FC9Y-B1378

IDEC

FT1A SERIES

MICROSmart pentra

User's Manual

Automation Organizer WindLDR

IDEC CORPORATION

SAFETY PRECAUTIONS

- Read the FT1A Series Pro/Lite User's Manual to make sure of correct operation before starting installation, wiring, operation, maintenance, and inspection of the SmartAxis.
- All SmartAxis modules are manufactured under IDEC's rigorous quality control system, but users must add a backup or failsafe provision to the control system when using the SmartAxis in applications where heavy damage or personal injury may be caused in case the SmartAxis 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.**

- The SmartAxis is not designed for use in medical equipment, nuclear power, railways, aviation, passenger vehicle equipment, or similar applications requiring a high degree of reliability and safety. The SmartAxis cannot be used for such applications.
- When using the SmartAxis in applications not described above that require a high degree of reliability in terms of functionality and precision, appropriate measures such as failsafe mechanisms and redundant mechanisms must be taken for the system containing the SmartAxis.
- Emergency stop and interlocking circuits must be configured outside the SmartAxis.
- If relays or transistors in the SmartAxis output circuits should fail, outputs may remain at on or off state. For output signals which may cause serious accidents, configure monitor circuits outside the SmartAxis.
- The SmartAxis self-diagnostic function may detect internal circuit or program errors, stop programs, and turn outputs off. Configure circuits so that the system containing the SmartAxis is not jeopardized when outputs turn off.
- Turn off power to the SmartAxis before installation, removal, wiring, maintenance, and inspection of the SmartAxis. Failure to turn power off may cause electrical shocks or fire hazard.
- Special expertise is required to install, wire, program, and operate the SmartAxis. People without such expertise must not use the SmartAxis.
- Install the SmartAxis according to the instructions described in FT1A series Pro/Lite user's manual. Improper installation will result in falling, failure, or malfunction of the SmartAxis.

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

- The SmartAxis is designed for installation in a cabinet. Do not install the SmartAxis outside a cabinet.
- Install the SmartAxis in environments described in FT1A series Pro/Lite user's manual. If the SmartAxis is used in places where the SmartAxis 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 SmartAxis is "Pollution degree 2." Use the SmartAxis in environments of pollution degree 2 (according to IEC 60664-1).
- Prevent the SmartAxis from falling while moving or transporting the SmartAxis, otherwise damage or malfunction of the SmartAxis will result.
- Wiring must use lead sizes that are appropriate for the applied voltage and current. Terminal screws must be tightened with the prescribed tightening torque.
- Prevent metal fragments and pieces of wire from dropping inside the SmartAxis housing. Put a cover on the SmartAxis 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 an IEC 60127-approved fuse on the power line outside the SmartAxis. This is required when equipment containing the SmartAxis is destined for Europe.
- Use an IEC 60127-approved fuse on the output circuit. This is required when equipment containing the SmartAxis is destined for Europe.
- Use an EU-approved circuit breaker. This is required when equipment containing the SmartAxis is destined for Europe.
- Make sure of safety before starting and stopping the SmartAxis or when operating the SmartAxis to force outputs on or off. Incorrect operation on the SmartAxis may cause machine damage or accidents.
- Do not connect the ground wire directly to the SmartAxis. Connect a protective ground to the cabinet containing the SmartAxis using an M4 or larger screw. This is required when equipment containing the SmartAxis is destined for Europe.
- Do not disassemble, repair, or modify the SmartAxis modules.
- The SmartAxis contains electronic parts and batteries. When disposing of the SmartAxis, do so in accordance with national and local regulations.

About This Manual

This user's manual describes basic and advanced instructions and the usage of software for SmartAxis ladder programming.

Chapter 1: Operation Basics

General information about simple operating procedures from creating a user program using WindLDR on a PC to monitoring the SmartAxis operation.

Chapter 3: Device Addresses

Device addresses available for the SmartAxis CPU modules to program basic and advanced instructions. Special internal relays and special data registers are also described.

Chapter 4: Instructions Reference

List of all basic and advanced instructions and general rules of using advanced instructions, terms, data types, and formats used for advanced instructions.

Chapter 5: Basic Instructions

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

Chapter 6 through Chapter 26:

Detailed descriptions on advanced instructions.

Appendix

Additional information about execution times and size for instructions.

Index

Alphabetical listing of key words.

Publication history

October 2012 First Edition

Trademarks

SmartAxis is a trademark of IDEC Corporation.

RELATED MANUALS

The following manuals related to the SmartAxis are available. Refer to them in conjunction with this manual.

Type No.	Manual Name	Description
FT9Y-B1378	FT1A Series Pro/Lite User's Manual (this manual)	Describes product specifications, installation and wiring instructions, instructions for basic programming operations and special functions, device and instruction lists, communication functions, and troubleshooting procedures for the SmartAxis Pro/Lite series.
FT9Y-B1382	FT1A Series Ladder Programming Manual	Describes basic operations for ladder programming, instructions for editing and monitoring ladders on the SmartAxis, available devices and instruction lists, and details of each instruction.
FT9Y-B1390	FT1A Series Touch User's Manual	Describes product specifications, installation and wiring instructions, instructions for setting basic programming actions and special functions, device and instruction lists, communication functions, and troubleshooting procedures for the Touch series.
WindLDR Help		Describes usage instructions for WindLDR, programming software for the SmartAxis Pro/Lite series.
WindO/I-NV3 Help		Describes programming for the SmartAxis Touch series, and usage instructions for the WindO/I-NV3 configuration software.

NAMES AND ABBREVIATIONS USED IN THIS MANUAL

Model Names

Name Used in this Manual	Description (Detailed Type No.)
SmartAxis	Name for the FT1A programmable logic controllers.
SmartAxis Lite	General name for modules with no LCD. (FT1A-B12RA, FT1A-B12RC, FT1A-B24RA, FT1A-B24RC, FT1A-B40RKA, FT1A-B40RSA, FT1A-B40RC, FT1A-B48KA, FT1A-B48SA, FT1A-B48KC, FT1A-B48SC)
SmartAxis Pro	General name for modules with LCD. (FT1A-H12RA, FT1A-H12RC, FT1A-H24RA, FT1A-H24RC, FT1A-H40RKA, FT1A-H40RSA, FT1A-H40RC, FT1A-H48KA, FT1A-H48SA, FT1A-H48KC, FT1A-H48SC)
SmartAxis Touch	General name for modules that extend the functionality of display. (FT1A-M12RA-W, FT1A-M12RA-B, FT1A-M12RA-S, FT1A-C12RA-W, FT1A-C12RA-B, FT1A-C12RA-S)
12-I/O type	General name for SmartAxis Pro and Lite models with 12 I/O points. (FT1A-B12RA, FT1A-B12RC, FT1A-H12RA, FT1A-H12RC)
24-I/O type	General name for SmartAxis Pro and Lite models with 24 I/O points. (FT1A-B24RA, FT1A-B24RC, FT1A-H24RA, FT1A-H24RC)
40-I/O type	General name for SmartAxis Pro and Lite models with 40 I/O points. (FT1A-B40RKA, FT1A-B40RSA, FT1A-B40RC, FT1A-H40RKA, FT1A-H40RSA, FT1A-H40RC)
48-I/O type	General name for SmartAxis Pro and Lite models with 48 I/O points. (FT1A-B48KA, FT1A-B48SA, FT1A-B48KC, FT1A-B48SC, FT1A-H48KA, FT1A-H48SA, FT1A-H48KC, FT1A-H48SC)
AC power type	General name for SmartAxis Pro and Lite models with an AC power supply. (FT1A-B12RC, FT1A-H12RC, FT1A-B24RC, FT1A-H24RC, FT1A-B40RC, FT1A-H40RC, FT1A-B48KC, FT1A-B48SC, FT1A-H48KC, FT1A-H48SC)
DC power type	General name for SmartAxis Pro and Lite models with a DC power supply. (FT1A-B12RA, FT1A-H12RA, FT1A-B24RA, FT1A-H24RA, FT1A-B40RKA, FT1A-H40RKA, FT1A-B40RSA, FT1A-H40RSA, FT1A-B48KA, FT1A-B48SA, FT1A-H48KA, FT1A-H48SA)

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APPENDIX

1: GENERAL INFORMATION

Introduction

This chapter describes SmartAxis functions and system configuration examples. The SmartAxis is available in three types: the SmartAxis Pro, the SmartAxis Lite, and the SmartAxis Touch. The SmartAxis Lite is equipped with the various control and communication functions as a PLC. In addition to the functions of the SmartAxis Lite, the SmartAxis Pro is equipped with an LCD and operation buttons on the front of the module. The SmartAxis Touch is equipped with the HMI functions of an operator interface and PLC control functions.

This document describes the SmartAxis Pro and Lite. Unless otherwise specified, SmartAxis refers to the SmartAxis Pro and Lite. For the SmartAxis Touch, refer to the FT1A Series Touch User's Manual.

About the SmartAxis

The SmartAxis is a small-size programmable controller that is fully equipped with powerful basic functions and various communication functions.
You can select the type of SmartAxis optimized for your applications, in such ways as the inclusion of the display function, the type of power supply, and the number of inputs and outputs.

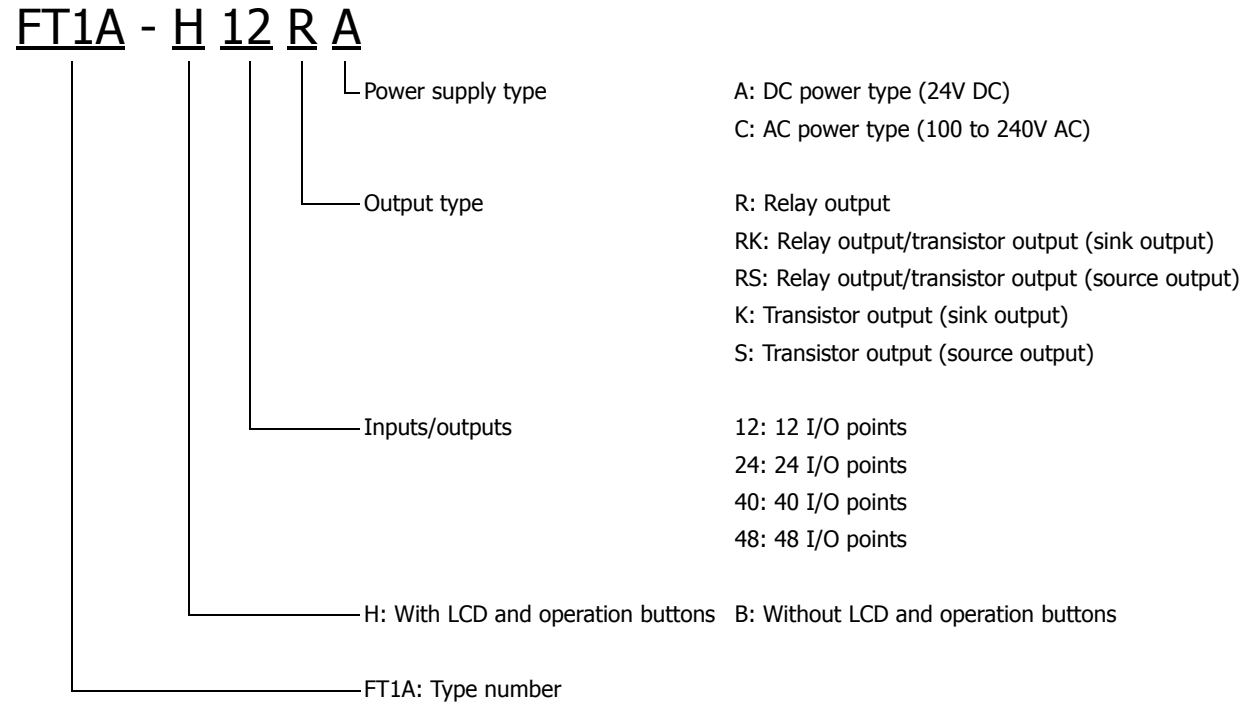
The SmartAxis Lite is equipped with basic functions. The SmartAxis Pro adds to the functionality of the SmartAxis Lite and is equipped with an LCD and operation buttons on the module enabling independent monitor and operation functions.

The SmartAxis supports 100 to 240V AC and 24V DC power supplies. CPU modules with Ethernet port (24-, 40-, 48-I/O types) can expand the number of inputs and outputs for a maximum of 90 inputs and a maximum of 54 outputs using the remote I/O function.

User programs can be created using WindLDR, the PLC programming software.

The SmartAxis supports two programming methods: ladder program and script. You can select any programming method for your purposes. Ladder programs for FT1A are compatible with the MicroSmart, so you can make use of existing software assets.

Type Numbers
The notation for SmartAxis type numbers is as follows.

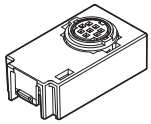


Type List

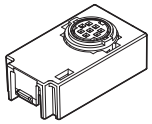
Type Number	Power Supply	Inputs and Outputs (In/Out)	LCD, Operation Buttons	USB Port	Expansion Communication Port	Ethernet Port	SD Memory Card slot
FT1A-H12RA	24V DC	12 (8/4)	Yes	Yes	—	—	—
FT1A-H12RC	100 to 240V AC						
FT1A-B12RA	24V DC		—				
FT1A-B12RC	100 to 240V AC						
FT1A-H24RA	24V DC	24 (16/8)	Yes		Yes 1 port	Yes	
FT1A-H24RC	100 to 240V AC						
FT1A-B24RA	24V DC		—				
FT1A-B24RC	100 to 240V AC						
FT1A-H40RKA	24V DC	40 (24/16)	Yes		Yes 2 ports		Yes
FT1A-H40RSA							
FT1A-H40RC	100 to 240V AC						
FT1A-B40RKA	24V DC		—				
FT1A-B40RSA							
FT1A-B40RC	100 to 240V AC						
FT1A-H48KA	24V DC	48 (30/18)	Yes				
FT1A-H48SA							
FT1A-H48KC	100 to 240V AC						
FT1A-H48SC							
FT1A-B48KA	24V DC		—				
FT1A-B48SA							
FT1A-B48KC	100 to 240V AC						
FT1A-B48SC							

Options

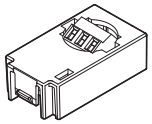
RS232C Communication Cartridge
FT1A-PC1 (Mini-DIN type)



RS485 Communication Cartridge
FT1A-PC2 (Mini-DIN type)

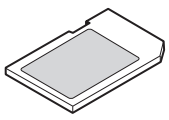


RS485 Communication Cartridge
FT1A-PC3 (Terminal block type)

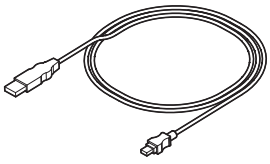


Memory Cartridge
FT1A-PM1

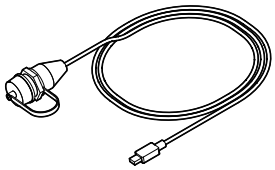
SD Memory Card
HG9Z-XMS2



USB Maintenance Cable
HG9Z-XCM42



Panel Mount USB Extension Cable
HG9Z-XCE21



Features

This section describes the features of the SmartAxis.

The SmartAxis is high-performance programmable controller in a compact package and is equipped with high speed counters can be used for positioning control. The SmartAxis enables you to build optimum systems to automate factories or control production lines.

Powerful HMI Functions

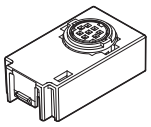
The SmartAxis Pro is equipped with an LCD on the front of the module which enables you to monitor and modify device values and basic instructions. Customized messages can be programmed to display current time, bar charts, scrolling messages, or simple text on the LCD. The operation buttons on the module are used for operations with LCD such as checking and modifying device values.

Powerful Communication Functions

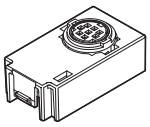
The SmartAxis supports various communications such as maintenance communication, user communication, Modbus communication, and remote I/O.

The SmartAxis is equipped with RS232C (optional), RS485 (optional), an Ethernet port, and a USB port and can be connected to various devices such as PCs, operator interfaces, and printers.

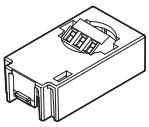
RS232C Communication Cartridge
FT1A-PC1 (Mini-DIN type)



RS485 Communication Cartridge
FT1A-PC2 (Mini-DIN type)



RS485 Communication Cartridge
FT1A-PC3 (Terminal block type)



Memory Cartridge

A user program of SmartAxis can be stored in a memory cartridge (FT1A-PM1). When a memory cartridge is inserted into a SmartAxis, the user program in the memory cartridge is executed instead of the user program in the SmartAxis. You can also download the user program in a memory cartridge to the SmartAxis.

Memory Cartridge
FT1A-PM1

SD Memory Card

The 40- and 48-I/O types are equipped with an SD memory card slot. The log data of device values can be saved to an optional SD memory card (HG9Z-XMS2) or a commercially available SD memory card (32 GB maximum).

32-bit and Floating Point Data Types

Some advanced instructions can select 32-bit data types from D (double word), L (long), and F (float) in addition to W (word) and I (integer).

Safety and High Quality Compliant with International Standards

The SmartAxis is compliant with international standards and can be used all over the world while maintaining safety and high quality.

Supports 9 Languages

The SmartAxis LCD supports the display of the following nine languages.

Setting Name	Character Set	Supported Languages
European	ISO 8859-1 (Latin-1)	English, German, Italian, Spanish, Dutch (Note), French (Note)
Japanese	Shift-JIS	Japanese (level 1)
Chinese	GB2312	Chinese (simplified)
Cyrillic	ANSI 1251	Russian

Note: Some of the characters cannot be input.

Special Functions

This section describes the functions of the SmartAxis.

I/O Related Functions

Catch Input
The catch input makes sure to receive short input pulses from sensors without regard to the scan time. A maximum of 6 catch inputs can be used.

Input Filter
The input filter can be adjusted according to the width of input signals to reject input noises. Selectable input filter values to pass input signals are 0 ms, and 3 through 15 ms in 1 ms increments. The input filter rejects inputs shorter than the selected input filter value minus 2 ms. This function is useful for eliminating input noises and chatter in limit switches.

Interrupt Input
The interrupt input can be used to call an interrupt program to respond to an external input that requires a response faster than the scan time. A maximum of six interrupt inputs can be used.

Stop and Reset Inputs
Stop input is a function to stop SmartAxis operation. Reset input is a function to stop SmartAxis operation and clear device values. Any input terminal on the SmartAxis can be designated as a stop or reset input to control the SmartAxis operation.

Remote I/O
When the number of SmartAxis inputs and outputs is insufficient, the number of inputs and outputs can be expanded to a maximum of 192 points by connecting additional SmartAxis as remote I/O slaves over Ethernet. With the remote I/O function, the analog inputs on the SmartAxis connected as remote I/O slaves can also be used.

Analog Input
Analog input of 0 to 10V DC can be converted to a digital value of 0 to 1000. A maximum of eight inputs can be used as analog inputs.

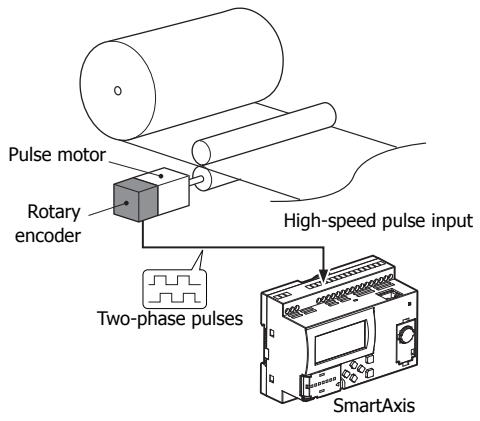
Forced I/O
The inputs and outputs of the SmartAxis can be forced on or off. This function can be used to check the I/O wiring or the user program operation.

Pulse I/O Functions

High-speed Counter
This function counts high-speed pulse inputs that cannot be measured in normal user program processing.

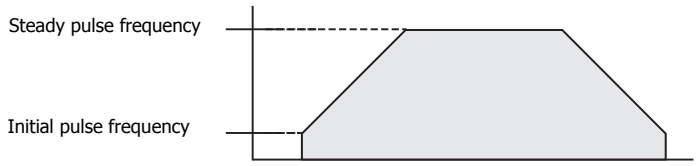
Use this function for applications such as positioning control with a rotary encoder or motor control. The SmartAxis can use single-phase high-speed counters and two-phase high-speed counters. A maximum of six single-phase high-speed counters and a maximum of two two-phase high-speed counters can be used simultaneously.

Example: Controlling a motor by counting two-phase pulse input with a high-speed counter



Positioning Control
The SmartAxis can perform positioning control with pulse outputs. The SmartAxis features the PULS instructions that can generate pulse outputs with configured frequency at the fixed pulse width ratio, pulse-width modulation (PWM) instructions that can generate pulse outputs with configured pulse width ratio at a fixed frequency, RAMP instructions for trapezoidal control, ZRN instructions for zero return operation, and ARAMP instructions that can generate pulse outputs according to a table in which the changes of the frequency are configured.

Example: Pulse output by the RAMP instruction



Frequency Measurement
This function measures the frequency of pulses input to an input terminal. The frequencies of a maximum of six inputs can be measured.

Convenient Functions

Calendar/Clock
The SmartAxis features a real-time clock on-board. Using the calendar and clock function, the SmartAxis can operate according to the current date and time. These functions can be used to control time schedule for lighting or air conditioning equipments.

User Program Read/Write Protection
The user program in the SmartAxis 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.

"Keep" or "Clear" Designation of SmartAxis Data
Internal relays, shift register bits, counter current values, and data register values can be designated to be kept or cleared when the SmartAxis is powered down. All or a specified range of these devices can be designated as keep or clear types.

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 SmartAxis is powered down, the user can select whether the SmartAxis starts to run or not to prevent undesirable operation at the next startup.

Log Data
Device values of the SmartAxis can be saved to CSV files on the SD memory card. The DLOG instruction saves device values to the SD memory card. The TRACE instruction accumulates device values at each scan and saves them to the SD memory card at the desired timing.

Constant Scan Time
The variations in scan time that occur when the user program is running can be made constant.

Timer Interrupt
The timer interrupt can be used to call an interrupt program at a predetermined interval of time without being affected by the scan time.

Communication Functions

The SmartAxis features a variety of communication functions.

RS232C and RS485 communication of SmartAxis is possible by installing the RS232C or RS485 communication cartridges into the expansion communication ports on the SmartAxis module. The 24-, 40-, and 48-I/O types also feature an Ethernet port as standard enabling the communication over Ethernet.

Communication Functions

Maintenance Communication (Chapter 9)	Maintenance communication enables you to check the operating status and I/O status of the SmartAxis, monitor and change device values, and download and upload user programs using a PC or operator interface.
User Communication (Chapter 10)	The SmartAxis can communication with external devices equipped with RS232C, RS485, or Ethernet ports using user communication.
Modbus Communication (Chapter 11)	The SmartAxis can send and receive data with Modbus compliant devices on RS232C, RS485, or Ethernet port.
Remote I/O (Chapter 12)	The number of digital inputs and outputs and analog inputs of the SmartAxis can be expanded by connecting separate SmartAxis modules to the SmartAxis as remote I/O slaves over Ethernet.

For details on the communications functions, refer to the chapter for each function.

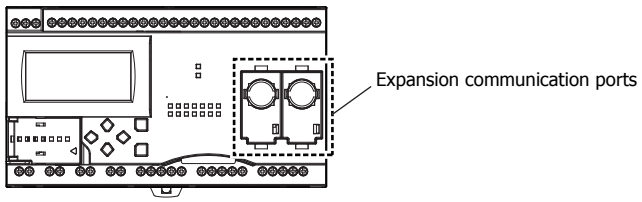
Communication Ports

USB Port	Maintenance communication can be performed by connecting the SmartAxis and a PC with USB.
Ethernet Port	The SmartAxis can communicate with Ethernet devices such as PCs and operator interfaces. Maintenance communication, user communication, Modbus communication, and remote I/O are possible.
Expansion Communication Ports	Maintenance communication, user communication, and Modbus RTU communication are possible.

Expansion Communication Ports

The SmartAxis can perform RS232C/RS485 communication by installing RS232C or RS485 communication cartridges to the expansion communication ports on the SmartAxis. The expansion communication ports are available on 24-, 40-, and 48-I/O types.

Example: 40-I/O type



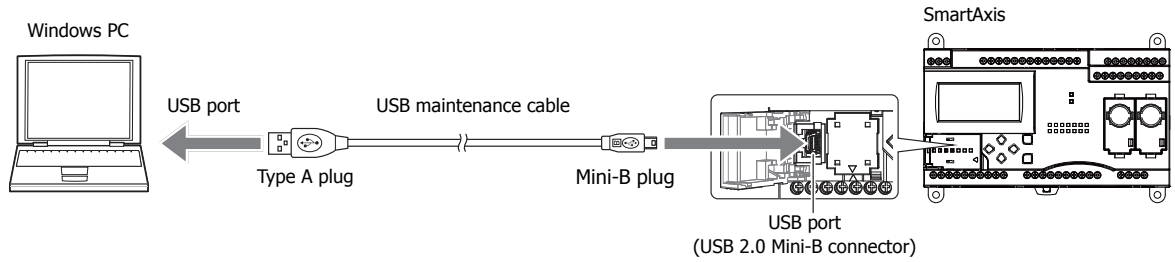
Maintenance Communication

The maintenance communication of the SmartAxis enables you to check the operating status and I/O status of the SmartAxis, monitor and change device values, and download and upload user programs with the PLC programming software WindLDR installed on a PC. For details on maintenance communication, refer to Chapter 9 "Maintenance Communication" on page 9-1.

Supported ports: USB port, Ethernet port, and expansion communication ports

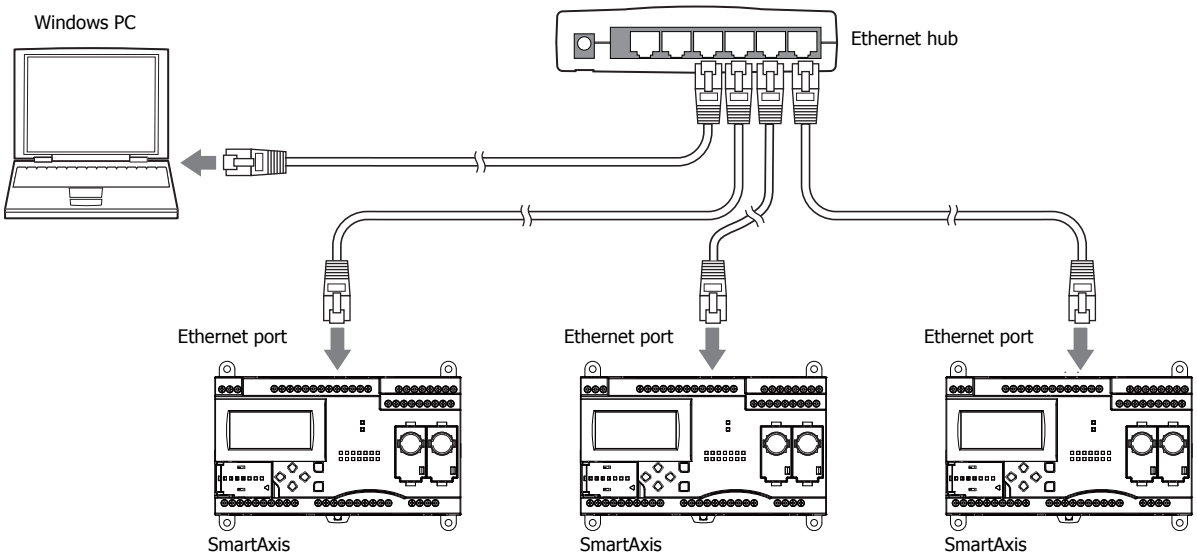
- **1:1 Maintenance Communication System**

This example shows a 1:1 maintenance communication system in which a SmartAxis and a PC are connected with USB. The USB maintenance cable (HG9Z-XCM42) is used.



