remedy	– Check this INTERBUS device. – Check the supply voltage of this INTERBUS device whether it conforms to the rated value and whether the permissible AC voltage portion is exceeded. Refer to the relevant data sheet for the values. – Check the BK module's power supply unit for an overload condition. Refer to the relevant data sheets for the maximum permissible output current of the BK module and for the typical current consumption of the connected local bus devices.
Add_Error_Info	Error location (Segment . Position).

0CD4hex to 0CD7hex (RB FAIL) or 0DD4hex to 0DD7hex (LB FAIL)

Meaning	Error in the 8-wire local bus connected to the specified INTERBUS device.
Cause	– Defective local bus cable that belongs to the local bus of the specified device. – Defective INTERBUS device connected to the local bus of the specified INTERBUS device. – Failure of the supply voltage (communication voltage U_L) for the module electronics made available by the BK module.
Remedy	Check this local bus.
Add_Error_Info	Error location (Segment . Position).

0CD8hex to 0CDBhex (RB FAIL) or 0DD8hex to 0DDBhex (LB FAIL)

Meaning	The local bus connected to the specified bus terminal module consists of more local bus devices than were entered in the active configuration.
Add_Error_Info	Error location (Segment . Position).

0CDChex to 0CDFhex (RB FAIL) or 0DDChex to 0DDFhex (LB FAIL)

Meaning	The INTERBUS device connected to the outgoing bus interface (OUT2) of the specified INTERBUS device has an invalid ID code.
Add_Error_Info	Error location (Segment . Position).

The error codes described above are excerpts from:

INTERBUS User Manual
Generation 4 Controller Boards as of Firmware 4.12
Designation: IBS SYS FW G4 UM E
Order No. 27 45 18 5
Section 3 Error Codes

25: DEVICENET SLAVE MODULE

Introduction

This chapter describes DeviceNet slave module FC3A-SX5DS1 used with the OpenNet Controller to interface with the DeviceNet™ network, and provides details on the DeviceNet system setup and the DeviceNet slave module specifications.

The OpenNet Controller can be linked to DeviceNet networks. For communication through the DeviceNet network, the DeviceNet slave module is available. Mounting the DeviceNet slave module beside the OpenNet Controller CPU module makes a slave station used as an I/O terminal in a DeviceNet network. The slave station can transfer I/O data to and from the master station just as an ordinary I/O module in a distributed network.

DeviceNet Slave Module Features

Since the DeviceNet slave module conforms to the DeviceNet specifications, the OpenNet Controller can be linked to DeviceNet networks consisting of DeviceNet compliant products manufactured by many different vendors, such as I/O terminals, sensors, drives, operator interfaces, and barcode readers.

The transmit/receive data quantity can be selected from 0 through 8 bytes (64 bits) in 1-byte increments. One DeviceNet slave module enables the OpenNet Controller CPU module to transmit 64 bits and receive 64 bits at the maximum to and from the DeviceNet master station.

About DeviceNet

DeviceNet was originally developed by Allen-Bradley as a network for sensors, actuators, and other discrete devices, and later the specifications were opened. Now, major automotive manufacturers and various industries employ DeviceNet networks.

DeviceNet Features

The network configuration is based on the bus system. The basic network consists of a trunkline-dropline topology. Multi-drop or daisy-chain configuration is also possible.

The DeviceNet protocol is based on CAN (Controller Area Network) which has been widely used for networks on automobiles, making it possible to configure reliable networks with high noise immunity.

Transmission Distance and Nodes

The maximum transmission distance is 500 meters when using a thick trunk cable at a data rate of 125k baud, and the maximum quantity of nodes is 64 including a master station.

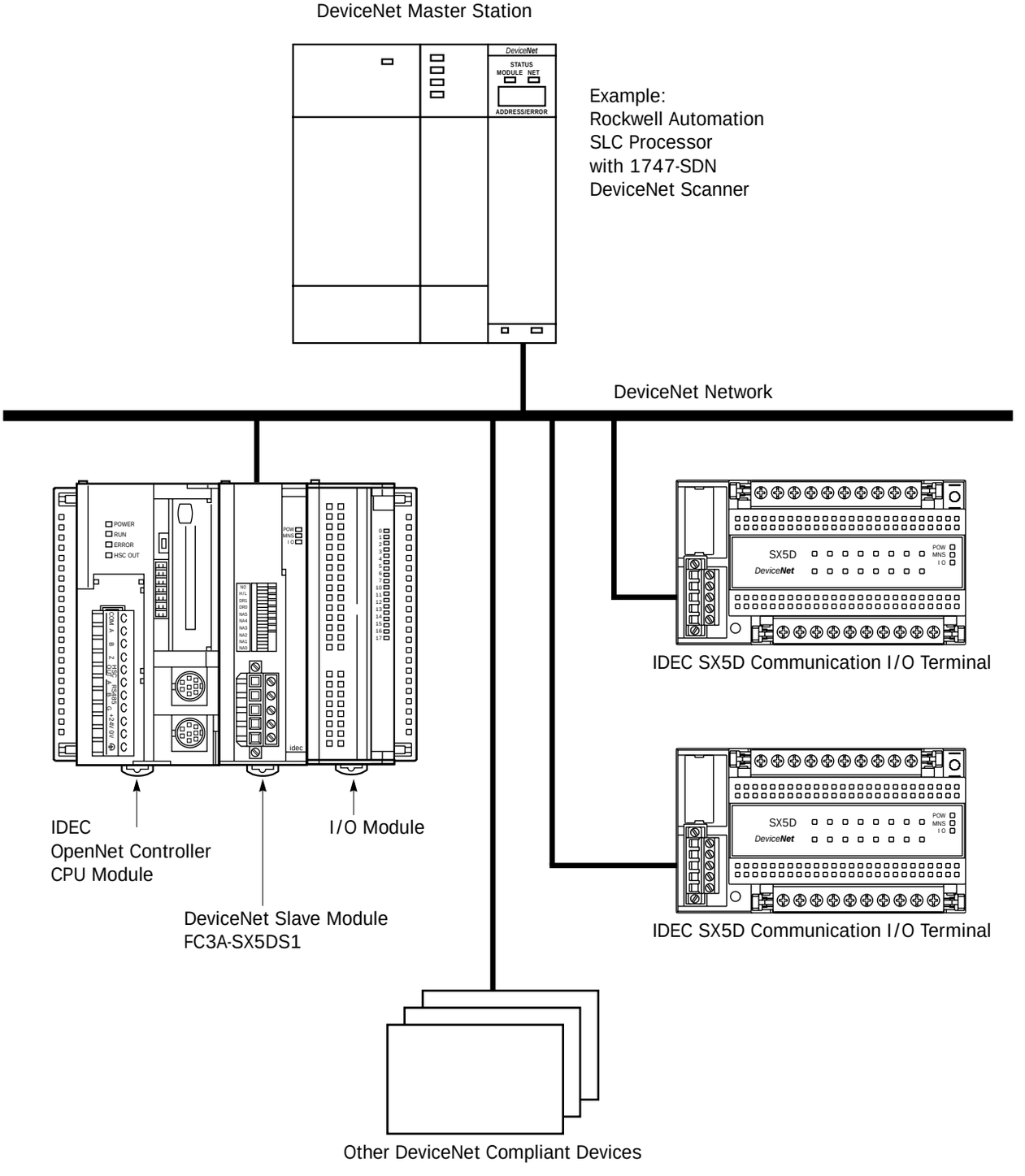
DeviceNet is a trademark of Open DeviceNet Vendor Association, Inc. (ODVA).

DeviceNet Network System Setup

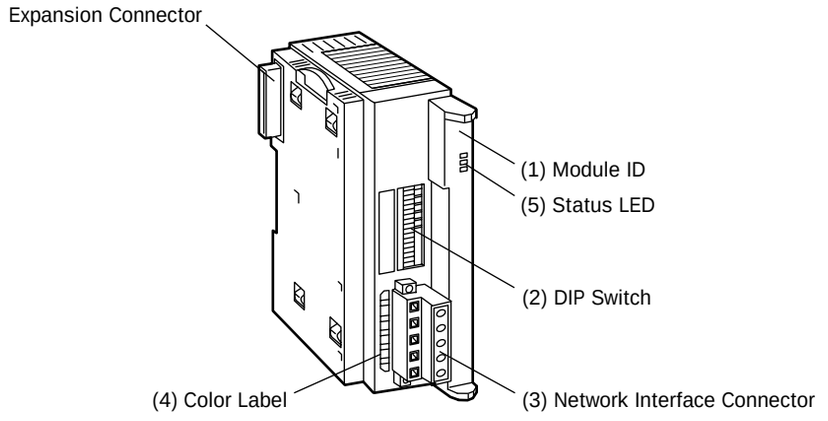
Various DeviceNet compliant devices, such as the DeviceNet slave module and IDEC SX5D communication I/O terminals, can be connected to the DeviceNet network.

The DeviceNet network requires a DeviceNet master module available from other manufacturers. The OpenNet Controller can be used as a slave station by adding the DeviceNet slave module to the right of the OpenNet Controller CPU module.

A maximum of seven OpenNet slave modules, such as DeviceNet slave modules and LONWORKS interface modules, and analog I/O modules can be mounted with one OpenNet Controller CPU module.



DeviceNet Slave Module Parts Description



Module Name	DeviceNet Slave Module
Type No.	FC3A-SX5DS1

(1) Module ID FC3A-SX5DS1 indicates the DeviceNet slave module ID.

(2) DIP Switch 10-pole DIP switch for setting node address (MAC ID), data rate, output hold/load off, and physical port number

(3) Network Interface Connector For connecting the DeviceNet communication cable

(4) Color Label A five-color label is located beside the connector on the DeviceNet slave module. Connect each of the five different-color wires of the DeviceNet communication cable to the terminal of a matching color.

Label and Wire Insulation Color	Name
Black	V–
Blue	CAN_L
Bare Wire	Drain
White	CAN_H
Red	V+

(5) Status LED Indicates operating status

Indicator	Status		Description
POW (power)	—	OFF	Module power OFF
	Green	ON	Module power ON
MNS (module/network status)	—	OFF	Power OFF or Dup_MAC_ID test not completed
	Green	Flash	Normal operation (communication not established)
		ON	Normal operation (communication established)
	Red	Flash	Minor fault (temporary network error)
		ON	Critical fault
IO (I/O status)	—	OFF	I/O inactive
	Green	ON	I/O active
	Red	Flash	Minor fault
		ON	Critical fault

DeviceNet Slave Module Specifications

General Specifications

Communication Interface Power Voltage Range	11 to 25V DC
Current Draw	Approx. 25 mA
Isolation	Between control circuit and communication terminal: Photocoupler isolated
Insulation Resistance	Between communication terminal and FG: 10 MΩ minimum (500V DC megger)
Dielectric Strength	Between communication terminal and FG: 1000V AC, 1 minute (10 mA maximum)
Vibration Resistance	10 to 57 Hz, amplitude 0.075 mm; 57 to 150 Hz, acceleration 9.8 m/sec^2 (1G); 10 sweep cycles each in 3 axes (total 80 minutes) (IEC1131)
Shock Resistance	147 m/sec^2 (15G), 11 msec, 3 shocks each in 3 axes (IEC1131)
Altitude	Operation: 0 to 2000m Transportation: 0 to 3000m
Operating Temperature	0 to +55°C (no freezing)
Operating Humidity	30 to 90% RH (no condensation)
Storage Temperature	–25 to +75°C
Storage Humidity	30 to 90% RH (no condensation)
Corrosion Immunity	Free from corrosive gases
Mounting	Snap-on mounting on 35-mm DIN rail
Weight (approx.)	180g

Communication Specifications

- **Data Rate and Transmission Distance**

Data Rate	Max. Cable Distance for 100% Thick Cable	Max. Cable Distance for 100% Thin Cable	Max. Drop Line Length	Max. Total Drop Line Length
500k baud	100m	100m	6m	39m
250k baud	250m	100m	6m	78m
125k baud	500m	100m	6m	156m

- **Maximum Number of Stations in the Network** 64 stations (including a master)

- **Communication Data Length** Transmit: 0 to 8 bytes (selectable in 1-byte increments)
  Receive: 0 to 8 bytes (selectable in 1-byte increments)

- **Network Interface Connector** In the module: MSTB2.5/5-GF-5.08AU (made by Phoenix Contact)
  To the cable: FRONT-MSTB2.5/5-STF-5.08AU (made by Phoenix Contact)

- **Communication Cable (Special DeviceNet Cable)**

Thick Cable Type No.	Thin Cable Type No.	Maker
1485C-P1A50	1485C-P1-C150	Rockwell Automation For details about cables, consult Rockwell Automation.

- **Terminator** Terminators must be connected to both ends of the DeviceNet network. When setting up a network, either connect commercially-available terminators at both ends of the network or connect the following resistor to the branch taps at both ends of the network.

  Metal film resistor: 121Ω, ±1%, 1/4W

Wiring DeviceNet Slave Module

Precautions for Wiring

- Do not run the network cable in parallel with or near power lines, and keep the network cable away from noise sources.
- Power down the DeviceNet slave module before you start wiring. Make sure that wiring is correct before powering up the DeviceNet slave module.
- Use the special DeviceNet cable for connecting the network.
- A five-color label is located beside the connector on the DeviceNet slave module. Connect each of the five different-color wires of the cable to the terminal of a matching color.
- When using thick cables, only one wire can be connected to a terminal of the network interface connector. To connect two wires of thick cables, use a device tap.
- Tighten the mounting screws of the network interface connector to a recommended torque of 0.3 to 0.5 N·m.
- Tighten the terminal screws of the network interface connector to a recommended torque of 0.5 to 0.6 N·m.
- Either connect commercially-available terminators at both ends of the network or connect the following resistor to the branch taps at both ends of the network. Connect the terminator between the CAN_H (white) and CAN_L (blue) lines.

  Metal film resistor: 121Ω, ±1%, 1/4W

Ferrules, Crimping Tool, and Screwdriver for Phoenix Terminal Blocks

The screw terminal block of the network interface connector can be wired with or without using ferrules on the end of the cable. Applicable ferrules for the terminal block and crimping tool for the ferrules are listed below. Use a screwdriver to tighten the screw terminals on the DeviceNet slave module. Ferrules, crimping tool, and screwdriver are made by and are available from Phoenix Contact.

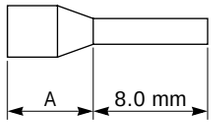
Type numbers of Phoenix Contact ferrules, crimping tool, and screwdriver are listed below. When ordering these products from Phoenix Contact, specify the Order No. and quantity listed below.

DeviceNet slave modules are connected to the network using special DeviceNet thick or thin cables, each cable consisting of three different sizes of wires listed below.

• Ferrule Order No.

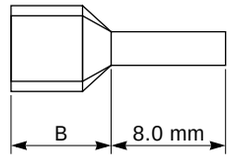
Applicable Wire Size		For 1-wire connection		For 2-wire connection		Pcs. / Pkt.
mm^2	AWG	Phoenix Type	Order No.	Phoenix Type	Order No.	
0.25	24	AI 0,25-8 YE	32 00 85 2	—	—	100
0.5	20	AI 0,5-8 WH	32 00 01 4	AI-TWIN 2 x 0,5-8 WH	32 00 93 3	100
0.75	18	AI 0,75-8 GY	32 00 51 9	AI-TWIN 2 x 0,75-8 GY	32 00 80 7	100
1.0	18	AI 1-8 RD	32 00 03 0	AI-TWIN 2 x 1-8 RD	32 00 81 0	100
1.5	16	AI 1,5-8 BK	32 00 04 3	AI-TWIN 2 x 1,5-8 BK	32 00 82 3	100
2.5	14	AI 2,5-8 BU	32 00 52 2	—	—	100

For 1-wire Connection



Ferrule	Dimension A
AI 0,25-8 YE	4.5 mm
AI 0,5-8 WH AI 0,75-8 GY AI 1-8 RD AI 1,5-8 BK AI 2,5-8 BU	6.0 mm

For 2-wire connection



Ferrule	Dimension B
AI-TWIN 2 x 0,5-8 WH AI-TWIN 2 x 0,75-8 GY AI-TWIN 2 x 1-8 RD	7.0 mm
AI-TWIN 2 x 1,5-8 BK	8.0 mm

• Crimping Tool and Screwdriver Order No.

Tool Name	Phoenix Type	Order No.	Pcs. / Pkt.
Crimping Tool	CRIMPFOX UD 6	12 04 43 6	1
Screwdriver	SZS 0,6 x 2,5	12 05 04 0	10

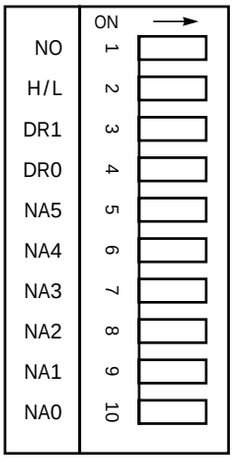
DIP Switch Settings

DIP switches are inside the protective lid. After setting the DIP switches, replace the lid into position.

All DIP switches are set to off before shipping from factory.

Set the DIP switches to select the node address (MAC ID: media access control identifier), data rate, output hold/load off, and physical port number.

Do not set the DIP switches to the “Selection Prohibited” positions.



Node Address (MAC ID)

Node Address	NA0	NA1	NA2	NA3	NA4	NA5	Node Address	NA0	NA1	NA2	NA3	NA4	NA5
0	OFF	OFF	OFF	OFF	OFF	OFF	32	OFF	OFF	OFF	OFF	OFF	**ON**
1	**ON**	OFF	OFF	OFF	OFF	OFF	33	**ON**	OFF	OFF	OFF	OFF	**ON**
2	OFF	**ON**	OFF	OFF	OFF	OFF	34	OFF	**ON**	OFF	OFF	OFF	**ON**
3	**ON**	**ON**	OFF	OFF	OFF	OFF	35	**ON**	**ON**	OFF	OFF	OFF	**ON**
4	OFF	OFF	**ON**	OFF	OFF	OFF	36	OFF	OFF	**ON**	OFF	OFF	**ON**
5	**ON**	OFF	**ON**	OFF	OFF	OFF	37	**ON**	OFF	**ON**	OFF	OFF	**ON**
6	OFF	**ON**	**ON**	OFF	OFF	OFF	38	OFF	**ON**	**ON**	OFF	OFF	**ON**
7	**ON**	**ON**	**ON**	OFF	OFF	OFF	39	**ON**	**ON**	**ON**	OFF	OFF	**ON**
8	OFF	OFF	OFF	**ON**	OFF	OFF	40	OFF	OFF	OFF	**ON**	OFF	**ON**
9	**ON**	OFF	OFF	**ON**	OFF	OFF	41	**ON**	OFF	OFF	**ON**	OFF	**ON**
10	OFF	**ON**	OFF	**ON**	OFF	OFF	42	OFF	**ON**	OFF	**ON**	OFF	**ON**
11	**ON**	**ON**	OFF	**ON**	OFF	OFF	43	**ON**	**ON**	OFF	**ON**	OFF	**ON**
12	OFF	OFF	**ON**	**ON**	OFF	OFF	44	OFF	OFF	**ON**	**ON**	OFF	**ON**
13	**ON**	OFF	**ON**	**ON**	OFF	OFF	45	**ON**	OFF	**ON**	**ON**	OFF	**ON**
14	OFF	**ON**	**ON**	**ON**	OFF	OFF	46	OFF	**ON**	**ON**	**ON**	OFF	**ON**
15	**ON**	**ON**	**ON**	**ON**	OFF	OFF	47	**ON**	**ON**	**ON**	**ON**	OFF	**ON**
16	OFF	OFF	OFF	OFF	**ON**	OFF	48	OFF	OFF	OFF	OFF	**ON**	**ON**
17	**ON**	OFF	OFF	OFF	**ON**	OFF	49	**ON**	OFF	OFF	OFF	**ON**	**ON**
18	OFF	**ON**	OFF	OFF	**ON**	OFF	50	OFF	**ON**	OFF	OFF	**ON**	**ON**
19	**ON**	**ON**	OFF	OFF	**ON**	OFF	51	**ON**	**ON**	OFF	OFF	**ON**	**ON**
20	OFF	OFF	**ON**	OFF	**ON**	OFF	52	OFF	OFF	**ON**	OFF	**ON**	**ON**
21	**ON**	OFF	**ON**	OFF	**ON**	OFF	53	**ON**	OFF	**ON**	OFF	**ON**	**ON**
22	OFF	**ON**	**ON**	OFF	**ON**	OFF	54	OFF	**ON**	**ON**	OFF	**ON**	**ON**
23	**ON**	**ON**	**ON**	OFF	**ON**	OFF	55	**ON**	**ON**	**ON**	OFF	**ON**	**ON**
24	OFF	OFF	OFF	**ON**	**ON**	OFF	56	OFF	OFF	OFF	**ON**	**ON**	**ON**
25	**ON**	OFF	OFF	**ON**	**ON**	OFF	57	**ON**	OFF	OFF	**ON**	**ON**	**ON**
26	OFF	**ON**	OFF	**ON**	**ON**	OFF	58	OFF	**ON**	OFF	**ON**	**ON**	**ON**
27	**ON**	**ON**	OFF	**ON**	**ON**	OFF	59	**ON**	**ON**	OFF	**ON**	**ON**	**ON**
28	OFF	OFF	**ON**	**ON**	**ON**	OFF	60	OFF	OFF	**ON**	**ON**	**ON**	**ON**
29	**ON**	OFF	**ON**	**ON**	**ON**	OFF	61	**ON**	OFF	**ON**	**ON**	**ON**	**ON**
30	OFF	**ON**	**ON**	**ON**	**ON**	OFF	62	OFF	**ON**	**ON**	**ON**	**ON**	**ON**
31	**ON**	**ON**	**ON**	**ON**	**ON**	OFF	63	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**

Data Rate

Data Rate	DR0	DR1
125k baud	OFF	OFF
250k baud	**ON**	OFF
500k baud	OFF	**ON**
(Selection Prohibited)	**ON**	**ON**

Output Hold or Load Off

Output / Load	H / L
LOAD OFF	OFF
HOLD	**ON**

Physical Port Number

Physical Port Number	NO
0	OFF
1	**ON**

Link Registers for DeviceNet Network Communication

DeviceNet network communication data is stored to link registers in the OpenNet Controller CPU module and the data is communicated through the DeviceNet slave module.

Since seven functional modules including the DeviceNet slave module can be mounted with one OpenNet Controller CPU module, link registers are allocated depending on the position where the DeviceNet slave module is mounted.

Link Register Allocation Numbers

Allocation Number	Area	Function	Description	R/W
L*00	Data area	Receive data	Stores received data from the network	Read
L*01	Data area	Receive data	Stores received data from the network	Read
L*02	Data area	Receive data	Stores received data from the network	Read
L*03	Data area	Receive data	Stores received data from the network	Read
L*04	Data area	Transmit data	Stores transmit data for the network	Write
L*05	Data area	Transmit data	Stores transmit data for the network	Write
L*06	Data area	Transmit data	Stores transmit data for the network	Write
L*07	Data area	Transmit data	Stores transmit data for the network	Write
L*12	Status area	Error data	Stores various error codes	Read
L*13	Status area	I/O counts	Stores the byte counts of transmit/receive data	Read
L*14	Status area	Connection status	Stores the allocation choice byte	Read
L*24	Reserved area	Software version	Stores the system software version	Read

Note: A number 1 through 7 comes in place of * depending on the position where the functional module is mounted, such as OpenNet interface module or analog I/O module. Consequently, operand numbers are automatically allocated to each functional module in the order of increasing distance from the CPU module, starting with L100, L200, L300, through L700.

Error Data (Status Area) L*12

L*12	b15	b14: unused	b13	b12-b9: unused	b8	b7-b0: unused

When an error occurs, the MNS or IO LED on the DeviceNet slave module goes on or flashes depending on the error, and a corresponding bit in the link register goes on. The status LED goes off when the cause of the error is removed. The error data bit remains on until the CPU is powered up again or reset.

b15 (initialization error)
This bit goes on when the CPU module fails to acknowledge the completion of initialization for communication with the DeviceNet slave module.

b13 (I/O error)
This bit goes on when an error occurs during communication through the CPU bus.

b8 (communication fault)
This bit goes on when a communication fault is detected.

I/O Counts (Status Area) L*13

L*13	b15-b12: transmit bytes	b11-b8: receive bytes	b7-b0: unused

This link register stores the transmit and receive byte counts selected in the **Function Area Setting** > **Open Bus** in WindLDR.

Connection Status (Status Area) L*14

L*14	b15-b8: allocation choice	b7-b0: unused

This link register stores the data of the allocation choice byte.

Software Version (Reserved Area) L*24

L*24	b15-b12: major revision	b11-b8: minor revision	b7-b0: unused

This link register stores the system software version number. [Example] Version 1.3 — 1: major revision, 3: minor revision

Function Area Setting for DeviceNet Slave Station

The quantity of transmit/receive data for DeviceNet network communication is specified using the Function Area Setting in WindLDR. The OpenNet Controller CPU module recognizes all functional modules, such as DeviceNet slave, LONWORKS interface, and analog I/O modules, automatically at power-up and exchanges data with the DeviceNet master station through the link registers allocated to each slave station (node).