- **1:N Maintenance Communication System**

This example shows a 1:N maintenance communication system in which three SmartAxis and a PC are connected over Ethernet. The Ethernet cables are connected to the Ethernet ports of three SmartAxis, and those SmartAxis are connected to the PC via an Ethernet hub.



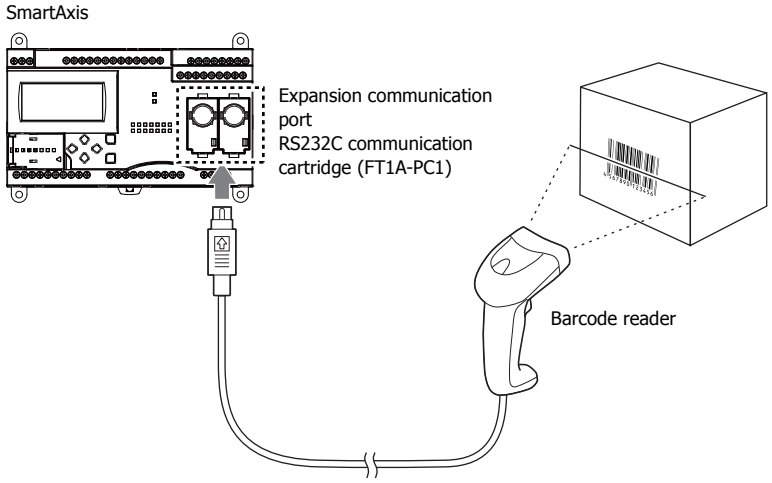
User Communication

The user communication of the SmartAxis enables you to control external devices such as PCs, printers, and barcode readers. For details on user communication, refer to Chapter 10 "User Communication" on page 10-1.

Supported ports: Ethernet port and expansion communication ports

- **User Communication on RS232C**

This example shows a system in which a SmartAxis receives the data read by a barcode reader. The RS232C communication cartridge (FT1A-PC1) is installed in a SmartAxis expansion communication port, and then the barcode reader is connected to the RS232C port.



Modbus Communication

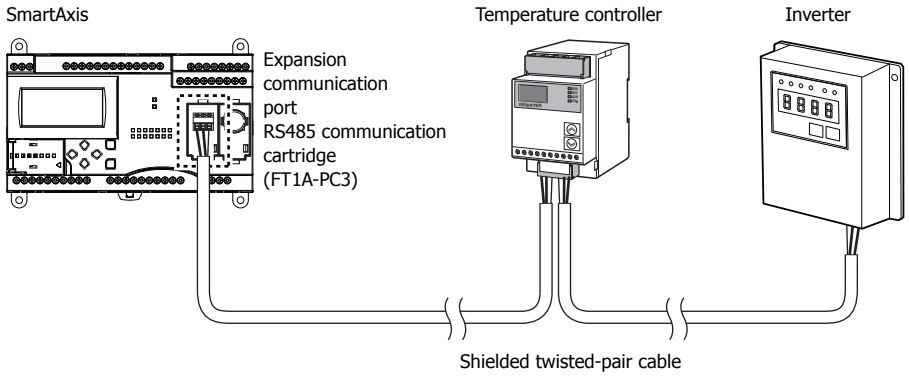
The SmartAxis is compliant with the Modbus protocol and can be used as either a Modbus communication master or slave. When used as a Modbus master, the SmartAxis can monitor and modify the data of Modbus compliant devices such as inverters and temperature controllers using Modbus communication.

For details on Modbus communication, refer to Chapter 11 "Modbus Communication" on page 11-1.

Supported ports: Ethernet port and expansion communication ports

- **Modbus Communication on RS485**

This example shows a system in which a SmartAxis communicating with a temperature controller and an inverter that support Modbus RTU. The RS485 communication cartridge (FT1A-PC3) is installed in an expansion communication port on the SmartAxis.



Remote I/O

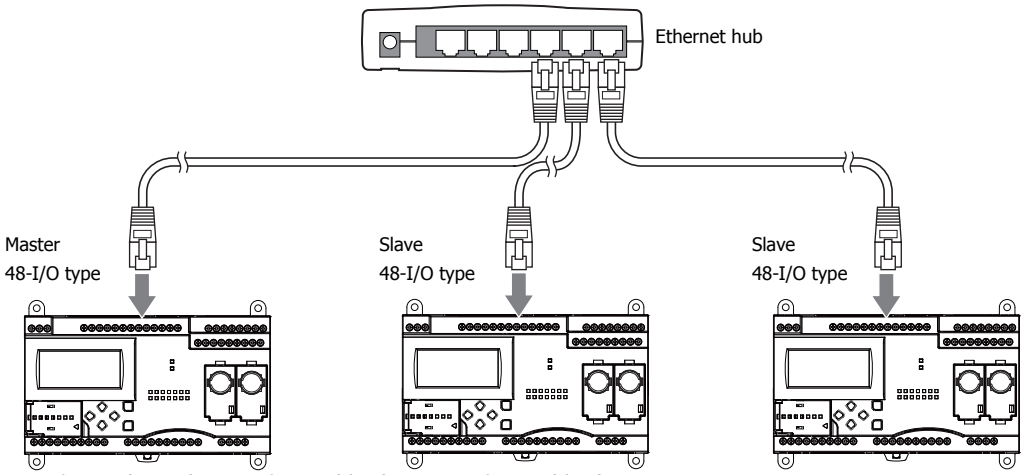
The remote I/O of the SmartAxis enables you to expand the number of inputs and outputs by connecting separate SmartAxis modules over Ethernet as remote I/O slaves when you run out of inputs and outputs. The SmartAxis remote I/O master can use the digital inputs and outputs and analog inputs on the remote I/O slaves.

This function can be used on the Ethernet port only. Remote I/O cannot be used with the expansion communication ports (RS232C and RS485).

- **Remote I/O System Example**

A SmartAxis is connected to an Ethernet network as a remote I/O master. Two other SmartAxis are used as remote I/O slaves.

Up to a maximum of 3 SmartAxis can be connected to a remote I/O master as remote I/O slaves.



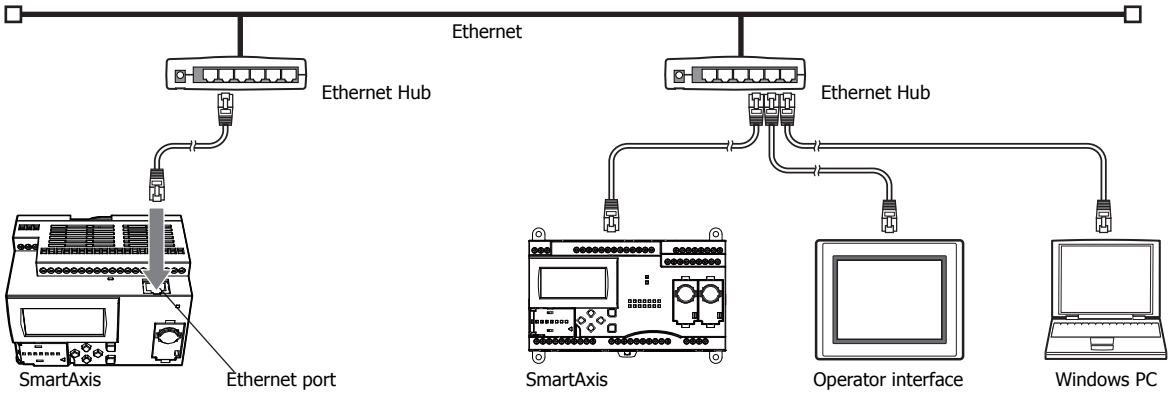
Ethernet Communication

The SmartAxis can be connected to Ethernet network via Ethernet port and communicate with network devices over Ethernet.

The SmartAxis has three TCP/IP connections that can be used for Ethernet communication functions. Each of these connections can simultaneously be used for a different communication protocol. Each connection can be configured for maintenance communication, user communication, Modbus TCP, or remote I/O master.

- **Ethernet Communication Example**

This example shows a system in which a SmartAxis communicates with another SmartAxis, an operator interfacen, and a PC simultaneously over Ethernet. Among the three connections the SmartAxis has, the connection 1 is configured as maintenance communication for the PC to communicate with the SmartAxis. The connection 2 is configured as Modbus TCP server for the operator interface to communicate with the SmartAxis. The connection 3 is configured as the remote I/O master to communicate with another SmartAxis.



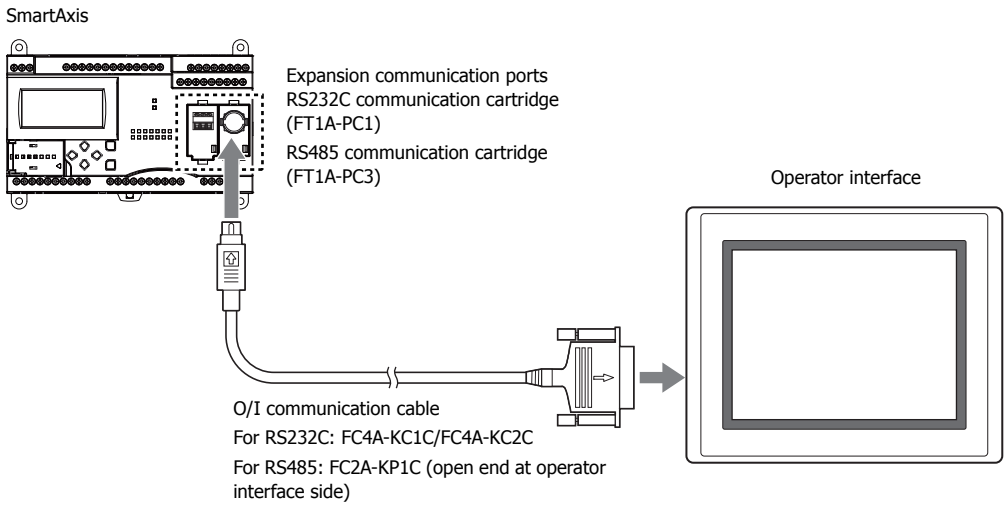
Notes:

- When accessing the SmartAxis over Internet, adequate safety measures are required. Be sure to consult your network administrator or Internet service provider. IDEC bears no responsibility for damages or problems caused due to security in Ethernet communication.
- Restrict the access to smartAxis with IP addresses and ports using appropriate measures such as the firewall.

Operator Interface Connectivity

The SmartAxis can perform maintenance communication with IDEC operator interfaces using the Ethernet port and expansion communication ports. Device values of the SmartAxis can be monitored and modified with the connected operator interface. An Ethernet cable or an O/I communication cable (Note) is used to connect the SmartAxis and the operator interface.

For details on communication settings, refer to the operator interface manuals.



Note: For details on O/I communication cables, see Appendix "Cables" on page Appendix-10.

2: PRODUCT SPECIFICATIONS

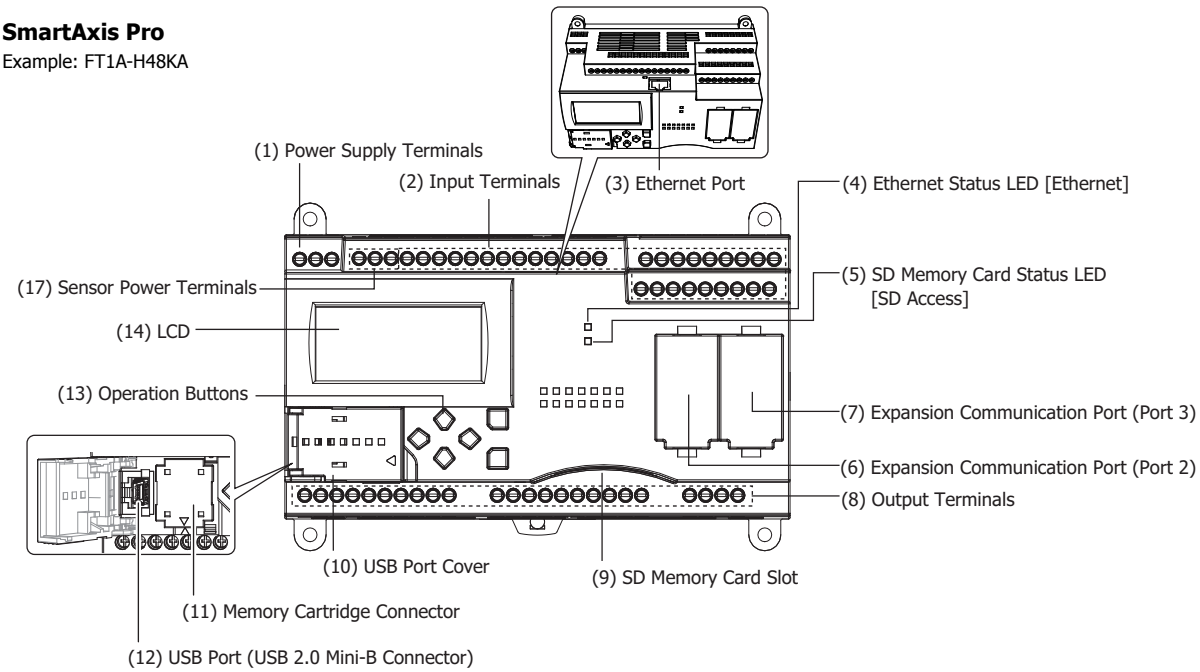
Introduction

This chapter describes parts names and specifications of the SmartAxis.

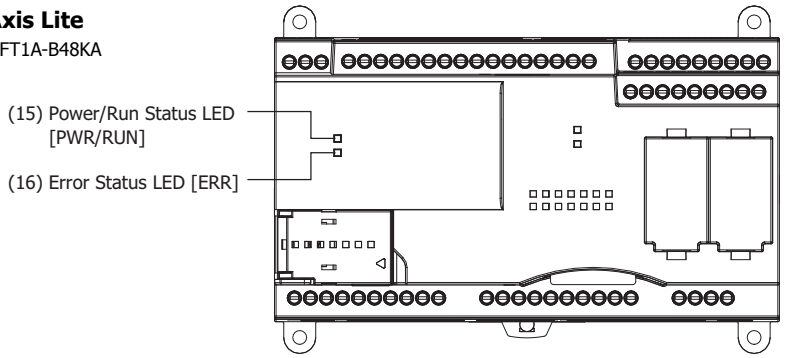
SmartAxis is available in 12-, 24-, 40-, and 48-I/O types. The 12-I/O type has 8 input and 4 output terminals, the 24-I/O type has 16 input and 8 output terminals, the 40-I/O type has 24 input and 16 output terminals, and the 48-I/O type has 30 input and 18 output terminals. The 24-, 40-, and 48-I/O types have 1 or 2 port connectors to install an optional RS232C or RS485 communication cartridge for maintenance communication, user communication, or Modbus RTU communication. The 24-, 40-, and 48-I/O types have built-in Ethernet port for maintenance communication, user communication, Modbus TCP, or Remote I/O. The 40- and 48-I/O types have SD memory card slot to install an SD memory card for logging the device data. Every type of SmartAxis has a cartridge connector to install an optional memory cartridge.

Parts Description

SmartAxis Pro
Example: FT1A-H48KA



SmartAxis Lite
Example: FT1A-B48KA



The text in square brackets is printed on the SmartAxis to describe LED.

(1) Power Supply Terminals

Connect power supply to these terminals.

(2) Input Terminals

For connecting input signals from input devices such as sensors and pushbuttons.

DC power type can use high-speed input of up to 100 kHz and 0 to 10V DC analog input, which is shared with digital input.

(3) Ethernet Port

This port is used for Ethernet connection. An Ethernet cable can be connected to enable the SmartAxis to communicate with network devices, such as computers or PLCs. Not available on the 12-I/O type.

(4) Ethernet Status LED [Ethernet]

Turns on or blinks when an Ethernet cable is connected to the SmartAxis and the SmartAxis communicates with network devices. Not available on the 12-I/O type.

Ethernet Status LED	Status
OFF	Ethernet cable is not connected.
ON	Ethernet cable is connected and communication is possible.
Flashing	Ethernet cable is connected and data is being sent or received.

(5) SD Memory Card Status LED [SD Access]

Turns on or blinks when the SD memory card is being accessed. Not available on the 12- or 24-I/O type.

SD Memory Card Status LED	Status
OFF	• When the SD memory card is not inserted • When an unsupported or unformatted SD memory card was inserted • When access to the SD memory card was stopped by SD memory card access stop flag (M8076) • When the SmartAxis power is off
ON	The standby state where the SD memory card can be written or read
Slow Flash (1-sec interval)	• When the SmartAxis is recognizing the SD memory card • When the SmartAxis is stopping access due to SD memory card access stop flag (M8076) turning on (slow flashing, then off)
Quick Flash (100 ms interval)	Reading or writing to the SD memory card

(6) Expansion Communication Port (Port2)

(7) Expansion Communication Port (Port3)

This port is used to install a communication cartridge for communication with external devices. The 24-I/O type has one expansion communication port while the 40- and 48-I/O types have two. Not available on the 12-I/O type.

(8) Output Terminals

For connecting output signals to output devices such as electromechanical relays and solenoid valves. Relay output (10A and 2A types) and transistor output (sink/source) are available.

(9) SD Memory Card Slot

Insert SD memory card to this slot. Not available on the 12- or 24-I/O type.

(10) USB Port Cover

Protects the USB port and the memory cartridge. If a USB extension cable is connected to the USB port, the cable can be secured to the USB port cover using a cable tie.

(11) Memory Cartridge Connector

For connecting an optional memory cartridge.

(12) USB Port

A Mini-B type USB 2.0 port for connecting a USB maintenance cable or USB extension cable. A user program can be downloaded or uploaded using WindLDR on a computer.

(13) Operation Buttons

For operating the menus displayed on the LCD to access functions. There are six operation buttons: [△], [▽], [▷], [◁], [OK], and [ESC].

Not available on the SmartAxis Lite.

(14) LCD

Displays operation menus, status, and setting of the SmartAxis. Not available on the SmartAxis Lite.

(15) Power/Run Status LED [PWR/RUN]

A green LED that turns on or flashes to indicate the power supply and operation status.

Power/Run Status LED	Status
OFF	Power is not supplied.
ON	Power is supplied and a user program is being executed.
Slow Flash (1-sec interval)	Power is supplied, but the SmartAxis is stopped.
Quick Flash (100 ms interval)	Power is supplied and a user program is being executed. I/Os are forced on/off. (See ##"Forced I/O Function"## on page xx-xx.)

Not available on the SmartAxis Pro.

(16) Error Status LED [ERR]

A red LED that turns on if an error occurs.

Error Status LED	Status
OFF	Normal operation
ON	An error has occurred.

Not available on the SmartAxis Pro.

(17) Sensor Power Terminals

For supplying power to sensors (24V DC). Not available on the DC power type.

General Specifications

AC Power Type

Type Number	FT1A-			
	H12RC, B12RC	**H24RC, B24RC**	**H40RC, B40RC**	**H48KC, H48SC B48KC, B48SC**
Normal Operating Conditions				
Operating Temperature	0 to 55°C (operating ambient temperature)			
Storage Temperature	–25 to +70°C (no freezing)			
Relative Humidity	10 to 95% (non-condensing, operating and storage humidity)			
Pollution Degree	2 (IEC60664-1)			
Degree of Protection	IP20 (IEC60529)			
Corrosion Immunity	Atmosphere 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)			
Installation Location	Inside cabinet (Note)			
Device Class	Open equipment			
Overvoltage Category	II			
Vibration Resistance	When mounted on a DIN rail or panel surface: 5 to 8.4 Hz amplitude 3.5 mm, 8.4 to 150 Hz acceleration 9.8 m/s^2 (1G) 2 hours per axis on each of three mutually perpendicular axes			
Shock Resistance	147 m/s^2 (15G), 11 ms duration, 3 shocks per axis on three mutually perpendicular axes			
Power Supply				
Rated Power Voltage	100 to 240V AC			
Allowable Voltage Range	85 to 264V AC			
Rated Power Frequency	50/60 Hz (47 to 63 Hz)			
Maximum Power Consumption	35VA	55VA	65VA	65VA
Allowable Momentary Power Interruption	10 ms maximum (at the rated power voltage)			
Dielectric Strength Voltage	Between power and PE terminals: 1,500V AC, 1 minute			
	Between input and PE terminals: 1,500V AC, 1 minute			
	Between transistor output and PE terminals: 1,500V AC, 1 minute			
	Between relay output and PE terminals: 2,300V AC, 1 minute			
	Between power and input terminals: 1,500V AC, 1 minute			
	Between power and transistor output terminals: 1,500V AC, 1 minute			
	Between power and relay output terminals: 2,300V AC, 1 minute			
	Between input and transistor output terminals: 1,500V AC, 1 minute			
	Between input and relay output terminals: 2,300V AC, 1 minute			
EMC Immunity	IEC/EN 61131-2:2007 compliant			
Inrush Current	35A maximum (Cold start with T_a = 25°C, 200V AC)			
Ground	D-type ground (Class 3 ground)			
Grounding Wire	UL1007 AWG16			
Power Supply Wire	UL1015 AWG22, UL1007 AWG18			
Effect of Improper Power Supply Connection	Reverse polarity: Normal operation			
	Improper voltage or frequency: Permanent damage may be caused			
	Improper lead connection: Permanent damage may be caused			
Weight	Approx. 230g	Approx. 400g	Approx. 580g	Approx. 540g

Note: Use in environments that satisfy product specifications.

DC Power Type

Type Number		FT1A-			
		H12RA, B12RA	H24RA, B24RA	H40RKA, H40RSA B40RKA, B40RSA	H48KA, H48SA B48KA, B48SA
Normal Operating Conditions					
	Operating Temperature	0 to 55°C (operating ambient temperature)			
	Storage Temperature	–25 to +70°C (no freezing)			
	Relative Humidity	10 to 95% (non-condensing, operating and storage humidity)			
	Pollution Degree	2 (IEC60664-1)			
	Degree of Protection	IP20 (IEC60529)			
	Corrosion Immunity	Atmosphere 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)			
	Installation Location	Inside cabinet (Note)			
	Device Class	Open equipment			
	Overvoltage Category	II			
	Vibration Resistance	When mounted on a DIN rail or panel surface: 5 to 8.4 Hz amplitude 3.5 mm, 8.4 to 150 Hz acceleration 9.8 m/s^2 (1G) 2 hours per axis on each of three mutually perpendicular axes			
	Shock Resistance	147 m/s^2 (15G), 11 ms duration, 3 shocks per axis on three mutually perpendicular axes			
Power Supply					
	Rated Power Voltage	24V DC			
	Allowable Voltage Range	20.4 to 28.8V DC (Including ripple voltage)			
	Maximum Power Consumption	4.3W	4.8W	6.0W	7.9W
	Allowable Momentary Power Interruption	10 ms maximum (Rated voltage, PS2)			
	Dielectric Strength Voltage	Between power/input and FE terminals: 500V AC, 1 minute			
		Between transistor output and FE terminals: 500V AC, 1 minute			
		Between relay output and FE terminals: 2,300V AC, 1 minute			
		Between power/input and transistor output terminals: 500V AC, 1 minute			
		Between power/input and relay output terminals: 2,300V AC, 1 minute			
	EMC Immunity	IEC/EN 61131-2:2007 compliant			
	Inrush Current	30A maximum			
	Ground	D-type ground (Class 3 ground)			
	Grounding Wire	UL1007 AWG16			
	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			
	Weight	Approx. 190g	Approx. 310g	Approx. 420g	Approx. 380g

Note: Use in environments that satisfy product specifications.

Function Specifications

Function Specifications

Type Number		FT1A-							
		H12RA B12RA	H12RC B12RC	H24RA B24RA	H24RC B24RC	H40RKA H40RSA B40RKA B40RSA	H40RC B40RC	H48KA H48SA B48KA B48SA	H48KC H48SC B48KC B48SC
Program Capacity (Note 1)		12,000 bytes (3,000 steps)		47,400 bytes (11,850 steps)					
I/O Points	Digital Input (Terminal No.)	6 (I0 to I5)	8 (I0 to I7)	12 (I0 to I7, I10 to I13)	16 (I0 to I7, I10 to I17)	18 (I0 to I7, I10 to I17, I20, I21)	24 (I0 to I7, I10 to I17, I20 to I27)	22 (I0 to I7, I10 to I17, I20 to I25)	30 (I0 to I7, I10 to I17, I20 to I27, I30 to I35)
	Shared Analog Input (Terminal No.)	2 (I6, I7)	—	4 (I14 to I17)	—	6 (I22 to I27)	—	8 (I26, I27, I30 to I35)	—
	Output (Terminal No.)	4 (Q0 to Q3)		8 (Q0 to Q7)		16 (Q0 to Q17)		18 (Q0 to Q21)	
User Program Storage		Flash ROM (10,000 rewriting life)							
Backup Function									
	RAM	Backup data: Internal relay, shift register, counter current value, data register (Note 2), clock data (year, month, and day)							
	Backup Duration	Approx. 30 days (typical) at 25°C after backup battery fully charged							
	Battery	Lithium secondary battery							
	Charging Time	Approx. 15 hours for charging from 0% to 90% of full charge							
	Battery Life	5 years in cycles of 9-hour charging and 15-hour discharging							
	Replaceability	Not possible to replace battery							
Clock Function (Note 3)		Clock accuracy: ±30 sec/month (typical) at 25°C							
Control System		Stored program system							
Instruction Words									
	Basic Instructions	42							
	Advanced Instructions	99		107		DC type: 125, AC type: 111			
Processing Time									
	Basic Instruction	0.95 ms (1000 steps)							
	END Processing	0.1 ms							
Internal Relay		1024							
Shift Register		128							
Data Register		12-I/O type: 400 24-I/O type, 40-I/O type, 48-I/O type: 2,000							
Counter (adding, reversible)		100		200					
Timer (1-sec, 100 ms, 10 ms, 1 ms)		100		200					
Input Filter		Without filter, 3 to 15 ms (selectable in increments of 1 ms)							
Catch Input/Interrupt Input									
	Input Points	4		6					

Note1: 1 step is equivalent to 4 bytes.

Note2: Among data registers D0 to D1999, only D0 to D999 are backed up.

Note3: Set the calendar/clock using WindLDR to use the clock function.

Type Number	FT1A-							
	H12RA B12RA	H12RC B12RC	H24RA B24RA	H24RC B24RC	H40RKA H40RSA B40RKA B40RSA	H40RC B40RC	H48KA H48SA B48KA B48SA	H48KC H48SC B48KC B48SC
Self-diagnostic Function	Keep data Power failure Clock error Watchdog timer Timer/counter preset value change error User program syntax User program execution System error Memory cartridge transfer error							
High-speed Counter								
Points	Total 4 points	—	Total 6 points	—	Total 6 points	—	Total 6 points	—
Maximum Counter Frequency	Single/two-phase selectable: 100 kHz (2 points) Single-phase: 100 kHz (2 points)		Single/two-phase selectable: 100 kHz (2 points) Single-phase: 100 kHz (4 points)					
Counting Range	0 to 4,294,967,295 (32 bits)							
Operation Mode	Rotary encoder mode and adding counter mode							
Pulse Output (Maximum frequency: 100 kHz)								
Points	—				2 (Q14, Q15)	—	2 (Q14, Q15)	—
Pulse Output (Maximum frequency: 5 kHz)								
Points	—				2 (Q16, Q17)	—	2 (Q16, Q17)	—
Analog Voltage Input								
Points (Terminal No.)	2 (I6, I7)	—	4 (I14 to I17)	—	6 (I22 to I27)	—	8 (I26, I27, I30 to I35)	—
Input voltage Range	0 to 10V DC							
Digital Resolution	0 to 1000							
USB Port								
Points	1							
USB Standard	USB 2.0							
Connector	Mini-B type							
Expansion Communication Ports								
Points	—		1		2			
Ethernet Port								
Points	—		1					
Memory Cartridge Connectors								
Points	1							
SD Memory Card Slots								
Points	—				1			

LCD Specifications (SmartAxis Pro only)

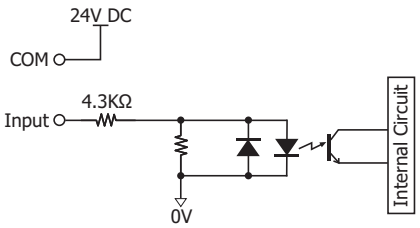
	Description/Specifications
Type	STN monochrome LCD
Resolution	64 x 192 pixels
Number of Characters	24 digits x 8 lines (8 x 8 pixel font) 12 digits x 8 lines (16 x 8 pixel font) 12 digits x 4 lines (16 x 16 pixel font)
Display Content	System menus, messages, operation status monitor
Contrast Adjustment	Not possible
Backlight	Yes (backlight can be turned on and off)

Input Specifications (AC Power Type)

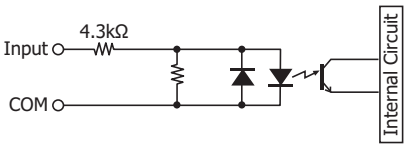
Type Number		FT1A-			
		H12RC B12RC	H24RC B24RC	H40RC B40RC	H48KC H48SC B48KC B48SC
Input Points		8	16	24	30
Rated Input Voltage		24V DC			
Input Voltage Range		0 to 28.8V DC			
Terminal Arrangement		See CPU Module Terminal Arrangement on page 2-14.			
Digital Input					
	Input Type	Contacts	Sink/Source		
	Input Points (Terminal No./ Common Line Name)	8 points in 1 common line (I0 to I7/COM)	16 points in 1 common line (I0 to I7, I10 to I17/COM)	24 points in 1 common line (I0 to I7, I10 to I17, I20 to I27/COM)	30 points in 2 common lines (I0 to I7, I10 to I17, I20 to I25/COMA, I26, I27, I30 to I35/COMB)
	Rated Input Current	5.3 mA			
	Input Impedance	4.3 kΩ			
	Turn ON Time	40 µs + filter value			
	Turn OFF Time	150 µs + filter value			
	Isolation	Between input terminals: Not isolated			
		Internal circuit: Photocoupler isolated			
	Input Type	Type 1 (IEC61131-2)			
Shared Digital/ Analog Inputs		— (No shared digital/analog inputs)			
Status Display	Pro	LCD display			
	Lite	—			
External Load for I/O Interconnection		Not needed			
Signal Determination Method		Static			
Cable Length		100m in compliance with electromagnetic immunity			
Effect of Improper Input Connection		No damage. If any input exceeding the rated value is applied, permanent damage may be caused.			

Input Internal Circuit

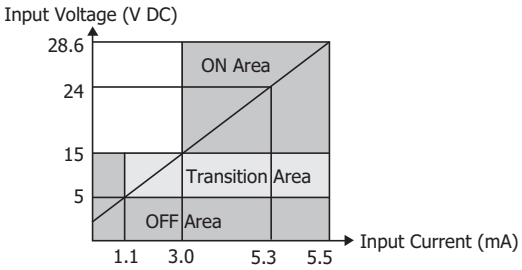
• Contact Input (FT1A-*12RC)



• Sink/Source Input (FT1A-*24/40/48RC)



Input Operating Range



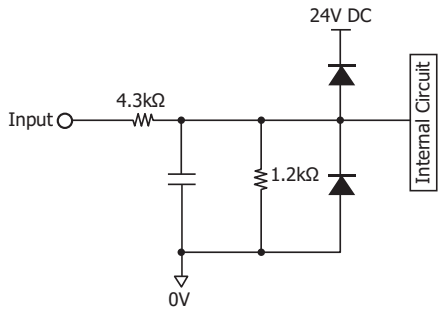
Input Specifications (DC Power Type)

Type Number	FT1A-					
	H12RA B12RA	H24RA B24RA	H40RKA B40RKA	H40RSA B40RSA	H48KA B48KA	H48SA B48SA
Input Points	12	16	24		30	
Rated Input Voltage	24V DC					
Input Voltage Range	0 to 28.8V DC					
Terminal Arrangement	See CPU Module Terminal Arrangement on page 2-14.					
Digital Input						
Input Type	Sink		Source	Sink	Source	Sink
Input Points (Terminal No. /Common Line Name)	6 points in 1 common line (I0 to I5/ internal - terminal)	12 points in 1 common line (I0 to I7, I10 to I13/ internal - terminal)	18 points in 1 common line (I0 to I7, I10 to I17, I20, I21/ internal +terminal)	18 points in 1 common line (I0 to I7, I10 to I17, I20, I21/ internal - terminal)	22 points in 1 common line (I0 to I7, I10 to I17, I20 to I25/ internal +terminal)	22 points in 1 common line (I0 to I7, I10 to I17, I20 to I25/ internal - terminal)
Rated Input Current	4.4 mA		5.2 mA	4.4 mA	5.2 mA	4.4 mA
Input Impedance	5.5 kΩ		4.7 kΩ	5.5 kΩ	4.7 kΩ	5.5 kΩ
Turn ON Time	2.5 µs + filter value	I0 to I7: 2.5 µs + filter value Others: 40 µs + filter value				
Turn OFF Time	5 µs + filter value	I0 to I7: 5 µs + filter value Others: 150 µs + filter value				
Isolation	Between input terminals: Not isolated					
	Internal circuit: Not isolated					
Input Type	Type 1 (IEC61131-2)					
External Load for I/O Interconnection	Not needed					
Signal Determination Method	Static					
Cable Length (in compliance with electromagnetic immunity)	3m (9.84 ft.)	I0 to I7: 3m (9.84 ft.) Others: 100m (328.1 ft.)				

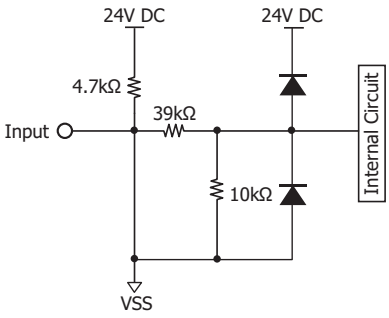
Type Number			FT1A-					
			H12RA B12RA	H24RA B24RA	H40RKA B40RKA	H40RSA B40RSA	H48KA B48KA	H48SA B48SA
Analog Input								
Input Signal Type			Voltage Input					
Input Points (Terminal No. /Common Line Name)			2 points in 1 common line (I6, I7/ internal - terminal)	4 points in 1 common line (I14 to I17 internal - terminal)	6 points in 1 common line (I22 to I27/internal -terminal)		8 points in 1 common line (I26, I27, I30 to I35/internal - terminal)	
Input Range			0 to 10.0V DC					
Rated Input Current			0.3 mA					
Input Impedance			78.0 kΩ					
Digital Resolution			0 to 1000 (10 bits)					
Data Type			Binary data: 0 to 1000					
Input Value of LSB			10 mV					
Type of Input			Single-ended input					
AD Conversion		**Sample Duration Time**	2 ms maximum					
		Sample Repetition Time	2 ms maximum					
		Total Input System Transfer Time	2 ms + filtering time + scan time					
Input Error		**Maximum Error at 25°C**	±1.5% of full scale					
		Temperature Coefficient	±0.25% of full scale/°C					
		Maximum Error	±5.0% of full scale					
General Characteristics		**Operating Mode**	Self-scan					
		Conversion Method	ΣΔ type					
Status Display		**Pro**	"Device Monitor" screen (LCD)					
		Lite	—					
Maximum Temporary Deviation during Electrical Noise Tests			±5.0% of full scale					
Recommended Cable for Noise Immunity			Twisted pair shielded cable					
Calibration or Verification to Maintain Rated Accuracy			Not possible					
Maximum Permanent Allowed Overload (No Damage)			28.8V DC					
Overload Status (Outside Input Range) Detection			Detectable (Stored in special data register D8077)					
Isolation			Between input terminals: Not isolated					
			Between input and internal circuit: Not isolated					
Used as Digital Input		**Digital Input Type**	— (IEC 61131-2 digital input type is not supported)					
		Input Threshold	ON voltage: 15V minimum (ON current: 0.20 mA minimum)					
			OFF voltage: 5V maximum (OFF current: 0.06 mA maximum)					
Effect of Improper Input Connection			No damage. If any input exceeding the rated value is applied, permanent damage may be caused.					

Digital Input Internal Circuits

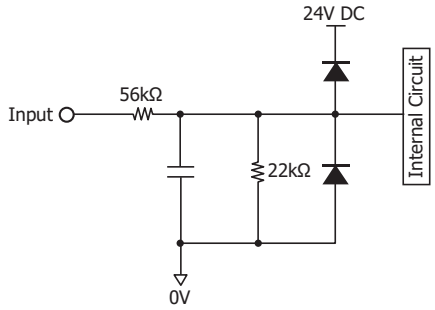
• Sink Input



• Source Input

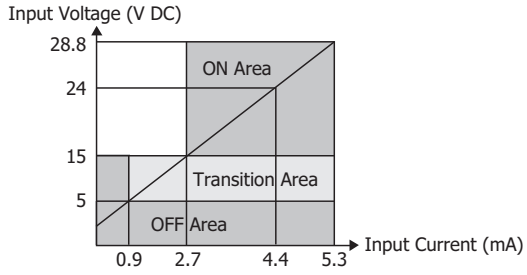


Internal Circuit with Shared Digital/Analog Input

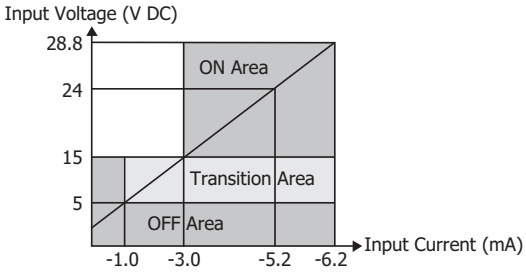


Digital Input Operating Range

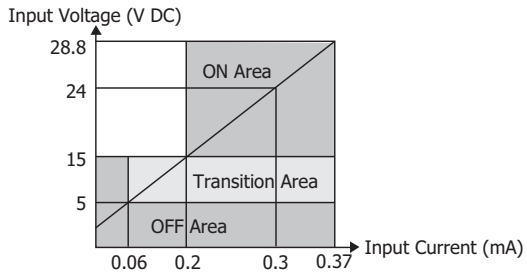
• Sink Input



• Source Input



• Operating Range of Shared Digital/Analog Input

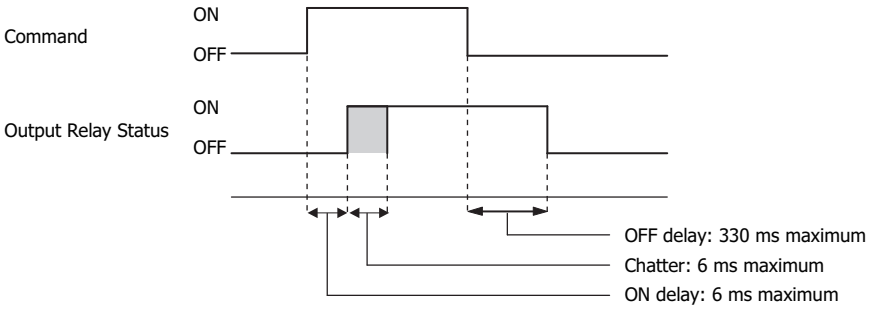


Output Specifications (10A Relay)

Type Number		FT1A-					
		H12RC B12RC	H12RA B12RA	H24RC B24RC	H24RA B24RA	H40RC B40RC	H40RKA H40RSA B40RKA B40RSA
No. of Outputs (Terminal No.)		4 (Q0 to Q3)					
Terminal Arrangement		See Terminal Arrangement on page 2-14.					
Output Type		1a contact					
Maximum Load Current (Note)		10A					
Minimum Switching Load		10 mA/5V DC (reference value)					
Initial Contact Resistance		100 mΩ maximum (1A, 6V DC)					
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 (Note)		250V AC/10A, 30V DC/10A					
Dielectric Strength		Between output terminal and internal circuit: 2,300V AC, 1 minute Between output terminals (COMs): 2,300V AC, 1 minute					
Status Display	**Pro**	LCD display					
	Lite	—					

Note: Values for resistive/inductive load.

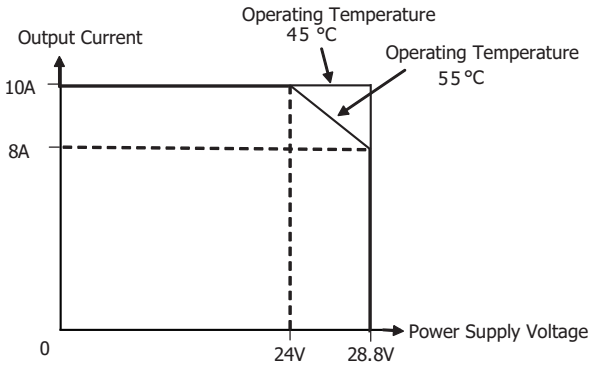
Output Delay



Derating

When using the SmartAxis at an operating temperature of 45°C or higher, reduce the output current of the 10A relay and power supply voltage as shown in the figure below.

Normal Installation

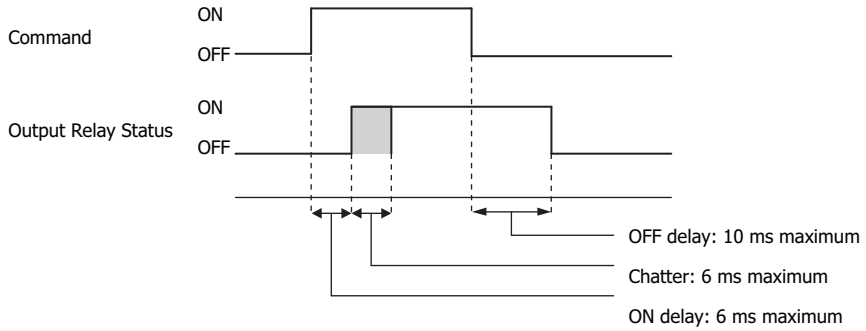


Output Specifications (2A Relay)

Type Number		FT1A-		
		H24RC B24RC H24RA B24RA	H40RC B40RC	H40RKA H40RSA B40RKA B40RSA
No. of Outputs (Terminal No.)		4 (Q4 to Q7)	12 (Q4 to Q7, Q10 to Q13, Q14 to Q17)	8 (Q4 to Q7, Q10 to Q13)
Output Points per Common Line	COM4	4 (Q4 to Q7)	4 (Q4 to Q7)	4 (Q4 to Q7)
	COM5	—	4 (Q10 to Q13)	4 (Q10 to Q13)
	COM6	—	4 (Q14 to Q17)	—
Terminal Arrangement		See Terminal Arrangement on page 2-14.		
Output Type		1a contact		
Maximum Load Current	1 point	2A		
	1 common line	8A maximum		
Minimum Switching Load		0.1 mA/0.1V DC (reference value)		
Initial Contact Resistance		1A, 6V DC		
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 (Note)		250V AC/2A, 30V DC/2A		
Dielectric Strength		Between output terminal and internal circuit: 2,300V AC, 1 minute Between output terminals (COMs): 2,300V AC, 1 minute		
Status Display	Pro	LCD display		
	Lite	—		

Note: Values for resistive/inductive load.

Output Delay

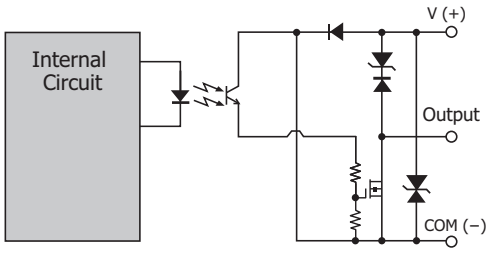


Output Specifications (Transistor)

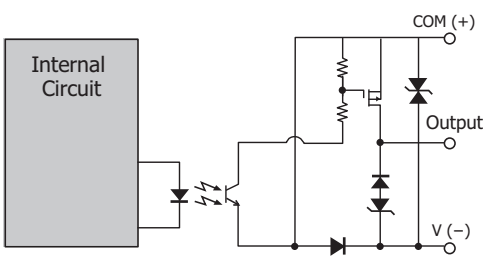
Type Number			FT1A-					
			H40RKA B40RKA	H40RSA B40RSA	H48KC B48KC	H48SC B48SC	H48KA B48KA	H48SA B48SA
Output	Model/ No. of Point	Sink output	4 (Q14 to Q17)	—	18 (Q0 to Q7, Q10 to Q17, Q20, Q21)	—	18 (Q0 to Q7, Q10 to Q17, Q20, Q21)	—
		Source output	—	4 (Q14 to Q17)	—	18 (Q0 to Q7, Q10 to Q17, Q20, Q21)	—	18 (Q0 to Q7, Q10 to Q17, Q20, Q21)
Output Points per Common Line		COM0	—		8 (Q0 to Q7)			
		COM1	—		8 (Q10 to Q17)			
		COM2	—		2 (Q20, Q21)			
		COM6	4 (Q14 to Q17)		—			
Rated Load Voltage			24V DC					
Operating Load Voltage Range			20.4 to 28.8V DC					
Terminal Arrangement			See Terminal Arrangement on page 2-14.					
Maximum Load Current		1 point	0.3A maximum					
		1 common line	1A maximum					
Voltage Drop (ON Voltage)			1V maximum (voltage between COM and output terminals when output is on)					
Inrush Current			1A maximum					
Leakage Current			0.1 mA maximum					
Clamping Voltage			39V±1V					
Maximum Lamp Load			8W					
Inductive Load			L/R = 10 ms (28.8V DC, 1 Hz)					
External Current Draw			Sink output: 100 mA maximum, 24V DC (power voltage at the +V terminal) Source output: 100 mA maximum, 24V DC (power voltage at the +COM terminal)					
Isolation		Between output terminal and internal circuit	Photocoupler isolated					
		Between output terminals	Same common line: Not isolated					
			Separate common line: Isolated					
Output Delay		Turn ON Time	High-speed output terminal (100 kHz pulse output terminal): 5 µs maximum Normal output terminal (including 5 kHz pulse output terminal): 100 µs maximum					
		Turn OFF Time	High-speed output terminal (100 kHz pulse output terminal): 5 µs maximum Normal output terminal (including 5 kHz pulse output terminal): 100 µs maximum					
Status Display		Pro	LCD display					
		Lite	—					

Output Internal Circuit

Sink Output



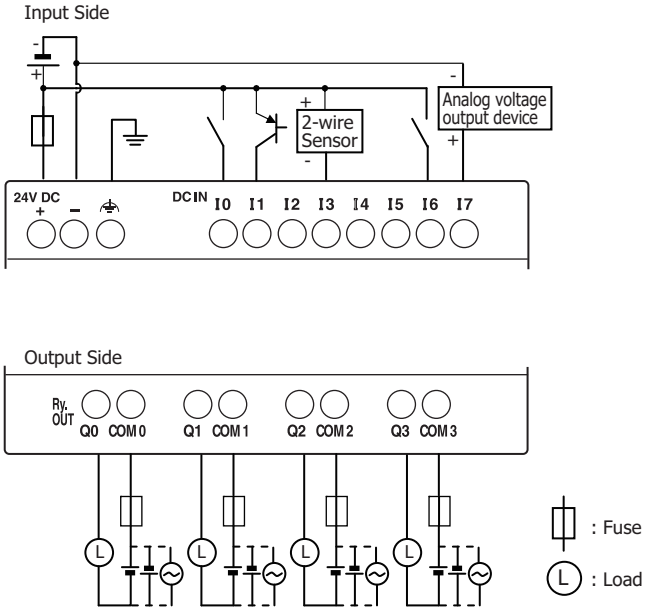
Source Output



Terminal Arrangement

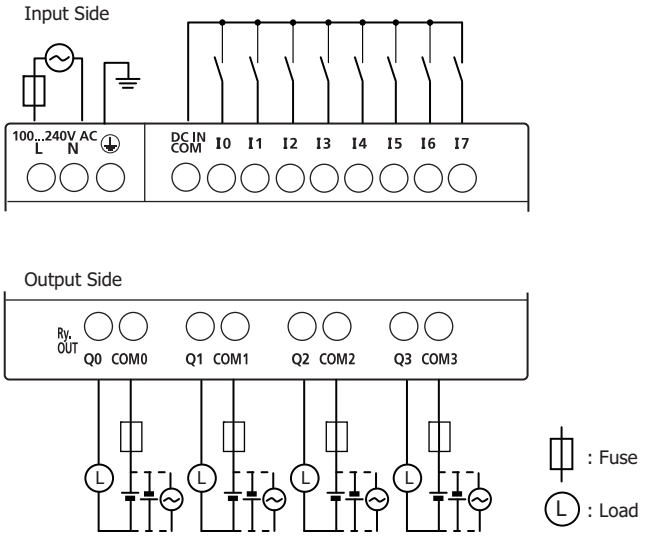
FT1A-H12RA, FT1A-B12RA

Terminal Arrangement and I/O Wiring Diagrams



FT1A-H12RC, FT1A-B12RC

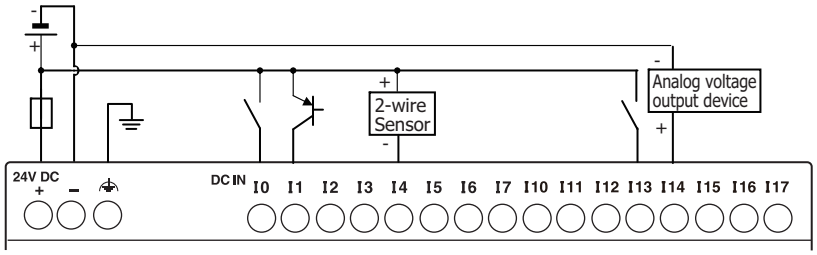
Terminal Arrangement and Wiring I/O Diagrams



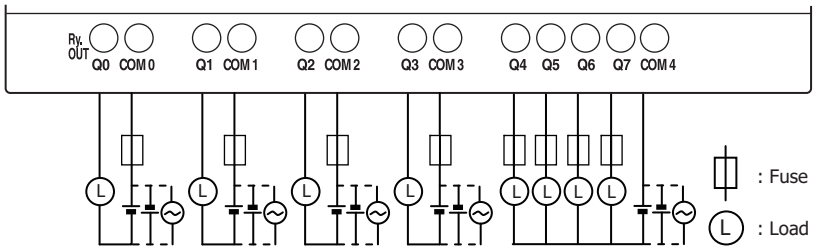
FT1A-H24RA, FT1A-B24RA

Terminal Arrangement and I/O Wiring Diagrams

Input Side



Output Side

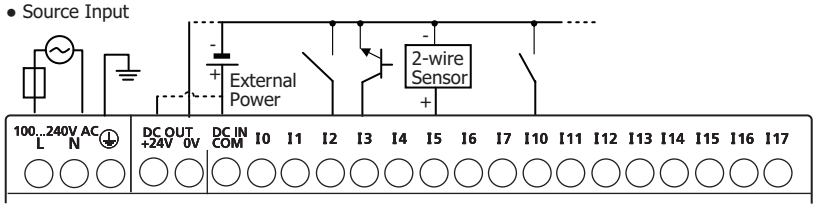


FT1A-H24RC, FT1A-B24RC

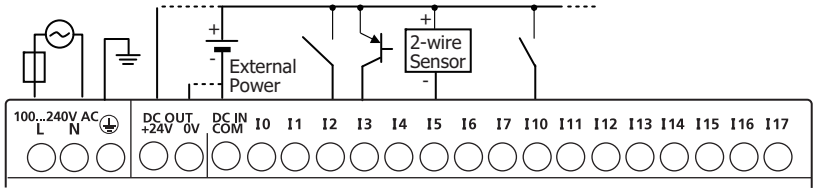
Terminal Arrangement and I/O Wiring Diagrams

Input Side

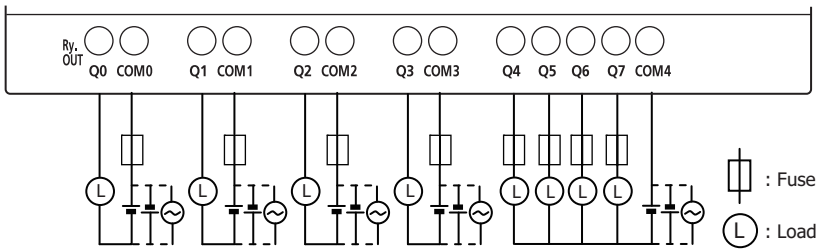
• Source Input



• Sink Input



Output Side

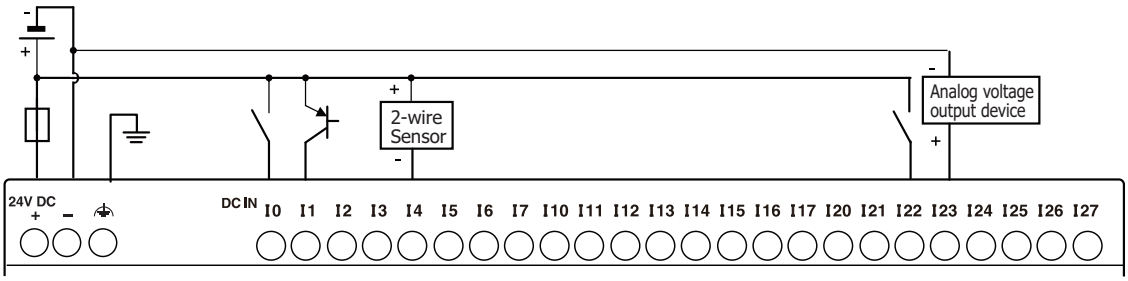


FT1A-H40RSA, FT1A-B40RSA

Terminal Arrangement and I/O Wiring Diagrams

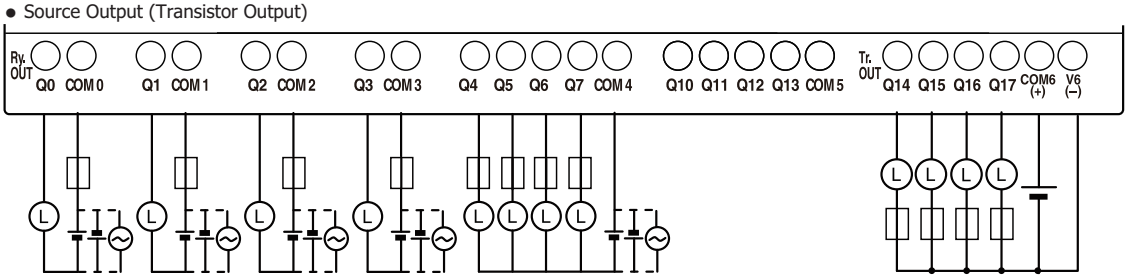
Input Side

- Sink Input



Output Side

- Source Output (Transistor Output)