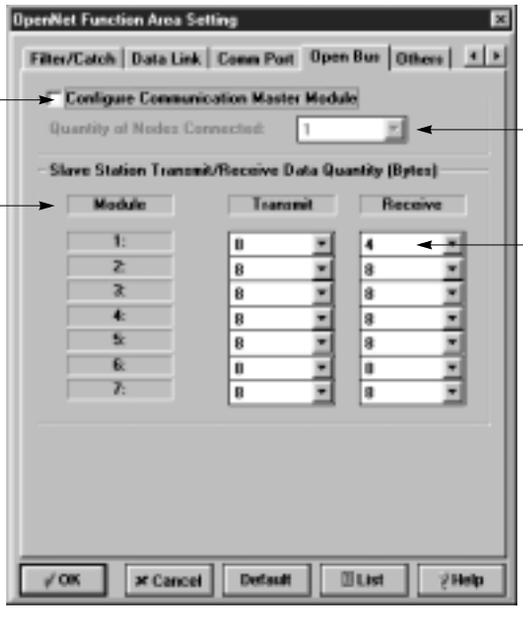
Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller CPU module after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Open Bus** tab.

Configure Communication Master Module Check Box
Check this box only when the remote I/O master module is used.

Slave Station Transmit / Receive Data Quantity (Bytes)
When using DeviceNet slave module or LONWORKS interface module, specify the data bytes to communicate through each slave or interface module.



Quantity of Nodes Connected
When using the remote I/O master module, specify the quantity of nodes from 1 through 32.

Transmit / Receive Bytes 0 to 8 (default: 8 bytes)
This value determines the data quantity 0 through 8 bytes (64 bits) to communicate with the DeviceNet master module.
For the example on the next page, select 8 transmit bytes and 4 receive bytes for Module 1.

3. Select transmit and receive data bytes for module position 1 through 7 where the DeviceNet slave module is mounted.
4. Click the **OK** button and download the user program to the OpenNet Controller.

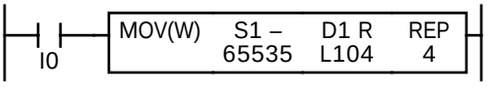
Programming Transmit / Receive Data Using WindLDR

The OpenNet interface module, such as DeviceNet slave or LONWORKS interface module, exchanges data between the open network and the link registers in the CPU module allocated to the OpenNet interface module, depending on the slot where the OpenNet interface module is mounted.

To create a communication program for an OpenNet interface module, first determine the slot number where the OpenNet interface module is mounted, and make a program to write data to link registers allocated to transmit data and to read data from link registers allocated to receive data.

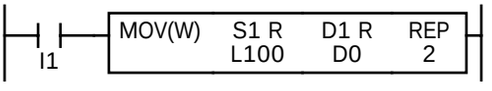
Example: When a DeviceNet slave module is mounted in the first slot of all functional modules

- **Transmit Data**



65535 → L104 through L107
When input I0 is on, constant 65535 (FFFFh) designated by source operand S1 is moved to four link registers L104 through L107 designated by destination operand D1. All 64 bits (8 bytes) in link registers L104 through L107 are turned on. Since link registers L104 through L107 transmit data, the data is transmitted to the network.

- **Receive Data**



L100·L101 → D0·D1
When input I1 is on, 32-bit (4-byte) data in two link registers L100 and L101 designated by source operand S1 is moved to data registers D0 and D1 designated by destination operand D1. Since link registers L100 and L101 receive data, communication data read to L100 and L101 is moved to data registers D0 and D1.

Starting Operation

1. Set up the OpenNet Controller CPU and DeviceNet slave modules, and connect the DeviceNet slave module to the DeviceNet network using DeviceNet cables.
2. Power up the CPU module and download the user program to the CPU module using WindLDR.
3. Start the CPU module to run, then DeviceNet communication starts.

The delay until the communication starts after power-up depends on the size of the user program and the system setup.

While the CPU is stopped, data exchange between the CPU and DeviceNet slave modules is halted, but communication with the DeviceNet network continues.

Data exchange between the CPU and DeviceNet slave modules is asynchronous with the user program scanning in the CPU module.

Transmission Time

The response time of the DeviceNet network varies greatly depending on factors such as the quantity of nodes, data bytes, and DeviceNet system setup. To determine the accurate response time, confirm the response time on the actual network system.

The following example describes a response time in a DeviceNet network system comprised of IDEC SX5D communication I/O terminals.

Example: DeviceNet Transmission Time

- **System Setup**

  PLC: 1747-L532 (SLC5/03 CPU made by Rockwell Automation)

  Master: 1747-SDN (SLC500 DeviceNet Scanner Module made by Rockwell Automation)

  Slaves: SX5D-SBM16K (8pt transistor source input / 8pt transistor sink output)
  SX5D-SBM16P (8pt transistor sink input / 8pt transistor protect source output)
  SX5D-SBR08 (8pt relay output)

  Data Rate: 125k baud

  Operation Mode: Communication according to the scan list in the master

- **System Operation (Data Flow)**

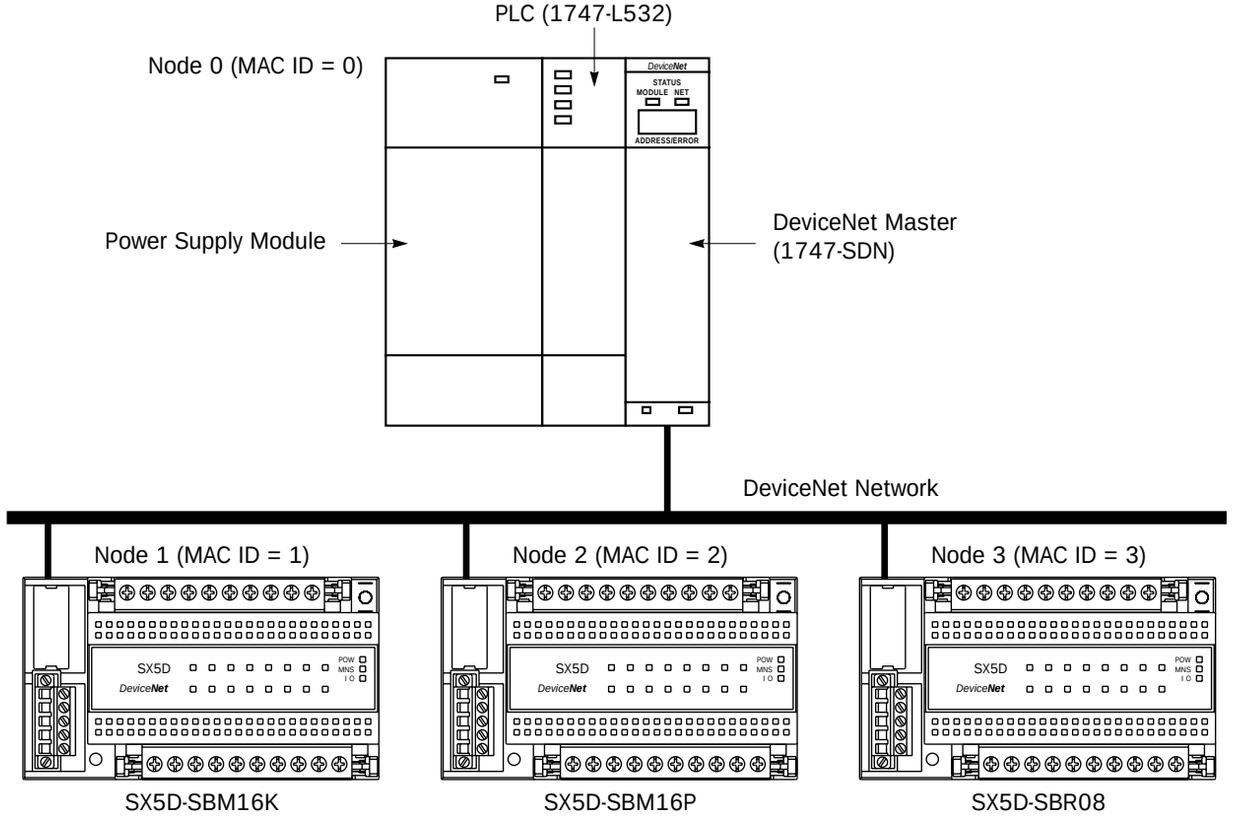
  (1) SX5D-SBM16K sends 8-input data to the master, and the master sends 8-output data to SX5D-SBM16K.
  (2) SX5D-SBM16P sends 8-input data to the master, and the master sends 8-output data to SX5D-SBM16P.
  (3) SX5D-SBM16K sends 8-input data to the master, and the master sends 8-output data to SX5D-SBR08.

- **Calculating the Response Time**

  Response time = Input processing time (slave) + Communication time (slave to master) + Data processing time (master and PLC) + Communication time (master to slave) + Output processing time (slave)

- **Measured Value of Response Time**

  SX5D-SBM16K Input ON/OFF → SX5D-SBM16K Output ON/OFF response time = Approx. 18 msec



DeviceNet Network Troubleshooting

Three LED indicators are provided on the DeviceNet slave module. When a trouble occurs during DeviceNet communication, these status LEDs go on or flash depending on the error. When the LEDs go on or flash, locate the error referring to the table described below.

Probable Causes for Network Errors

When a trouble occurs during DeviceNet communication, the following causes are suspected.

- Strong external noise
- The power voltage to the DeviceNet slave module has dropped below the minimum operating voltage (at least momentarily).
- Use of a faulty communication line, incorrect cable, or transmission over the rated distance
- Improper terminator

DeviceNet master module fails to recognize the DeviceNet slave module

Status LEDs on DeviceNet Slave Module			Cause	Action
POW	MNS	IO		
OFF	OFF	OFF	Power is not supplied to the OpenNet Controller CPU module	Supply 24V DC to the OpenNet Controller CPU module
				Plug in the expansion connector correctly
Green ON	OFF	OFF	Power is not supplied to the DeviceNet interface	Plug in the communication connector correctly
				Connect the DeviceNet power lines red (V+) and black (V–) correctly
				Supply 11-25V DC to the DeviceNet power line
Green ON	OFF	Green ON	Master is not found	Plug in the communication connector correctly
				Set the data rate correctly using DIP switches
				Set the data rate of the master station correctly
				Make sure that network wiring is correct in the entire DeviceNet network, without short circuit or disconnection
				Connect terminators (121Ω) at both ends of the network
Green ON	Red ON	Green ON	Physical communication trouble or duplicate MAC ID exists in the network	Plug in the communication connector correctly
				Set the data rate correctly using DIP switches
				Set the MAC ID correctly using DIP switches
				Make sure that nodes with duplicate MAC ID does not exist in the same network
				Make sure that network wiring is correct in the entire DeviceNet network, without short circuit or disconnection
				Connect terminators (121Ω) at both ends of the network
Green ON	Green Flash	Green ON	Slave operates normally, but is not recognized by the master	Supply power to the DeviceNet master
				Make sure that the settings for the master are correct
				Plug in the communication connector correctly
				Set the data rate correctly using DIP switches
				Set the MAC ID correctly using DIP switches
				Make sure that network wiring is correct in the entire DeviceNet network
				Connect terminators (121Ω) at both ends of the network

Communication error occurs

Status LEDs on DeviceNet Slave Module			Cause	Action
POW	MNS	IO		
OFF	OFF	OFF	Power is not supplied to the OpenNet Controller CPU module	Supply 24V DC to the OpenNet Controller CPU module
				Plug in the expansion connector correctly
Green ON	Red ON	Green ON	Physical communication problem exists in the network	Plug in the communication connector correctly
				Make sure that network wiring is correct in the entire DeviceNet network, without short circuit or disconnection
				Make sure that the network is not affected by noise
Green ON	Red ON	Green ON or Red Flash	Data from the master does not arrive	Make sure that the master is operating
				Plug in the communication connector correctly
				Make sure that network wiring is correct in the entire DeviceNet network, without short circuit or disconnection
				Make sure that the network is not affected by noise
Green ON	Green Flash	Green ON	Communication with the master is not established	Make sure that the settings for the master are correct
				Make sure that the slave is not stopped by power-down or other causes (if automatic recovery is enabled at the master, communication resumes when power is restored at the slave)
				Plug in the communication connector correctly
				Make sure that network wiring is correct in the entire DeviceNet network, without short circuit or disconnection
				Supply 11-25V DC to the DeviceNet power line

OpenNet Controller link registers cannot receive data from the network correctly

Status LEDs on DeviceNet Slave Module			Cause	Action
POW	MNS	IO		
ON or OFF	ON or OFF	ON or OFF	Incorrect setting or communication error	Make sure that the settings for the master are correct
				Set the transmit/receive bytes in the Function Area Settings correctly
				Make sure that the link register numbers are correct
				See “DeviceNet Master Module fails to recognize the slave module” and “Communication error occurs” described above

OpenNet Controller link registers cannot send out data to the network correctly

Status LEDs on DeviceNet Slave Module			Cause	Action
POW	MNS	IO		
ON or OFF	ON or OFF	ON or OFF	Incorrect setting or communication error	Make sure that the settings for the master are correct
				See “DeviceNet Master Module fails to recognize the slave module” and “Communication error occurs” described above

26: LONWORKS INTERFACE MODULE

Introduction

This chapter describes LONWORKS interface module FC3A-SX5LS1 used with the OpenNet Controller to interface with the LONWORKS® network, and provides details on the LONWORKS system setup and the LONWORKS interface module specifications.

The OpenNet Controller can be linked to LONWORKS networks. For communication through the LONWORKS network, the LONWORKS interface module is available. Mounting the LONWORKS interface module beside the OpenNet Controller CPU module makes up a node on a LONWORKS network. The node can communicate I/O data with other nodes in a distributed network.

LONWORKS Interface Module Features

The LONWORKS interface module conforms to the specifications of LONWORKS that is recognized worldwide as a de facto industry standard open network, so the OpenNet Controller can be linked to the LONWORKS networks consisting of LONWORKS compliant products manufactured by many different vendors, such as I/O terminals, sensors, drives, operator interfaces, and barcode readers. The flexible, configurable, and interoperable features of the LONWORKS network make it possible to build, expand, or modify production lines with reduced cost.

The transmit/receive data quantity can be selected from 0 through 8 bytes (64 bits) in 1-byte increments. One LONWORKS interface module enables the OpenNet Controller CPU module to transmit 64 bits and receive 64 bits at the maximum to and from the LONWORKS network.

The network can be configured either in bus or free topology. The total transmission distance can be 1,400m in bus topology and 500m in free topology. The free topology makes it possible to configure a flexible network.

About LON

The LON® (Local Operating Network) technology is a network control system developed by Echelon, USA. The LON technology is an intelligent, distributed network for communication with various sensors and actuators at a maximum of 32,385 nodes.

LONWORKS is the open control standard for buildings, factories, houses, and transportation systems. Now, LONWORKS networks are widely used in major building automation (BA), process automation (PA), and many other industries in the world.

Communication between application programs installed in LonWorks compliant nodes is performed using the LonTalk protocol based on the reference model of the Open System Interconnection (OSI) issued by the International Standard Organization (ISO).

LONWORKS Network Components

Physical Layer — Transceiver

The LONWORKS interface module incorporates an FTT-10A (Free Topology Twisted Pair Transceiver) for the physical layer. The FTT-10A transceiver is a transformer-isolated type and has the following specifications:

Name	Communication Media	Transmission Rate	Transmission Distance	Topology
FTT-10A Transceiver	Twisted pair cable	78 kbps	500m (maximum total wire length) 400m (maximum node-to-node distance)	Free
			1,150m	Bus

Note: The transmission distance is the value when Level 4 AWG22 cables and proper terminators are used.

LonTalk Protocol

The LonTalk protocol has all seven layers in compliance with the reference model of the Open System Interconnection (OSI) issued by the International Standard Organization (ISO).

Neuron Chip

Some special LSI Neuron Chips that support the LonTalk protocol have firmware embedded in the built-in memory. The Neuron Chip used in the LONWORKS interface module is Toshiba TMP3150B1AF, with firmware embedded in the external memory (flash memory). This Neuron Chip uses a 10MHz quartz clock oscillator. The Neuron Chip and peripheral circuit are powered through the CPU bus.

Application Program

The application program for the LONWORKS interface module is in compliance with the application layer of the OSI reference model, and is described in Neuron C that is derived from ANSI C.

Communication data is transferred through the registers located between the OpenNet Controller CPU bus and the Neuron Chip external memory expansion bus. An application program including access to the registers is created and embedded in the external memory (flash memory) along with firmware by IDEC before shipment. Users do not have to create and install application programs, although programmers familiar with Neuron C can also create or modify the application program using a special tool, such as LonBuilder Developer's Kit. When a user creates or modifies the application program, the user must keep a backup file. For application program examples, see pages 26-18 through 26-22.

Network Variables

The LonTalk protocol allocates communication data to network variables (NV) specifically designed to simplify the procedures for packet transmission. The variables are available in input network variables and output network variables. The values of output network variables are transmitted to input network variables of the target node on the network. Details are described on pages 26-9 and 26-23.

Network Management

When setting up a LONWORKS network system, the user has to install network configuration information shown below.

Addressing:	Determines each node address
Binding:	Determines target nodes to communicate with
Configuration:	Determines the type of message service, retry cycles, timeout period, etc.

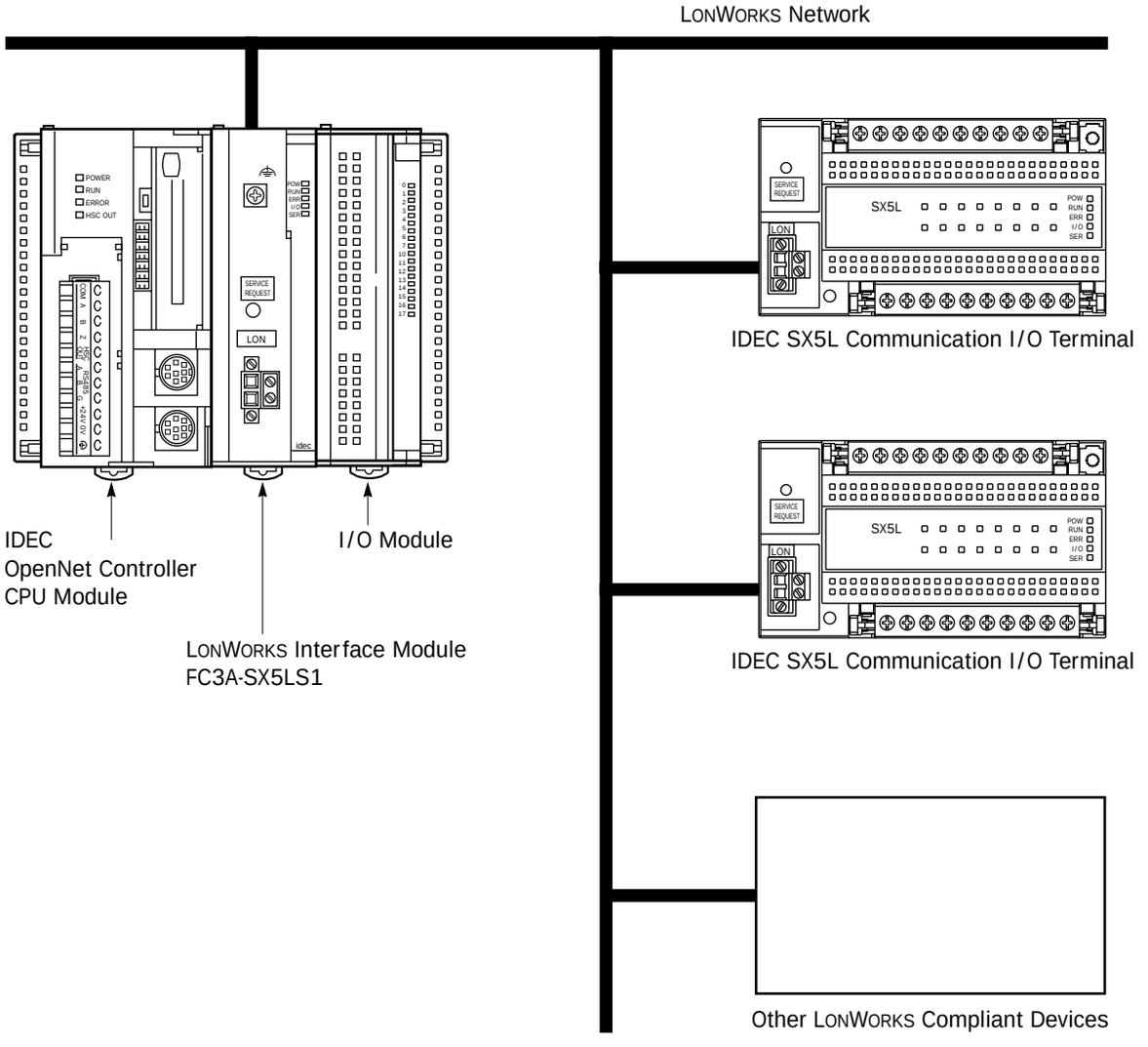
Use a network management tool from other manufacturers (such as LonMaker for Windows Integration Tool) to install network configuration information. An external interface file (XIF extension) unique to each product series is needed to install the network configuration information. The external interface file for the LONWORKS interface module is available from IDEC. The user must keep a backup file of the information used for network management.

LONWORKS Network System Setup

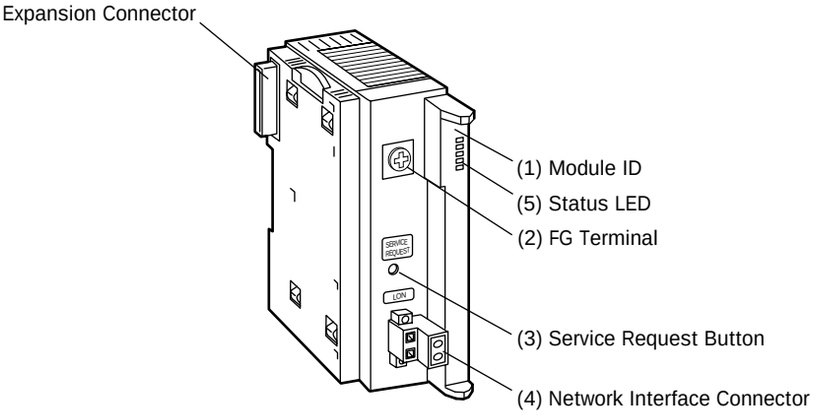
Various LONWORKS compliant devices, such as the LONWORKS interface module and IDEC SX5L communication I/O terminals, can be connected to the LONWORKS network.

The OpenNet Controller can be used as a node by adding the LONWORKS interface module to the right of the OpenNet Controller CPU module.

A maximum of seven OpenNet interface modules, such as LONWORKS interface modules and DeviceNet slave modules, and analog I/O modules can be mounted with one OpenNet Controller CPU module.



LONWORKS Interface Module Parts Description



Module Name	LONWORKS Interface Module
Type No.	FC3A-SX5LS1

(1) Module ID FC3A-SX5LS1 indicates the LONWORKS interface module ID.

(2) FG Terminal Frame ground terminal

(3) Service Request Button Pushbutton used for network management

(4) Network Interface Connector For connecting the LONWORKS communication cable

(5) Status LED Indicates operating status

Indicator	Status		Description
POW (POWER)	—	OFF	Module power OFF
	Green	ON	Module power ON
RUN	Green	ON	Normal operation
ERR (COM_ERROR)	—	OFF	Normal operation
	Red	ON	Communication error
I/O (I/O_ERROR)	—	OFF	Normal operation
	Red	ON	Access error to the CPU through I/O bus
SER (SERVICE)	Yellow	ON	Application program not configured
		Flash	Network management not configured

LONWORKS Interface Module Specifications

Normal Operating Conditions

Operating Ambient Temperature	0 to +55°C (no freezing)
Storage Temperature	–25 to +70°C (no freezing)
Operating Humidity	Level RH1 30 to 90% (no condensation)
Pollution Degree	2 (IEC 60664)
Corrosion Immunity	Free from corrosive gases
Altitude	Operation: 0 to 2000m Transportation: 0 to 3000m
Vibration Resistance	10 to 57 Hz, amplitude 0.075 mm; 57 to 150 Hz, acceleration 9.8 m/sec^2 (1G); 10 sweep cycles each in 3 axes (total 80 minutes) (IEC1131)
Shock Resistance	147 m/sec^2 (15G), 11 msec, 3 shocks each in 3 axes (IEC1131)

Power Supply (supplied from the OpenNet Controller CPU module)

Dielectric Strength	Between power terminal on CPU module and FG: 500V AC, 1 minute
Insulation Resistance	Between power terminal on CPU module and FG: 10 MΩ (500V DC megger)
Current Draw	Approx. 30 mA

Grounding

Ground Terminal	M3 sems
Grounding Resistance	100Ω maximum
Grounding Wire	UL1015 AWG22, UL1007 AWG18

Weight

Weight	Approx. 180g

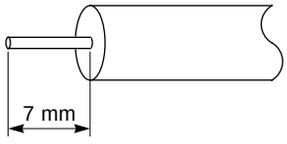
Communication Specifications

Communication System	LON® system
Transceiver	FTT-10A (Free Topology Twisted Pair Transceiver made by Echelon)
Transmission Rate	78 kbps
Transmission Distance (when using Level 4 AWG22 cables)	Free topology: Total 500m (400m maximum between nodes) Bus topology: 1,150m (when using FTT-10A transceivers only)
Maximum Nodes	32,385 nodes in a network
Network Interface Connector	In the module: MSTB2.5/2-GF-5.08 (made by Phoenix Contact) To the cable: FRONT-MSTB2.5/2-STF-5.08 (made by Phoenix Contact)
Network Cable	1-wire connection: 0.2 to 2.5 mm^2, AWG24 to 14 2-wire connection: 0.2 to 1.5 mm^2, AWG24 to 16

Wiring LONWORKS Interface Module

Precautions for Wiring

- Use a twisted-pair cable to connect the LONWORKS interface module to the network. Do not run the network cable in parallel with or near power lines, output lines, and motor lines. Keep the network cable away from noise sources.
- Power down the LONWORKS interface module before you start wiring. Make sure wiring is correct before powering up the LONWORKS interface module.
- One or two cables can be connected to one terminal of the network interface connector. When connecting one cable, use AWG24 to AWG14 cables (core cross-section 0.2 to 2.5 mm^2). When connecting two cables to one terminal, use the same cables of AWG24 to AWG16 (0.2 to 1.5 mm^2). Do not use cables of different diameters. Strip the cable insulation as shown at right.