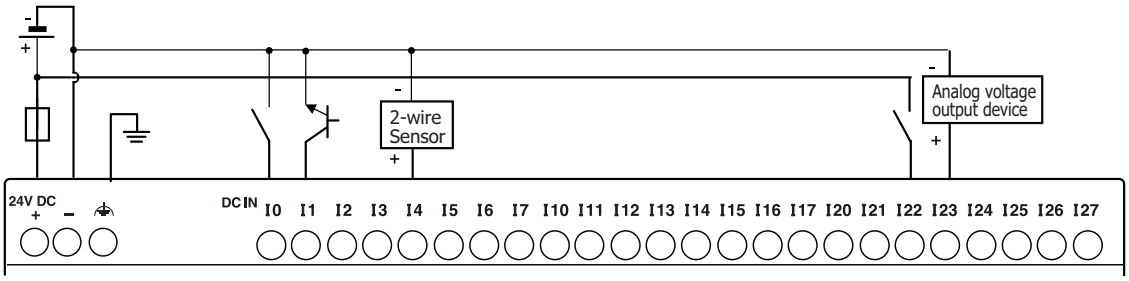


FT1A-H40RKA, FT1A-B40RKA

Terminal Arrangement and I/O Wiring Diagrams

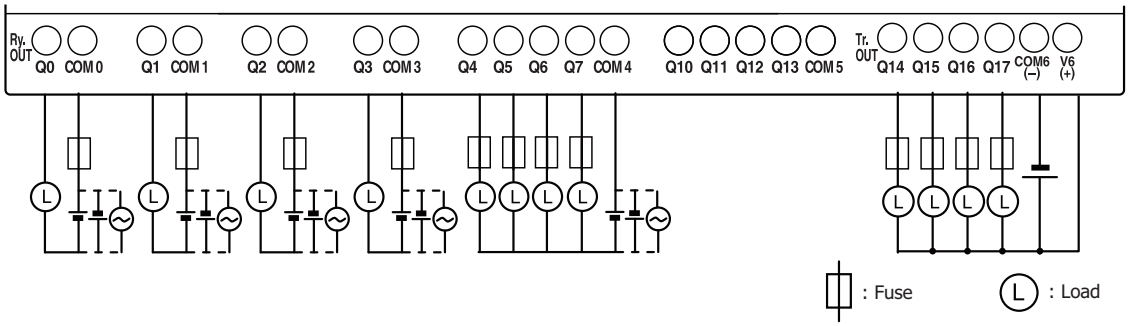
Input Side

- Source Input (Analog/Digital Shared Input is Sink Input)



Output Side

- Sink Output (Transistor Output)

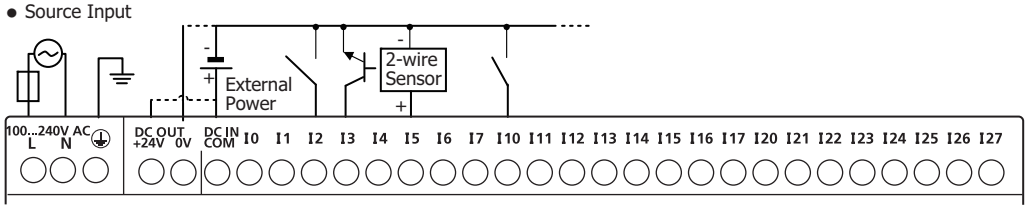


FT1A-H40RC, FT1A-B40RC

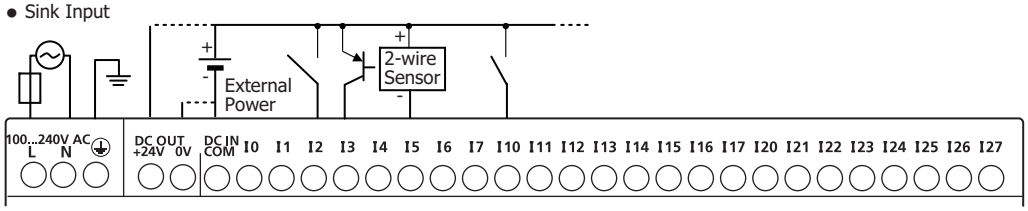
Terminal Arrangement and I/O Wiring Diagrams

Input Side

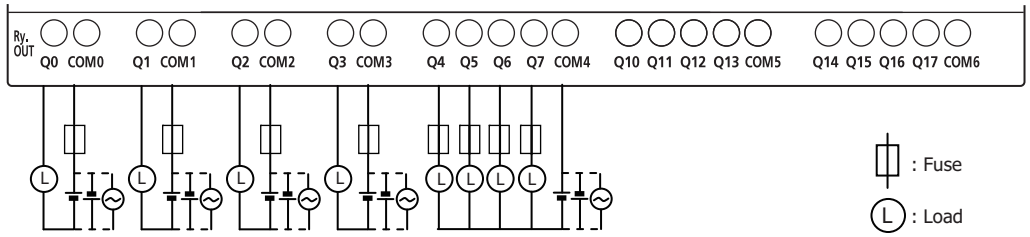
- Source Input



- Sink Input



Output Side

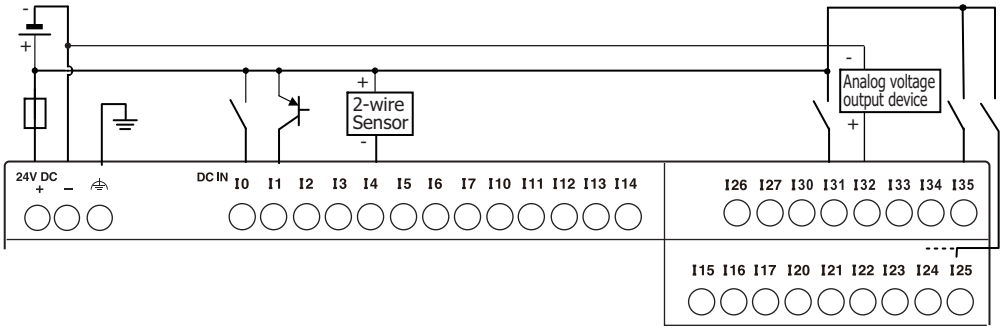


FT1A-H48SA, FT1A-B48SA

Terminal Arrangement and I/O Wiring Diagrams

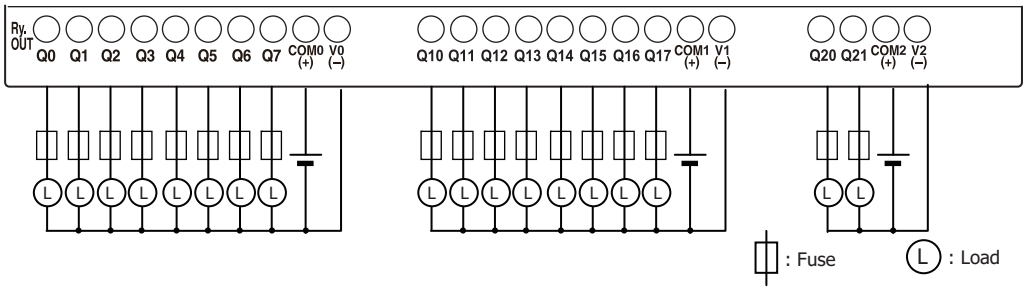
Input Side

● Sink Input



Output Side

● Source Output

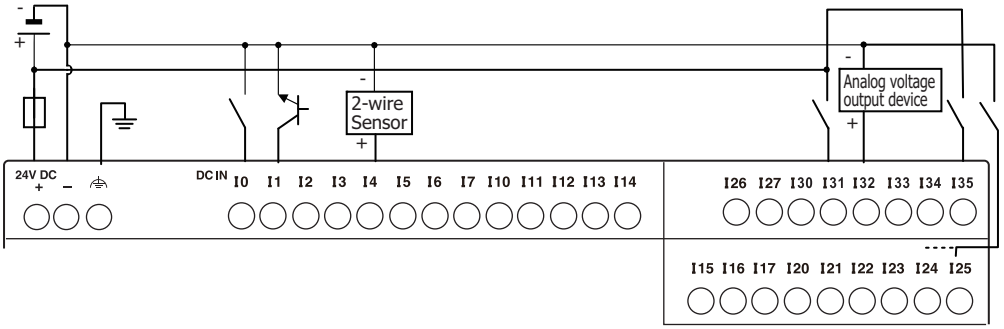


FT1A-H48KA, FT1A-B48KA

Terminal Arrangement and I/O Wiring Diagrams

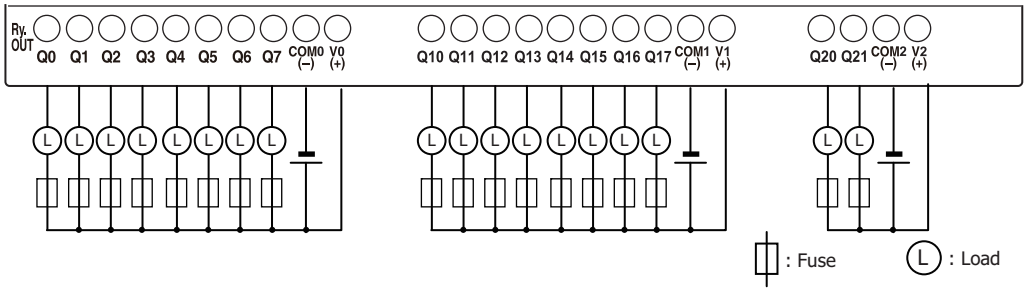
Input Side

● Source Input (Analog/Digital Shared Input is Sink Input)



Output Side

● Sink Output

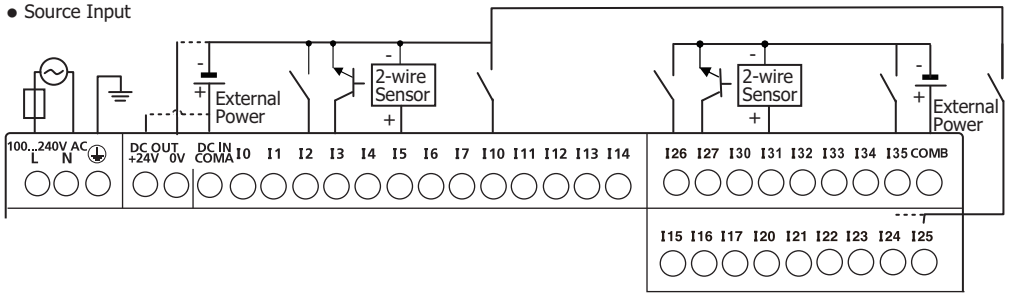


FT1A-B48SC, FT1A-H48SC

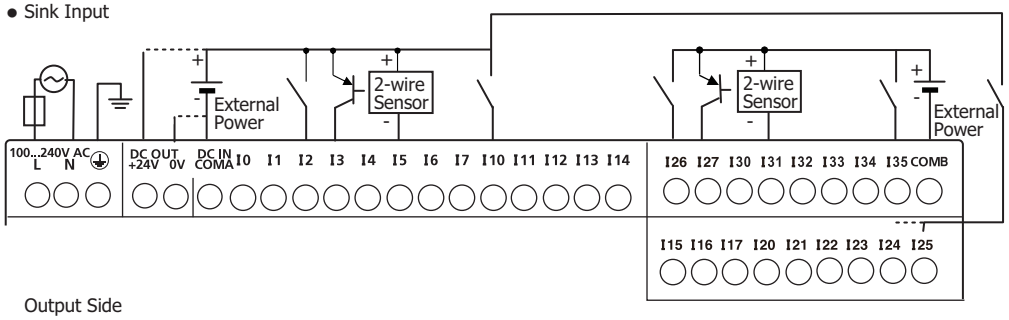
Terminal Arrangement and I/O Wiring Diagrams

Input Side

● Source Input

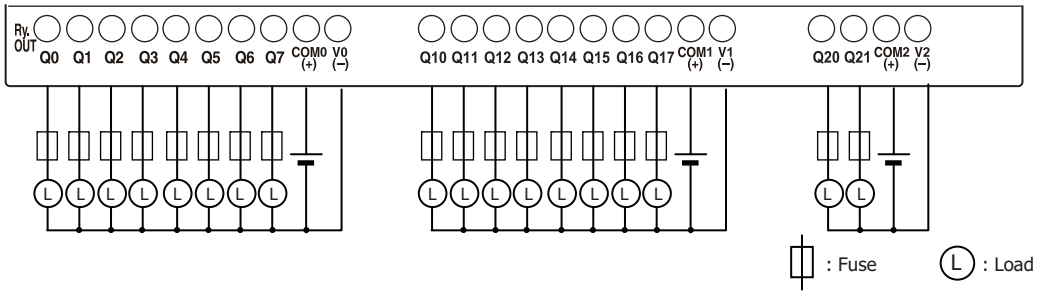


● Sink Input



Output Side

● Source Output

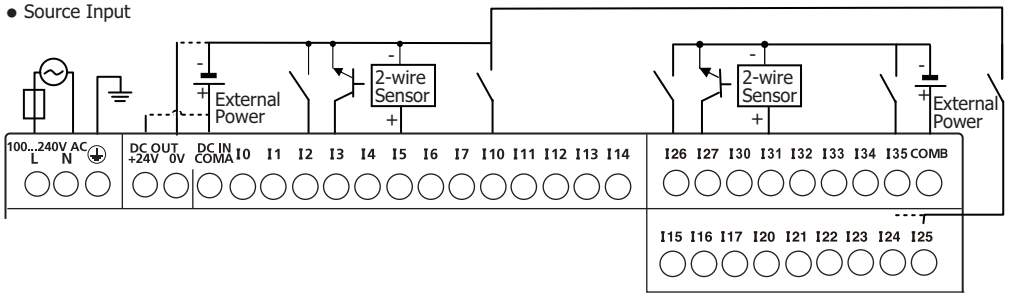


FT1A-H48KC, FT1A-B48KC

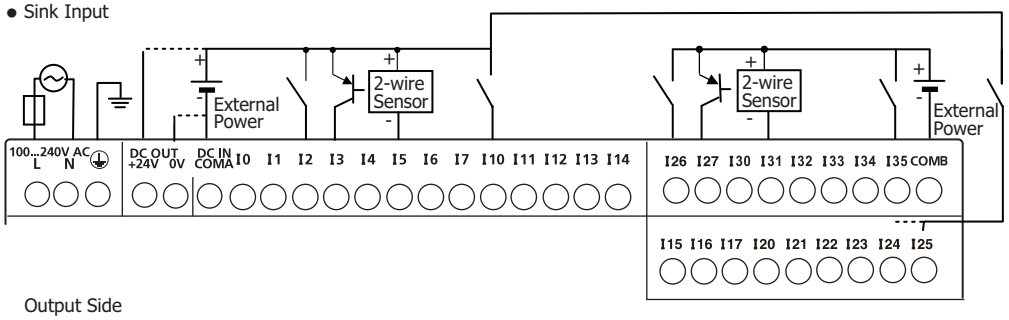
Terminal Arrangement and I/O Wiring Diagrams

Input Side

● Source Input

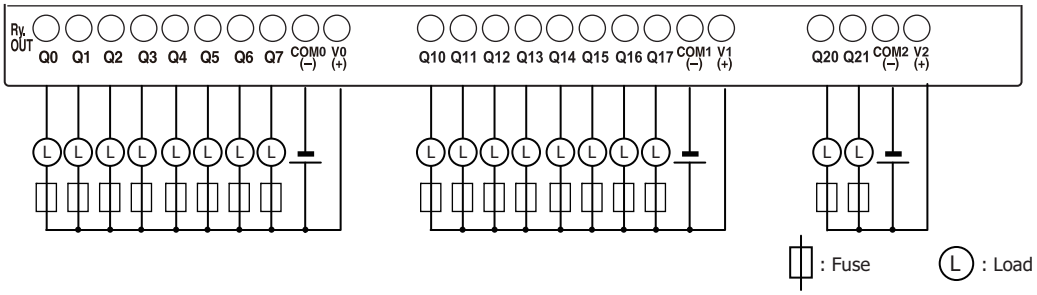


● Sink Input



Output Side

● Sink Output



Communication Cartridge

Functions

By installing a communication cartridge on the SmartAxis expansion communication port, the SmartAxis can communicate with communication devices supporting RS232C/RS485, such as Modbus RTU compliant devices, barcode readers, or operator interfaces.

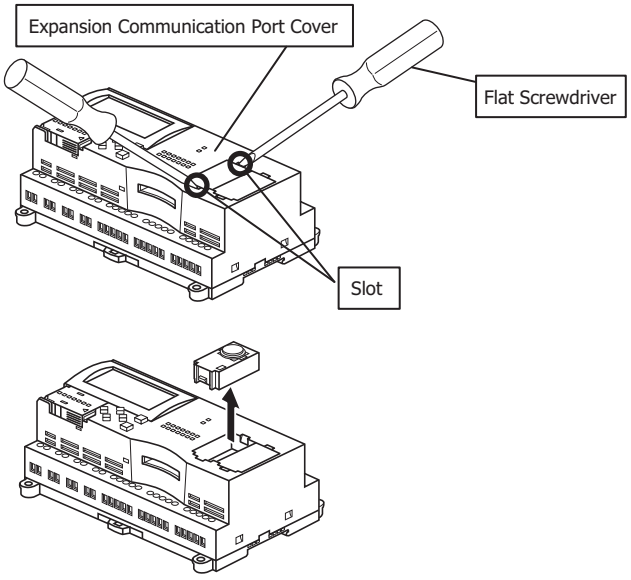
Specifications

Type No.	Item	Specifications
FT1A-PC1	**Termination Connector**	Mini DIN
	Standards	EIA RS232C
	Maximum Baud Rate	115,200 bps
	Communication Functions	Maintenance communication, User communication, Modbus RTU master/slave
	Isolation between Internal Circuit and Communication Port	Not isolated
	Recommended Communication Cable	Special cable
FT1A-PC2	**Termination Connector**	Mini DIN
	Standards	EIA RS485
	Maximum Baud Rate	115,200 bps
	Communication Functions	Maintenance communication, User communication, Modbus RTU master/slave
	Isolation between Internal Circuit and Communication Port	Not isolated
	Recommended Communication Cable	Special cable
FT1A-PC3	**Termination Connector**	Screw Terminal block
	Standards	EIA RS485
	Maximum Baud Rate	115,200 bps
	Communication Functions	Maintenance communication, User communication, Modbus RTU master/slave
	Isolation between Internal Circuit and Communication Port	Not isolated
	Recommended Communication Cable	Twisted-pair shielded cable with a minimum core wire of 0.3 mm^2 (Conductor resistance 85 Ω/km maximum, shield resistance 20 Ω/km maximum)
	Maximum Cable Length	200 m

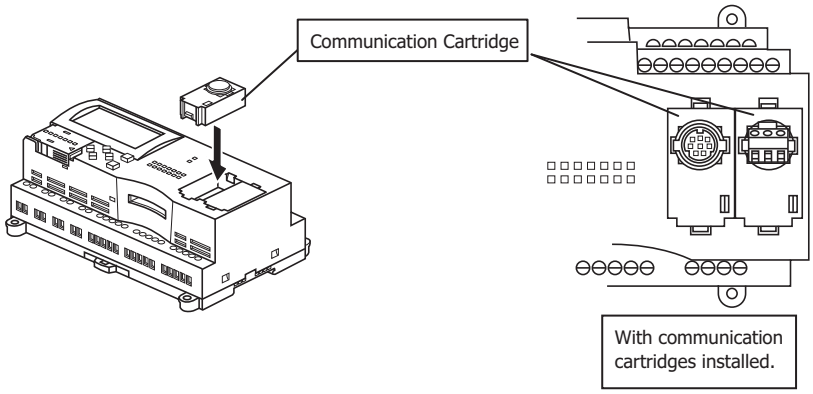
Note: For details on recommended communication cables, see ##"Cables"## on page xx-xx.

Installation Procedure

Remove the expansion communication port cover by inserting a flat screwdriver into the slots at the top and bottom of the cover. Press in the tabs at either end of the cover and lift the cover directly upward.

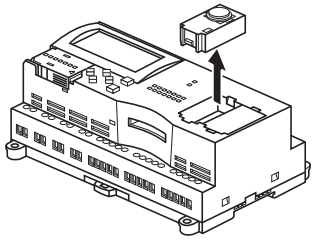


After removing the expansion communication port cover, carefully install a communication cartridge on the SmartAxis expansion communication port. Ensure that the cartridge is installed with the correct orientation.



Removal Procedure

As in the procedure to remove the expansion communication port cover, insert a flat screwdriver into the slots, press in the tabs at either end of the communication cartridge, and lift it directly upward. If the cartridge is removed in a crooked state, the housing of the cartridge or the internal connector may be damaged.



⚠ Caution

- Turn off the power to the SmartAxis before removing or installing a communication cartridge.
- If a communication cartridge is installed while the SmartAxis is powered, the SmartAxis or the communication cartridge may be damaged.

Memory Cartridge

Functions

By installing a memory cartridge on which a user program is stored to the SmartAxis, it is possible to change the user program executed by the SmartAxis without using WindLDR. It is also possible to download a user program from a memory cartridge to the SmartAxis. The user program stored in the SmartAxis ROM can also be uploaded to a memory cartridge.

Memory Cartridge	User Program Execution Priority
Installed on the SmartAxis	• When a memory cartridge is installed on the SmartAxis, the user program stored in the memory cartridge is executed. • User programs can be downloaded from memory cartridges to the SmartAxis using the memory cartridge download function or LCD operation (SmartAxis Pro only). • User programs can be uploaded to memory cartridges from the SmartAxis ROM using the memory cartridge upload function or LCD operation (SmartAxis Pro only). For details, see ##"Memory Cartridges"## on page xx-xx.
Not installed on the SmartAxis	The user program stored in the SmartAxis ROM is executed.

Note: Program capacity when using a memory cartridge is the same as the program capacity of the applicable SmartAxis model. See "CPU Module Specifications" on page 2-5.

Specifications

Item	Specifications
Type Number	FT1A-PM1
Memory Type	Flash ROM
Hardware for Storing Data	SmartAxis
Quantity of Stored Programs	One user program per a memory cartridge

User Program Compatibility

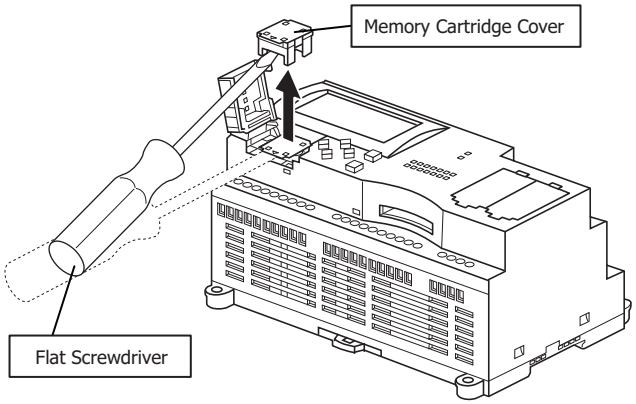
The CPU module can execute only user programs created for the same PLC type. When installing a memory cartridge, make sure that the user program stored on the memory cartridge matches the PLC type. If the user program is not for the same PLC type, a user program syntax error occurs and the PLC cannot run the user program.

⚠ Caution

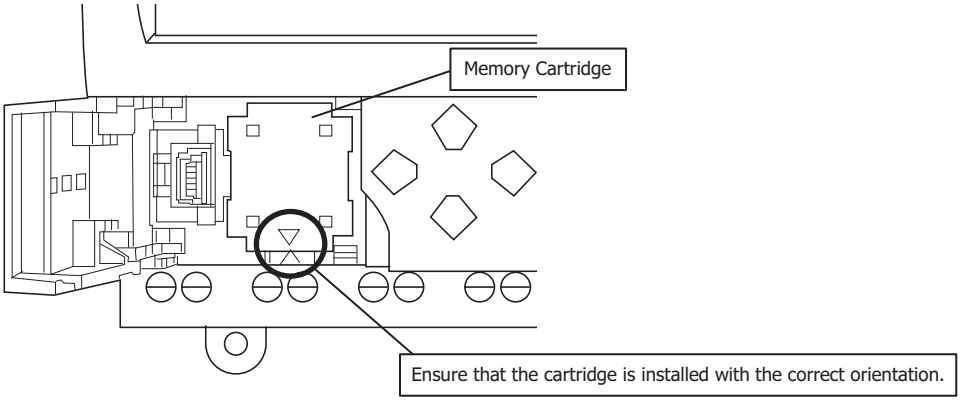
- **Compatibility of User Program with PLC System Software**
  When a memory cartridge contains a user program for higher functionality, do not install the memory cartridge into PLCs with lower functionality, otherwise the user program syntax error occurs. Upgrade the system software of the PLCs so that the PLCs can run the user program in the memory cartridge.

Installation Procedure

Insert a flat screwdriver under the memory cartridge cover and pull the cover directly upward to remove it.



After removing the memory cartridge cover, install a memory cartridge. Confirm that the triangular marks on the memory cartridge and on the SmartAxis point at each other to ensure that the memory cartridge is installed with the correct orientation.



Removal Procedure

As in the procedure to remove the memory cartridge cover, insert a flat screwdriver under the memory cartridge cover and pull the cover directly upward to remove it. If the cartridge is removed in a crooked state, the housing of the cartridge or the internal connector may be damaged.

Caution

- Turn off the power to the SmartAxis before removing or installing a memory cartridge.
  If a memory cartridge is installed while the SmartAxis is powered, the SmartAxis or the memory cartridge may be damaged.
- Do not damage the SmartAxis with the screwdriver.

Ethernet Port

Functions

SmartAxis with Ethernet port can communicate with the other network devices that support Ethernet communications, such as maintenance communication, Modbus TCP (client and server) communication, and user-defined communication (ETXD and ERXD commands).

Applicable Models

An Ethernet port is available on the 24-, 40-, and 48-I/O types.

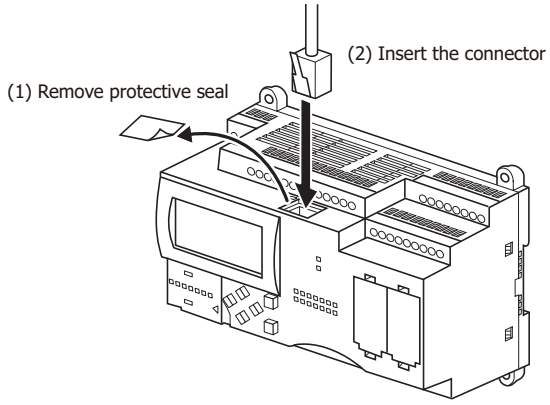
12-I/O type	24-I/O type	40-I/O type	48-I/O type
No	Yes	Yes	Yes

Specifications

Item	Specifications
Transmission Speed	10BASE-T/100BASE-TX
Electrical Characteristics	IEEE 802.3-compliant
Recommended Cable	CAT.5 STP (Category 5 shielded twisted-pair cable)
Connector	RJ45

Installation Procedure

Remove the protective seal covering the Ethernet port and insert the connector of an Ethernet cable securely.



Caution

- Turn off the power to the SmartAxis before connecting an Ethernet cable to the Ethernet port.
- If an Ethernet cable is connected while the SmartAxis is powered, electrical shock to the operator or damage to the SmartAxis may be caused.

SD Memory Card

Applicable Models

SD memory cards can be used only with the 40- and 48-I/O types.

Memory Card	12-I/O type	24-I/O type	40-I/O type	48-I/O type
SD memory card	No	No	Yes	Yes

SD Memory Card Usage

Specified device values can be saved in CSV files on an SD memory card using the DLOG and TRACE instructions. This makes it possible to save log data or analyze the data when an error occurs.

CSV files saved on an SD memory card can be read out to a computer using WindLDR.

For details on the DLOG and TRACE instructions, see ####Chapter 25#### - ##""Data History Commands"## in the ####FT1A Programming Manual####.

Specifications

Item		Specifications
Supported SD Memory Cards		SD memory cards (2GB maximum), SDHC memory cards (32GB maximum)
File System		FAT16/FAT32 SD memory cards of 2GB or less are only supported in FAT16 format. SD memory cards of 2GB formatted in FAT32 are not recognized.
File Specifications	**Format**	CSV
	Size	5MB maximum
	Supported Characters	Single-byte alphanumeric characters The following characters cannot be used in drive names: \ " & ( ) * + , . / : ; < > [ ] = | ^ The following characters cannot be used in file and folder names: \ / : * ? " < >
Maximum Number of Files		Dependant on file system: • FAT16 65,534 maximum per sub-directory • FAT32 65,534 maximum per sub-directory

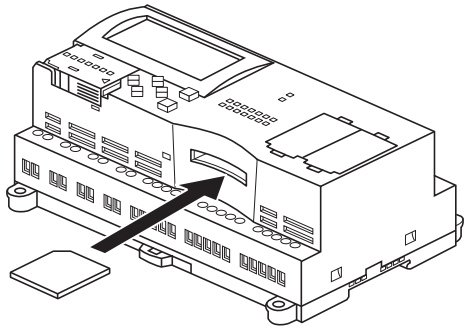
Recommended SD Memory Card

Recommended SD Memory Card	HG9Z-XMS2 (Capacity: 2GB, IDEC)
Compatible SD Memory Cards	See the IDEC website.

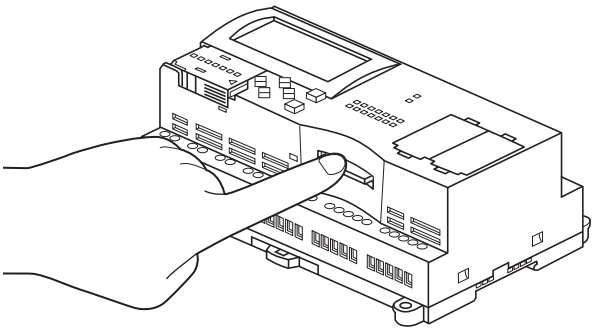
Notes:

- It is recommended that SD memory cards are formatted on the SmartAxis before it is used. The recommended SD memory card in the table above can be used immediately without formatting.
- It is recommended that important data is regularly backed up on separate media such as CDs or DVDs.

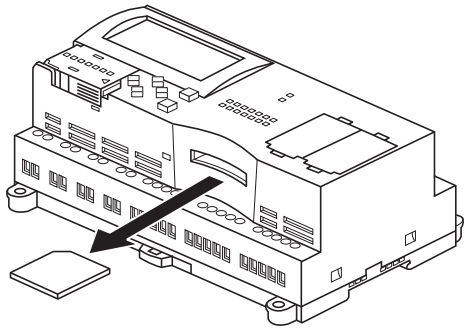
Installation
Follow the indications on the SmartAxis and insert an SD memory card into the SD memory card slot on the SmartAxis until you hear a click.



Removal
Press the SD memory card in the SD memory card slot on the SmartAxis until you hear a click and move your finger back.



The SD memory card will come partially out of the slot. Use your fingers to remove the SD memory card completely.



Notes:

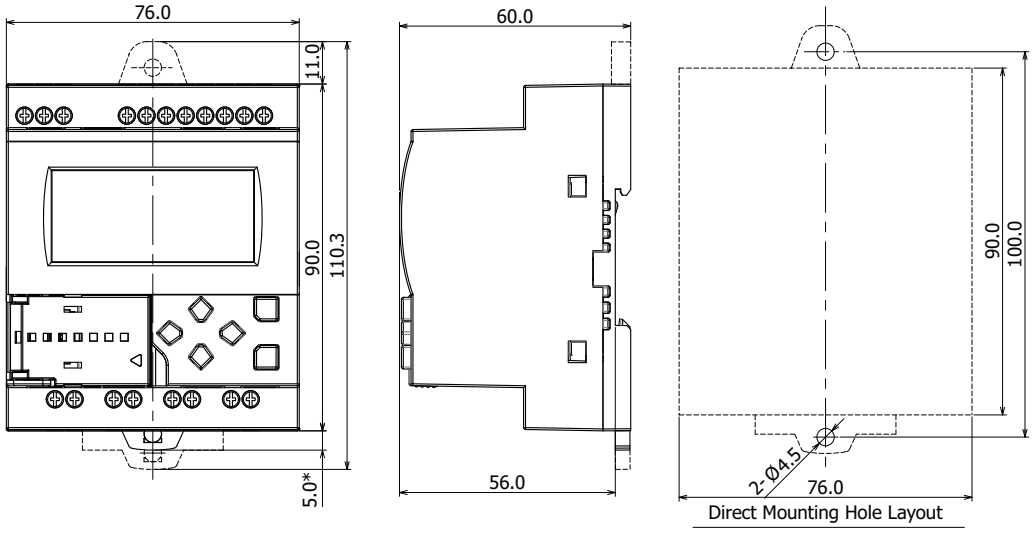
- Insert and remove the SD memory card in the direction indicated on the SmartAxis.
- Set the write-protect switch of the SD memory card to the OFF position before inserting to the SmartAxis.

⚠ Caution If any of the actions below is performed while the SD memory card is being accessed, data on the card may be damaged.

- The SmartAxis is turned off.
- The SD memory card is removed.

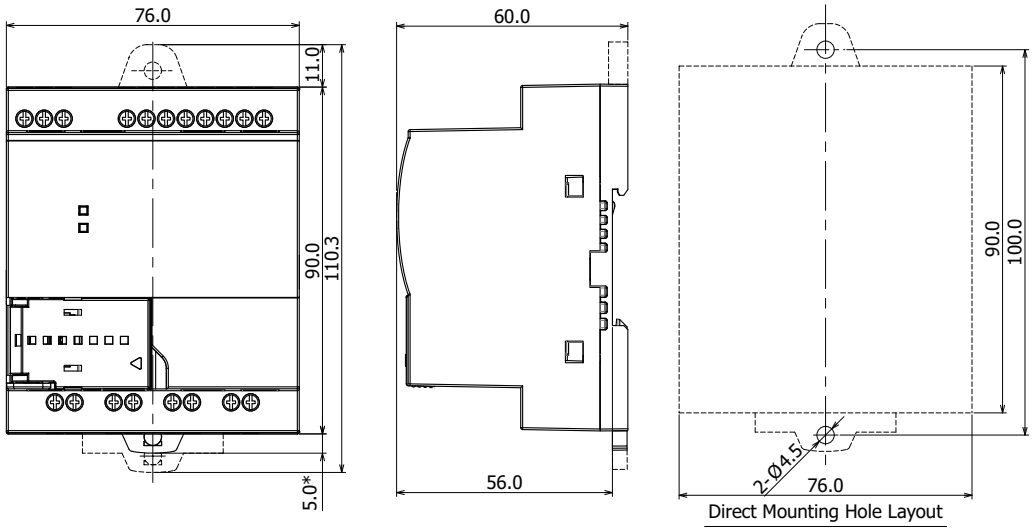
Do not turn off the SmartAxis while the SD memory card is being accessed (while the SD memory card status LED is flashing). Confirm that the SD memory card status LED is not flashing before removing the card from the SmartAxis. For details on SD memory card status LED, see Chapter 5 "Special Functions" - "SD Memory Card" - "SD Memory Card Status LED and SD Memory Card States".

Dimensions



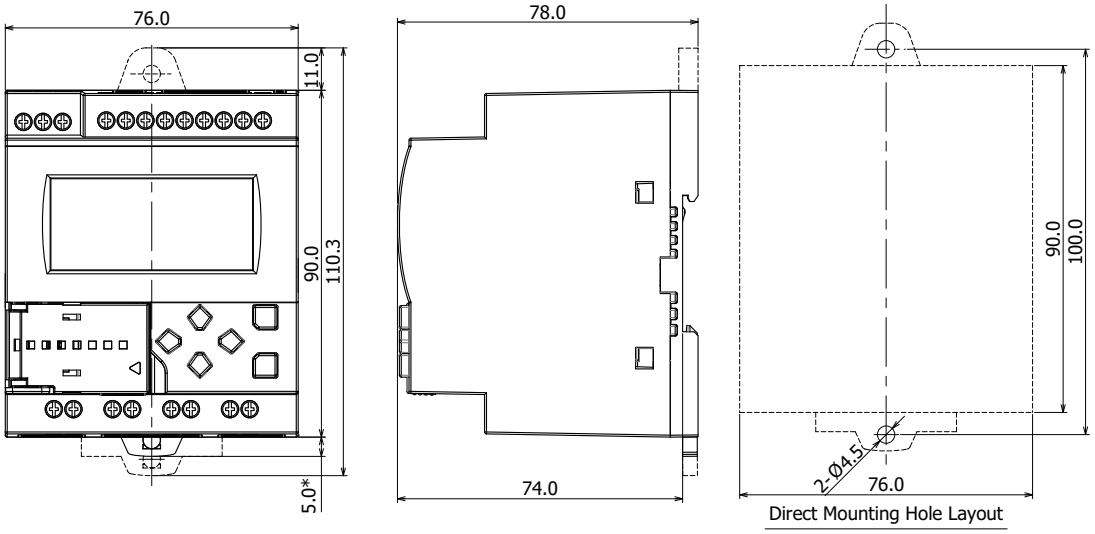
*9.3 mm when the clamp is pulled out.

FT1A-B12RA



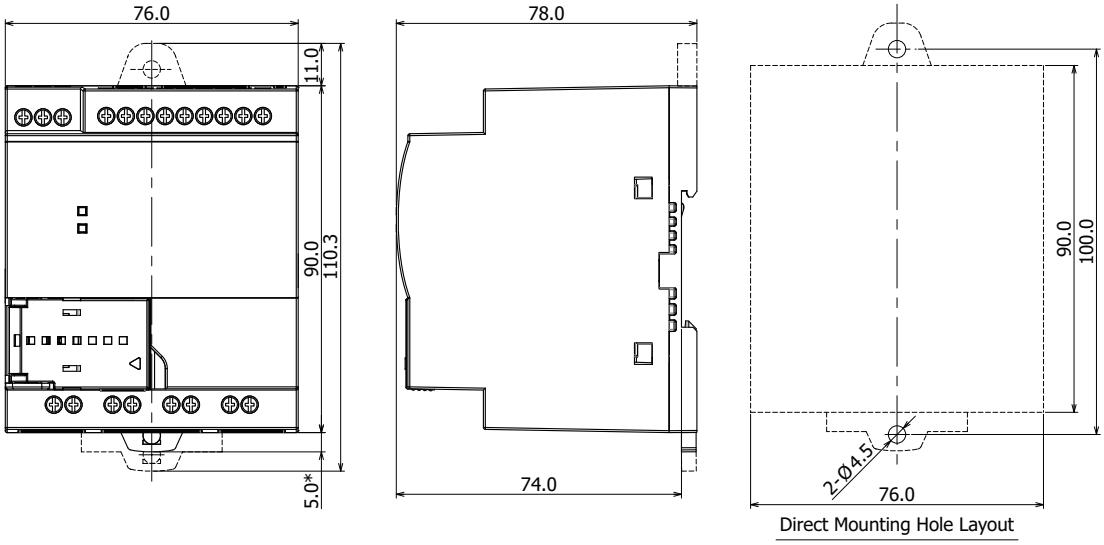
*9.3 mm when the clamp is pulled out.

FT1A-H12RC



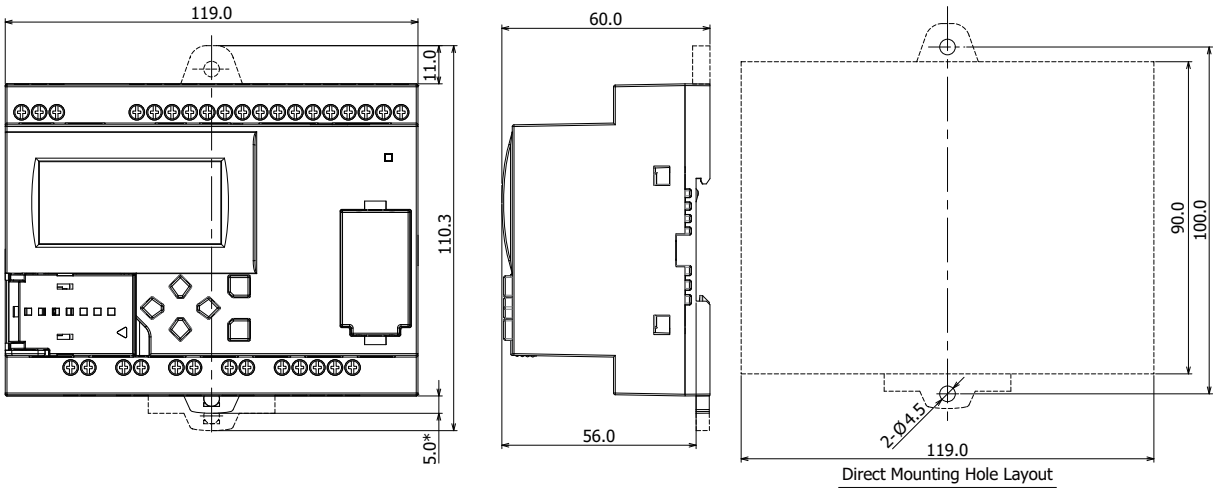
*9.3 mm when the clamp is pulled out.

FT1A-B12RC



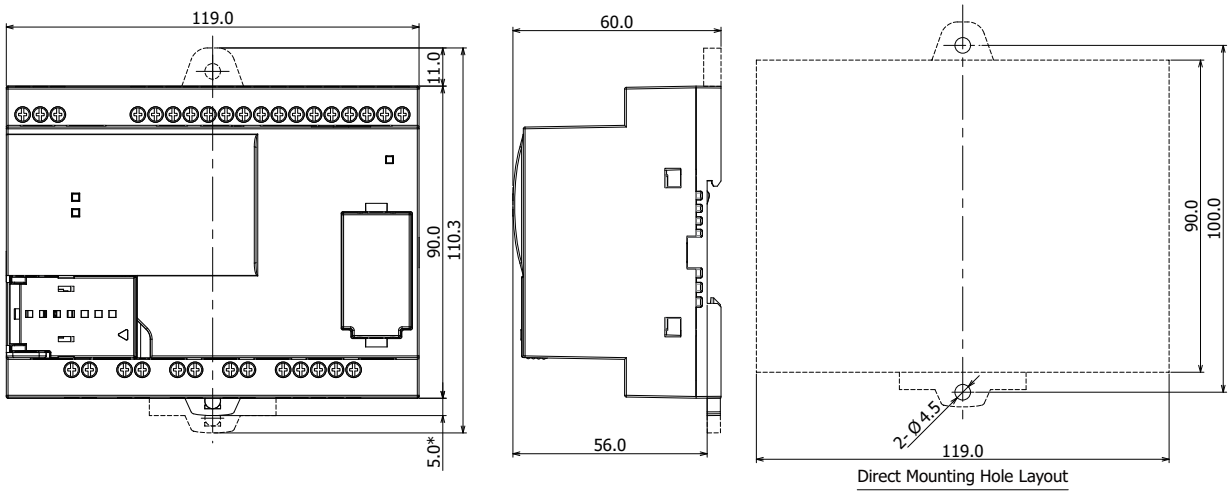
*9.3 mm when the clamp is pulled out.

FT1A-H24RA



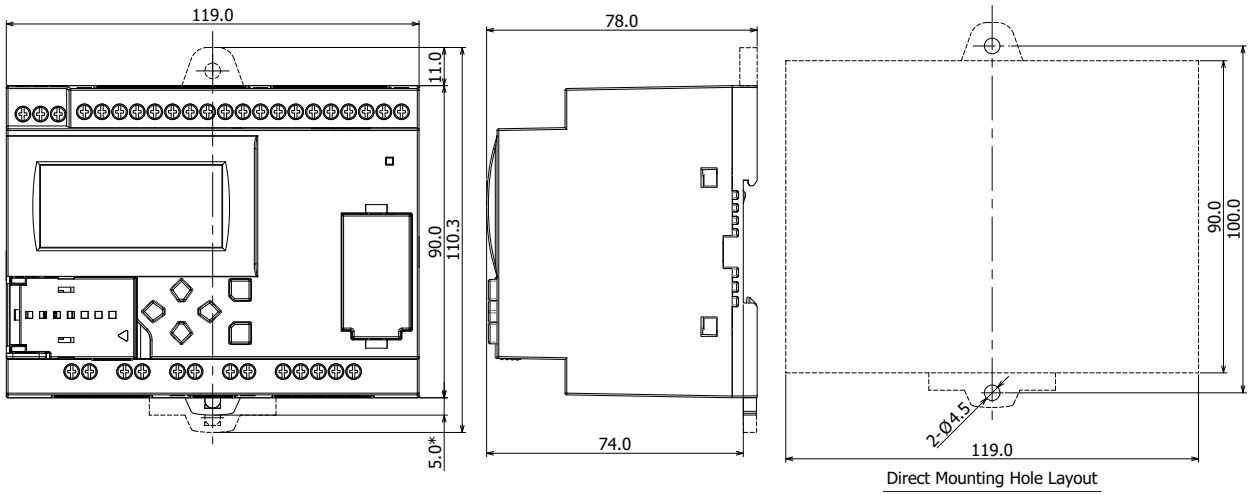
*9.3 mm when the clamp is pulled out.

FT1A-B24RA



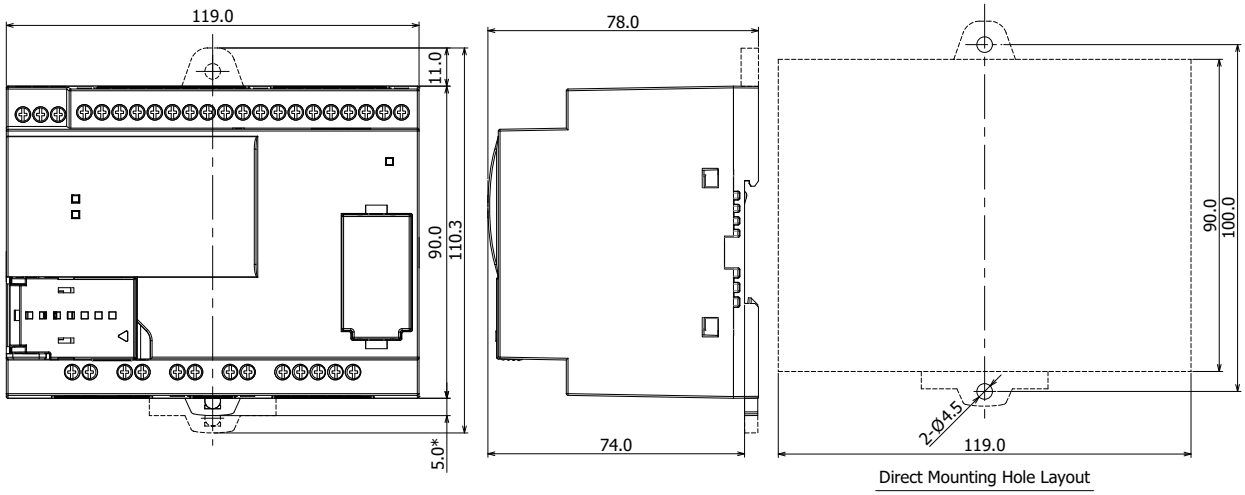
*9.3 mm when the clamp is pulled out.

FT1A-H24RC



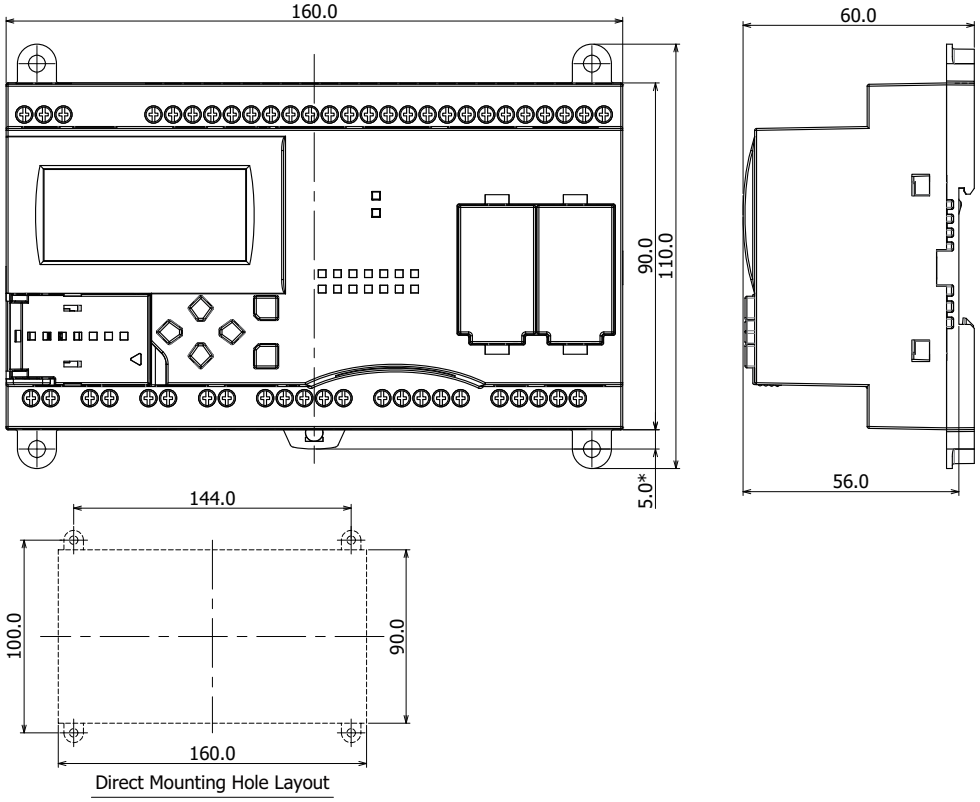
*9.3 mm when the clamp is pulled out.

FT1A-B24RC



*9.3 mm when the clamp is pulled out.

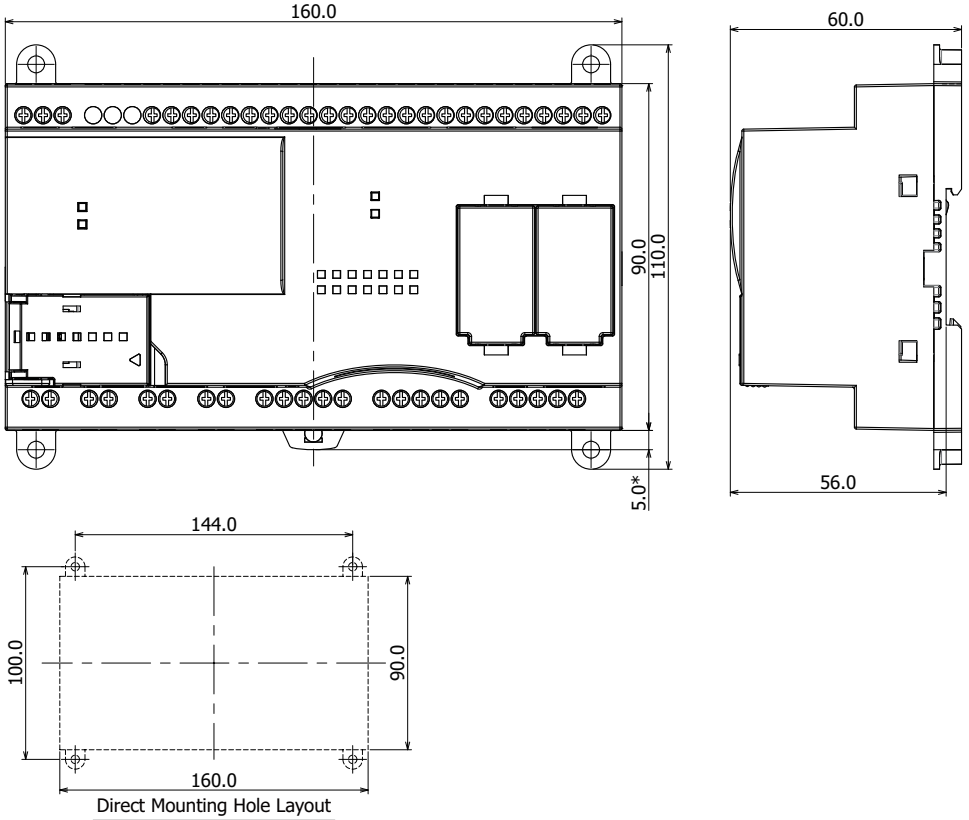
FT1A-H40RSA, FT1A-H40RKA



Direct Mounting Hole Layout

*9.3 mm when the clamp is pulled out.