- Tighten the mounting screws of the network interface connector to a recommended torque of 0.3 to 0.5 N·m.
- Tighten the terminal screws of the network interface connector to a recommended torque of 0.5 to 0.6 N·m.
- To prevent electrical shocks or communication error due to noises, connect the FG terminal to a proper ground using a grounding wire of UL1015 AWG22 or UL1007 AWG18 (grounding resistance 100Ω maximum). Do not connect the grounding wire in common with the grounding wire of motor equipment.

Ferrules, Crimping Tool, and Screwdriver for Phoenix Terminal Blocks

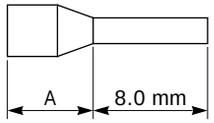
The screw terminal block of the network interface connector can be wired with or without using ferrules on the end of the cable. Applicable ferrules for the terminal block and crimping tool for the ferrules are listed below. Use a screwdriver to tighten the screw terminals on the LONWORKS interface module. Ferrules, crimping tool, and screwdriver are made by and available from Phoenix Contact.

Type numbers of Phoenix Contact ferrules, crimping tool, and screwdriver are listed below. When ordering these products from Phoenix Contact, specify the Order No. and quantity listed below.

• Ferrule Order No.

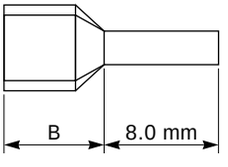
Applicable Wire Size		For 1-wire connection		For 2-wire connection		Pcs. / Pkt.
mm^2	AWG	Phoenix Type	Order No.	Phoenix Type	Order No.	
0.25	24	AI 0,25-8 YE	32 00 85 2	—	—	100
0.5	20	AI 0,5-8 WH	32 00 01 4	AI-TWIN 2 x 0,5-8 WH	32 00 93 3	100
0.75	18	AI 0,75-8 GY	32 00 51 9	AI-TWIN 2 x 0,75-8 GY	32 00 80 7	100
1.0	18	AI 1-8 RD	32 00 03 0	AI-TWIN 2 x 1-8 RD	32 00 81 0	100
1.5	16	AI 1,5-8 BK	32 00 04 3	AI-TWIN 2 x 1,5-8 BK	32 00 82 3	100
2.5	14	AI 2,5-8 BU	32 00 52 2	—	—	100

For 1-wire Connection



Ferrule	Dimension A
AI 0,25-8 YE	4.5 mm
AI 0,5-8 WH AI 0,75-8 GY AI 1-8 RD AI 1,5-8 BK AI 2,5-8 BU	6.0 mm

For 2-wire connection



Ferrule	Dimension B
AI-TWIN 2 x 0,5-8 WH AI-TWIN 2 x 0,75-8 GY AI-TWIN 2 x 1-8 RD	7.0 mm
AI-TWIN 2 x 1,5-8 BK	8.0 mm

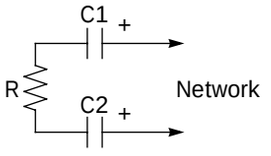
• Crimping Tool and Screwdriver Order No.

Tool Name	Phoenix Type	Order No.	Pcs. / Pkt.
Crimping Tool	CRIMPFOX UD 6	12 04 43 6	1
Screwdriver	SZS 0,6 x 2,5	12 05 04 0	10

Terminator

Terminators must be connected to the LONWORKS network. When setting up a network, connect one or two terminators depending on the topology. The terminator consists of one resistor and two capacitors as illustrated below:

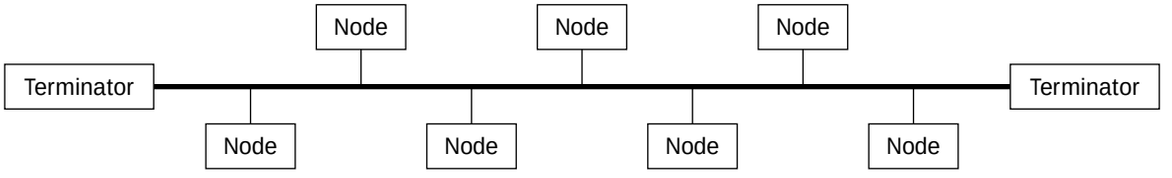
Terminator Configuration



Bus Topology

Connect terminators to the both ends of the bus topology network.

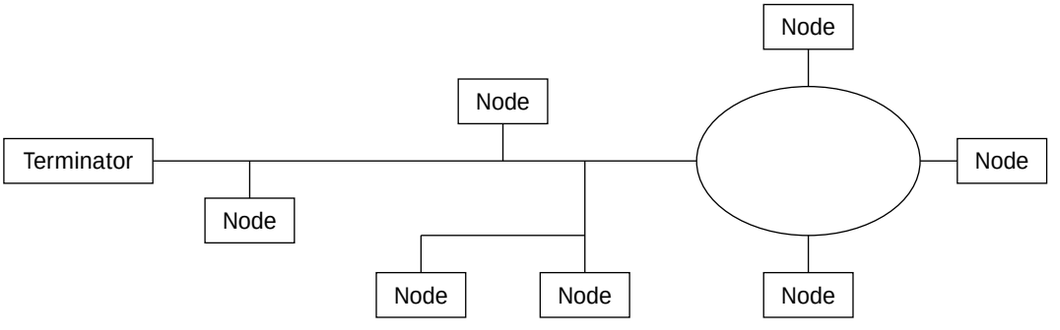
R	105Ω, 1%, 1/8W
C1 and C2	100 µF, ≥50V (note the polarity)



Free Topology

Connect a terminator to any position on the free topology network.

R	52.3Ω, 1%, 1/8W
C1 and C2	100 µF, ≥50V (note the polarity)



Link Registers for LONWORKS Network Communication

LONWORKS network communication data is stored to link registers in the OpenNet Controller CPU module and the data is communicated through the LONWORKS interface module.

Since seven functional modules, including a LONWORKS interface module, can be mounted with one OpenNet Controller CPU module, link registers are allocated depending on the position where the LONWORKS interface module is mounted.

Link Register Allocation Numbers

Allocation Number	Area	Function	Description	R/W
L*00	Data area	Receive data	Stores received data from the network	Read
L*01	Data area	Receive data	Stores received data from the network	Read
L*02	Data area	Receive data	Stores received data from the network	Read
L*03	Data area	Receive data	Stores received data from the network	Read
L*04	Data area	Transmit data	Stores transmit data for the network	Write
L*05	Data area	Transmit data	Stores transmit data for the network	Write
L*06	Data area	Transmit data	Stores transmit data for the network	Write
L*07	Data area	Transmit data	Stores transmit data for the network	Write
L*12	Status area	Error data	Stores various error codes	Read
L*13	Status area	I/O counts	Stores the byte counts of transmit/receive data	Read
L*24	ID area	Software version	Stores the user application software version	Read
L*25	ID area	Expansion module ID	Stores the user program module ID	Read

Note: A number 1 through 7 comes in place of * depending on the position where the functional module is mounted, such as OpenNet interface module or analog I/O module. Consequently, operand numbers are automatically allocated to each functional module in the order of increasing distance from the CPU module, starting with L100, L200, L300, through L700.

Error Data (Status Area) L*12

L*12	b15	b14: unused	b13	b12	b11	b10-b0: unused

When an error occurs, the I/O or ERR LED on the LONWORKS interface module goes on, according to the error, and a corresponding bit in the link register goes on. The status LED goes off when the cause of the error is removed. The error data bit remains on until the CPU is powered up again or reset.

b15 (initialization error)
This bit goes on when the CPU module fails to acknowledge the completion of initialization for communication with the LONWORKS interface module. When this bit goes on, the I/O LED also goes on.

b13 (I/O error)
This bit goes on when an error occurs during communication with the LONWORKS interface module through the CPU bus. When this bit goes on, the I/O LED also goes on.

b12 (transaction timeout)
This bit goes on when the CPU module fails to receive an acknowledge reply during communication through the LONWORKS network, with the acknowledge (ACKD) service enabled. When this bit goes on, the ERR LED also goes on. The transaction timeout is enabled only when the ACKD service is selected.

b11 (transmission error)
This bit goes on when a CRC error is detected while receiving incoming data from the LONWORKS network. When this bit goes on, the ERR LED also goes on.

I/O Counts (Status Area) L*13

L*13	b15-b12: transmit bytes	b11-b8: receive bytes	b7-b0: unused

This link register stores the transmit and receive byte counts selected in the **Function Area Setting** > **Open Bus** in WindLDR.

Link Registers and Network Variables

Network variables are allocated to data areas of the link registers as shown below.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
L*00	nv_i8[1]								nv_i8[0]							
L*01	nv_i8[3]								nv_i8[2]							
L*02	nv_i8[5]								nv_i8[4]							
L*03	nv_i8[7]								nv_i8[6]							
L*04	nv_o8[1]								nv_o8[0]							
L*05	nv_o8[3]								nv_o8[2]							
L*06	nv_o8[5]								nv_o8[4]							
L*07	nv_o8[7]								nv_o8[6]							

- **Example**

Network variables nv_i8[0] and nv_i8[1] are allocated to link register data areas L100.00 through L100.15 as listed below.

	nv_i8[1]								nv_i8[0]							
L100	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 1	0	0	0	1	1	1	LSB 1	MSB 0	1	0	0	0	1	1	LSB 1

Transmission Time

The transmission time depends on the network configuration, application program, and user program. It is recommended that you confirm the transmission time on the actual network system.

Processing transmit and receive data to and from the LONWORKS network is described below:

- **Processing Transmit Data**

The data in link registers are updated each time the CPU module scans the user program. The LONWORKS interface module reads data from the link registers allocated to transmit data in the OpenNet Controller CPU module. When any changes are found in the comparison between the new and old read data, the interface module updates the transmit network variables of which the data has been changed, and the new data is transmitted to the network.

The refresh cycle of reading from the link register to the interface module is approximately 15 msec. When the data in the link register is changed within 15 msec, the preceding data is not transmitted to the interface module. Data communication between the CPU module and the interface module through link registers is not in synchronism with the user program scanning.

When the CPU is powered up, the transmit data in the link registers are cleared to 0. Consequently, 0 cannot be transmitted in the first cycle immediately after the CPU is powered up because the transmit network variables are not updated.

- **Processing Receive Data**

When the interface module receives data from the network, corresponding receive network variables are updated, and the updated data is stored to the receive data area of link registers in the CPU module.

The refresh cycle of reading from the interface module to the link register is also approximately 15 msec, and is not in synchronism with the user program scanning. When the interface module receives subsequent data within 15 msec, the incoming data is stored in the buffer and is transmitted to link registers every 15 msec. The data in the link register is read each time the CPU module scans the user program.

Function Area Setting for LONWORKS Node

The quantity of transmit/receive data for LONWORKS network communication is specified using the Function Area Setting in WindLDR. The OpenNet Controller CPU module recognizes all functional modules, such as LONWORKS interface, DeviceNet slave, and analog I/O modules, automatically at power-up and exchanges data with LONWORKS nodes through the link registers allocated to each node.

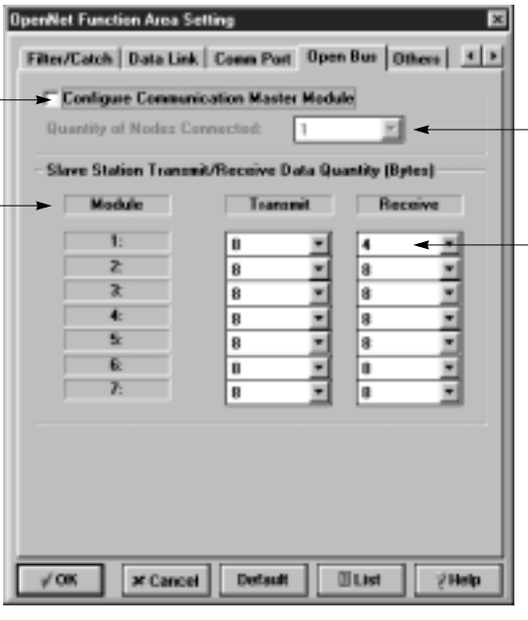
Since these settings relate to the user program, the user program must be downloaded to the OpenNet Controller CPU module after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configure** > **Function Area Settings**. The Function Area Setting dialog box appears.
2. Select the **Open Bus** tab.

Configure Communication Master Module Check Box
Check this box only when the remote I/O master module is used.

Slave Station Transmit/Receive Data Quantity (Bytes)
When using LONWORKS interface module or DeviceNet slave module, specify the data bytes to communicate through each interface or slave module.



Quantity of Nodes Connected
When using the remote I/O master module, specify the quantity of nodes from 1 through 32.

Transmit/Receive Bytes 0 to 8 (default: 8 bytes)
This value determines the data quantity 0 through 8 bytes (64 bits) to communicate with the network.
For the example on the next page, select 8 transmit bytes and 4 receive bytes for Module 1.

3. Select transmit and receive data bytes for module position 1 through 7 where the LONWORKS interface module is mounted.
4. Click the **OK** button and download the user program to the OpenNet Controller.

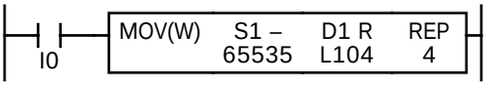
Programming Transmit / Receive Data Using WindLDR

The OpenNet interface module, such as LONWORKS interface or DeviceNet slave module, exchanges data between the open network and the link registers in the CPU module allocated to the OpenNet interface module, depending on the slot where the OpenNet interface module is mounted.

To create a communication program for an OpenNet interface module, first determine the slot number where the OpenNet interface module is mounted, and make a program to write data to link registers allocated to transmit data and to read data from link registers allocated to receive data.

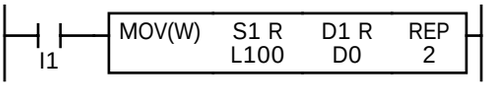
Example: When a LONWORKS interface module is mounted in the first slot of all functional modules

• Transmit Data



65535 → L104 through L107
When input I0 is on, constant 65535 (FFFFh) designated by source operand S1 is moved to four link registers L104 through L107 designated by destination operand D1. All 64 bits (8 bytes) in link registers L104 through L107 are turned on. Since link registers L104 through L107 transmit data, the data is transmitted to the network.

• Receive Data



L100·L101 → D0·D1
When input I1 is on, 32-bit (4-byte) data in two link registers L100 and L101 designated by source operand S1 is moved to data registers D0 and D1 designated by destination operand D1. Since link registers L100 and L101 receive data, communication data read to L100 and L101 is moved to data registers D0 and D1.

Starting Operation

The LONWORKS network requires installation of network configuration information into each node. When setting up the LONWORKS network for the first time, follow the procedures described below:

1. Set up the OpenNet Controller CPU and LONWORKS interface modules, connect the LONWORKS interface module to the LONWORKS network using LONWORKS cables, and power up the CPU module.
2. Connect a network management tool to the network and install network configuration information to the LONWORKS interface module. See Network Management described below.
3. Download the user program to the CPU module.
4. Start the CPU module to run, then the CPU module starts to communicate with other nodes on the LONWORKS network as specified in the network configuration information and user program.

The delay until the communication starts after power-up depends on the size of the user program and the system setup.

While the CPU is stopped, data exchange between the CPU and LONWORKS interface modules is halted, but communication with the LONWORKS network continues.

Data exchange between the CPU and LONWORKS interface modules is asynchronous with the user program scanning in the CPU module.

Network Management

When setting up a LONWORKS network system, the user has to install network configuration information into each node. Use a network management tool available from other manufacturers (such as LonMaker for Windows Integration Tool) to install network configuration information. An external interface file (XIF extension) unique to each product series is needed to install the network configuration information. The external interface file for the LONWORKS interface module is available from IDEC. Find an XIF No. printed on the side of the LONWORKS interface module or on the shipping package. When requesting an external interface file, inform IDEC of the XIF No. that represents the external interface file version number. Without a correct external interface file of the matching XIF No., network configuration information cannot be installed successfully.

The network configuration information includes addressing, binding, and configuration.

Addressing:	Determines each node address
Binding:	Determines target nodes to communicate with
Configuration:	Determines the type of message service, retry cycles, timeout period, etc.

⚠ Caution

- When using the LONWORKS interface module, select the acknowledge (ACKD) service to enable the message service for network variables and set the retry cycles to a value of 1 or more. If communication is performed using other than the ACKD service, the ERR LED on the interface module does not function properly.
- When installing the network configuration information without modifying the application program, an external interface file (XIF extension) containing information, such as the network variables of the LONWORKS interface module, is needed. Consult IDEC for the external interface file.
- The user must keep a backup file of the network configuration information used for network management.

Precautions for Modifying Application Program

The LONWORKS interface module is shipped with a standard application program installed. Users with expertise in programming can also modify or create application programs using a special programming tool, such as LonBuilder Developer's Kit. The application program is written in Neuron C. Read this section before starting modifications.

Define Neuron Chip I/O pins

As shown in the sample program on page 19, define I/O pins IO.0 through IO.4 and IO.6 of the Neuron Chip. If these pins are not defined correctly, the LONWORKS interface module may be damaged. For the description of I/O pins, see page 26-15.

Include necessary codes in the application program

When you modify or create an application program, make sure that the codes shown in italics in the application program examples on pages 26-18 through 26-22 are included in the application program.

Defined network variables

The application program installed in the LONWORKS interface module defines network variables for transmit and receive data listed on page 26-23. When you modify or create an application program, do not use these variable names, otherwise verification of the application program will be difficult.

Precautions for writing and reading registers

Make a program to write and read data to and from registers in the LONWORKS interface module as shown in the sample programs on pages 26-21 and 26-22.

While data write or read is in progress, do not execute any other command.

Precautions for downloading an application program to the flash memory through the network

A special tool is required to download an application program. Before starting download, stop the OpenNet Controller CPU operation. While downloading is in progress, make sure the power voltage is within the rated operating voltage range.

Precautions for flash memory used for the application program

Do not store variables to the flash memory. To hold variables and other data while power is off, use the RAM backup function of the CPU module.

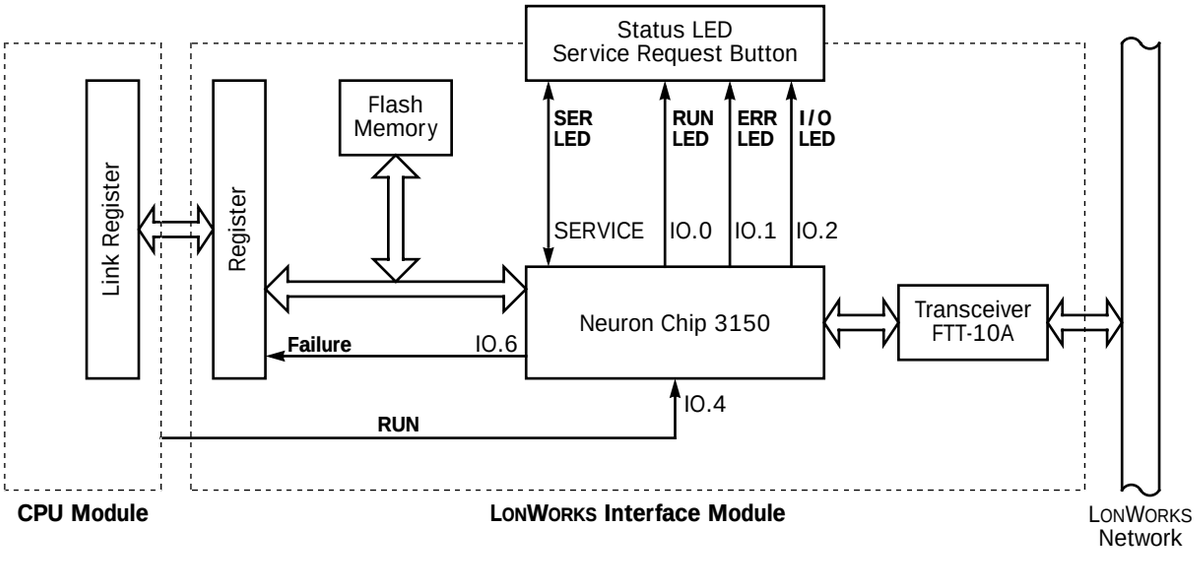
The flash memory can be rewritten a maximum of 10,000 times.

Precautions for system setup

Set the retry cycles of the message service to a value of 1 or more.

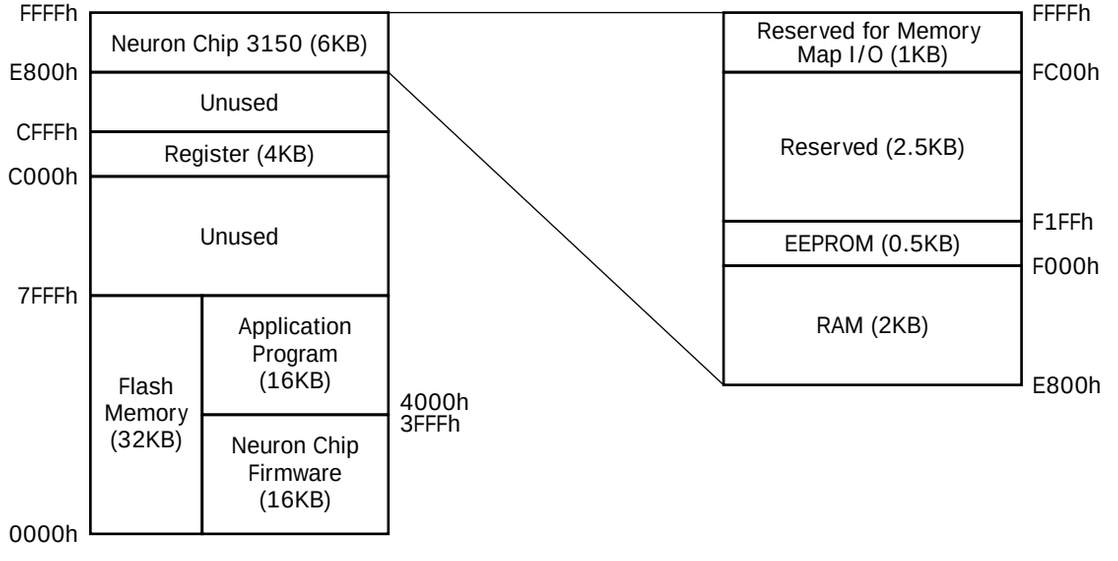
LONWORKS Interface Module Internal Structure

The LONWORKS interface module block diagram is illustrated in the figure below:



Memory Map

The LONWORKS interface module memory map is illustrated in the figure below:



Flash Memory

The LONWORKS interface module contains a 32KB nonvolatile rewritable memory. Of the 32KB memory area, a 16KB area of 0000h through 3FFFh is allocated to the Neuron Chip firmware, and the remaining 16KB area of 4000h through 7FFFh is allocated to the application program.

Neuron Chip I/O Pins and Status LEDs

Neuron Chip I/O pins and status LEDs are assigned as listed below:

I/O Pin No.	I/O	Signal Name	Description
0	Output	RUN LED	Controls the RUN LED (green). 0: ON, 1: OFF
1	Output	ERR LED	Controls the ERR LED (red). 0: ON, 1: OFF
2	Output	I/O LED	Controls the I/O LED (red). 0: ON, 1: OFF
3	Input	—	The IO.3 pin must be defied as an input when the application program is modified by the user. See page 26-19.
4	Input	RUN	Monitors the CPU module operating status. 0: CPU stopped, 1: CPU in operation
5	—	unused	
6	Output	Failure	Error signal to the CPU 0: The Neuron Chip cannot write data to registers. When modifying the application program, make sure to turn this pin to 0 when an unrecoverable critical error occurs. 1: Normal operation
7-10	—	unused	

Registers

The OpenNet Controller CPU module exchanges communication data through the registers in the LONWORKS interface module. The register addresses are listed in the table below:

Address	Name	Data Flow Direction		Description
		CPU Module	Interface Module	
C000h - C007h	Data register (8 bytes)	←		Allocate network variables to these addresses to exchange data between the CPU and interface modules.
C008h - C00Fh	Data register (8 bytes)		→	
C010h - C011h	reserved	—	—	Do not write data into this area.
C012h	Error data	←		Use this address to read error data from the interface module.
C013h	I/O counts		→	Use this address to store the byte counts of transmit/receive data selected in WindLDR Function Area Settings.
C014h - C017h	reserved	—	—	Do not write data into this area.
C018h	Software version	←		Use this address to write the user application software version number (use any number other than 00h).
C019h	Expansion module ID	←		Use this address to write the user program module ID (use a number 40h through 7Fh).
C01Ah - CFFFh	reserved	—	—	Do not write data into this area.

Data Exchange between LONWORKS Interface Module and CPU Module

Communication data, status data, and ID data are exchanged through registers in the LONWORKS interface module and link registers in the CPU module. The registers correspond to link registers as listed below:

Register Address in LONWORKS Interface Module	Link Register in CPU Module	Function	Area
C000h - C001h	L*00	Receive Data	Communication Data Area
C002h - C003h	L*01		
C004h - C005h	L*02		
C006h - C007h	L*03		
C008h - C009h	L*04	Transmit Data	
C00Ah - C00Bh	L*05		
C00Ch - C00Dh	L*06		
C00Eh - C00Fh	L*07		
C012h	L*12	Error Data	Status Area
C013h	L*13	I/O Counts	
C018h	L*24	Software Version	ID Area
C019h	L*25	Expansion Module ID	

Note: A number 1 through 7 comes in place of * depending on the position where the functional module, such as OpenNet interface module or analog I/O module, is mounted. Consequently, operand numbers are automatically allocated to each functional module in the order of increasing distance from the CPU module, starting with L100, L200, L300, through L700.

Example 1: Receive Data in Registers C000h and C001h

When receive data enters registers C000h and C001h in the LONWORKS interface module, the data is transferred to a link register in the CPU module as illustrated below:

	C001h (8 bits)								C000h (8 bits)							
Registers in the LONWORKS Interface Module	b7	b6	b5	b4	b3	b2	b1	b0	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 0	0	0	0	0	0	1	LSB 0	MSB 0	0	0	0	0	0	0	LSB 1
	↓								↓							
Link Register L*00 in the CPU Module	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	LSB 1

Example 2: Transmit Data in Link Register L*04

When transmit data is stored to link register L*04 in the CPU module, the data is transferred to registers in the LONWORKS interface module as illustrated below:

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Link Register L*04 in the CPU Module	MSB 0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	LSB 0
	↓								↓							
	C009h (8 bits)								C008h (8 bits)							
Registers in the LONWORKS Interface Module	b7	b6	b5	b4	b3	b2	b1	b0	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 0	1	1	0	0	0	0	LSB 0	MSB 0	0	1	0	0	0	0	LSB 0

Example 3: Error Data in Register C012h

When error data enters register C012h in the LONWORKS interface module, the data is transferred to a link register in the CPU module as illustrated below:

Register in the LONWORKS Interface Module	C012h (8 bits)							
	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 1	0	0	0	0	0	1	LSB 0

↓

Link Register L*12 in the CPU Module	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	LSB 0

Example 4: I/O Counts in Link Register L*13

When 8 bytes (output) and 4 bytes (input) are selected as the transmit and receive data quantities in WindLDR Function Area Settings, respectively, these values are stored to link register L*13 in the CPU module, and the data is transferred to register C013h in the LONWORKS interface module as illustrated below:

Link Register L*13 in the CPU Module	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	LSB 0

↓

Register in the LONWORKS Interface Module	C013h (8 bits)							
	Transmit Byte Count (8)				Receive Byte Count (4)			
	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 1	0	0	0	0	1	0	LSB 0

Note: Link register L*13 is for read only. Do not write data into L*13.

Example 5: Software Version in Register C018h and Expansion Module ID in Register C019h

When a software version number is stored to register C018h in the LONWORKS interface module, or when an expansion module ID is stored to register C019h in the LONWORKS interface module, the data is transferred to a link register in the CPU module as illustrated below:

Register in the LONWORKS Interface Module	C018h or C019h (8 bits)							
	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 0	1	0	0	0	0	0	LSB 0

↓

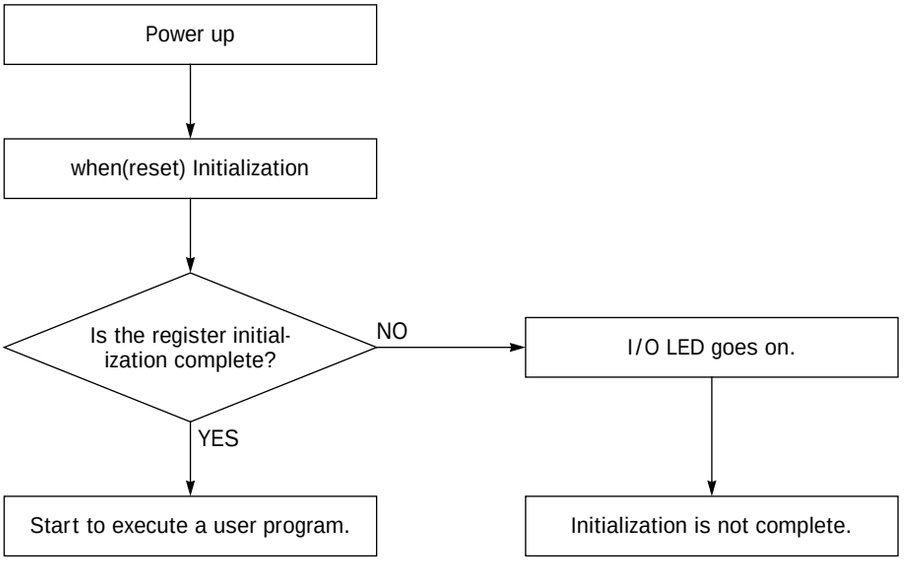
Link Register L*24 or L*25 in the CPU Module	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	MSB 0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	LSB 0

Application Program Examples

This section describes application program examples for initializing the registers in the LONWORKS interface module, writing receive data to data registers, and reading transmit data from data registers.

Initialization

Before starting LONWORKS communication through the network, the data registers in the LONWORKS interface module have to be initialized. The initialization sequence is illustrated in the chart below:



The following program is an example of an application program in Neuron C to initialize the LONWORKS interface module, consisting of initialization codes and a header file. *When you modify or create an application program, make sure that the application program includes the following codes in italics.*

Initialization Codes

```
1.  ////////////////////////////
2.  ///     PRAGMA           ///
3.  ////////////////////////////
4.  #pragma scheduler_reset
5.  /*******************************************************
6.  Network Variable
7.  *******************************************************/
8.  /* Define network variables                             */
9.  /*******************************************************
10. Write the software version number to C018h
11. *******************************************************/
12. #define FC3ASX5L_VERSION   0x10
13. /*******************************************************
14. Write the expansion module ID to C019h
15. *******************************************************/
16. #define EMID_CODE        0x50
17. /*******************************************************
18. include file
19. *******************************************************/
20. #include    <access.h>
21. #include    <msg_addr.h>
22. #include    <control.h>
23. #include    <status.h>
24. #include    <snvt_lev.h>
25. #include    "fc3asx5l.h"          /* Refer to the header file shown below */
26. /*******************************************************
```

```
Main Program
*********************************************************/
when(reset){
    initialize();
/* Insert other commands here to execute within when(reset), if required. */
}
```

Header File (fc3asx5l.h)

```
//Header File: fc3asx5l.h
/************************************/
/* Common Definition                */
/************************************/
#define     LED_OFF     1
#define     LED_ON      0
#define OK              1
#define NG              0
#define HIGH            1
#define LOW             0
/* Timer Value */
#define DTm_5sec        5000
/************************************/
/*  Memory Mapped I/O Definition    */
/************************************/
#define IO_GA_BASE          0xc000          // I/O Base Address
/************************************/
/*  Digital I/O Register Address    */
/************************************/
#define GA_FCDR    (IO_GA_BASE + 0x00)      // Data Register
#define GA_CSR_ERR (IO_GA_BASE + 0x12)      // Error Register
#define GA_FVER    (IO_GA_BASE + 0x18)      // I/O Version Register
#define GA_EMID    (IO_GA_BASE + 0x19)      // Expansion Module ID Register
#define GA_BCTL    (IO_GA_BASE + 0x1a)
/************************************/
/*  I/O Register Bit Definition     */
/************************************/
#define BCTL_CENABLE        0x10
#define BCTL_NWR_REQ        0x04
#define BCTL_NENABLE        0x01
#define MAX_FCDR_DATA_LEN   16
/* Define Neuron Chip IO pins as follows. */
IO_0    output  bit  PO_RUN_LED = HIGH;
IO_1    output  bit  PO_ERR_LED = HIGH;
IO_2    output  bit  PO_IO_LED = HIGH;
IO_3    input   bit  PI_ODE;
IO_4    input   bit  PI_RUN;
IO_6    output  bit  PO_F_ERR = LOW;
/************************************/
/*      Prototype                   */
/************************************/
void    initialize(void);
void    init_internal_io(void);
void    init_external_io(void);
void    init_gate_array(void);

/************************************/
/*   Global Variable                */
/************************************/
mtimer  io_check_timer;
unsigned char csr_error_data;           // CSR_ERROR Reg. data save area

void initialize(void){
```

```
54.     init_internal_io();
55.     init_external_io();
56. }
57. void init_internal_io(void){
58.     io_change_init(PI_ODE);
59.     io_change_init(PI_RUN);
60. }
61. void init_external_io(void){
62.     init_gate_array();
63. }
64. void init_gate_array(void){
65.     int st, n;
66.     unsigned char *pGA;
67.     unsigned char dat;
68.
69.     io_check_timer = DTm_5sec;
70.     while(TRUE){
71.         post_events();
72.         pGA = (unsigned char *)GA_BCTL;
73.         *pGA |= BCTL_NWR_REQ;
74.         dat = *pGA;
75.         if (dat & BCTL_NWR_REQ){
76.             pGA = (unsigned char *)GA_FCDR;
77.             for (n = 0; n < MAX_FCDR_DATA_LEN; n++){
78.                 *pGA++ = 0x00;
79.             }
80.             pGA = (unsigned char *)GA_CSR_ERR;
81.             csr_error_data = 0;
82.             *pGA  = csr_error_data;
83.             pGA = (unsigned char *)GA_FVER;
84.             *pGA = FC3ASX5L_VERSION;
85.             pGA = (unsigned char *)GA_EMID;
86.             *pGA = EMID_CODE;
87.             pGA = (unsigned char *)GA_BCTL;
88.             *pGA  |= BCTL_NENABLE;
89.             dat = *pGA;
90.             if (dat & BCTL_NENABLE){
91.                 *pGA &= ~BCTL_NWR_REQ;
92.                 break;
93.             }else{
94.                 *pGA &= ~BCTL_NWR_REQ;
95.             }
96.         }
97. /* The following program turns on the I/O LED when initialization fails within 5 seconds, and
    can be modified by the user. */
98.         if (timer_expires(io_check_timer)){
99.             io_out(PO_IO_LED, LOW);             /* I/O LED goes on when timeout */
100.            break;
101.        }
102.    }
103.}
```

Note: ~ is an exclusive OR of every bit.

Brief description of functions used for the initialization program

- `init_internal_io()` function

This function initializes the Neuron Chip internal IO pins.

- `init_external_io()` function

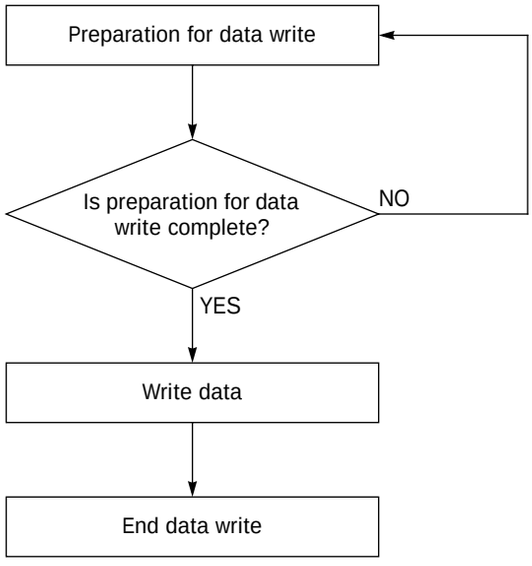
This function substitutes the number of register IO points for max_out_number or max_in_number.

- `init_gate_array()` function

This function turns on the I/O LED when initialization of registers fails within 5 seconds.

Writing Receive Data to Data Registers in the LONWORKS Interface Module

The following diagram shows a typical example of writing receive data to the data registers in the LONWORKS interface module.



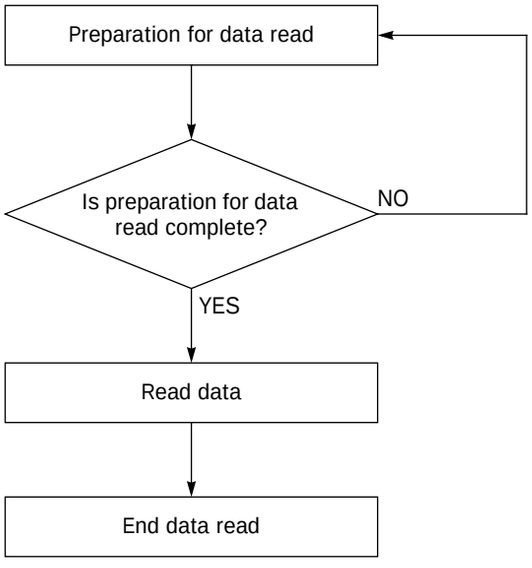
Application Program Example for Data Write

The following program is an example to write receive data to data register C000h of the LONWORKS interface module when an 8-bit input network variable (nv_i8) is updated. *When you modify or create an application program, make sure that the application program includes the following codes in italics.*

```
1.  /*  Input Network Variables  */
2.  network input unsigned char nv_i8;
3.  /* define */
4.  #define GA_BCTL         0xC01A
5.  #define BCTL_NWR_REQ      0x04
6.  #define GA_FCDR_RX      0xC000
7.
8.  when(nv_update_occurs(nv_i8)){              /* Acknowledge input network variable update */
9.      unsigned char *pGA;
10.     unsigned char dat;
11.     while(TRUE){
12.         pGA = (unsigned char *)GA_BCTL;     /* Preparation for data write */
13.         *pGA |= BCTL_NWR_REQ;
14.         dat = *pGA;
15.         if (dat & BCTL_NWR_REQ){            /* Preparation for data write complete */
16.             pGA = (unsigned char *)GA_FCDR_RX;
17.             pGA = nv_i8;                    /* Write input NV data to data register C000h */
18.             pGA = (unsigned char *)GA_BCTL;
19.             pGA &= ~BCTL_NWR_REQ;           /* End data write */
20.             break;
21.         }
22.     }
23. }
```

Reading Transmit Data from Data Registers in the LONWORKS Interface Module

The following diagram is a typical example of reading transmit data from the data registers in the LONWORKS interface module.



Application Program Example for Data Read

The following program is an example to substitute transmit data of data register C008h for an 8-bit output network variable (nv_o8). *When you modify or create an application program, make sure that the application program includes the following codes in italics.*

```
1.  /* Output Network Variables */
2.  network output unsigned char nv_o8;
3.  /* define */
4.  #define GA_BCTL       0xC01A
5.  #define GA_FCDR_TX    0xC008
6.  #define BCTL_NWR_REQ    0x04
7.  #define HIGH               1
8.  /* Define IO_4 RUN */
9.  IO_4 input bit PI_RUN;
10.
11. when(TRUE){
12.     unsigned char *pGA;
13.     unsigned char dat;
14.     unsigned char tx_dat;
15.     while(TRUE){
16.         if (io_in(PI_RUN) == HIGH){
17.             pGA = (unsigned char *)GA_BCTL;        /* Preparation for data read */
18.             *pGA |= BCTL_NWR_REQ;
19.             dat = *pGA;
20.             if (dat & BCTL_NWR_REQ){               /* Preparation for data read complete */
21.                 pGA = (unsigned char *)GA_FCDR_TX;
22.                 tx_dat = *pGA;                     /* Read data from register C008h */
23.                 pGA = (unsigned char *)GA_BCTL;
24.                 pGA &= ~BCTL_NWR_REQ;              /* End data read */
25.               nv_o8 = tx_dat;    /* Substitute the value for output network variable (nv_o8) */
26.                 break;
27.             }
28.         }
29.     }
30. }
```

Defined Network Variables

The application program installed in the LONWORKS interface module defines network variables for transmit and receive data listed below. When you modify or create an application program, do not use these variables, otherwise verification of the application program will be difficult. The network variables, their data type and structure are listed in the following tables.

Input Network Variables

Input Network Variable	Data Type and Structure	Used For
nv_i8[0]	unsigned char	8-point inputs, 8 bits
nv_i8[1]	unsigned char	8-point inputs, 8 bits
nv_i8[2]	unsigned char	8-point inputs, 8 bits
nv_i8[3]	unsigned char	8-point inputs, 8 bits
nv_i8[4]	unsigned char	8-point inputs, 8 bits
nv_i8[5]	unsigned char	8-point inputs, 8 bits
nv_i8[6]	unsigned char	8-point inputs, 8 bits
nv_i8[7]	unsigned char	8-point inputs, 8 bits
nv_i16	BIT16_DAT	16-point inputs, 8 bits × 2
nv_i24	BIT24_DAT	24-point inputs, 8 bits × 3
nv_i32	BIT32_DAT	32-point inputs, 8 bits × 4
nv_i40	BIT40_DAT	40-point inputs, 8 bits × 5
nv_i48	BIT48_DAT	48-point inputs, 8 bits × 6
nv_i56	BIT56_DAT	56-point inputs, 8 bits × 7
nv_i64	BIT64_DAT	64-point inputs, 8 bits × 8

Output Network Variables

Output Network Variable	Data Type and Structure	Used For
nv_o8[0]	unsigned char	8-point outputs, 8 bits
nv_o8[1]	unsigned char	8-point outputs, 8 bits
nv_o8[2]	unsigned char	8-point outputs, 8 bits
nv_o8[3]	unsigned char	8-point outputs, 8 bits
nv_o8[4]	unsigned char	8-point outputs, 8 bits
nv_o8[5]	unsigned char	8-point outputs, 8 bits
nv_o8[6]	unsigned char	8-point outputs, 8 bits
nv_o8[7]	unsigned char	8-point outputs, 8 bits
nv_o16	BIT16_DAT	16-point outputs, 8 bits × 2
nv_o24	BIT24_DAT	24-point outputs, 8 bits × 3
nv_o32	BIT32_DAT	32-point outputs, 8 bits × 4
nv_o40	BIT40_DAT	40-point outputs, 8 bits × 5
nv_o48	BIT48_DAT	48-point outputs, 8 bits × 6
nv_o56	BIT56_DAT	56-point outputs, 8 bits × 7
nv_o64	BIT64_DAT	64-point outputs, 8 bits × 8

Structure Name	Structure	Used For
BIT16_DAT	typedef struct { unsigned char dat[2]; }BIT16_DAT	16-point outputs, 8 bits × 2
BIT24_DAT	typedef struct { unsigned char dat[3]; }BIT24_DAT	24-point outputs, 8 bits × 3
BIT32_DAT	typedef struct { unsigned char dat[4]; }BIT32_DAT	32-point outputs, 8 bits × 4
BIT40_DAT	typedef struct { unsigned char dat[5]; }BIT40_DAT	40-point outputs, 8 bits × 5
BIT48_DAT	typedef struct { unsigned char dat[6]; }BIT48_DAT	48-point outputs, 8 bits × 6
BIT56_DAT	typedef struct { unsigned char dat[7]; }BIT56_DAT	56-point outputs, 8 bits × 7
BIT64_DAT	typedef struct { unsigned char dat[8]; }BIT64_DAT	64-point outputs, 8 bits × 8

Example:

When the transmit and receive bytes are set to 3 using WindLDR (on the Open Bus page selected from Configure > Function Area Settings), only 24-point type declared network variables (nv_i24 and nv_o24) and the network variables shown in the table below can be used. Then, link registers listed below can be used for transmission and receiving.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
L*00	nv_i8[1]								nv_i8[0]							
L*01	cannot be used								nv_i8[2]							
L*04	nv_o8[1]								nv_o8[0]							
L*05	cannot be used								nv_o8[2]							

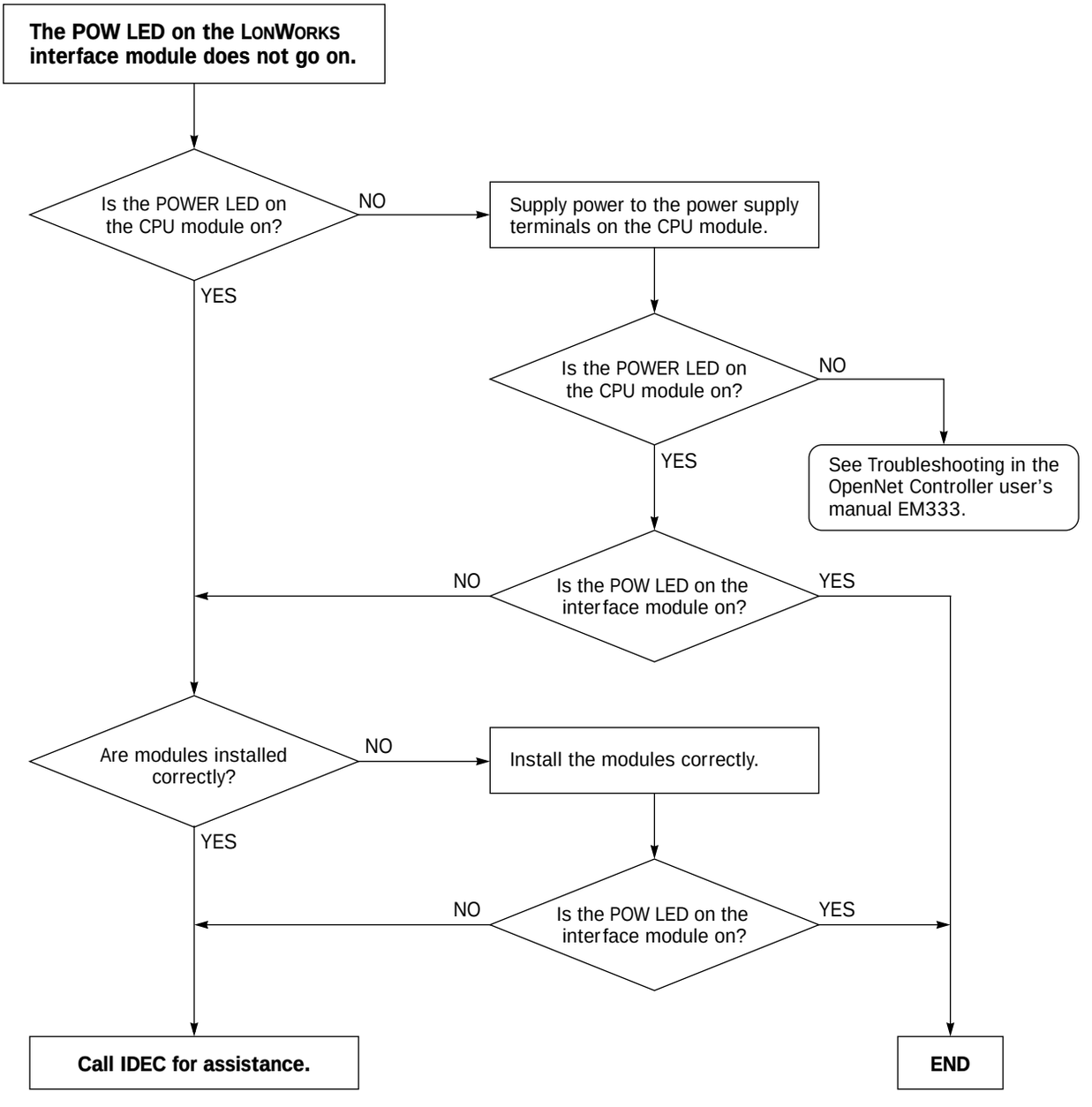
LONWORKS Network Troubleshooting

This section describes the procedures to determine the cause of trouble and actions to be taken when any trouble occurs while operating the LONWORKS interface module.