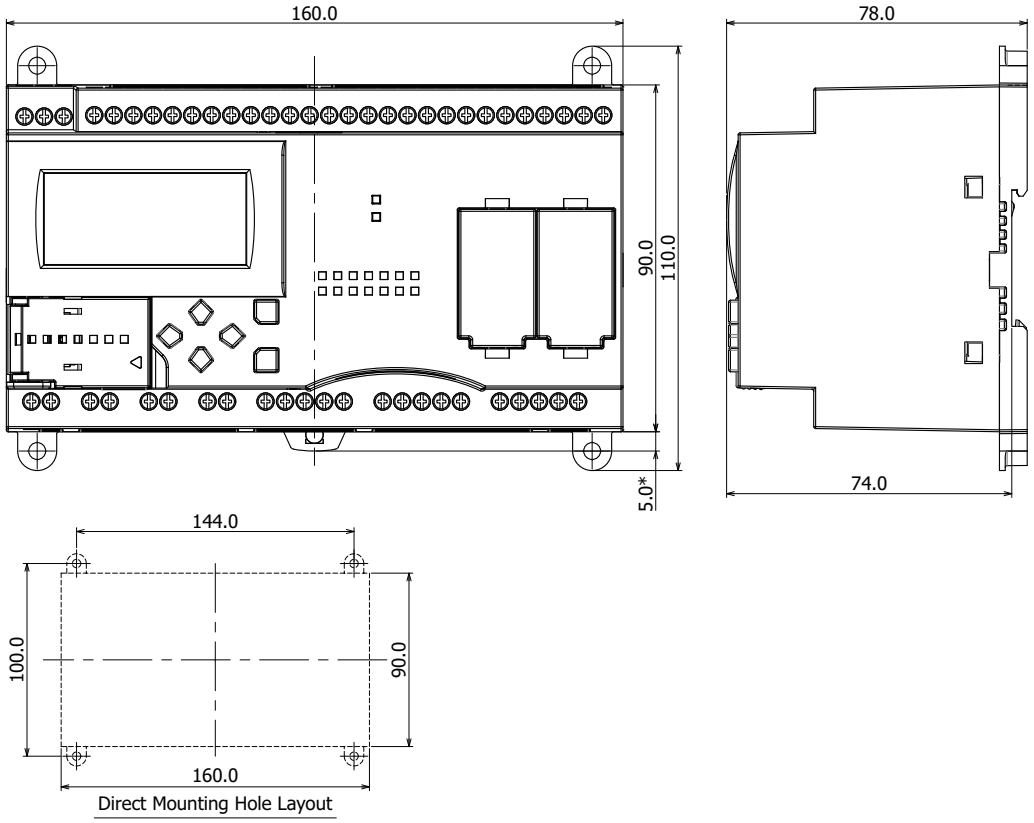
FT1A-B40RSA, FT1A-B40RKA



Direct Mounting Hole Layout

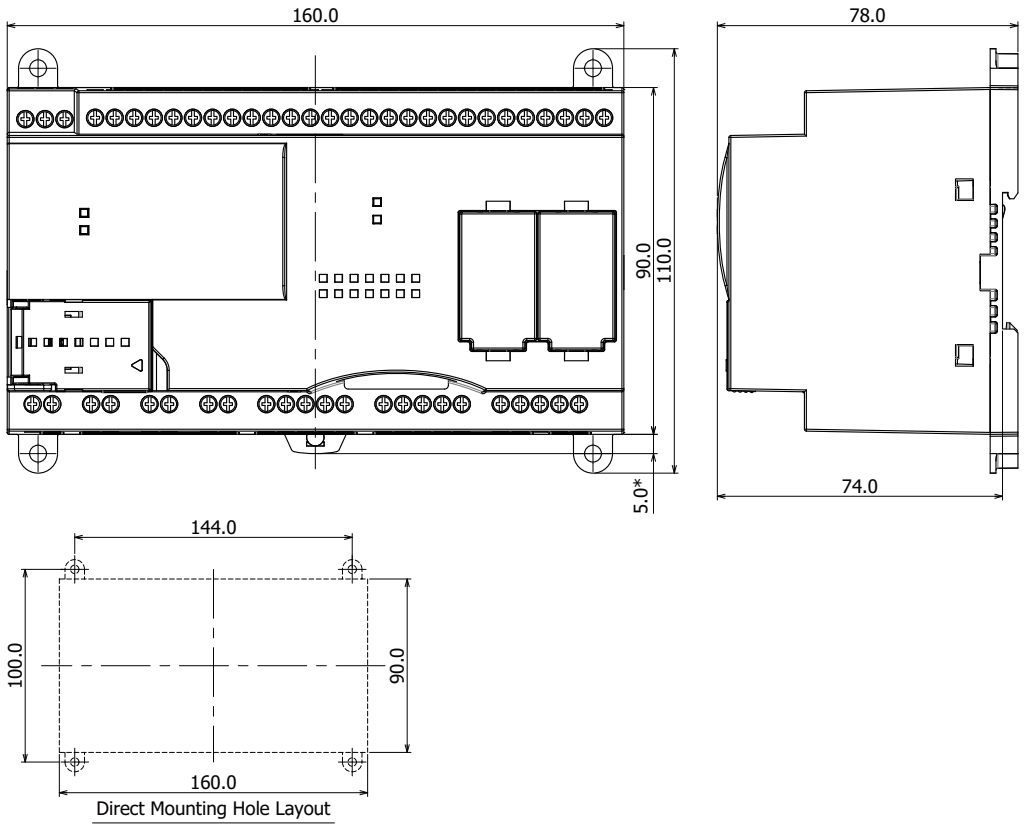
*9.3 mm when the clamp is pulled out.

FT1A-H40RC



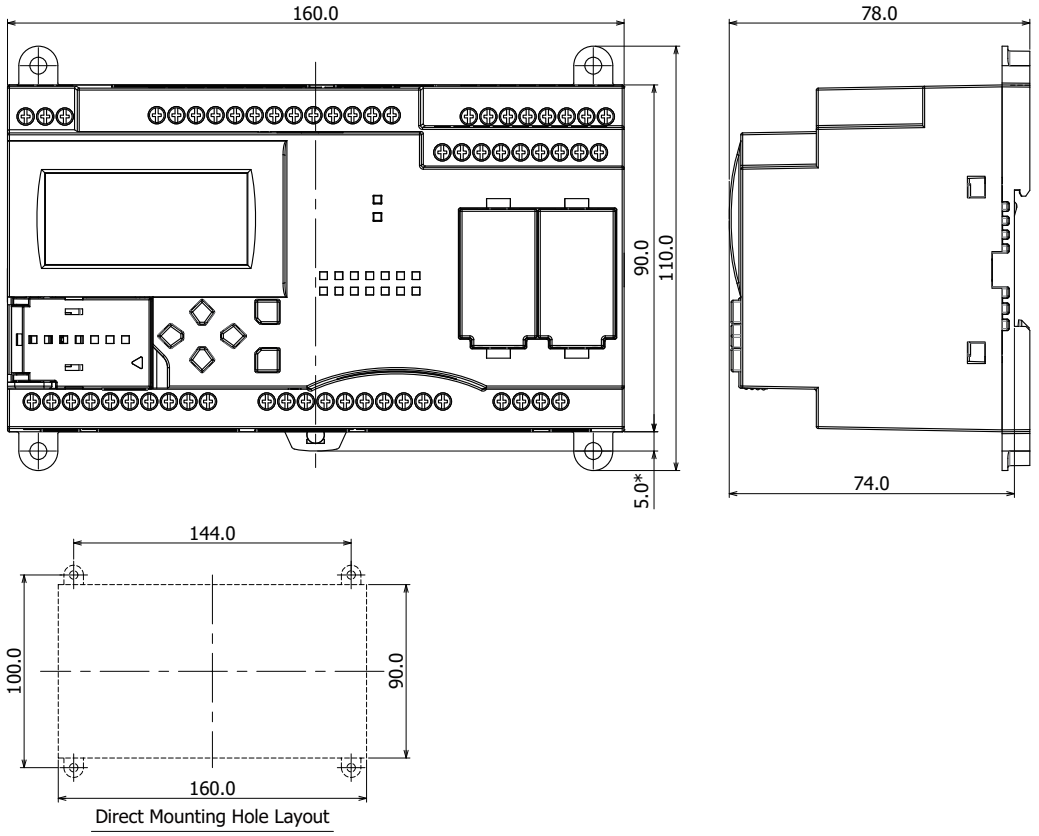
*9.3 mm when the clamp is pulled out.

FT1A-B40RC



*9.3 mm when the clamp is pulled out.

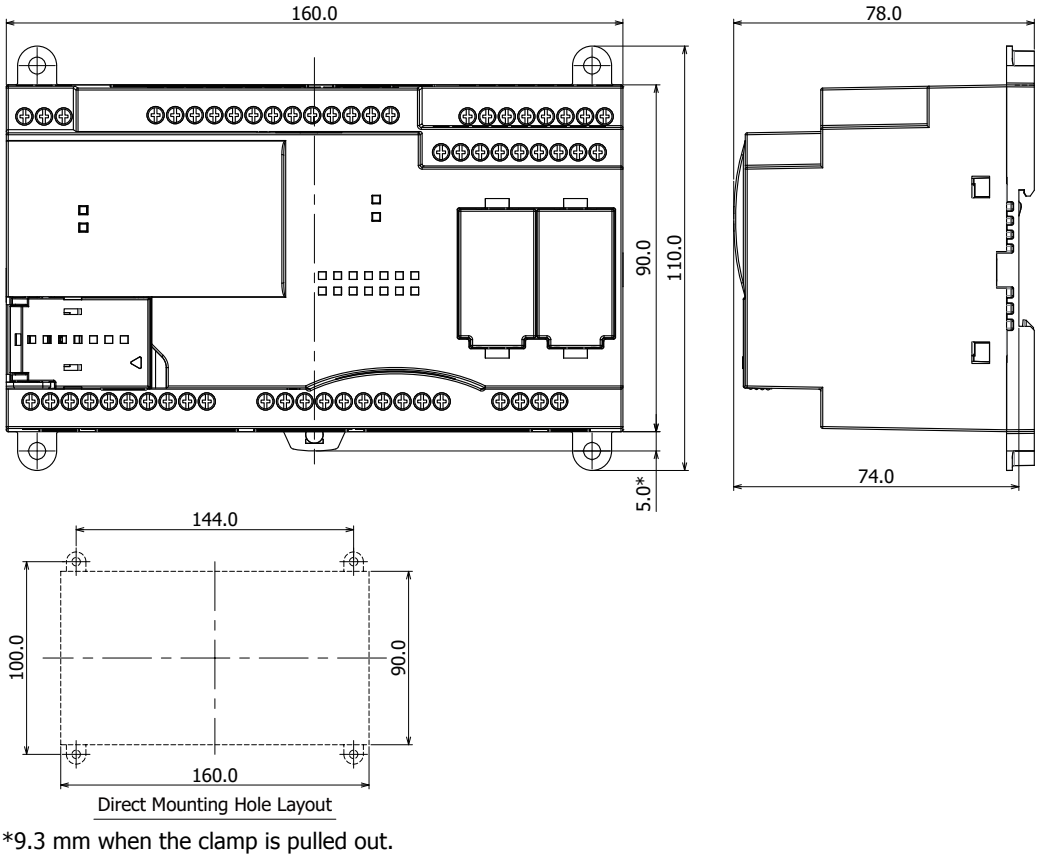
FT1A-H48SA, FT1A-H48KA



Direct Mounting Hole Layout

*9.3 mm when the clamp is pulled out.

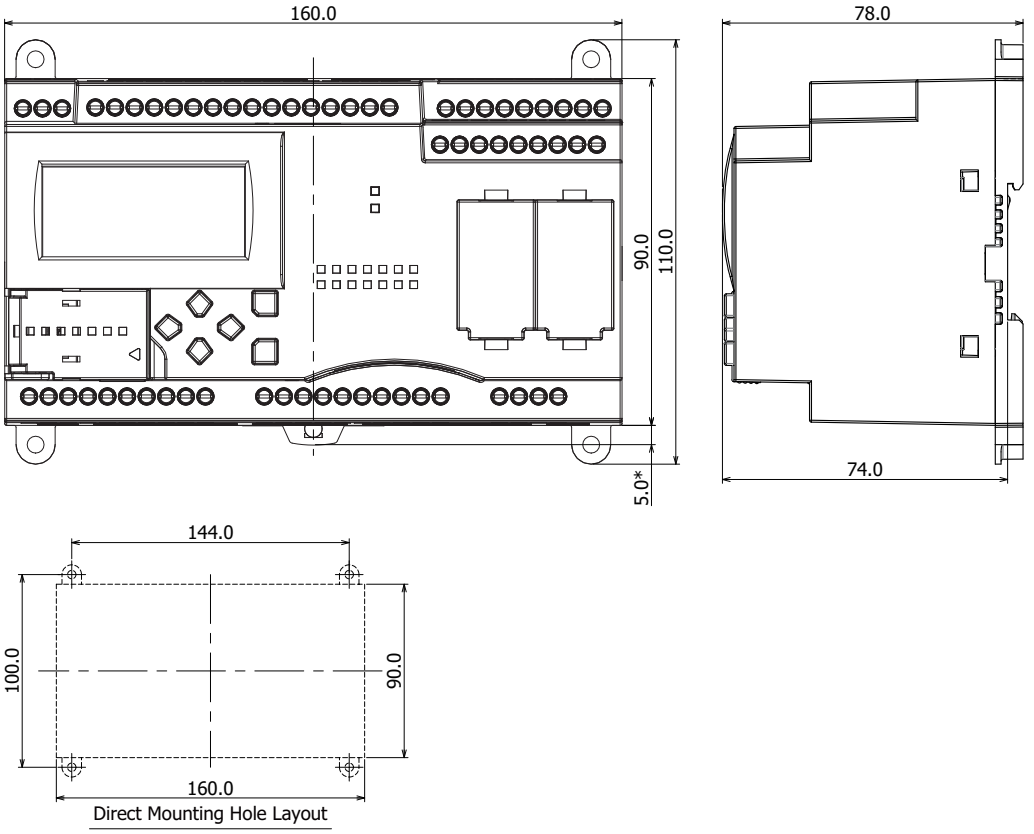
FT1A-B48SA, FT1A-B48KA



Direct Mounting Hole Layout

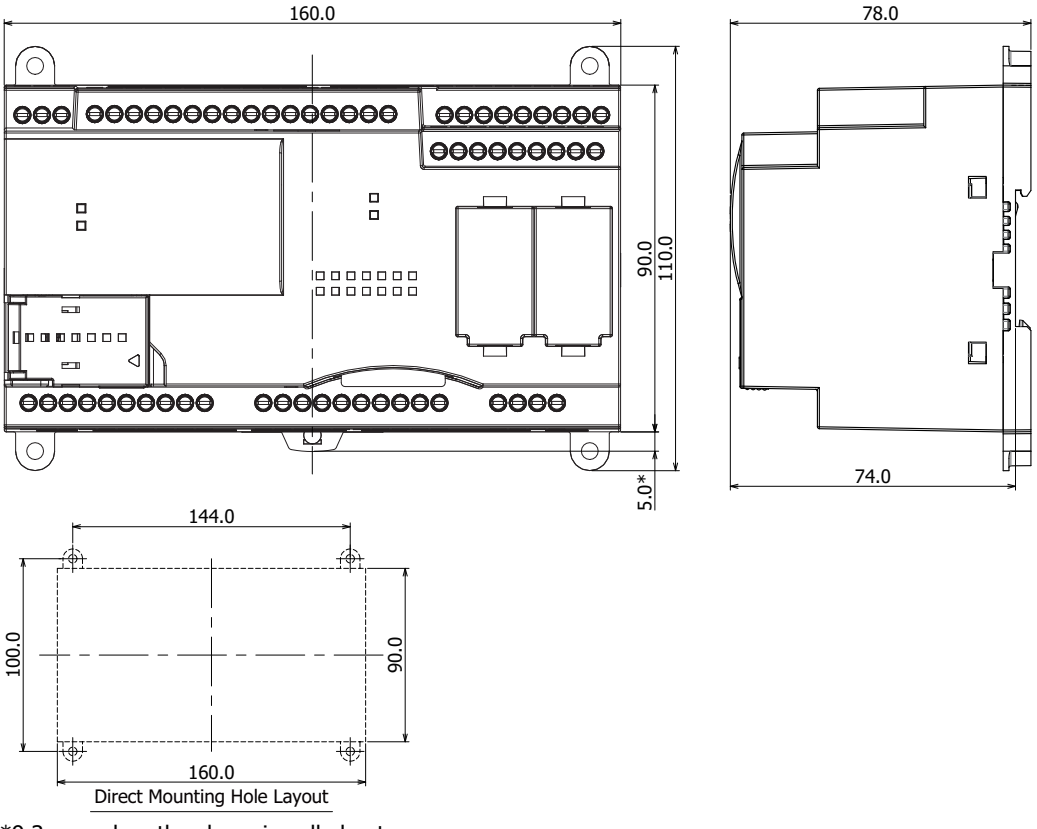
*9.3 mm when the clamp is pulled out.

FT1A-H48SC, FT1A-H48KC



*9.3 mm when the clamp is pulled out.

FT1A-B48SC, FT1A-B48KC



*9.3 mm when the clamp is pulled out.

3: INSTALLATION AND WIRING

Introduction

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

⚠ Caution

- Prevent metal fragments and pieces of wire from dropping inside the SmartAxis housing. Put a cover on the SmartAxis modules during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage, or malfunction.
- Do not touch the connector pins with hand, otherwise electrostatic discharge may damage the internal elements.
- When handling the SmartAxis, take measures to discharge static electricity.
- Keep the SmartAxis wiring away from motor lines.

Installation Location

The SmartAxis is designed to be installed in control panels and similar locations.

Install the SmartAxis within product specifications.

Avoid use in the environments below. Doing so may cause electric shock, fire, or malfunction.

Places where there is a lot of dust, salt, iron powder, or soot.

Places exposed to direct sunlight.

Places where the SmartAxis may be exposed to vibration or shock either directly or indirectly.

Atmospheres of corrosive or flammable gases.

Places where condensation may form.

Places where the SmartAxis may be directly exposed to water.

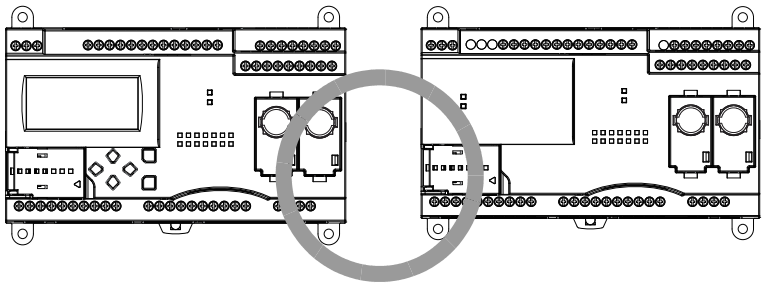
Around high-voltage lines, high-voltage equipment, motor lines, or motor equipment.

Places near where a large switching surge may occur.

Places subject to a strong magnetic or electric field.

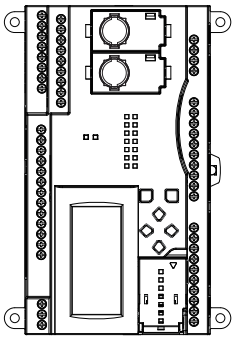
Always mount the SmartAxis vertically as shown below. To provide ample ventilation, ensure that there is sufficient space between the SmartAxis and other devices, heat sources, and panel surfaces.

SmartAxis Pro SmartAxis Lite

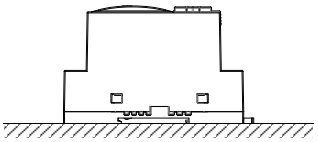


The SmartAxis can be mounted face-upward when the ambient temperature is 35°C or lower, and can be mounted side-on when the ambient operating temperature is 40°C or lower. Do not mount the SmartAxis on side-on when the ambient temperature will exceed 40°C.

Side-on Orientation (Use if 40°C or less)

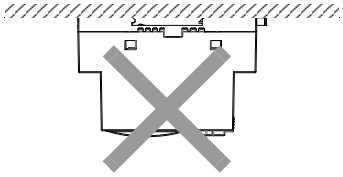


Face-upward Orientation (Use if 35°C or less)



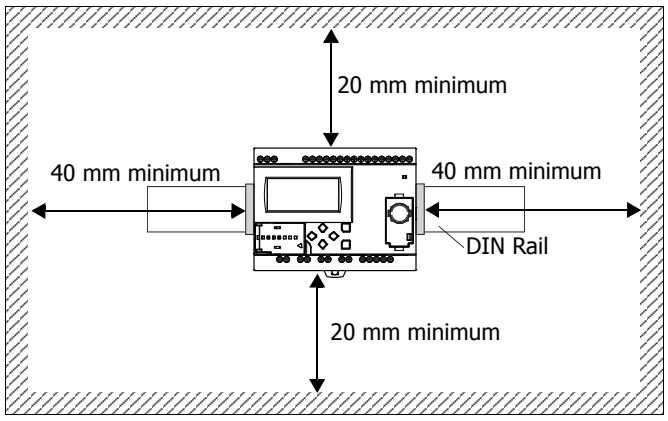
Do not install the SmartAxis face-downward.

Face-Downward

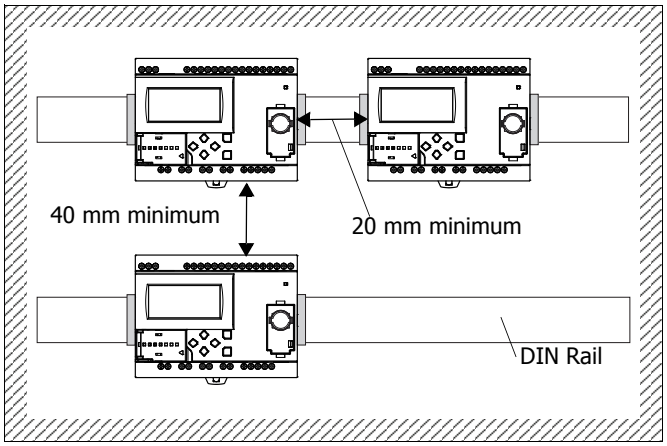


Mounting Space

To allow for heat dissipation and facilitate replacement, ensure that there is at least 20 to 40 mm between the SmartAxis and surrounding equipment and ducts.



Mounting Two or More Units



Mounting on DIN Rail

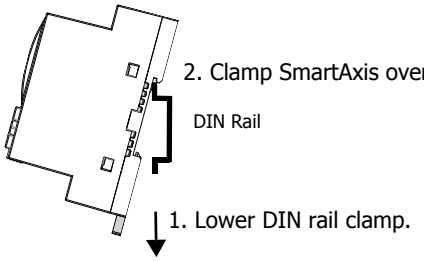
Caution

- Install the SmartAxis modules according to instructions described in this user's manual. Improper installation will result in falling, failure, or malfunction of the SmartAxis.
- Do not install the SmartAxis when it is powered up. Doing so may result in electric shock and may damage the product.

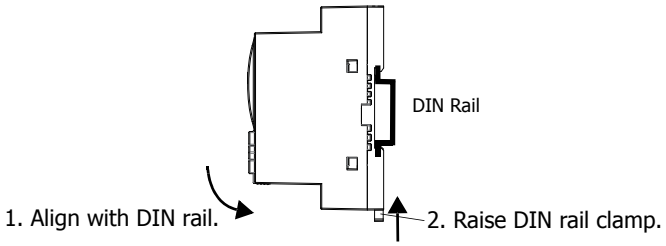
This section describes how to mount the SmartAxis.

The SmartAxis can be mounted directly on a DIN rail or in a control panel.

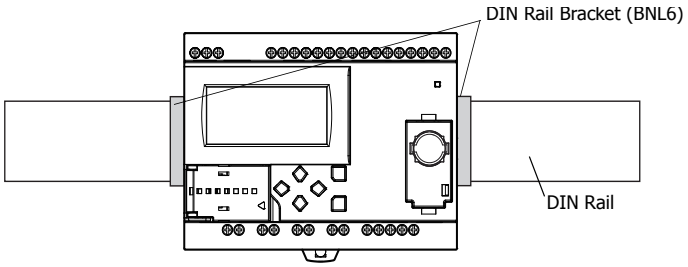
1. Fasten the DIN rail to a panel using screws firmly.
2. Using a flat screwdriver, lower the DIN rail clamp and hang the SmartAxis on the DIN rail.



3. Align the SmartAxis with the DIN rail and raise the DIN rail clamp.

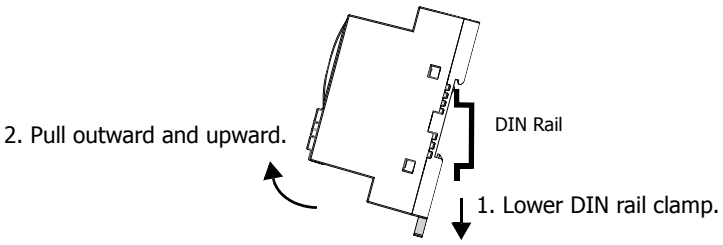


4. Secure both ends of the SmartAxis using the DIN rail brackets.



Removing from DIN Rail

1. Using a flat screwdriver, lower the DIN rail clamp on the SmartAxis.
2. Pull the SmartAxis outward and upward at the same time.



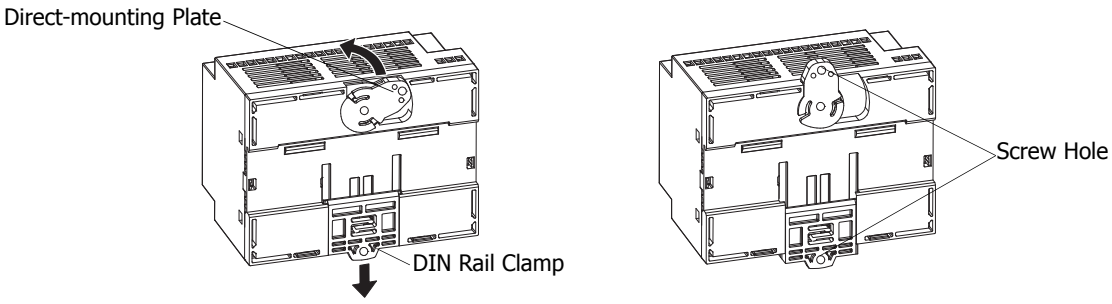
Note: The SmartAxis supports 35 mm wide DIN rails. Supported rails: IDEC BAA1000 (Length: 1000 mm)

Direct Mounting on Panel Surface

This section describes how to mount the SmartAxis directly onto a mounting plate for installation in a control panel. The 12- and 24-I/O types are mounted differently from the 40- and 48-I/O types. To mount the SmartAxis directly, it may be necessary to make holes in the mounting plate depending on the SmartAxis model.

Preparations

When directly mounting the 12- and 24-I/O types, pull out the direct-mounting plate and the DIN rail clamp on the back of the SmartAxis, and attach the SmartAxis to the mounting plate using the screw holes. Attach the 40- and 48-I/O types to the mounting plate using the screw holes on the back of the SmartAxis.

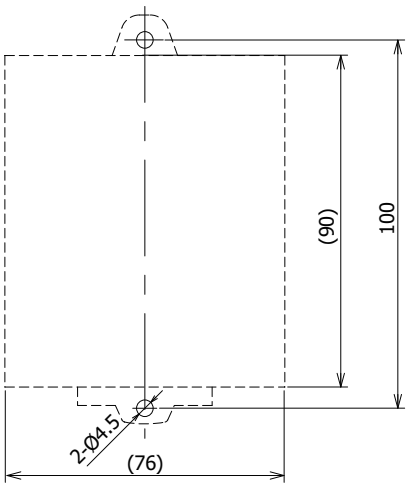


Mounting Hole Layout for Direct Mounting on Panel Surface

Attach the SmartAxis to the mounting plate using M4 tapping screws as shown below or make 5 to 6 mm mounting holes and secure the SmartAxis using M4 pan head screws.

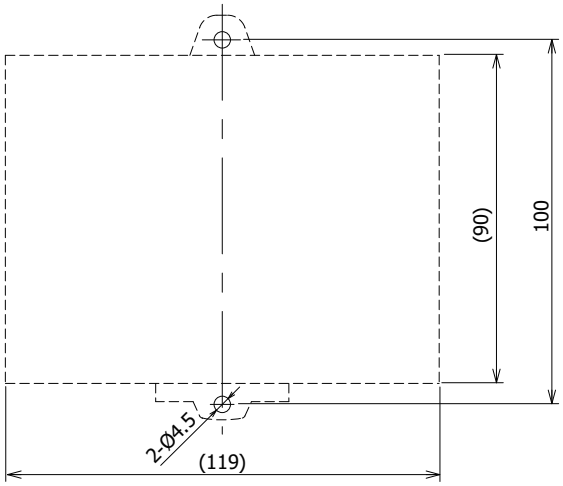
Always give sufficient consideration to operability, ease-of-maintenance, and environmental resistance when deciding on the mounting position.