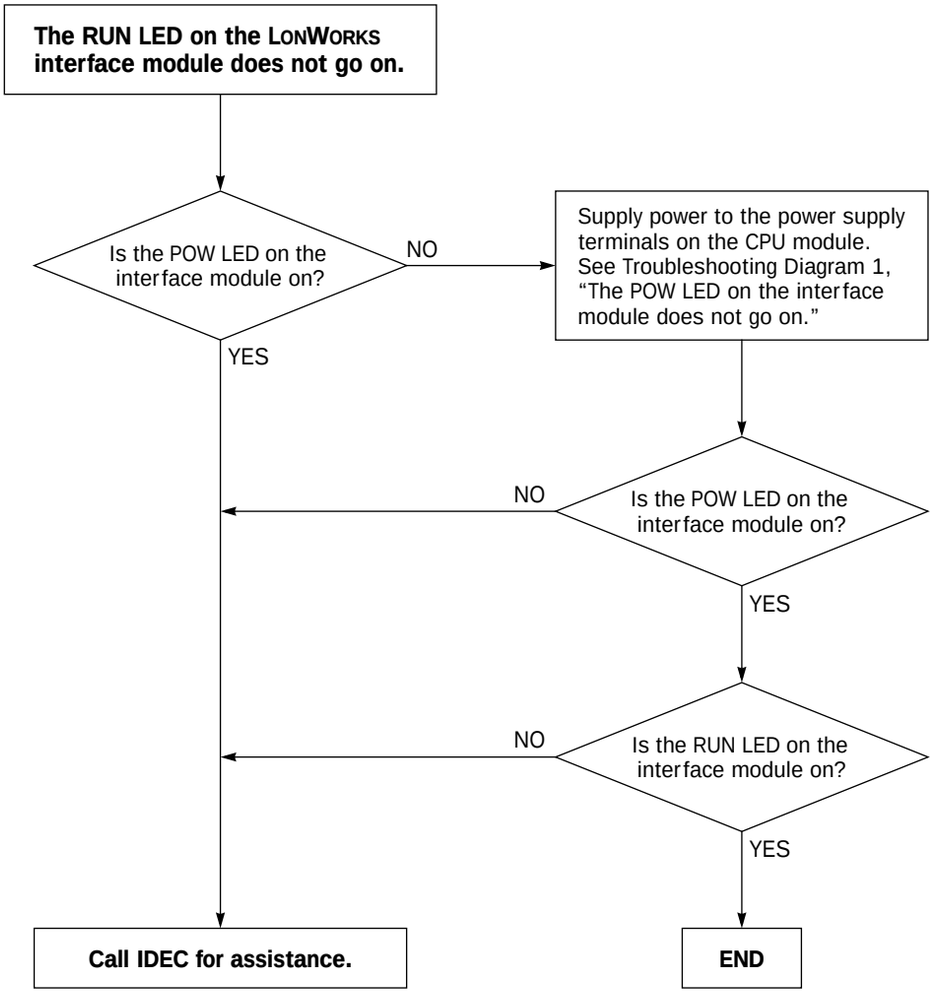
Probable Causes for Network Errors

- A network cable is disconnected or shorted.
- Strong external noise
- The power voltage to the module has dropped below the minimum operating voltage at least momentarily.
- Use of a faulty communication line, cable other than twisted-pair cables, or transmission beyond the rated distance.
- Improper terminator

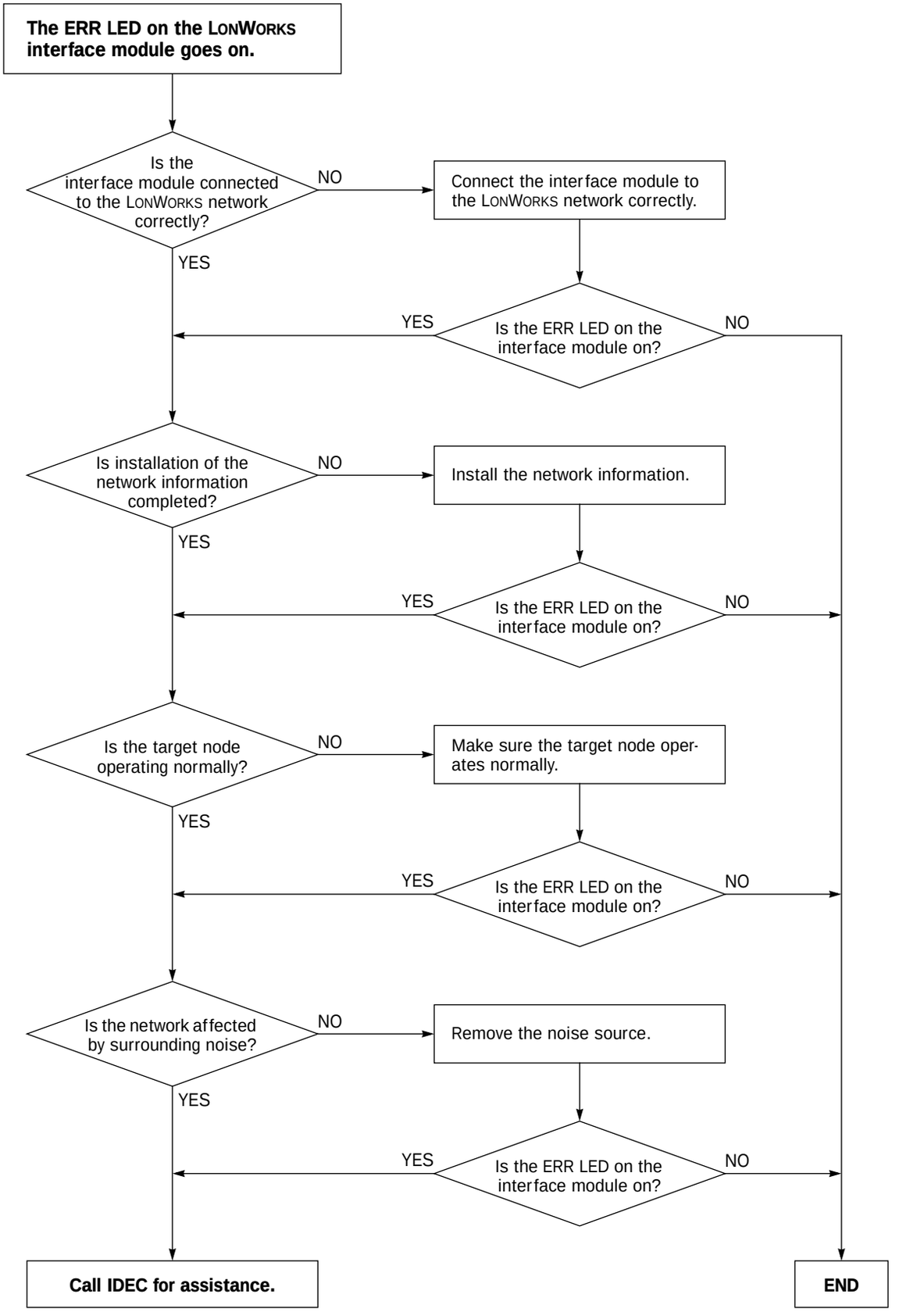
Troubleshooting Diagram 1



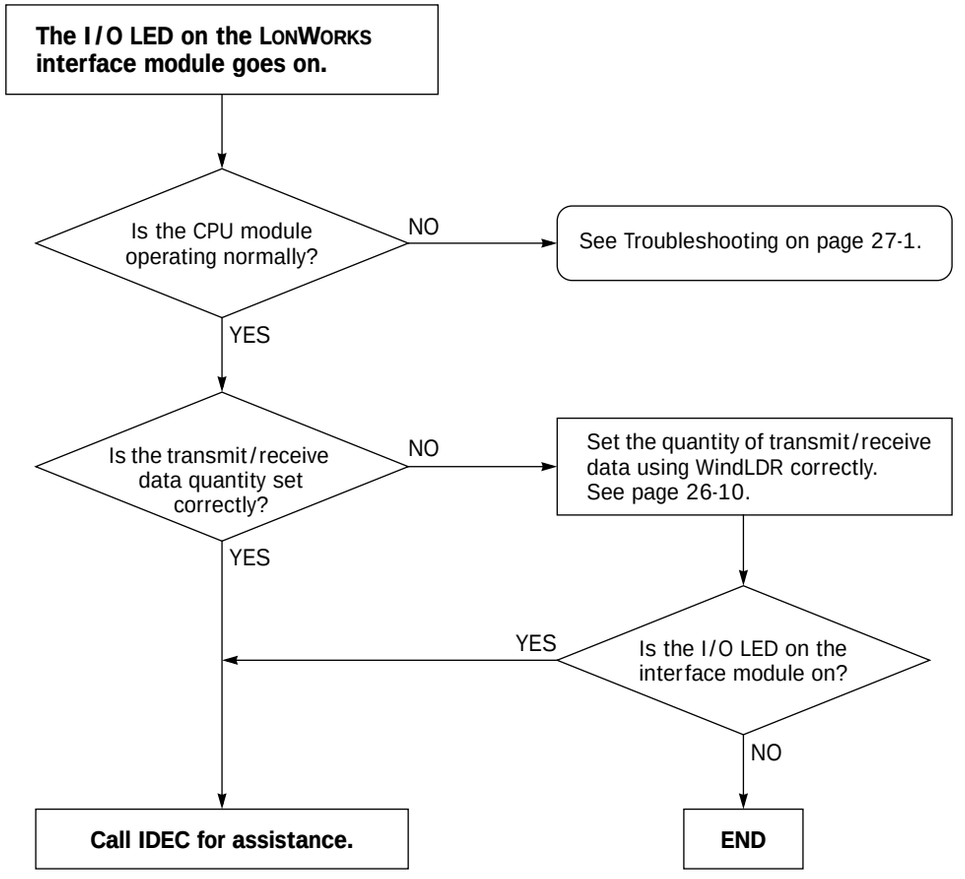
Troubleshooting Diagram 2



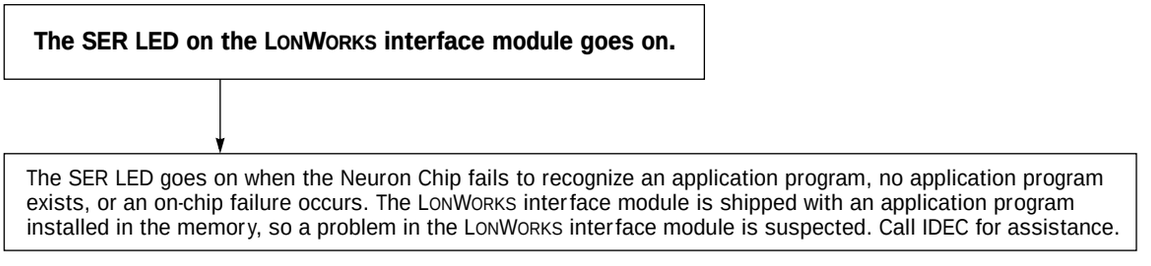
Troubleshooting Diagram 3



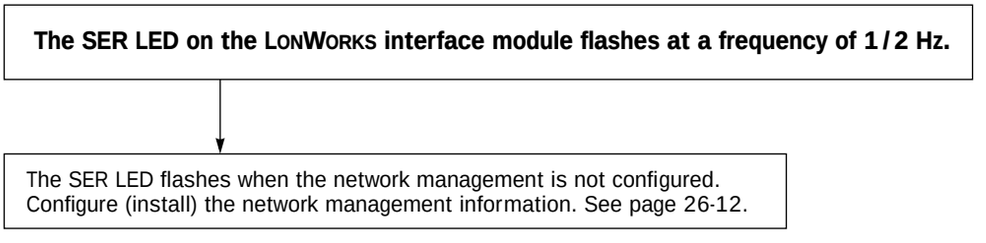
Troubleshooting Diagram 4



Troubleshooting Diagram 5



Troubleshooting Diagram 6



27: TROUBLESHOOTING

Introduction

This chapter describes the procedures to determine the cause of trouble and actions to be taken when any trouble occurs while operating the OpenNet Controller.

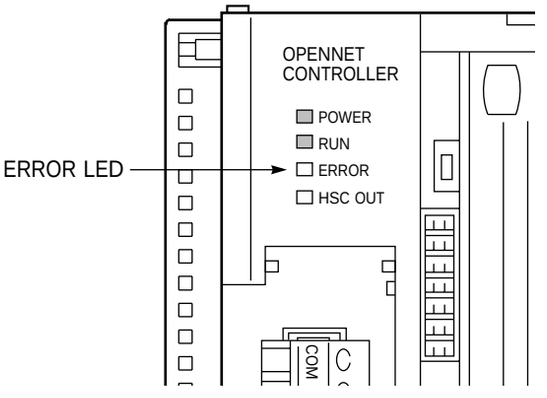
The OpenNet Controller has self-diagnostic functions to prevent the spread of troubles if any trouble should occur. In case of any trouble, follow the troubleshooting procedures to determine the cause and to correct the error.

Errors are checked in various stages. While editing a user program on WindLDR, incorrect operands and other data are rejected. User program syntax errors are found during compilation on WindLDR. When an incorrect program is downloaded to the OpenNet Controller, user program syntax errors are still checked. Errors are also checked at starting and during operation of the OpenNet Controller. When an error occurs, the error is reported by turning on the ERROR LED on the OpenNet Controller and an error message can be viewed on WindLDR.

ERROR LED

The OpenNet Controller CPU module has an error indicator ERROR. When an error occurs in the OpenNet Controller CPU module, the ERROR LED is lit. See the trouble shooting diagrams on page 27-10.

For error causes to turn on the ERROR LED, see page 27-4.



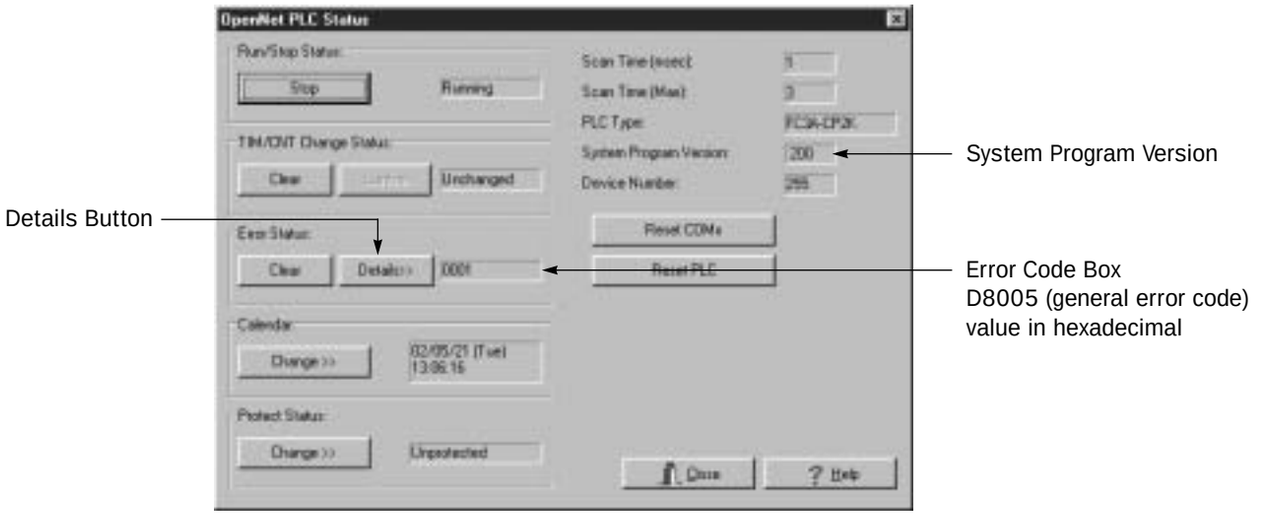
Reading Error Data

When any error occurs during the OpenNet Controller operation, the error codes and messages can be read out using WindLDR on a computer.

Monitoring WindLDR

1. From the WindLDR menu bar, select **Online** > **Monitor**. The monitor mode is enabled.
2. From the WindLDR menu bar, select **Online** > **PLC Status**. The PLC Status dialog box appears.

The general error code stored in special data register D8005 is displayed in the error code box.



3. Under the **Error Status** in the PLC Status dialog box, press the **Details** button. The Error Status screen appears.

Clearing Error Codes from WindLDR

After removing the cause of the error, clear the error code using the following procedure:

1. From the WindLDR menu bar, select **Online** > **Monitor**. The monitor mode is enabled.
2. From the WindLDR menu bar, select **Online** > **PLC Status**.
3. Under the **Error Status** in the PLC Status dialog box, press the **Clear** button.

This procedure clears the error code from special data register D8005 (general error code), and the error code is cleared from the PLC Status dialog box.

Special Data Registers for Error Information

Three data registers are assigned to store information on errors.

D8005	General Error Code
D8006	User Program Execution Error Code
D8007	User Program Execution Error Address

General Error Codes

The general error code is stored in special data register D8005 (general error code).

When monitoring the PLC status using WindLDR, the error code is displayed in the error code box under the **Error Status** in the PLC Status dialog box using four hexadecimal digits 0 through F. Each digit of the error code indicates a different set of conditions requiring attention. After the error code is cleared as described on the preceding page, the error code box is left blank.

For example, the error code may read out “0021.” This indicates two conditions requiring attention, “User program sum check error” from the third chart and “Power failure” from the fourth chart. If the read-out displays “000D,” this indicates three conditions exist from only the fourth chart.

Error Code: Most Significant Digit	**F000**	**E000**	**D000**	**C000**	**B000**	**A000**	**9000**	**8000**	**7000**	**6000**	**5000**	**4000**	**3000**	**2000**	**1000**	**0000**
INTERBUS master access error													X		X	
I/O bus initialize error													X	X		

Error Code: 2nd Digit from Left	**F00**	**E00**	**D00**	**C00**	**B00**	**A00**	**900**	**800**	**700**	**600**	**500**	**400**	**300**	**200**	**100**	**000**
User program writing error	X		X		X		X		X		X		X		X	
Protect output overload error	X	X			X	X			X	X			X	X		
Calendar/clock error	X	X	X	X					X	X	X	X				
I/O bus error	X	X	X	X	X	X	X	X								

Error Code: 3rd Digit from Left	**F0**	**E0**	**D0**	**C0**	**B0**	**A0**	**90**	**80**	**70**	**60**	**50**	**40**	**30**	**20**	**10**	**00**
TIM/CNT preset value sum check error	X		X		X		X		X		X		X		X	
User program RAM sum check error	X	X			X	X			X	X			X	X		
Keep data sum check error	X	X	X	X					X	X	X	X				
User program syntax error	X	X	X	X	X	X	X	X								

Error Code: Least Significant Digit	**F**	**E**	**D**	**C**	**B**	**A**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Power failure	X		X		X		X		X		X		X		X	
Watchdog timer error	X	X			X	X			X	X			X	X		
Data link connection error	X	X	X	X					X	X	X	X				
User program ROM sum check error	X	X	X	X	X	X	X	X								

OpenNet Controller Operating Status, Output, and ERROR LED during Errors

Error Items	Operating Status	Output	ERROR LED	Checked at
Power failure	Stop	OFF	ON *1	Any time
Watchdog timer error	Stop	OFF	ON	Any time
Data link connection error	Stop	OFF	OFF	Initializing data link
User program ROM sum check error	Stop	OFF	ON	During operation
TIM/CNT preset value sum check error	Maintained	Maintained	OFF	Starting operation
User program RAM sum check error	Stop *2	OFF	ON	Starting operation
Keep data sum check error	Maintained	Maintained	OFF	Turning power on
User program syntax error	Stop	OFF	ON	Downloading user program
User program writing error	Stop	OFF	ON	Downloading user program
Protect output overload error	Maintained	Maintained *3	ON	During operation
Calendar/clock error	Maintained	Maintained	ON	Any time
I/O bus error	Stop	OFF	ON	Any time
INTERBUS master access error	Maintained	Maintained	ON	Any time
I/O bus initialize error	Stop	OFF	ON	Turning power on
User program execution error	Maintained	Maintained	ON	Executing user program

*1: When the power voltage to the OpenNet Controller CPU module drops below the rated value, the ERROR LED is lit. While the power voltage remains below the rated value, the ERROR LED does not go on.

*2: When a program RAM sum check error occurs, operation is stopped momentarily for recompiling the user program. After completing the recompilation, operation resumes.

*3: Outputs where error occurs are turned off, and restore normal operation when the cause of error is removed.

Error Causes and Actions

0001h: **Power Failure**

This error indicates when the power supply is lower than the specified voltage. This error is also recorded when the power is turned off. Clear the error code using WindLDR on a computer.

0002h: **Watchdog Timer Error**

The watchdog timer monitors the time required for one program cycle (scan time). When the time exceeds approximately 1.68 seconds, the watchdog timer indicates an error. Clear the error code using WindLDR on a computer. If this error occurs frequently, the OpenNet Controller CPU module has to be replaced.

0004h: **Data Link Connection Error**

This error indicates that data link station numbers are incorrect. Make sure that the communication selector DIP switches are set to station number 0 at the master station and to station numbers 1 through 31 at slave stations. No duplication of station numbers is allowed. See page 21-2.

To correct this error, change the communication selector DIP switch setting to 0 at the master station and to 1 through 31 at slave stations. Turn power off and on again for the slave station. Then take one of the following actions:

- Turn power off and on for the master station.
- Initialize data link communication for the master station using WindLDR on a computer. See page 21-11.
- Turn on special internal relay M8007 (data link communication initialize flag) at the master station. See page 21-6.

0008h: **User Program ROM Sum Check Error**

The user program stored in the OpenNet Controller CPU module ROM is broken. Download a correct user program to the OpenNet Controller, and clear the error code using WindLDR on a computer.

When a memory card is installed in the CPU module, the user program in the memory card is checked.

0010h: **Timer/Counter Preset Value Sum Check Error**

The execution data of timer/counter preset values is broken. The timer/counter preset values are initialized to the values of the user program automatically. Note that modified preset values are cleared and that the original values are restored. Clear the error code using WindLDR on a computer.

0020h: **User Program RAM Sum Check Error**

The data of the user program compile area in the OpenNet Controller CPU module RAM is broken.When this error occurs, the user program is recompiled automatically and the timer/counter preset values are initialized to the values of the user program. Note that modified preset values are cleared and that the original values are restored. Clear the error code using WindLDR on a computer.

0040h: **Keep Data Sum Check Error**

This error indicates that the data designated to be maintained during power failure is broken because of memory backup failure. Note that the "keep" data of internal relays and shift registers are cleared. Clear the error code using WindLDR on a computer.

If this error occurs when power is shut down for a short period of time after the battery is charged as specified, the battery is defective and the CPU module has to be replaced.

0080h: **User Program Syntax Error**

This error indicates that the user program has a syntax error. Correct the user program, and download the corrected user program to the OpenNet Controller. The error code is cleared when a correct user program is transferred.

User program syntax errors include the following causes:

- Invalid opcode for basic instruction
- Invalid operand for basic instruction
- Invalid TIM/CNT/CC/TC/DC/SFR(N) preset value or data
- Invalid opcode for advanced instruction
- Invalid data for advanced instruction
- Invalid operand for advanced instruction
- Invalid repeated usage of advanced instructions, such as DISP or DGRD
- User program capacity over error

0100h: **User Program Writing Error**

This error indicates a failure of writing into the OpenNet Controller CPU module ROM when downloading a user program. The error code is cleared when writing into the ROM is completed successfully. If this error occurs frequently, the OpenNet Controller CPU module has to be replaced.

When a memory card is installed in the CPU module, writing into the memory card is checked.

0200h: **Protect Output Overload Error**

This error is issued when a protect transistor output is overloaded during operation, then only the overloaded output is forced off. When this error occurs, remove the cause of the overload, then the output restores normal operation automatically. Clear the error code using WindLDR on a computer.

0400h: **Calendar / Clock Error**

This error indicates that the real time calendar/clock in the OpenNet Controller CPU module has an error caused by invalid clock data due to voltage drop or by erroneous quartz oscillator operation.

Clear the error code and set the calendar/clock data using WindLDR on a computer. If the error continues, the OpenNet Controller CPU module has to be replaced. See Troubleshooting Diagram on page 27-21.

0800h: **I / O Bus Error**

This error indicates that an I/O module has a trouble. If this error occurs frequently or normal I/O function is not restored automatically, the I/O module has to be replaced.

This error also occurs when the I/O module mounting position is changed with Module ID Operation Selection is enabled in the Function Area Settings. Restore the original I/O module mounting positions or disable the Module ID Operation Selection and download the user program. See page 5-5.

1000h: **INTERBUS Master Access Error**

This error indicates that a remote I/O module has a trouble. If this error occurs frequently or normal remote I/O function is not restored automatically, the remote I/O module has to be replaced.

2000h: **I / O Bus Initialize Error**

This error indicates that an I/O module has a trouble. If this error occurs frequently or normal I/O function is not restored automatically, the I/O module has to be replaced.

User Program Execution Error

This error indicates that invalid data is found during execution of a user program. When this error occurs, the ERROR LED and special internal relay M8004 (user program execution error) are also turned on. The detailed information of this error can be viewed from the error code stored in special data register D8006 (user program execution error code). The error address is stored in special data register D8007 (user program execution error address).

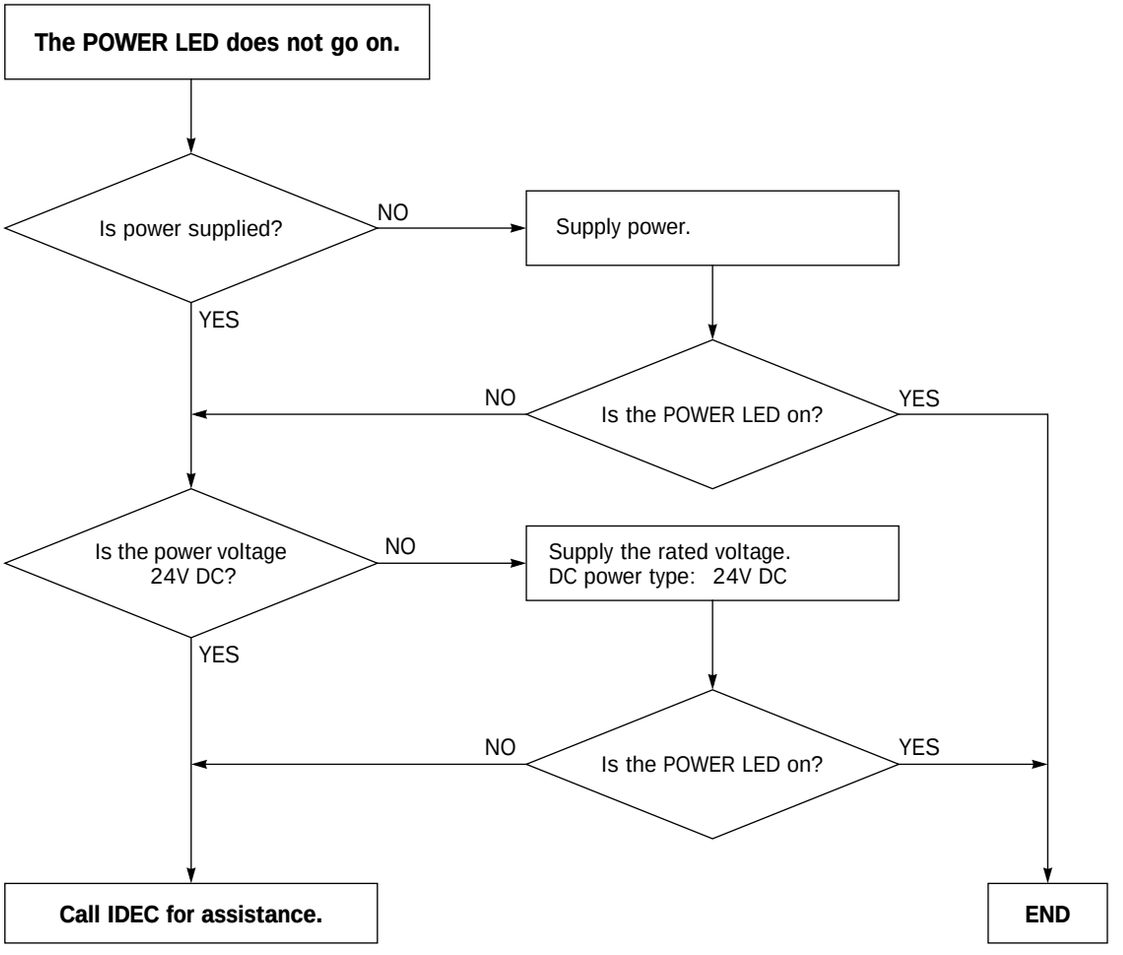
User Program Execution Error Code (D8006)	Error Details
1	Source/destination operand is out of range
2	MUL result is out of data type range
3	DIV result is out of data type range, or division by 0
4	BCDLS has S1 or S1+1 exceeding 9999
5	HTOB(W) has S1 exceeding 9999 HTOB(D) has S1(S1+1) exceeding 99999999
6	BTOH has any digit of S1(S+1) exceeding 9
7	HTOA/ATOH/BTOA/ATOB has quantity of digits to convert out of range
8	ATOH/ATOB has non-ASCII data for S1 through S1+4
9	WKCMP has S1, S2, and S3 exceeding the valid range S1: 0 through 127 S2: Hour data 0 through 23, minute data 0 through 59 S3: 0 through 2
10	WKTBL has S1 through Sn out of range
11	DGRD data exceeds 65535 with BCD5 digits selected
12	CVXTY/CVYTX is executed without matching XYFS
13	CVXTY/CVYTX has S2 exceeding the value specified in XYFS
14	Label in LJMP/LCAL/DJNZ is not found
15	TXD/RXD is executed while the RS232C port 1 or 2 is *not* set to user communication mode

Troubleshooting Diagrams

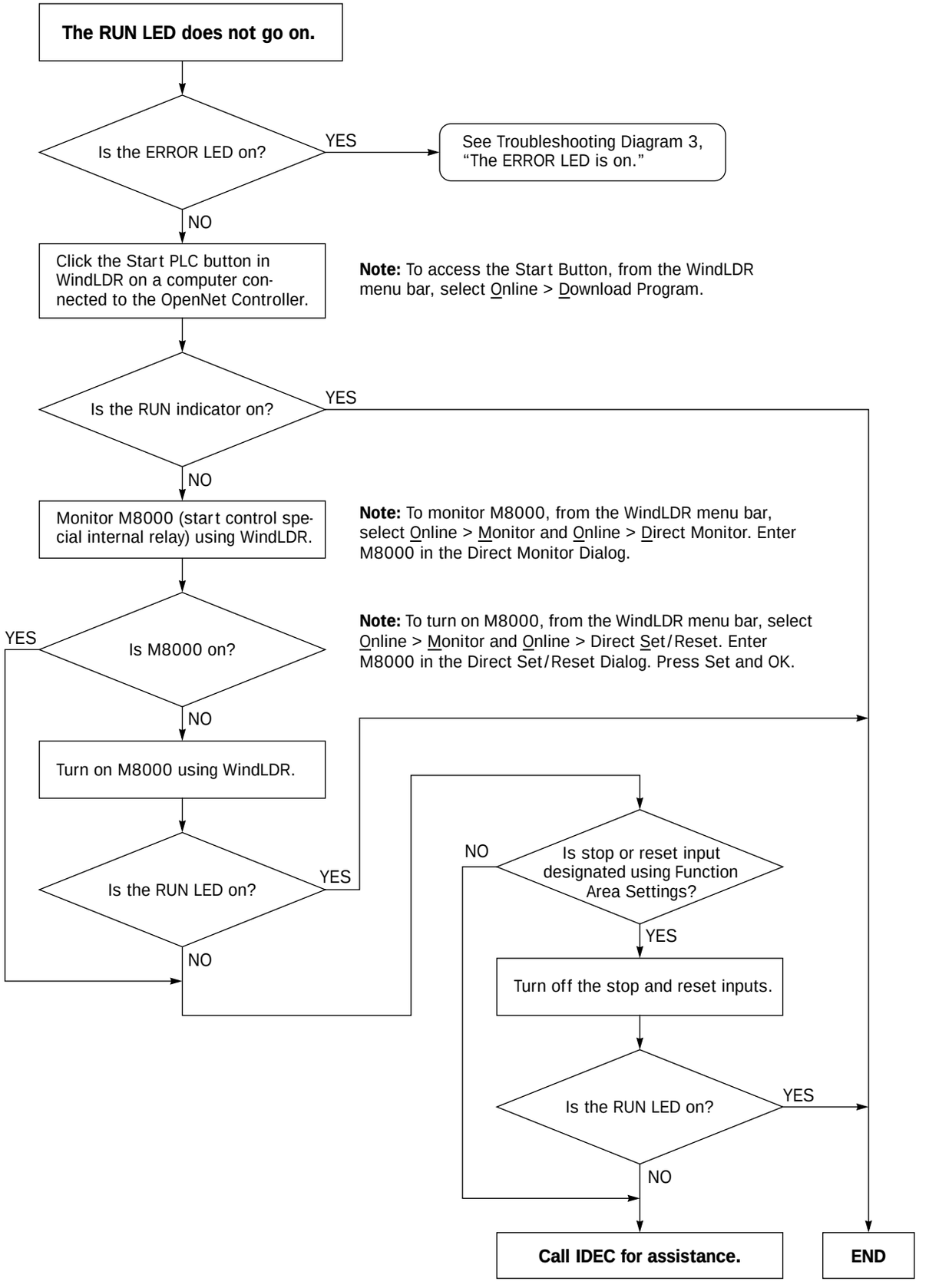
When one of the following problems is encountered, see the trouble shooting diagrams on the following pages.

Problem	Troubleshooting Diagram
The POWER LED does not go on.	Diagram 1
The RUN LED does not go on.	Diagram 2
The ERROR LED is on.	Diagram 3
Input module does not operate normally.	Diagram 4
Output module does not operate normally.	Diagram 5
Communication between WindLDR on a computer and the OpenNet Controller is not possible.	Diagram 6
Cannot stop or reset operation.	Diagram 7
Data link communication is impossible.	Diagram 8
Data is not transmitted at all in the user communication mode.	Diagram 9
Data is not transmitted correctly in the user communication mode.	Diagram 10
Data is not received at all in the user communication mode.	Diagram 11
Data is not received correctly in the user communication mode.	Diagram 12
The catch input function cannot receive short pulses.	Diagram 13
The calendar/clock does not operate correctly.	Diagram 14
Remote I/O communication is impossible and the FAIL LED is on.	Diagram 15
Remote I/O communication has stopped (Bus NG). The RDY/RUN LED flashes and the FAIL LED is on.	Diagram 16
The PF (peripheral fault) LED on the remote I/O master module is on.	Diagram 17

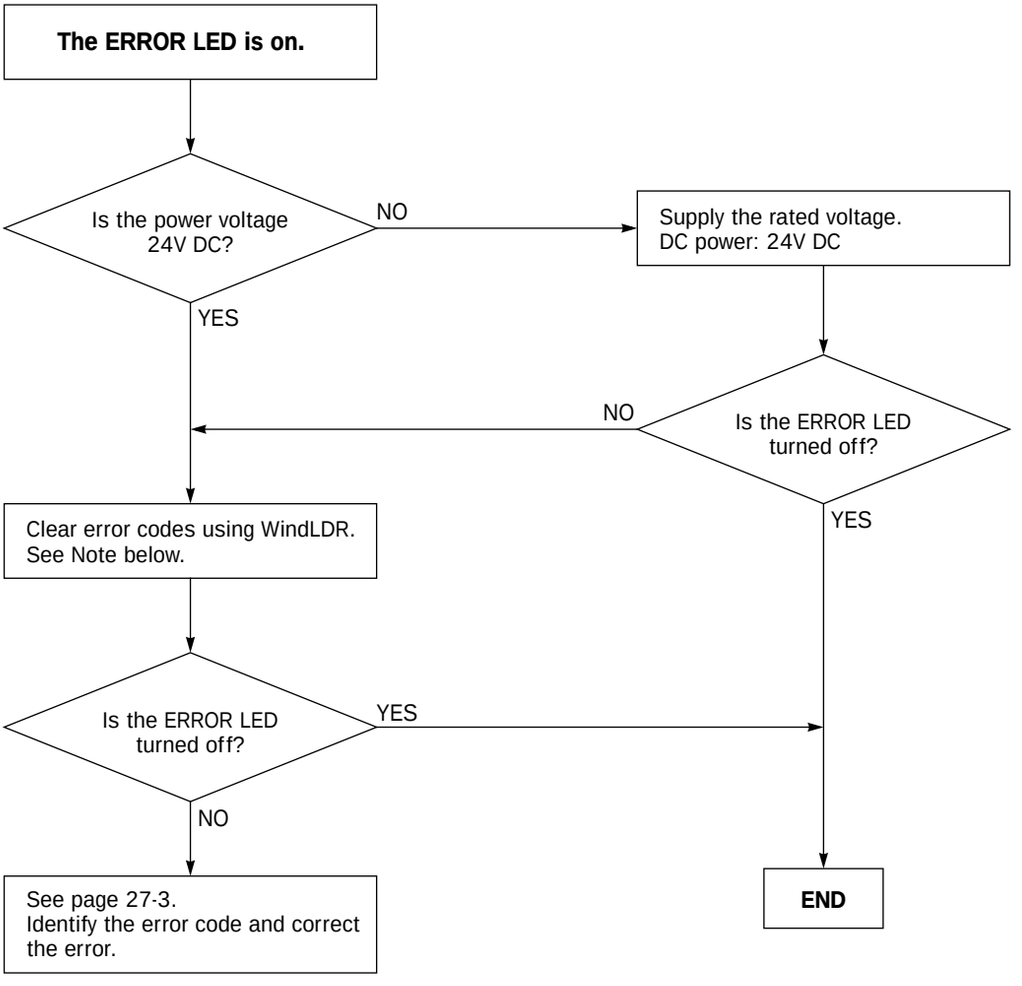
Troubleshooting Diagram 1



Troubleshooting Diagram 2

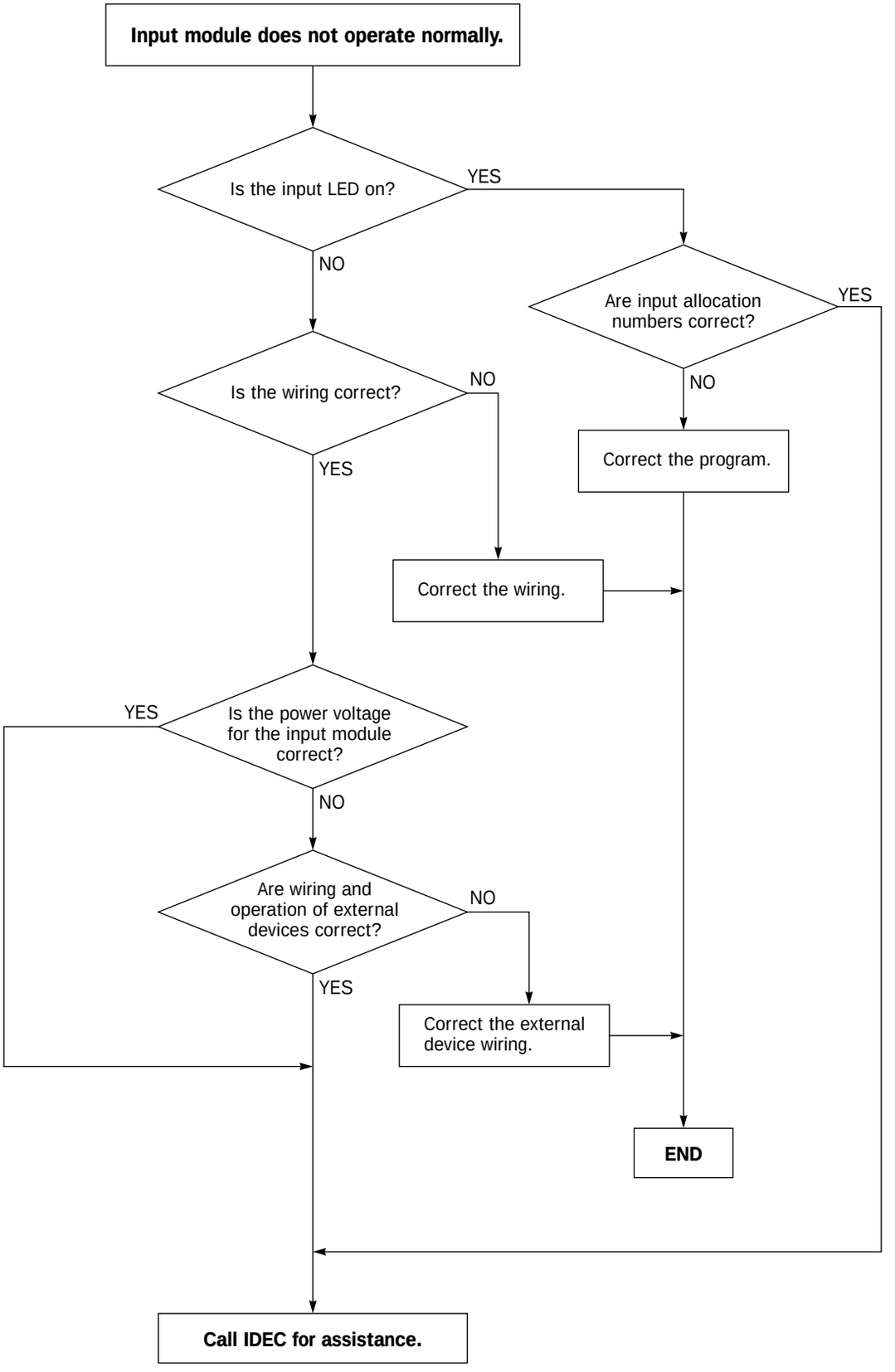


Troubleshooting Diagram 3

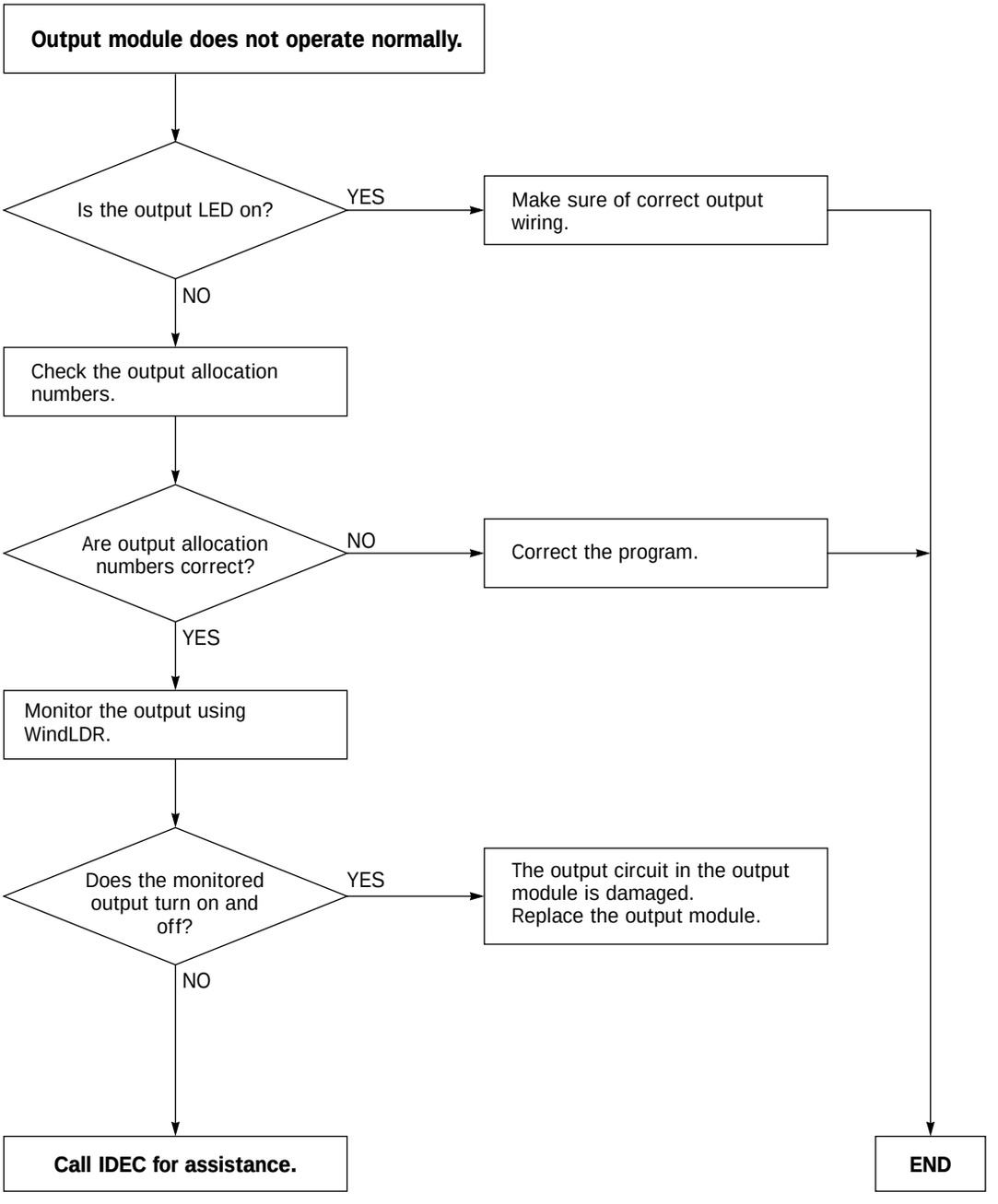


Note: Temporary errors can be cleared to restore normal operation by clearing error codes from WindLDR. See page 27-2.

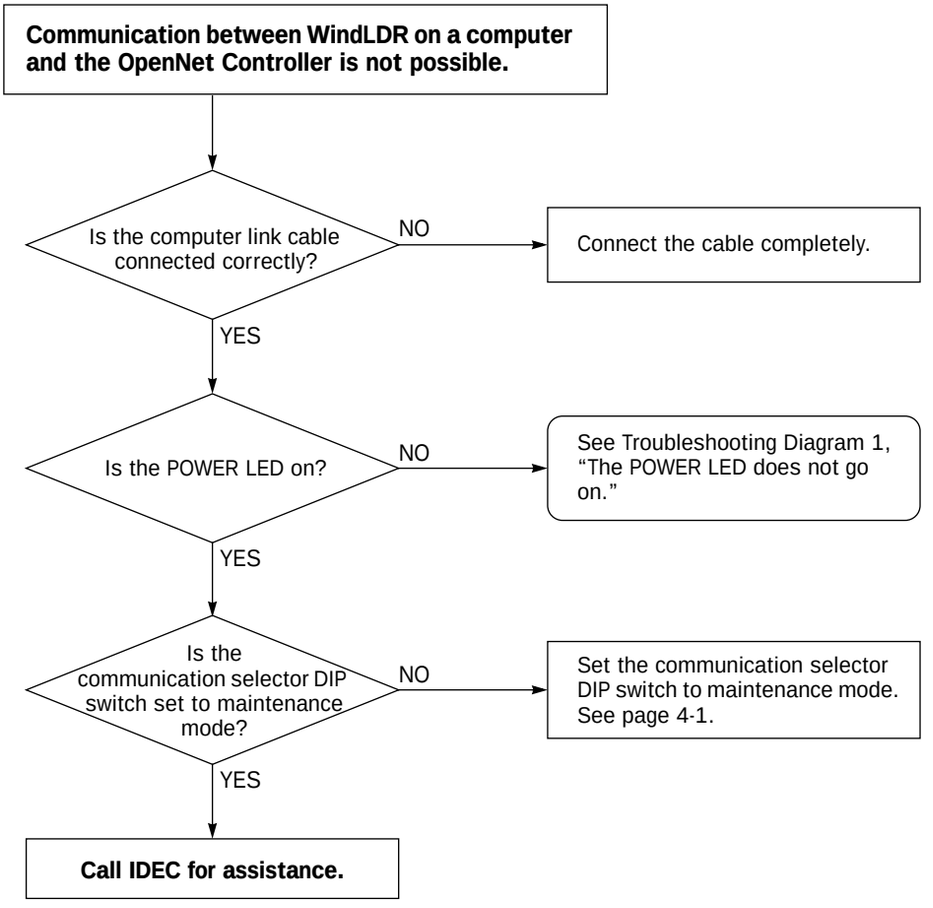
Troubleshooting Diagram 4



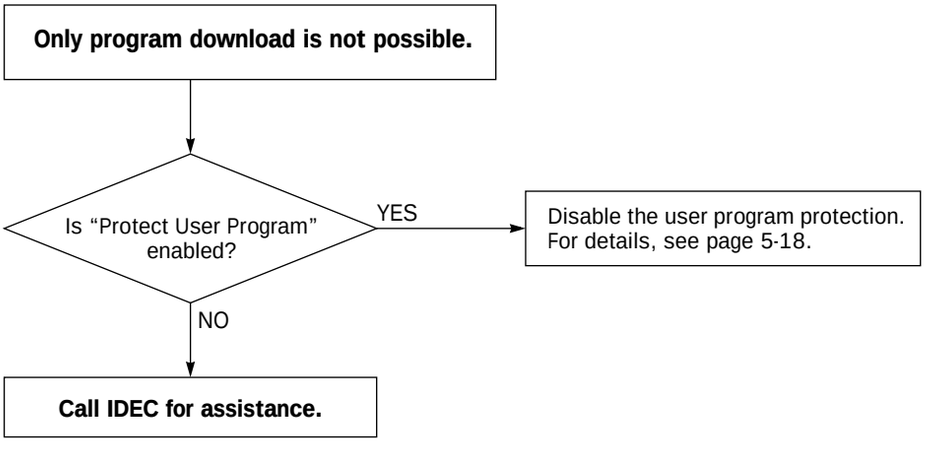
Troubleshooting Diagram 5



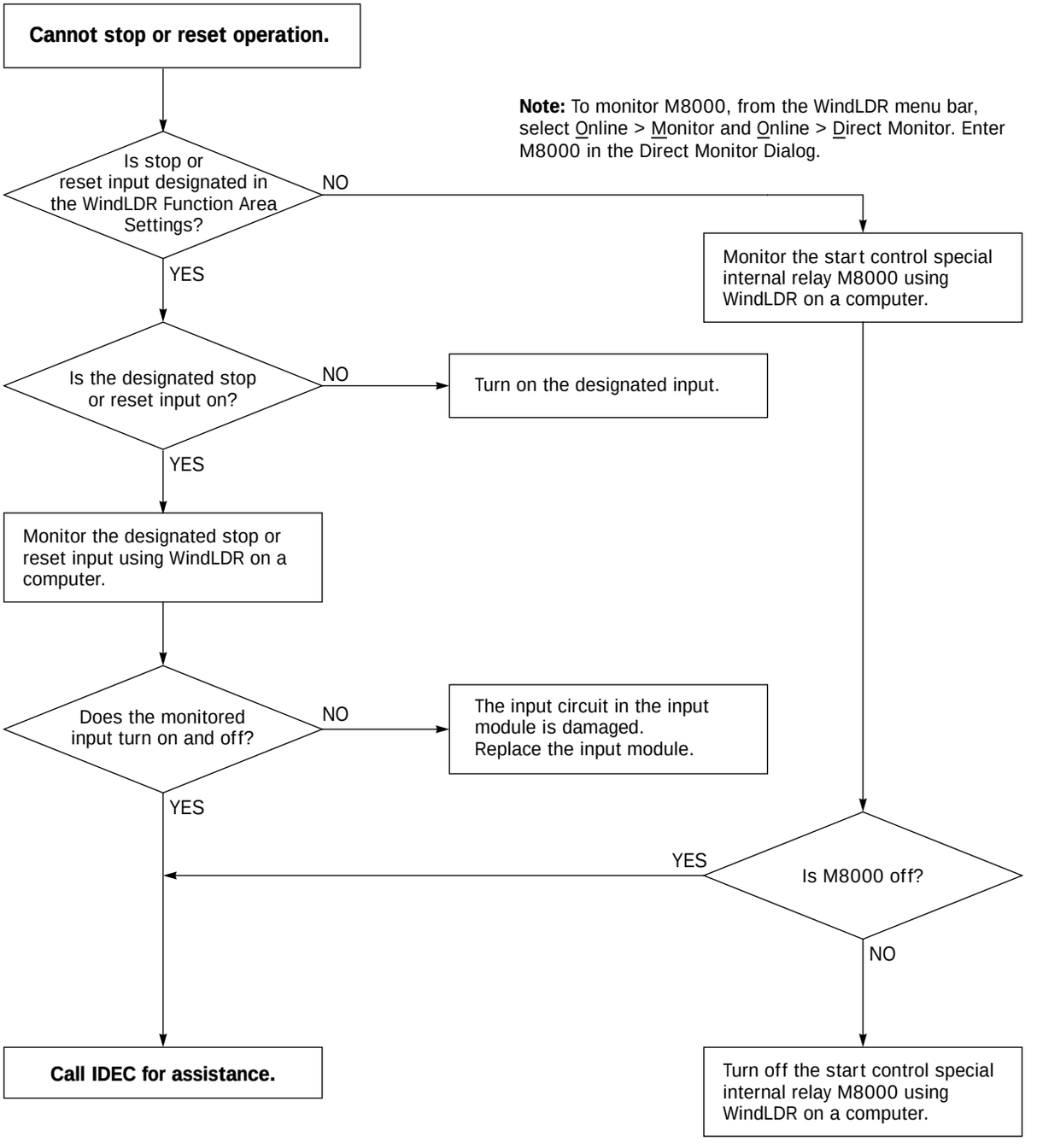
Troubleshooting Diagram 6



When only program download is not possible:



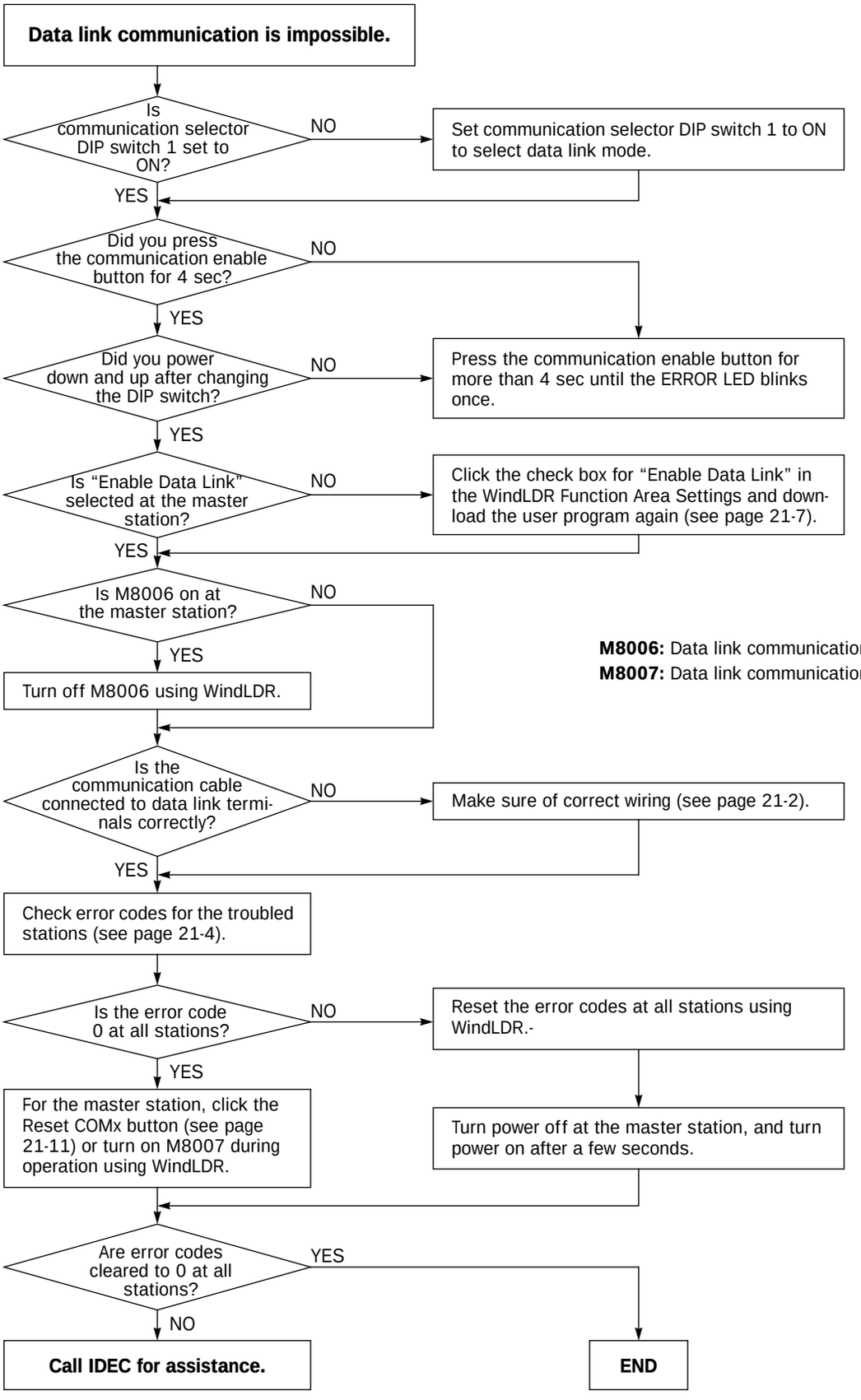
Troubleshooting Diagram 7



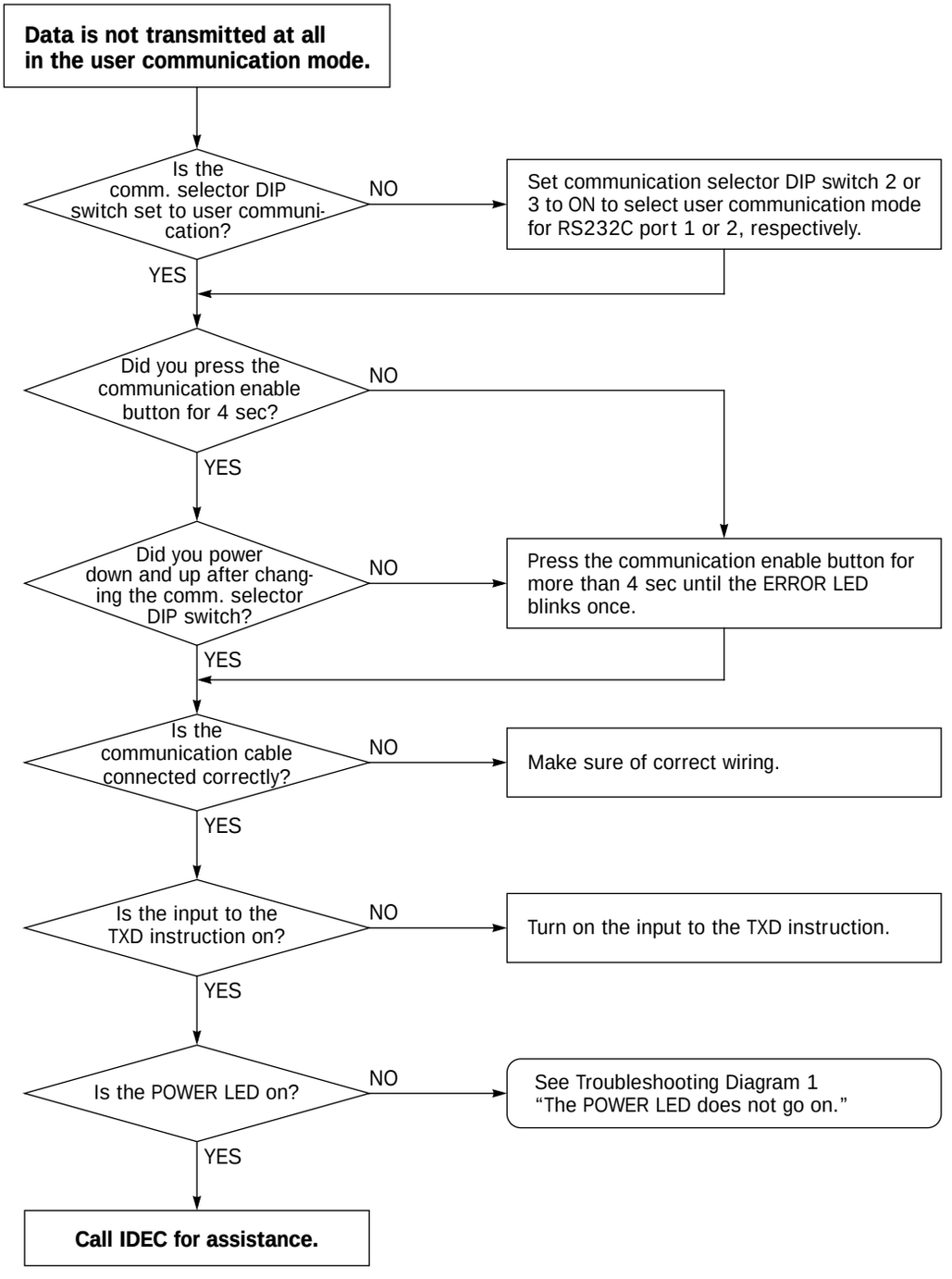
Note: To monitor M8000, from the WindLDR menu bar, select Online > Monitor and Online > Direct Monitor. Enter M8000 in the Direct Monitor Dialog.

Note: To turn off M8000, from the WindLDR menu bar, select Online > Monitor and Online > Direct Set/Reset. Enter M8000 in the Direct Set/Reset Dialog. Press Reset and OK.

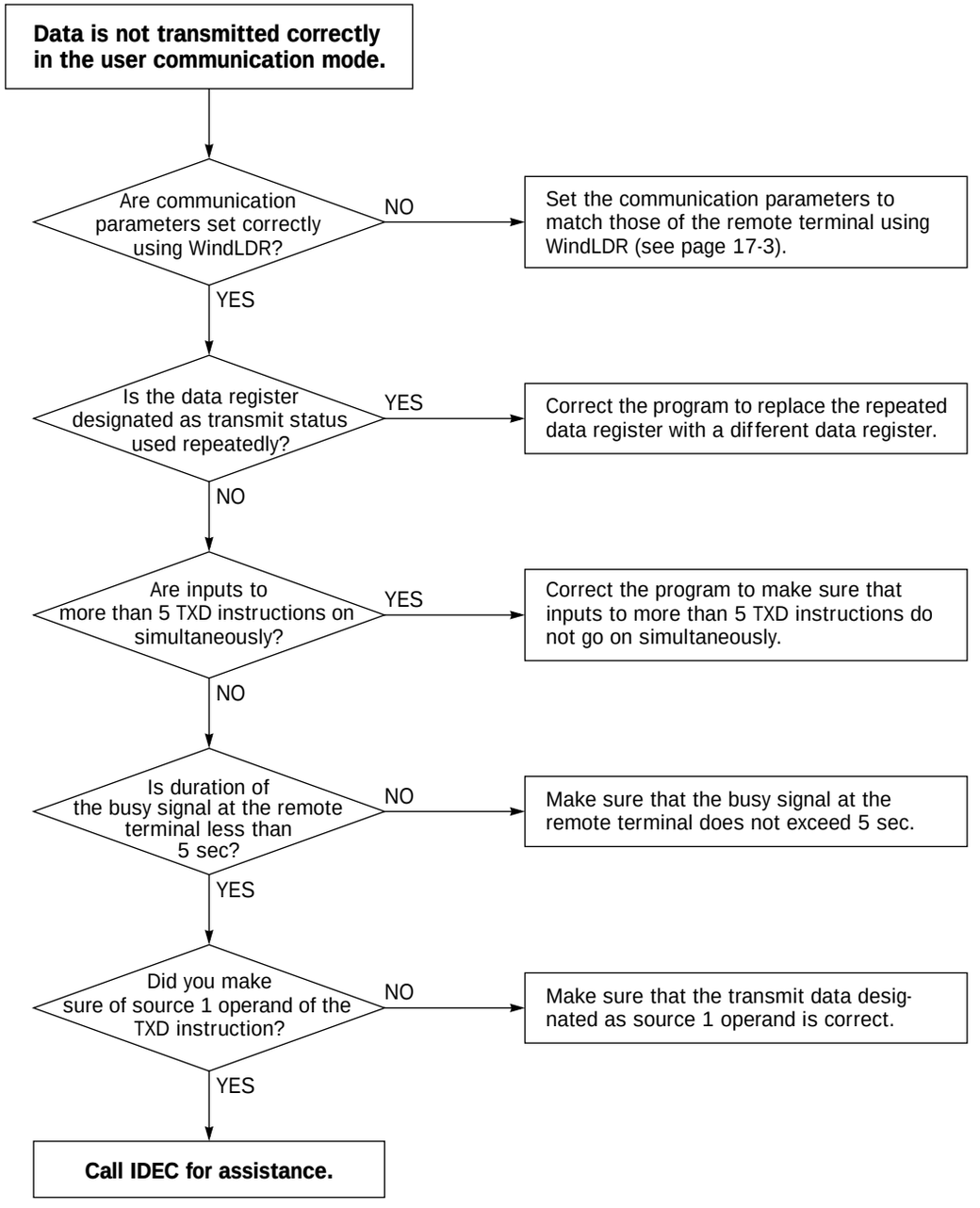
Troubleshooting Diagram 8



Troubleshooting Diagram 9

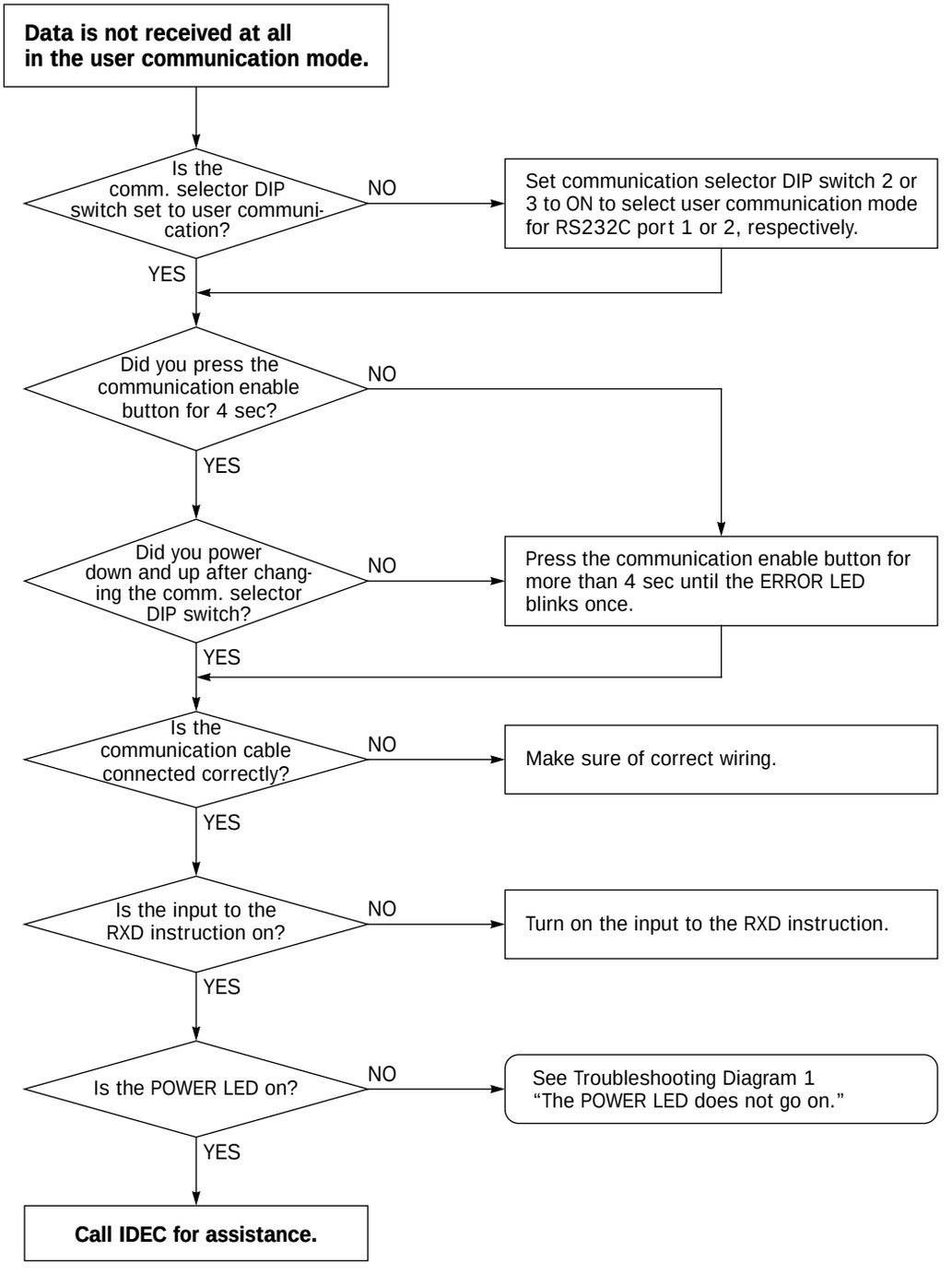


Troubleshooting Diagram 10

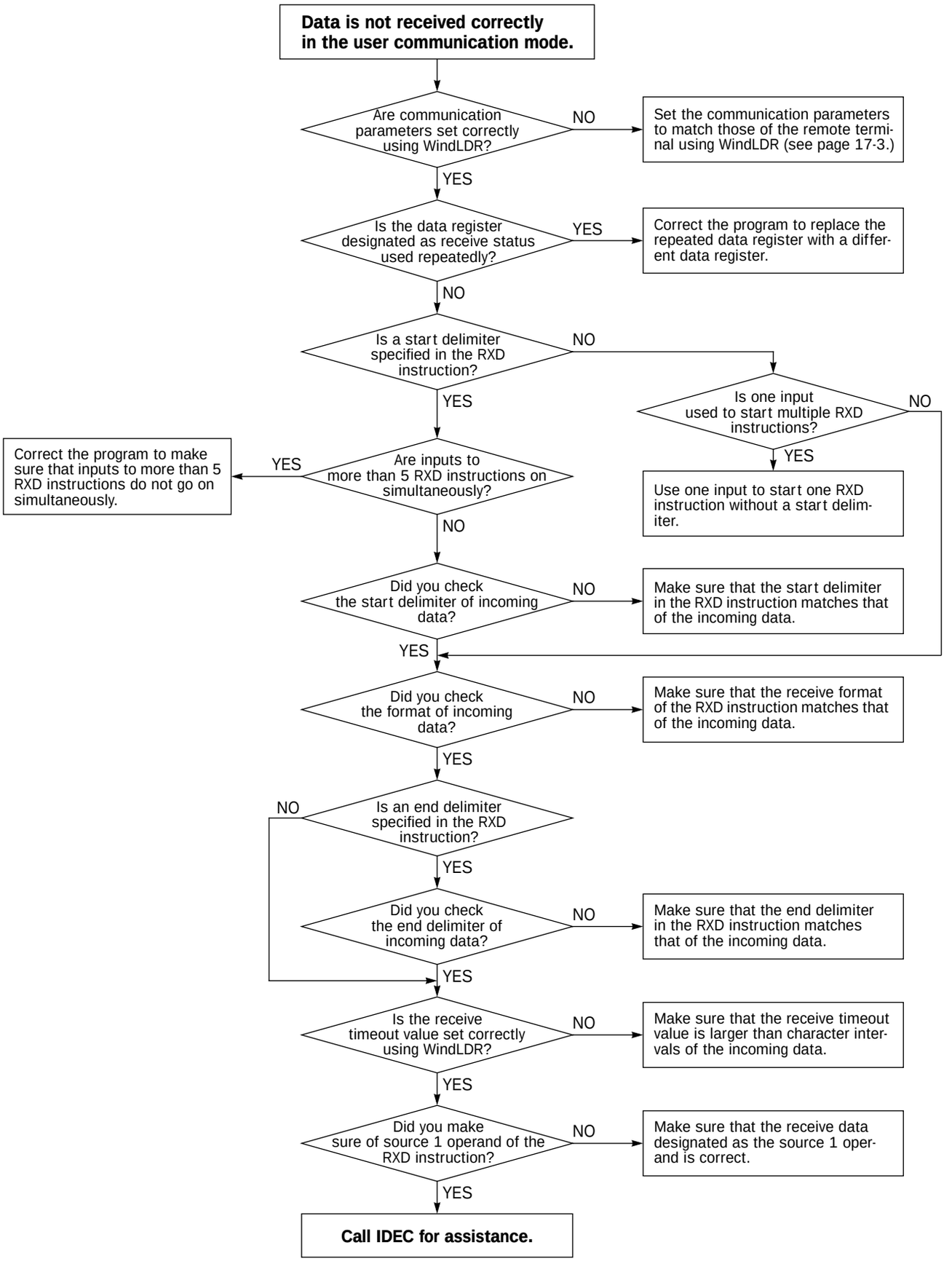


When the user communication still has a problem after completing the above procedure, also perform the procedure of Diagram 9 described on the preceding page.