- **12-I/O type (FT1A-H12RA, FT1A-B12RA, FT1A-H12RC, FT1A-B12RC)**



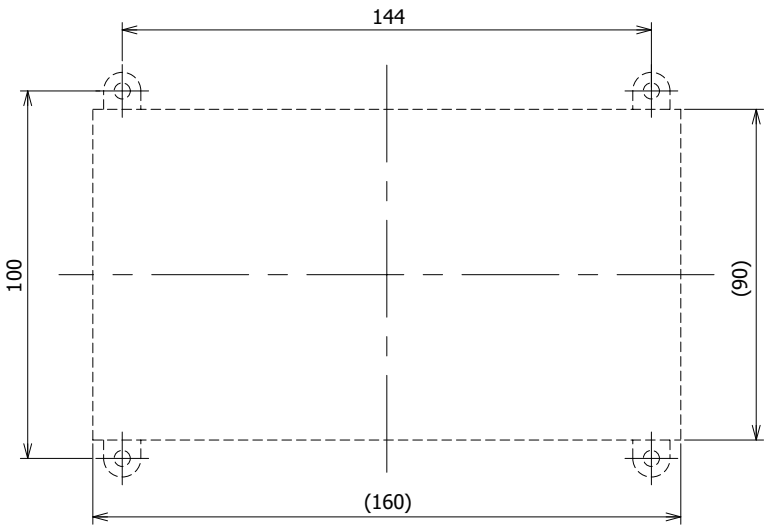
All dimensions in mm.

- **24-I/O type (FT1A-H24RA, FT1A-B24RA, FT1A-H24RC, FT1A-B24RC)**



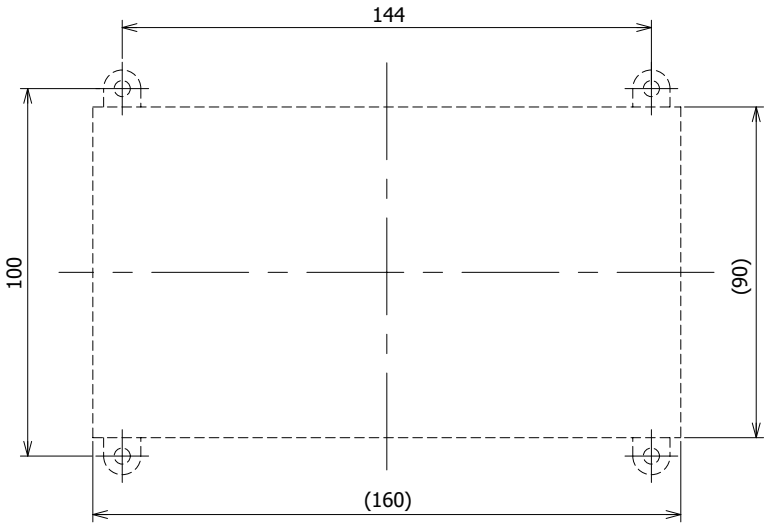
All dimensions in mm.

- **40-I/O type (FT1A-H40RKA, FT1A-H40RSA, FT1A-B40RKA, FT1A-B40RSA, FT1A-H40RC, FT1A-B40RC)**



All dimensions in mm.

- **48-I/O type**
  (FT1A-H48KA, FT1A-H48SA, FT1A-B48KA, FT1A-B48SA, FT1A-H48KC, FT1A-H48SC, FT1A-B48KC, FT1A-B48SC)



All dimensions in mm.

Caution
- When directly mounting the SmartAxis, tighten mounting screws with torque of 1 N·m (10 kgf·cm).

Input/Output Wiring

This section describes SmartAxis input/output device wiring.

Precautions for I/O Device Wiring

Input Terminal Wiring

When wiring input devices, separate wiring from power, output, and motor lines.

When using duct for wiring, ground piping using a D-type (type 3) ground.

When wiring DC power type models, keep wiring away from AC power lines.

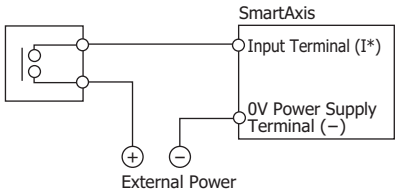
When using shielded cable for wiring, ground the shield on the SmartAxis side using a D-type (type 3) ground.

Wire input devices you want to connect to the SmartAxis according to type as shown below.

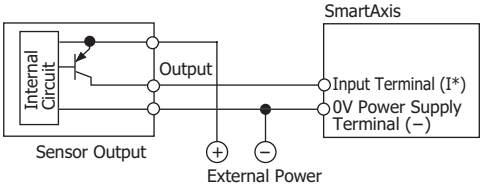
DC Power Type

Digital Input – Sink Input

• Contact Output

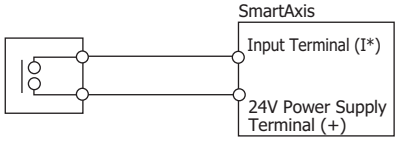


• PNP Output

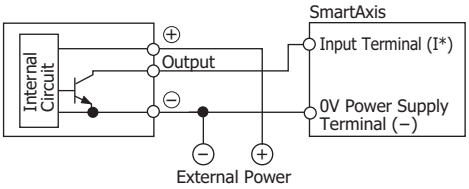


Digital Input – Source Input

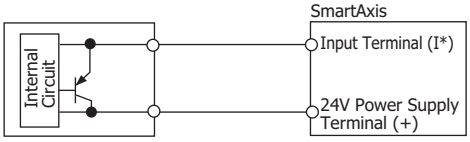
• Contact Output



• NPN Output

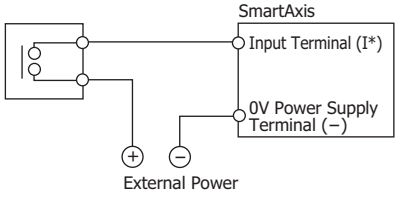


• 2-wire Sensor

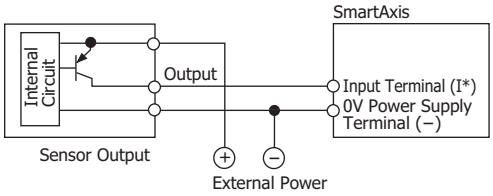


Shared Analog Input

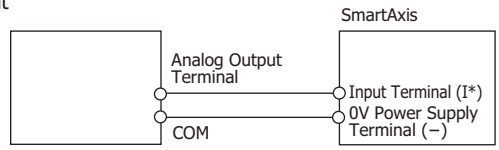
• Contact Output



• PNP Output



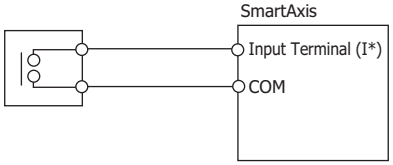
• Analog Output



AC Power Type

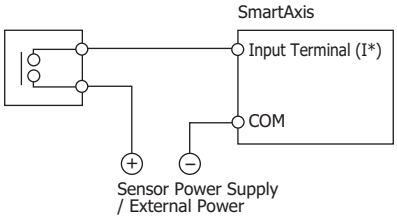
Contact Input

• Contact Output

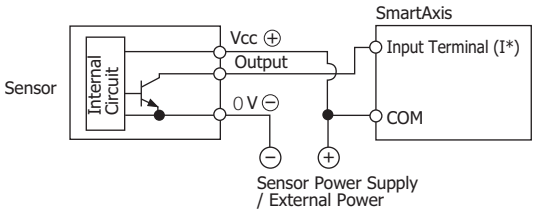


Sink/Source Input

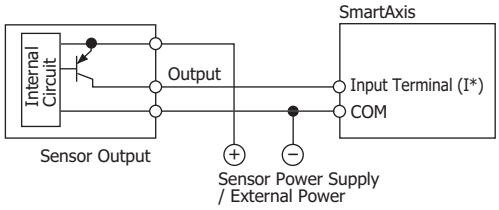
• Contact Output



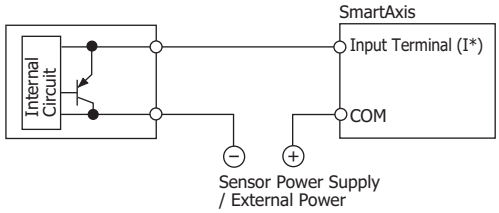
• NPN Output



• PNP Output



• 2-wire Sensor



Output Terminal Wiring

Caution

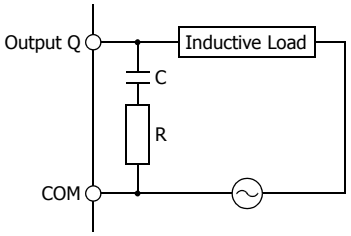
- If output relays or transistors in the SmartAxis or output modules should fail, outputs may remain on or off. For output signals which may cause heavy accidents, provide a monitor circuit outside the SmartAxis.
- Connect a fuse to the output module, selecting a fuse appropriate for the load.
- Use proper wires for output wiring.
  UL1015 AWG22 or UL1007 AWG18
- When equipment containing the SmartAxis is intended for use in European countries, insert an IEC 60127-approved fuse to each output of every module for protection against overload or short-circuit. This is required when equipment containing the SmartAxis is destined for Europe.
- When driving an inductive load that emits noise like a magnet or a valve, to reduce noise and protect circuits, use a diode for the output on DC power type models and a surge absorber for the output on AC power type models.
- Turn off the power to the SmartAxis when wiring input/output terminals.
- Emergency stop and interlocking circuits must be configured outside the SmartAxis.
- Use the input/output terminals within the SmartAxis ratings and specifications.
- Tighten mounting screws with torque of 0.5 N·m (5 kgf·cm).

Output Protection Circuit

When a motor, solenoid, or similar inductive load is connected, the life of the contact is shortened due to the inrush current and counter-electromotive force acting on the load. Set up a protection circuit to prevent this from happening. 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 SmartAXIS.

For protection of the transistor output of the SmartAxis modules, connect protection circuit C shown below to the transistor output circuit.

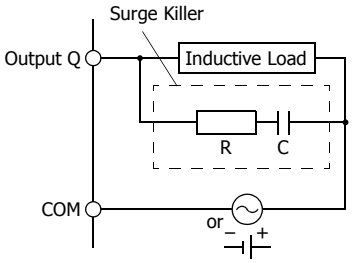
Protection Circuit A



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

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

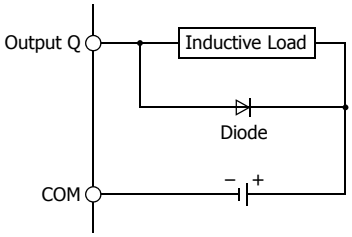
Protection Circuit B



This protection circuit can be used for both AC and DC load power circuits.

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

Protection Circuit C



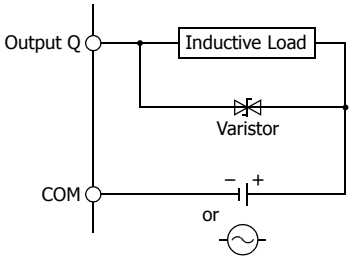
This protection circuit can be used for DC load power circuits.

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



This protection circuit can be used for both AC and DC load power circuits.

Power Supply

This section describes how to connect power supply to the SmartAxis. The SmartAxis is available in both AC and DC power types.

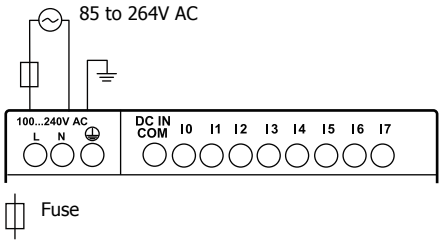
Caution

- Use a power supply of the rated value. Use of a wrong power supply may cause fire or malfunction.
- Ensure that the power voltage to the SmartAxis does not exceed the allowable power voltage range described in the power supply specifications. The SmartAxis may run and stop repeatedly within this voltage range, particularly if the power voltage turns on or off very slowly.
- Use an IEC 60127-approved fuse on the power line outside the SmartAxis. This is required when equipment containing the SmartAXIS is destined for Europe.

AC Power Type

Connect the power supply to the AC power types as shown below.

Example: **FT1A-*12**C**



When Power Is Turned Off

The AC power types detect a power failure when the power voltage drops below 85V AC.

A momentary power interruption of 10 ms or less is not recognized as a power failure when the power voltage is at the rated voltage.

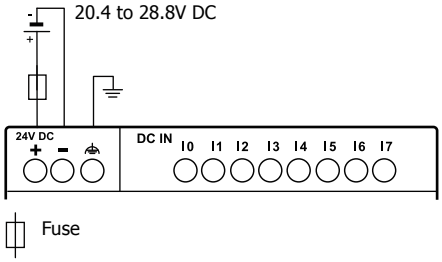
Inrush Current at Powerup

When the SmartAxis is powered up, an inrush current of a maximum of 35A flows. Use a power supply with sufficient capacity.

DC Power Type

Connect the power supply to the DC power types as shown below.

Example: **FT1A-*12**A**



When Power Is Turned Off

The DC power types detect a power failure when the power voltage drops below 20.4V DC.

A momentary power interruption of 10 ms or less is not recognized as a power failure when the power voltage is at the rated voltage.

Inrush Current at Powerup

When the SmartAxis is powered up, an inrush current of a maximum of 30A flows. Use a power supply with sufficient capacity.

Power Supply Wiring

When connecting the power supply, be sure to take care of the following:

- 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.
- ⏚ is the protective ground terminal. To prevent electric shocks, ground the terminal with D-type ground (type 3: ground resistance of 100 Ω maximum).
- ⏚ is the functional ground terminal. To prevent malfunction or breakdown of the SmartAxis due to noise, ground the terminal with D-type ground (class 3: ground resistance of 100 Ω maximum).
- When connecting a stranded wire or multiple wires to a terminal block, use a ferrule.

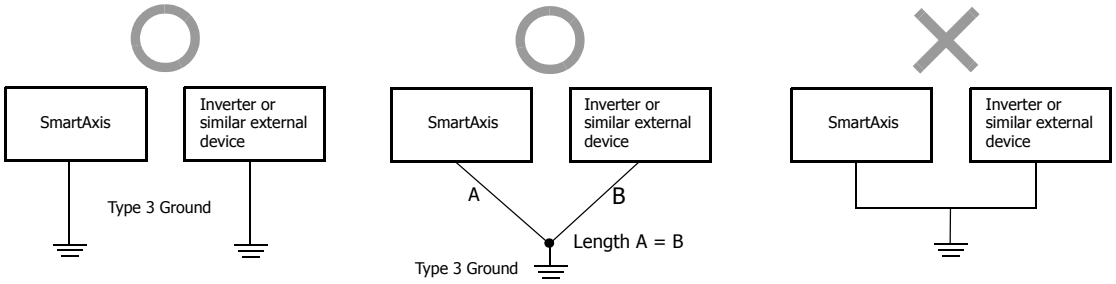
⚠ Caution

- Use the SmartAxis within the specifications of ratings and environmental conditions. Failure to do so may cause the SmartAxis to break down or reduce product life.
- 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.
- When connecting the power supply, tighten the terminal screws with torque of 0.5 N·m (5 kgf·cm).

Grounding

When grounding the power supply, be sure to take care of the following:

- Do not connect the grounding wire in common with the grounding wire of motor equipment. However, this is possible if both ground wires are the same length.
- Use a ground wire of UL1007 AWG16.
- Use a thick wire for grounding the SmartAxis and make the grounding wire as short as possible to make sure that noises from external devices can be conducted to the ground effectively.
- As shown below, external devices generating noise must be separated from the SmartAxis and grounded with the D-type ground (class 3).
- Make the length of the grounding wire for the SmartAxis as short as possible.



Terminal Connection

This section describes types of terminals and how to use them.

When connecting stranded wire or multiple solid wires to a terminal block, use appropriate ferrule for the terminal block.

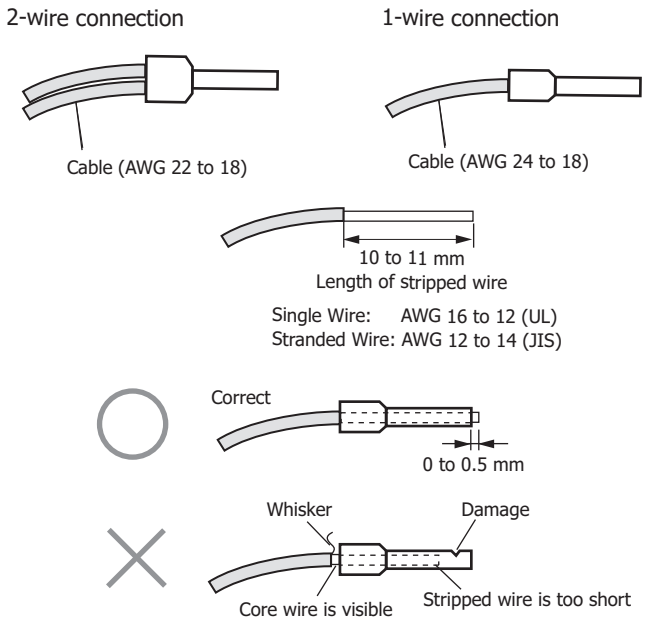
⚠ Caution

- Do not touch live terminals, otherwise electrical shocks may be caused.
- When the power is on, terminals to which external devices are connected may be heated. Do not touch terminals immediately after the power is turned off.
- Do not touch terminals immediately after the power is turned off, otherwise electrical shocks may be caused.
- When using ferrules, insert a wire to the bottom of the ferrule and crimp the ferrule.
- When connecting a stranded wire or multiple solid wires to a screw terminal block, use a ferrule. Otherwise the wire may slip off the screw terminal block.

Terminals for Terminal Blocks

Crimp ferrules using an appropriate tool according to the size of ferrules. Cut the end of the wire to the same length or about 0.5 mm longer than the ferrule.

Ensure that the core wire does not protrude at the end of the shield and there are no whiskers.



Ferrules

The ferrules and crimping tools below can be used.

Type numbers of the ferrules and crimping tool are the type numbers of Phoenix Contact.

Ferrule Order No.

Quantity of Cables	Cable Size	Phoenix Type	Order No.	Pcs./Pkt.
For 1-wire connection	UL1007 AWG16	AI 1,5-8 BK	32 00 04 3	100
	UL1007 AWG18	AI 1-8 RD	32 00 03 0	100
	UL1015 AWG22	AI 0,5-8 WH	32 00 01 4	100
	UL2464 AWG24	AI 0,25-8 YE	32 03 03 7	100
For 2-wire connection	UL1007 AWG18	AI-TWIN 2 x 0,75-8 GY	32 00 80 7	100
	UL1015 AWG22	AI-TWIN 2 x 0,5-8 WH	32 00 93 3	100

Crimping Tool Order No.

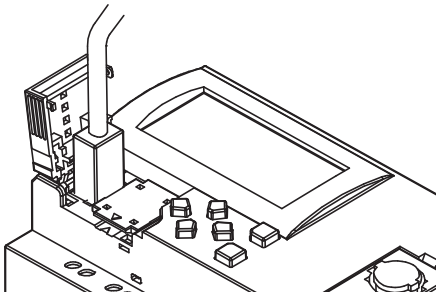
Tool Name	Phoenix Type	Order No.	Pcs./Pkt.
Crimping Tool	CRIMPFOX ZA 3	12 01 88 2	1

Securing USB Extension Cable Using Cable Tie

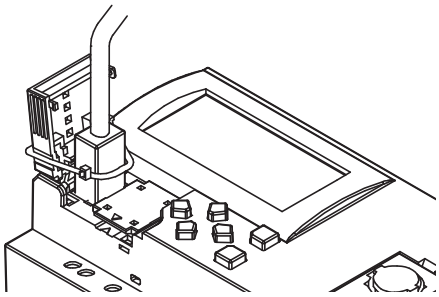
Using a USB extension cable (Note 1) makes it possible to access a SmartAxis installed in a control cabinet from the surface of the cabinet. When using a USB extension cable, it is recommended that the extension cable is secured to the USB port cover using a cable tie (Note 2) so that the USB extension cable does not come loose from the SmartAxis.

This section describes the procedure to secure the USB extension cable to the USB cover.

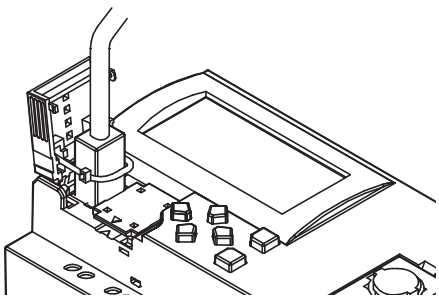
1. Open the USB port cover and insert a USB extension cable into the USB port.



2. Pass a cable tie around the USB port cover and the USB extension cable, taking care to route the cable tie through the notches on the USB cover.



3. The cable tie can also be inserted through the holes on the USB port cover.



4. Tighten the loop until it is the suitable size and trim the excess cable tie using wire cutters.

Note 1: IDEC USB extension cable for USB Mini-B (HG9Z-XCE21) is recommended.

Note 2: HellermanTyton cable tie T18R-1000 is recommended.

4: OPERATION BASICS

Introduction

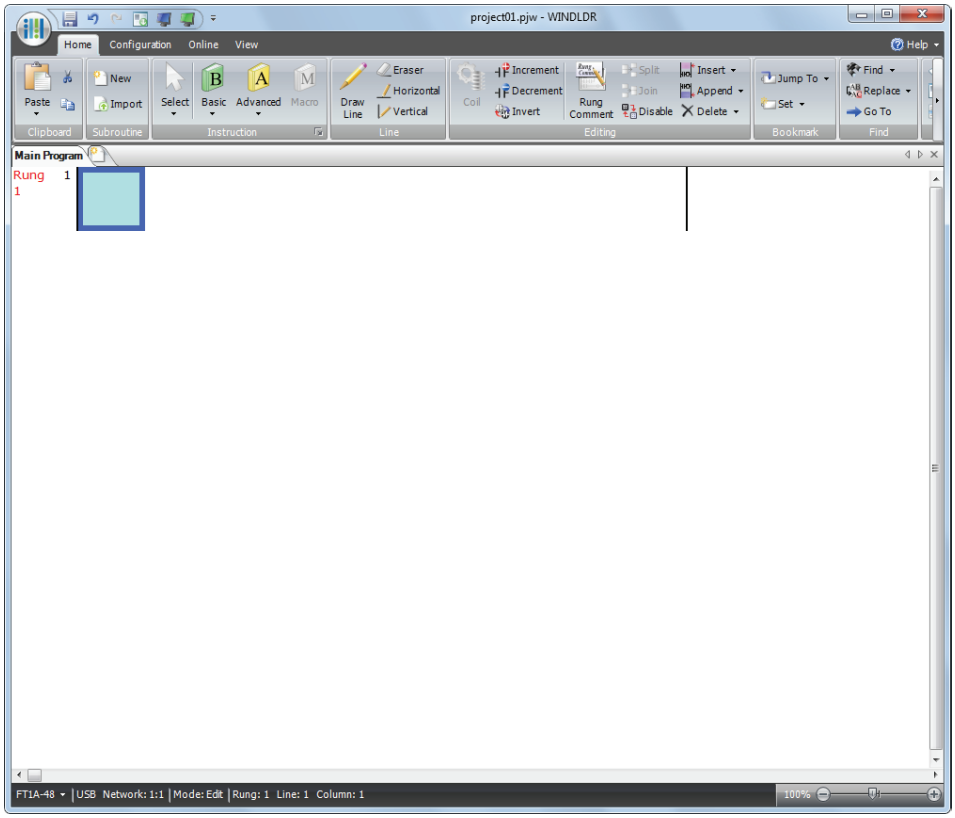
This chapter describes basic procedures for operating WindLDR, software required for programming and maintenance of the SmartAxis Pro/Lite series.

Note: SmartAxis Touch series use WindO/I-NV3 for programming. See the "FT1A Series Touch User's Manual" for instructions for programming and basic operation of WindO/I-NV3 with the Touch series.

Start WindLDR

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

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

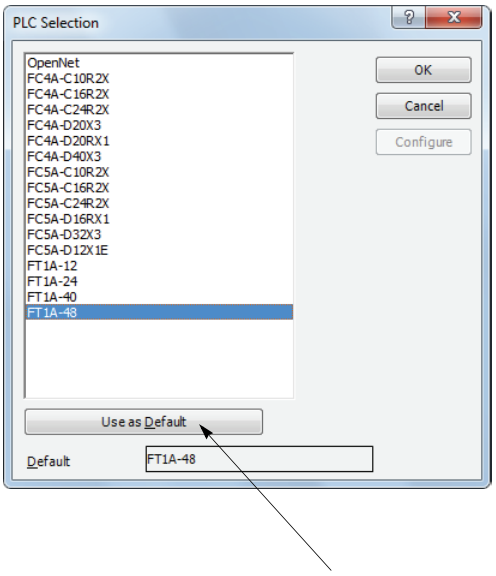


PLC Selection

Before programming a user program on WindLDR, select a PLC type.

1. Select **Configuration** from the WindLDR menu bar, then select **PLC Type**.

The PLC Selection dialog box appears.



Press this button, then the same PLC will be selected as default when WindLDR is started next time.

PLC Selection Option	SmartAxis CPU Module Type No.
FT1A-12	FT1A-H12RA FT1A-B12RA FT1A-H12RC FT1A-B12RC
FT1A-24	FT1A-H24RA FT1A-B24RA FT1A-H24RC FT1A-B24RC
FT1A-40	FT1A-H40RKA FT1A-H40RSA FT1A-B40RKA FT1A-B40RSA FT1A-H40RC FT1A-B40RC
FT1A-48	FT1A-H48KA FT1A-H48SA FT1A-B48KA FT1A-B48SA FT1A-H48KC FT1A-H48SC FT1A-B48KC FT1A-B48SC

2. Select a PLC type in the selection box.
3. Click **OK**.

Create Ladder Program

This section describes the procedure for creating a simple ladder program in WindLDR.

Note: See FT1A Series Ladder Programming Manual for details on basic and advanced instructions.

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.

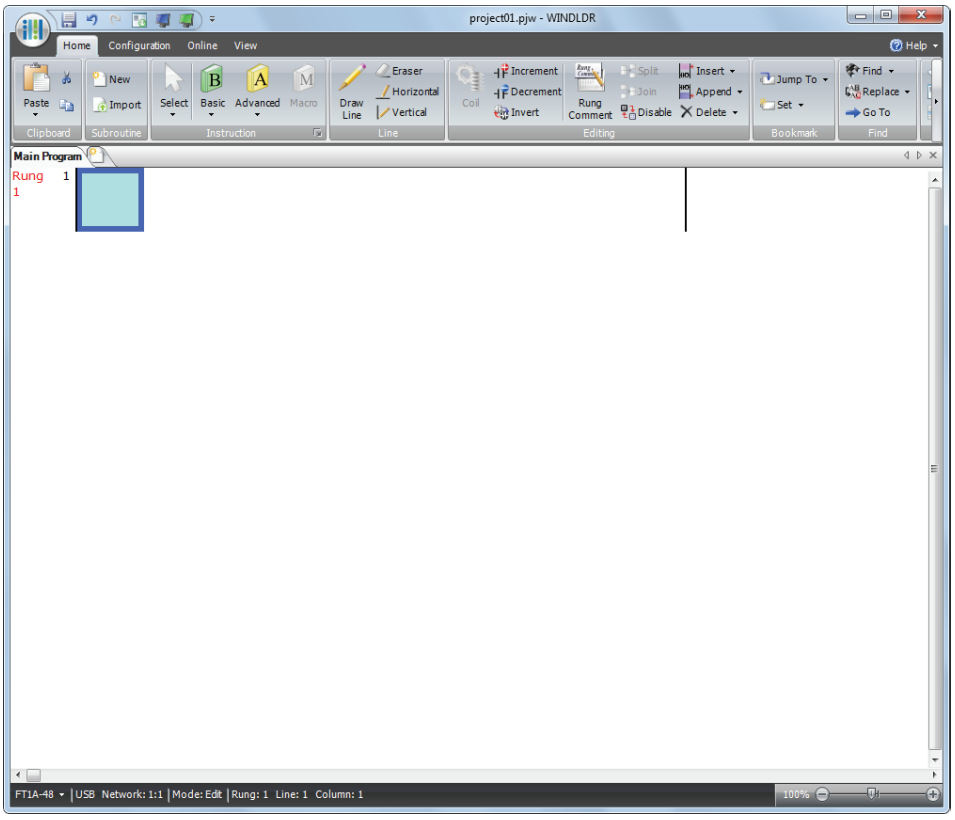
Rung No.	Input I0	Input I1	Output Operation
1	ON	OFF	Output Q0 is turned ON.
2	OFF	ON	Output Q1 is turned ON.
3	ON	ON	Output Q2 flashes in 1-sec increments.