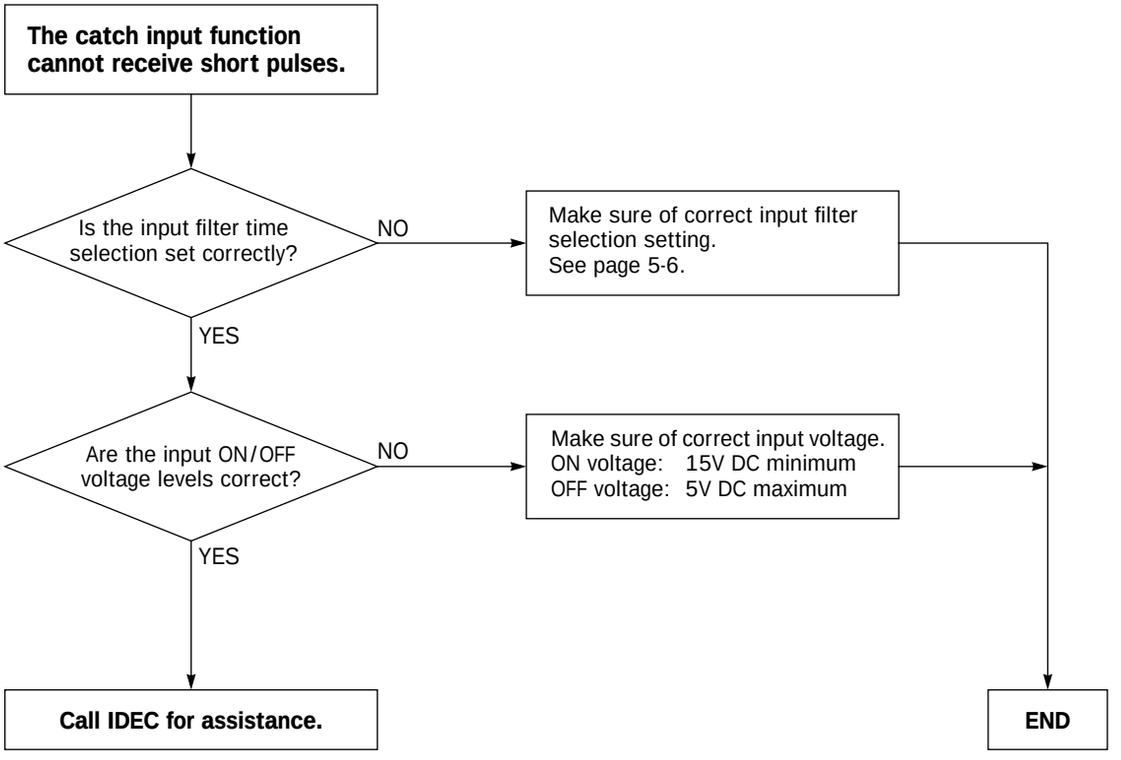
Troubleshooting Diagram 11



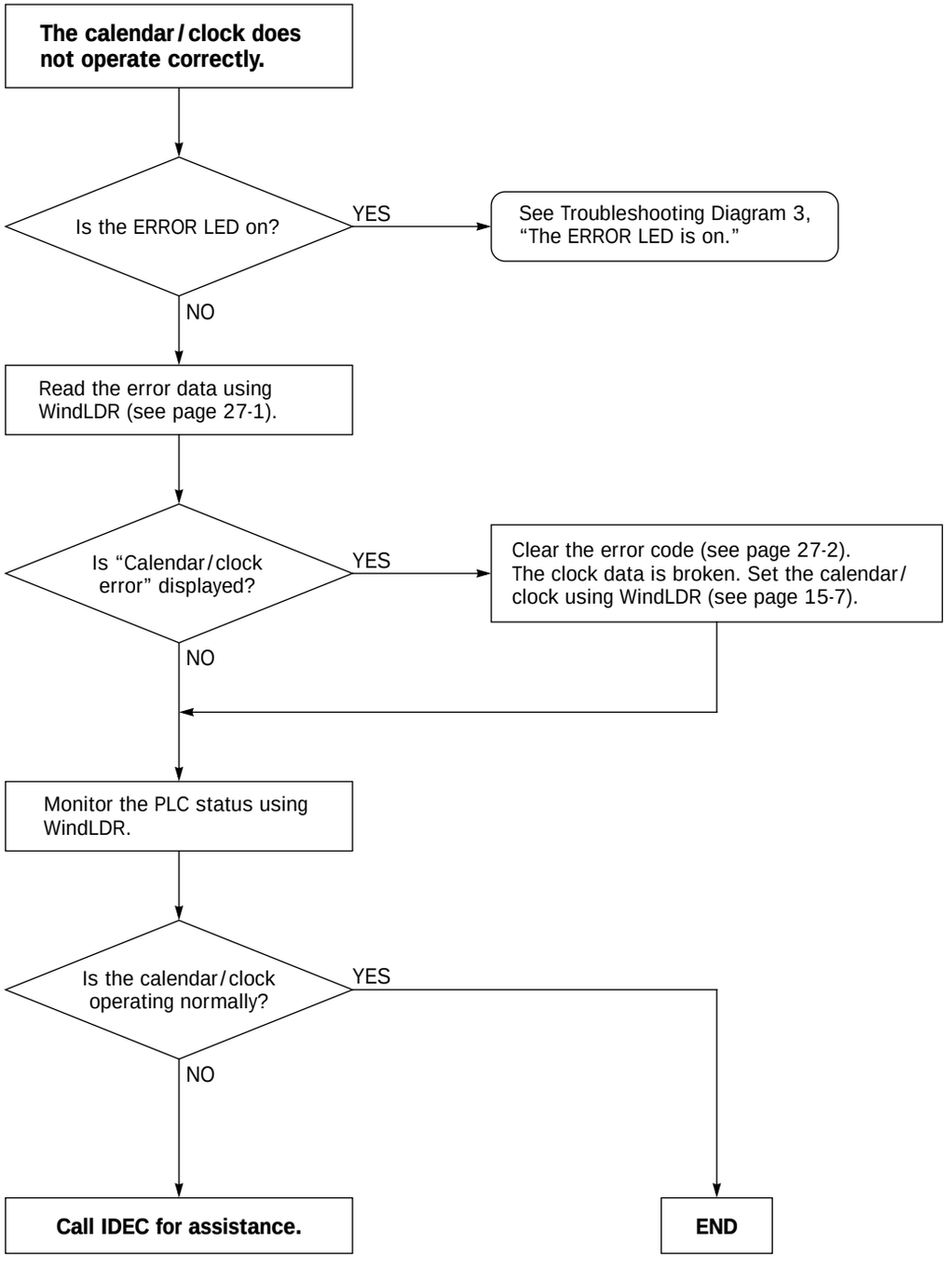
Troubleshooting Diagram 12



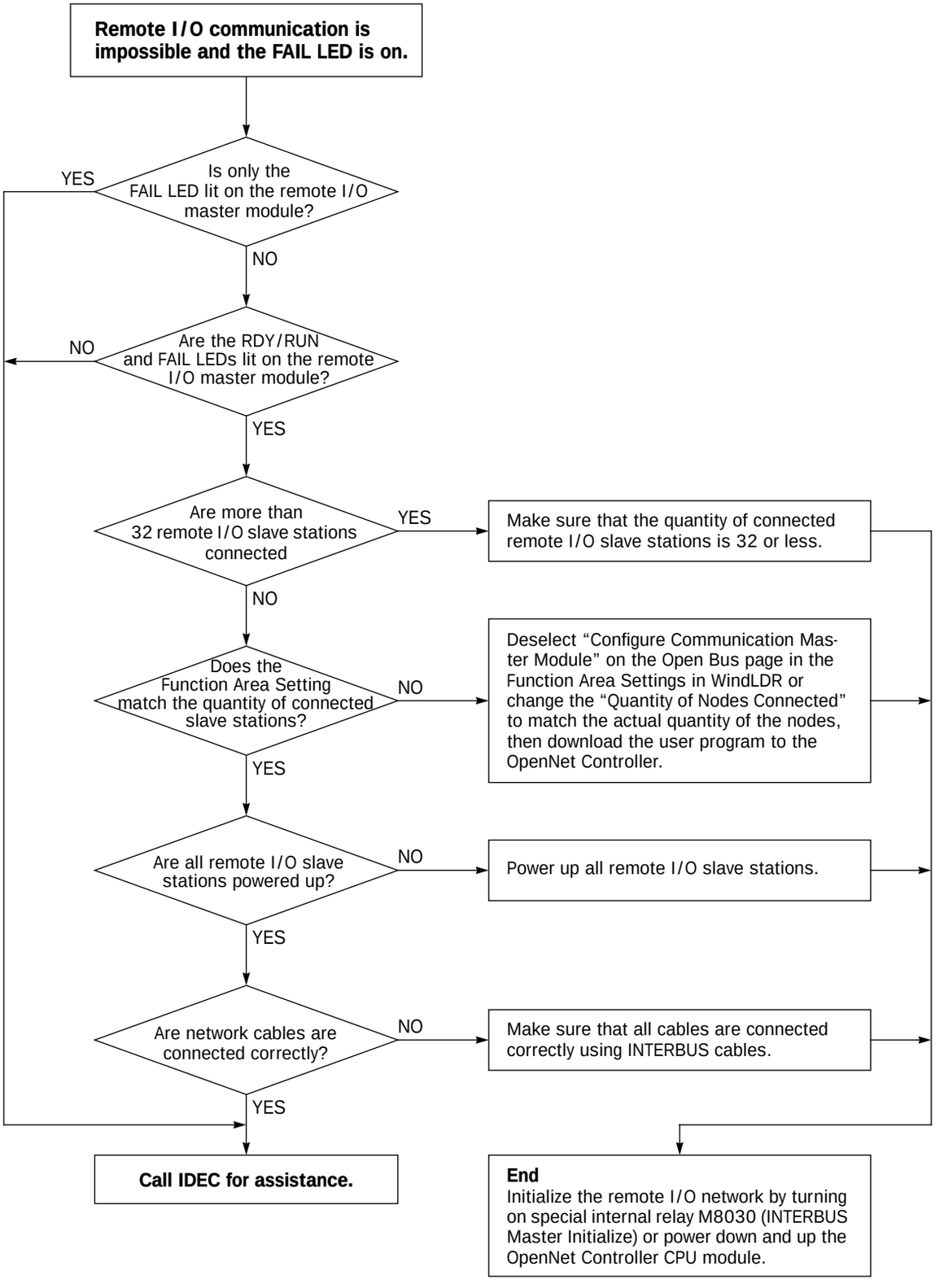
Troubleshooting Diagram 13



Troubleshooting Diagram 14

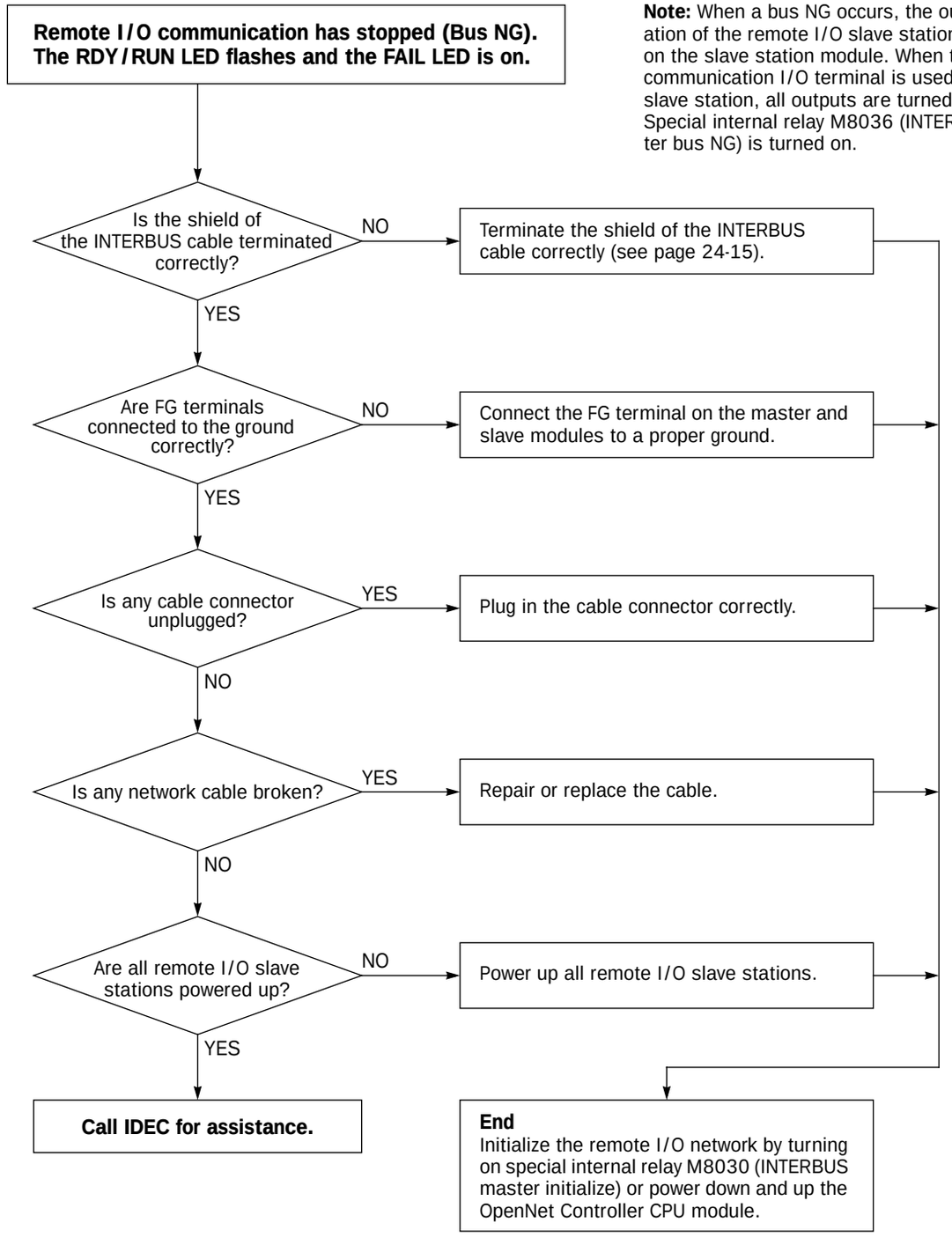


Troubleshooting Diagram 15



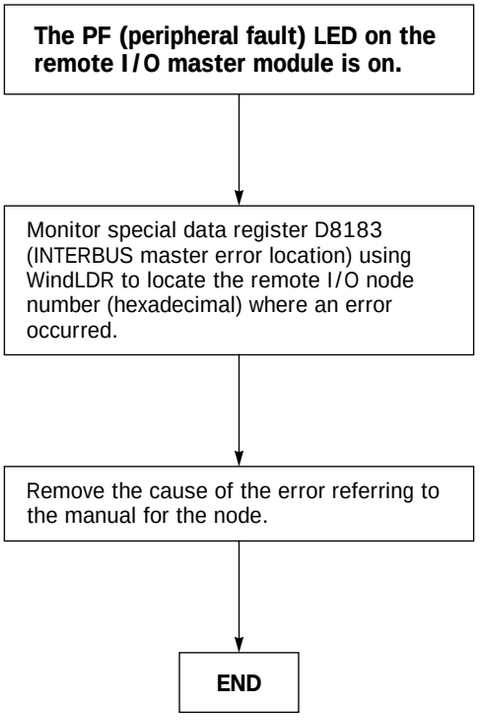
Monitor special data registers D8178, D8179, D8182, and D8183 to view the remote I/O system status, error code, and error location. See page 24-10.

Troubleshooting Diagram 16



Note: When a bus NG occurs, the output operation of the remote I/O slave station depends on the slave station module. When the SX5S communication I/O terminal is used for the slave station, all outputs are turned off. Special internal relay M8036 (INTERBUS master bus NG) is turned on.

Troubleshooting Diagram 17



A module error occurred at a remote I/O slave station. When this error occurs, the remote I/O network continues to work.
Special internal relay M8037 (INTERBUS master peripheral fault) is also turned on.

Special data register D8182 (INTERBUS master error code) stores user error code 0BB1h (peripheral fault). See page 24-16.

APPENDIX

Execution Times for Instructions

Execution times for main instructions of the OpenNet Controller are listed below:

Instruction	Operand and Condition	Maximum Execution Time (µsec)		
		w/o Data Type	Data Type: W or I	Data Type: D or L
LOD, LODN		0.65		
OUT, OUTN		1.15		
SET, RST		1		
AND, ANDN, OR, ORN		0.5		
AND LOD, OR LOD		0.3		
BPS		3		
BRD		0.5		
BPP		3		
TML, TIM, TMH, TMS		43		
CNT, CDP, CUD		42		
CC=, CC≥, TC=, TC≥, DC=, DC≥		22		
SFR, SFRN (N bits)	Reset input ON	190 + 1.1N		
	Pulse input ON	252 + 2.8N		
	Others	113		
SOTU, SOTD		50		
JMP, JEND, MCS, MCR		3		
END	See the next page.			
MOV, MOVN	M → M		170	240
	D → D		70	74
CMP=, <>, <, >, <=, >=	M ↔ M → M		210	260
	D ↔ D → M		115	125
ADD	M + M → D		172	232
	D + D → D		98	110
SUB	M – M → D		172	232
	D – D → D		98	110
MUL	M × M → D		172	238
	D × D → D		98	140
DIV	M ÷ M → D		205	280
	D ÷ D → D		136	192

Breakdown of END Processing Time

The END processing time depends on the OpenNet Controller settings and system configuration. The total of execution times for applicable conditions shown below is the actual END processing time.

Item	Condition	Execution Time
Housekeeping		540 µsec
I/O service	IN/OUT 32/32 points	630 µsec
	IN/OUT 64/64 points	730 µsec
	IN/OUT 128/128 points	910 µsec
	IN/OUT 240/240 points	1400 µsec
Calendar/clock function processing (Note 1)		66 µsec
Data link master station processing (Note 2)	When using a data link system (separate refresh mode)	2.083 × transmit/receive words + 3.125 msec (at 19200 bps) See page 21-9.

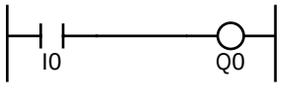
Note 1: Calendar/clock function is processed once every 100 msec.

Note 2: Data link slave stations are processed in interrupt processing asynchronous to the ordinary system processing.

In addition to processing user program instructions and END instruction, the OpenNet Controller system processing includes interrupt processing of various functions.

I/O Delay Time

The minimum delay from a standard input to a standard output in the program below is 1.31 msec.



Instruction	Data
LOD	I0
OUT	Q0

- Maximum execution time

  LOD 0.65 µsec
  OUT 1.15 µsec

- END processing time (without interrupt processing)

  Housekeeping 540 µsec
  I/O service 630 µsec

- Input delay time (DC input without filter setting)

  40 µsec

- Output delay time (transistor output)

  Approx. 100 µsec

The I/O delay time may be increased by such factors as increased END processing time (caused by frequent interrupt processing and larger program size) and input filter setting.

Type List

CPU Modules

HSC Output	Memory Card Connector	Type No.
Sink Output Type	Without	FC3A-CP2K
	With	FC3A-CP2KM
Source Output Type	Without	FC3A-CP2S
	With	FC3A-CP2SM

Note: Every CPU module is supplied with a pair of end plates.

Input Modules

Input Type	Input Points	Terminal / Connector	Type No.
24V DC Sink/Source	16 points	Screw Terminal	FC3A-N16B1
		Nylon Connector (10P × 2)	FC3A-N16B3
	32 points	Nylon Connector (18P × 2)	FC3A-N32B4
		Fujitsu Connector	FC3A-N32B5
100-120V AC Input	8 points	Screw Terminal	FC3A-N08A11
Analog Input 12-bit (resolution 1/4000) 6 channels 4-20mA, 0-5V, 0-10V, ±5V, ±10V input		Screw Terminal	FC3A-AD1261

Output Modules

Output Type	Output Points	Terminal / Connector	Type No.
Relay Output (240V AC/24V DC, 2A)	16 points	Screw Terminal	FC3A-R161
		Nylon Connector (5P × 4)	FC3A-R162
Transistor Sink Output 24V DC, 0.5A/point 2.0A/common	16 points	Screw Terminal	FC3A-T16K1
		Nylon Connector (10P × 2)	FC3A-T16K3
Transistor Protect Source Output 24V DC, 0.5A/point 2.0A/common	16 points	Screw Terminal	FC3A-T16P1
Transistor Sink Output 24V DC, 0.1A/point 2.0A/common	32 points	Nylon Connector (18P × 2)	FC3A-T32K4
		Fujitsu Connector	FC3A-T32K5
Analog Output 12-bit (resolution 1/4000) 2 channels 4-20mA, 0-5V, 0-10V, ±5V, ±10V output		Screw Terminal	FC3A-DA1221

Expansion Power Supply Module

Description	Connector	Type No.
Input Power Voltage 24V DC	Nylon Connector (5P × 1)	FC3A-EA1

Note: The expansion power supply module is supplied with a cable/connector (1 meter long) and 3 contacts for expanding cables.

Remote I/O Master Module

Description	Type No.
Remote I/O Master Module compatible with INTERBUS	FC3A-SX5SM1

OpenNet Interface Modules

Description	Type No.
DeviceNet Slave Module	FC3A-SX5DS1
LONWORKS Interface Module	FC3A-SX5LS1

SX5 Communication I/O Terminals

Bus	I/O Type	Input Type	Type No.
INTERBUS	DC Input	16-point source input (24V DC)	SX5S-SBN16S
		16-point sink input (24V DC)	SX5S-SBN16K
	Relay Output	8-point relay output (240V AC/24V DC, 5A)	SX5S-SBR08
	Transistor Output	16-point transistor sink output (24V DC, 0.5A/point, 6A/common)	SX5S-SBT16K
		16-point transistor protect source output (24V DC, 0.5A/pt, 6A/com)	SX5S-SBT16P
	DC Input Transistor Output	8-point source input (24V DC) 8-point transistor sink output (24V DC, 0.5A/point, 4A/common)	SX5S-SBM16K
		8-point source input (24V DC) 8-point transistor protect source output (24V DC, 0.5A/pt, 4A/com)	SX5S-SBM16P
DeviceNet	DC Input	16-point source input (24V DC)	SX5D-SBN16S
		16-point sink input (24V DC)	SX5D-SBN16K
	Relay Output	8-point relay output (240V AC/24V DC, 5A)	SX5D-SBR08
	Transistor Output	16-point transistor sink output (24V DC, 0.5A/point, 6A/common)	SX5D-SBT16K
		16-point transistor protect source output (24V DC, 0.5A/pt, 6A/com)	SX5D-SBT16P
	DC Input Transistor Output	8-point source input (24V DC) 8-point transistor sink output (24V DC, 0.5A/point, 4A/common)	SX5D-SBM16K
		8-point source input (24V DC) 8-point transistor protect source output (24V DC, 0.5A/pt, 4A/com)	SX5D-SBM16P
LONWORKS	DC Input	16-point source input (24V DC)	SX5L-SBN16S
		16-point sink input (24V DC)	SX5L-SBN16K
	Relay Output	8-point relay output (240V AC/24V DC, 5A)	SX5L-SBR08
	Transistor Output	16-point transistor sink output (24V DC, 0.5A/point, 6A/common)	SX5L-SBT16K
		16-point transistor protect source output (24V DC, 0.5A/pt, 6A/com)	SX5L-SBT16P
	DC Input Transistor Output	8-point source input (24V DC) 8-point transistor sink output (24V DC, 0.5A/point, 4A/common)	SX5L-SBM16K
		8-point source input (24V DC) 8-point transistor protect source output (24V DC, 0.5A/pt, 4A/com)	SX5L-SBM16P

Cables and Accessories

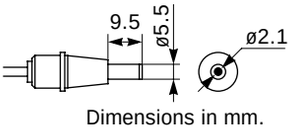
Name	Function	Type No.
End Plates	For mounting on both ends of OpenNet Controller module assembly (a pair of end plates are supplied with the CPU module)	FC9Z-W1
Modem Cable 1C (3m/9.84 ft. long)	Used to connect a modem to the OpenNet Controller RS232C port, with D-sub 25-pin male connector to connect to modem	FC2A-KM1C
Computer Link Cable 4C (3m/9.84 ft. long)	Used to connect an IBM PC to the OpenNet Controller RS232C port (1:1 computer link), with D-sub 9-pin female connector to connect to computer	FC2A-KC4C
Computer Link Cable 6C (2m/6.56 ft. long)	Used to connect an IBM PC to the OpenNet Controller RS485 terminals (1:1 computer link), with D-sub 9-pin female connector to connect to computer	FC2A-KC6C
User Communication Cable 1C (2.4m/7.87 ft. long)	Used to connect RS232C equipment to the OpenNet Controller RS232C port, without a connector to connect to RS232C equipment	FC2A-KP1C
PLC Connection Cable (3m/9.84 ft. long)	RS232C cable used to connect IDEC HG1B/2A/2C operator interface to the OpenNet Controller RS232C port	HG9Z-XC183
INTERBUS Cable	Used for wiring the remote I/O master and slave modules	See page 24-15
RS232C/RS485 Converter	Used for interface between an IBM PC and the OpenNet Controller CPU modules in the computer link 1:N communication system or through modems	FC2A-MD1
RS232C Cable (4-wire) (1.5m/4.92 ft. long)	Used to connect the RS232C/RS485 converter to an IBM PC, with D-sub 9-pin female connector to connect to computer	HD9Z-C52
DIN Rail (1m/3.28 ft. long)	35-mm-wide DIN rail to mount OpenNet Controller modules	BAA1000
Mounting Clip	Used on DIN rail to fasten OpenNet Controller modules	BNL6
Phoenix Ferrule	Ferrule for connecting 1 or 2 wires to screw terminal	See page 3-10
Phoenix Ferrule Tool	Used for crimping ferrules	See page 3-10
Screwdriver	Used for tightening screw terminals	See page 3-10
Terminal Block Removal Tool	Used for removing terminal blocks from I/O modules	FC9Z-FTP20
Miniature Memory Card	2MB memory card to store a user program	FC9Z-MC02
WindLDR	Programming and monitoring software for Windows PC (CD)	FC9Y-LP2CDW

AC Adapter

When using the computer link cable 6C to connect a computer to the RS485 terminals on the OpenNet Controller CPU module, an AC adapter is required to power the RS232C/RS485 converter on the computer link cable 6C. AC adapter output capacity: 5 to 6.5V DC, 4W

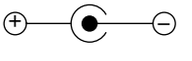
The RS232C/RS485 converter FC2A-MD1 for 1:N computer link communication is powered by 24V DC source or an AC adapter with 9V DC, 350mA output capacity.

The output plug of the AC adapter applicable to both the computer link cable 6C and the RS232C/RS485 converter is shown on the right.



Dimensions in mm.

Polarity



INDEX

T