Note: One collection of a group of instructions that control output or advanced instructions is called a rung. WindLDR manages programs in rung units. Function descriptions can be configured as rung comments for individual rungs.

Start WindLDR

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

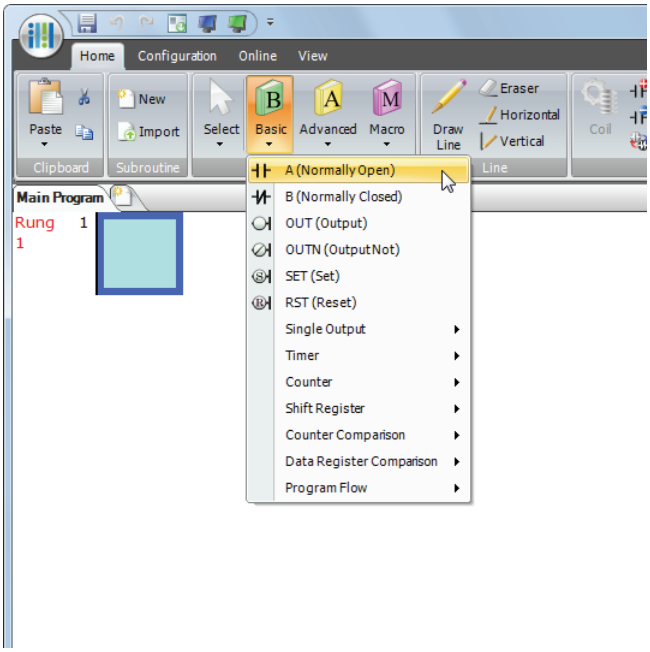
WindLDR starts and a blank ladder editing screen appears with menus and tool bars shown on top of the screen.



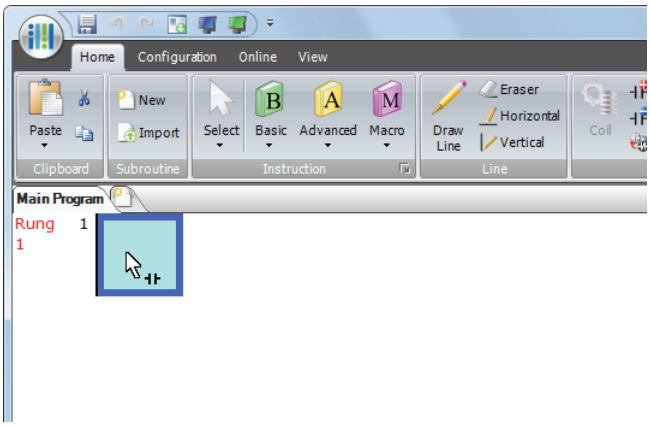
Edit User Program Rung by Rung

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

1. From the WindLDR menu bar, select **Home** > **Basic** > **A (Normally Open)**.



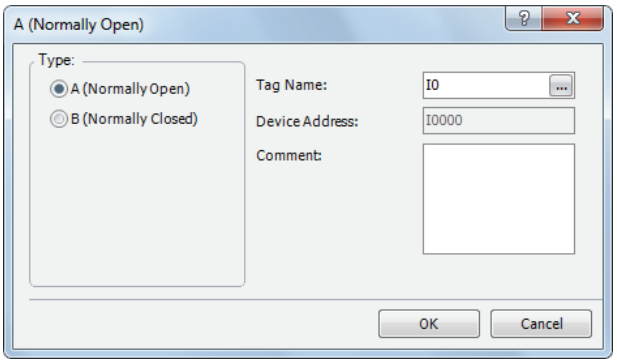
2. Move the mouse pointer to the first column of the first line where you want to insert a NO contact, and click the left mouse button.



Note: Another method to insert a NO (or NC) contact is to move the mouse pointer where you want to insert the contact, and type A (or B).

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. From the WindLDR menu bar, select **Home** > **Basic** > **B (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.

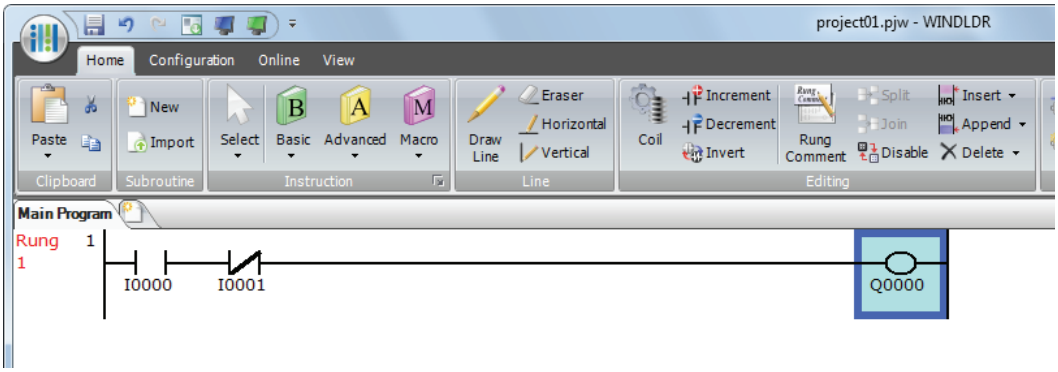
7. From the WindLDR menu bar, select **Home** > **Basic** > **OUT (Output)**.
8. Move the mouse pointer to the third column of the first ladder line where you want to insert an output coil, and click the left mouse button.

   Note: Another method to insert an instruction (either basic or advanced) is to type the instruction symbol, OUT, where you want to insert the instruction.

The Output dialog box appears.

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

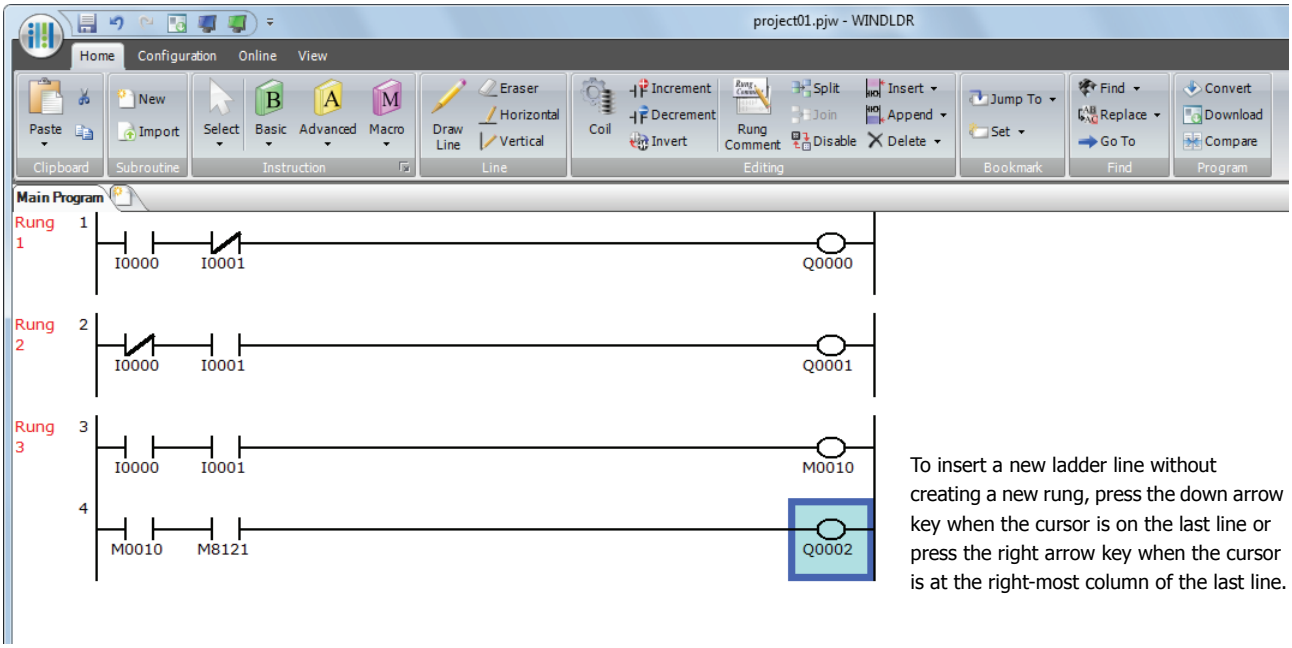
A NO output coil of output Q0 is programmed in the right-most column of the first ladder line. This completes programming for rung 1.



Continue programming for rungs 2 and 3 by repeating 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 **Home** > **Append** > **Append a Rung**.

When completed, the ladder program looks like below.



To insert a new ladder line without creating a new rung, press the down arrow key when the cursor is on the last line or press the right arrow key when the cursor is at the right-most column of the last line.

The ladder program can be checked whether it contains any user program syntax error.

10. From the menu bar, select **Home** > **Convert (above Program)**.

When the instruction symbols are connected correctly, conversion is completed successfully. If any error is found, the errors are listed on the screen. Then, make corrections as necessary.

Now, save the file with a new name.

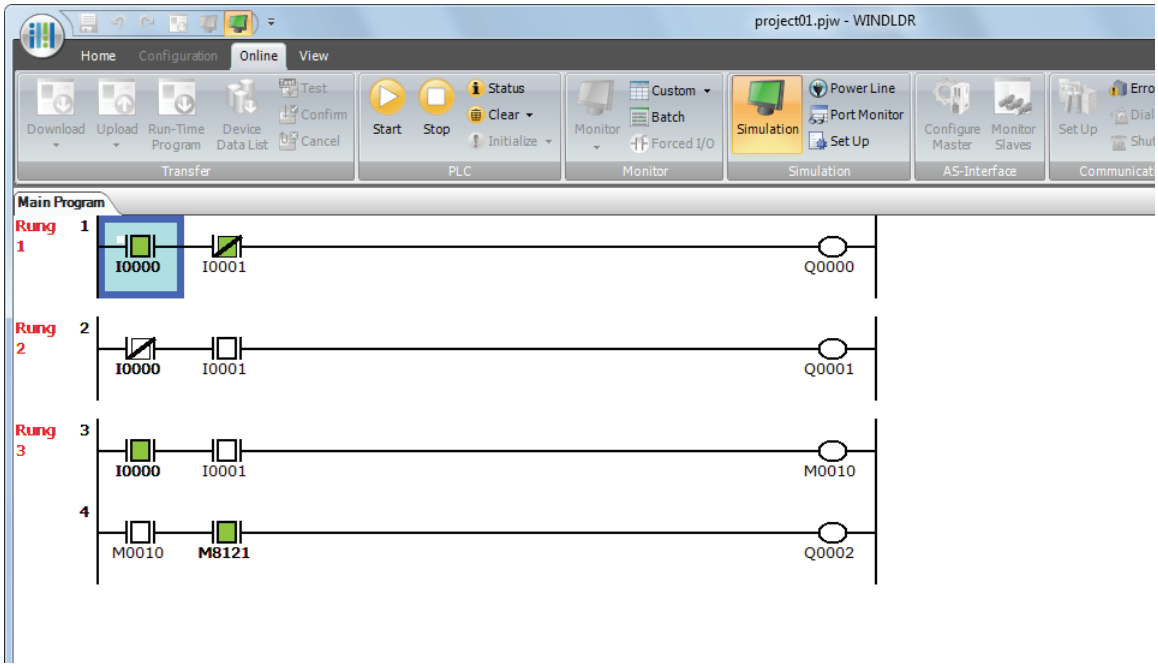
Save Project

1. Select the WindLDR application button at the upper-left corner of the WindLDR screen, followed by **Save**, and type **TEST01** in the File Name field. Change the Folder or Drive as necessary.

Simulate Operation

Before downloading the user program, you can simulate the operation on the WindLDR screen without connecting the SmartAxis.

From the WindLDR menu bar, select **Online** > **Simulation**. The Simulation screen appears.



To change an input status, place the mouse pointer on the input and right-click the mouse. In the pop-up menu, select Set or Reset to set or reset the input.

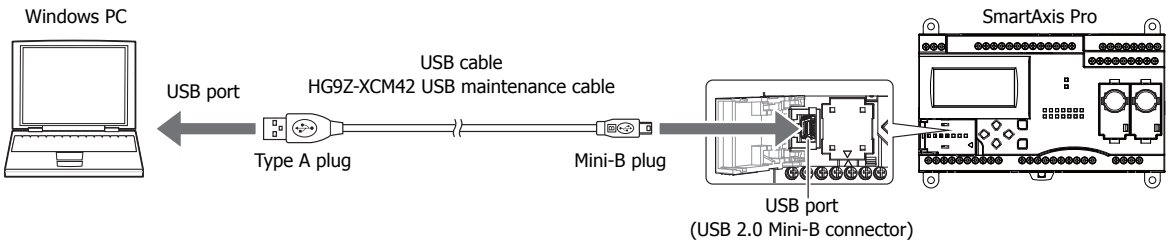
To quit simulation, from the WindLDR menu bar, select **Online** > **Simulation**.

Download Program

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

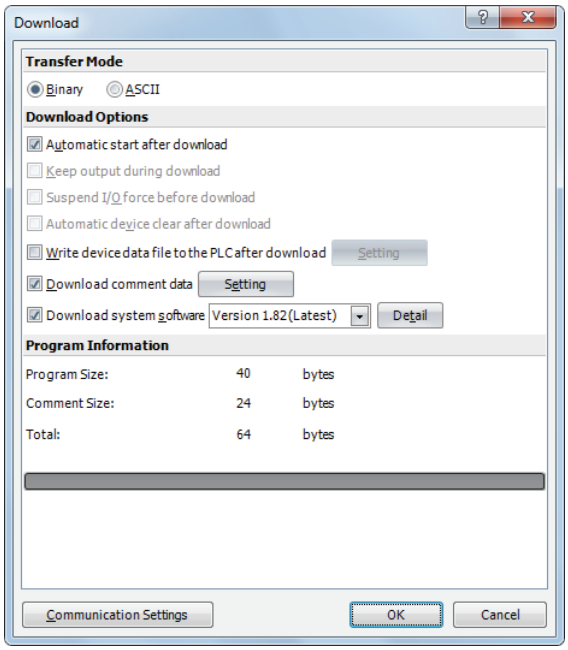
User programs can be downloaded to the SmartAxis from WindLDR using USB or Ethernet. This section describes the procedure from configuring communication settings to downloading a user program to the SmartAxis via USB.

To use USB, the SmartAxis USB port must be connected to a PC using a USB cable.



Note: In order for WindLDR to communicate with the SmartAxis via USB, a dedicated USB driver must be installed on the PC. See "USB Driver Installation Procedure" on page A-5.

1. From the WindLDR menu bar, select **Online** > **Set Up**.
2. The Communication Settings dialog box appears. Click the **USB** tab and then click **OK**.
   The communication method is now set to USB. Next, download a user program.
3. From the WindLDR menu bar, select **Online** > **Download**. The Download dialog box appears, then click **OK**. The user program is downloaded to the SmartAxis.



Note: The Download dialog box can also be opened by selecting **Home** > **Download**.

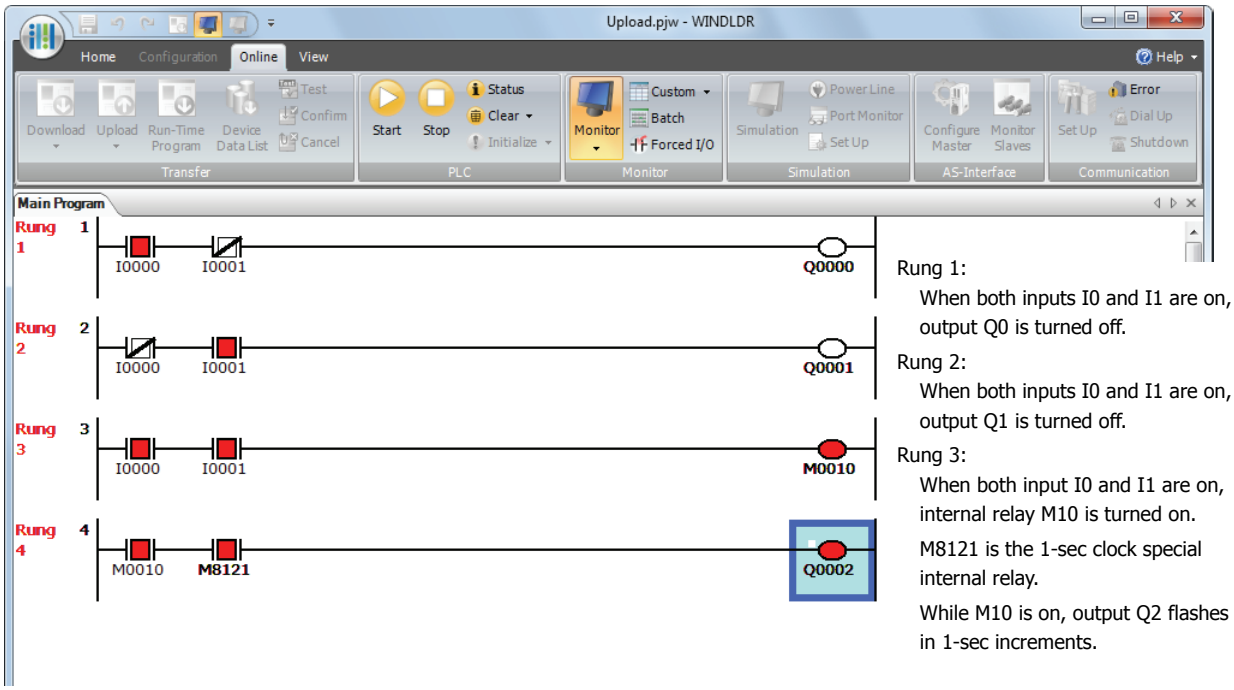
Note: When downloading a user program, all values and selections in the Function Area Settings are also downloaded to the SmartAxis. For details on function settings, see "Chapter 5 Special Functions" on page 5-1.

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** > **Monitor**.

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



Rung 1:

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

Rung 2:

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

Rung 3:

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.

Quit 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 WindLDR application button, click **Exit WindLDR**.

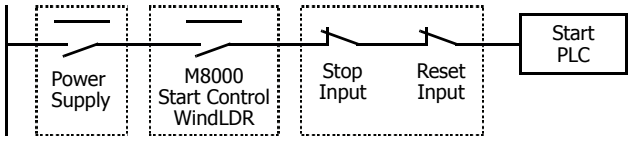
Start/Stop Operation

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

> **Caution**
> - Make sure of safety before starting and stopping the SmartAXIS. Incorrect operation on the SmartAXIS may cause machine damage or accidents.

Start/Stop Schematic

The start/stop circuit of the SmartAXIS 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 SmartAXIS while the other two blocks are set to run the SmartAXIS.



Start/Stop Operation Using WindLDR

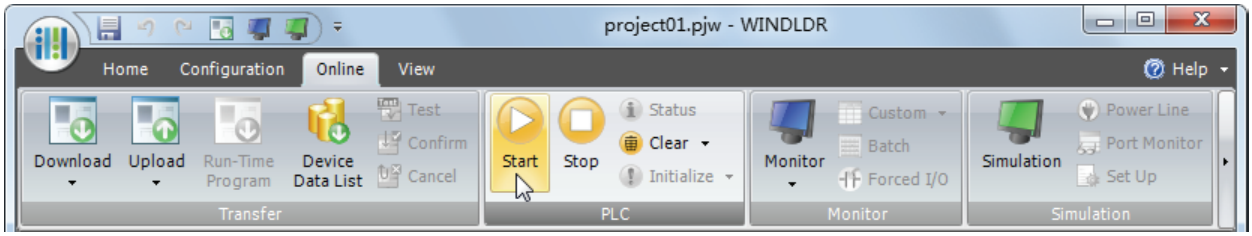
The SmartAXIS can be started and stopped using WindLDR run on a Windows PC connected to the SmartAXIS. When the **Start** button is pressed in the menu bar shown below, start control special internal relay M8000 is turned on to start the SmartAXIS. When the **Stop** button is pressed, M8000 is turned off to stop the SmartAXIS.

1. Connect the PC to the SmartAXIS, start WindLDR, and power up the SmartAXIS. See page 4-1.
2. Check that a stop input is not designated using **Configuration** > **Run/Stop Control** > **Stop and Reset Inputs**. See page 5-2.

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

3. Select **Online** from the WindLDR menu bar.

The Online tab appears.



4. Click the **Start** button to start operation, then the start control special internal relay M8000 is turned on.
5. Click the **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. Select **Online** > **Monitor** > **Monitor** and click the **Start** or **Stop** button.

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 SmartAXIS is powered up. The selection is made in **Configuration** > **Run/Stop Control** > **Run/Stop Selection at Memory Backup Error**. See page 5-3.

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 SmartAXIS can be started and stopped by turning power on and off.

1. Power up the SmartAXIS to start operation. See page 4-1.
2. If the MicroSmart does not start, check that start control special internal relay M8000 is on using WindLDR. If M8000 is off, turn it on. See page 4-9.
3. Turn power on and off to start and stop operation.

Note: If M8000 is off, the SmartAXIS 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 SmartAXIS at powerup depends on such factors as the contents of the user program and system setup. The table below shows an approximate time delay before starting operation after powerup.

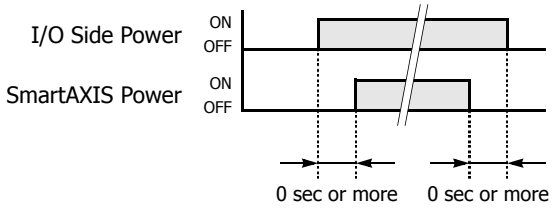
Response time:

User Program Size	After powerup, the SmartAXIS starts operation in	
	No memory cartridge is installed	Memory cartridge is installed
12,000 bytes (3,000 steps)	Approx. ?? seconds	Approx. ?? seconds
47,400 bytes (11,850 steps)	Approx. ?? seconds	Approx. ?? seconds

Order of Powerup and Powerdown

To turn the power on, turn on the SmartAXIS and I/O sides at the same time, or turn on the I/O side first, followed by the SmartAXIS side.

To turn the power off, turn off the SmartAXIS and I/O sides at the same time, or turn off the SmartAXIS side first, followed by the I/O side.



Start/Stop Operation Using Stop Input and Reset Input

Any input terminal available on the SmartAXIS can be designated as a stop or reset input using the Function Area Settings. The procedure for selecting stop and reset inputs is described on page 5-2.

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, the SmartAXIS 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 SmartAXIS stops operation, and all outputs are turned off.

The reset input has priority over the stop input.

System Statuses at Stop, Reset, and Restart

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

Mode	Output	Internal Relay, Shift Register, Counter, Data Register		Special Internal Relay	Special Data Register	Non-Maintained Data Register	Timer Current Value
		Keep Type	Clear Type				
Run	Operating	Operating	Operating	Operating	Operating	Operating	Operating
Stop	OFF	Unchanged	Unchanged	See Chapter 6	Unchanged	Unchanged	Unchanged
Restart	Unchanged	Unchanged	OFF/ Reset to zero	Unchanged	Unchanged	Unchanged	Reset to preset
Reset (Reset input ON)	OFF	OFF/ Reset to zero	OFF/ Reset to zero	Unchanged	Unchanged	OFF/ Reset to zero	Reset to zero
Power OFF	OFF	Unchanged	Unchanged	See Chapter 6	Unchanged	OFF/ Reset to zero	Reset to zero

5: SPECIAL FUNCTIONS

Introduction

The SmartAxis supports many features in addition to instructions.

For functions that require advanced setup including the functions to upload, download, and protect user programs and the network settings, first configure those settings on the Function Area Settings dialog, and then download the user program to the SmartAxis. Constant scan time and forced I/O can be used without advanced setup.

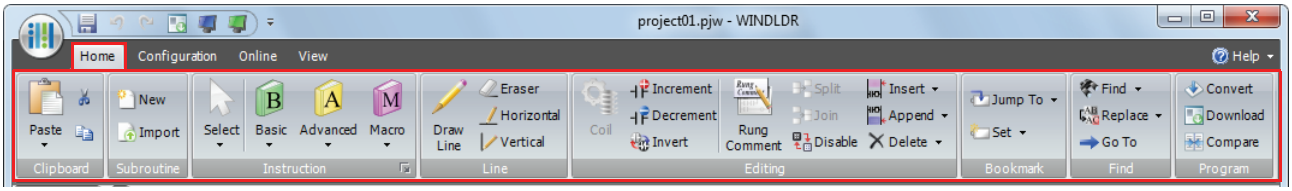
This chapter describes the SmartAxis special functions, how to configure them, and examples of their use.

Function List

Function name	Overview	Reference	Setup location
Stop input	A function that stops the user program with an external input	5-4	Function area settings
Reset input	A function that clears SmartAxis device values with an external input	5-6	
Run/stop selection at memory backup error	A function that selects the user program operating state (run/stop) when the user program is started with a dead SmartAxis backup battery	5-8	
Run/stop selection at power up	A function that runs and stops the user program when the SmartAxis power is turned on	5-9	
Keep and clear devices	A function that keeps or clears the state of devices such as the value of counters when the SmartAxis starts operation	5-10	
High-speed counter	A function that counts high-speed pulses with the SmartAxis hardware that can not be read by the execution of a normal user program	5-12	
Catch input	A function that reads short pulses such as sensor signals that change in a time less than one scan	5-31	
Interrupt input	A function that aborts execution of the user program by an external input and executes an interrupt program	5-42	
Frequency measurement	A function that measures the frequency of pulses input to an external input	5-40	
Input filter	A function that prevents malfunctions due to noise and chatter that enter through external inputs	5-33	
Analog input	A function that reads analog signals such as pressure sensors by converting them to digital values	5-35	
Timer interrupt	A function that aborts execution of the user program at a fixed time interval and executes an interrupt program	5-40	
Forced I/O function	A function that forcibly turns the inputs and outputs on or off	5-67	Monitor
Communication ports	Settings for the methods of communication and ports for connected devices	5-42	Function area settings
Memory cartridge	A function that downloads the user program from and uploads the user program to the SmartAxis using the memory cartridge	5-49	
SD memory card	A function that saves log data to, maintains, formats an SD memory card	5-52	Instructions
32-bit data storage setting	The setting for the order to store upper and lower word devices that compose 32-bit data	5-60	Function area settings
User program protection	A function that applies protection to user program uploads and downloads	5-57	
Watchdog timer settings	A function that changes the time configured for the SmartAxis watchdog timer	5-59	
Constant scan time	A function that makes the processing time for one scan constant	5-66	Special data registers
Daylight savings time	A function that automatically adjusts the SmartAxis time according to the daylight savings time settings	5-48	Function area settings
Clock function	A function that controls the time schedule for lighting and air conditioning equipment using the internal clock on the SmartAxis	5-45	Instructions
Network settings	Network settings for connecting the SmartAxis to an Ethernet network	5-67	Function area settings
Connection settings	The settings for the communication modes used by SmartAxis Ethernet communication	5-68	
Remote host list	A function that registers and manages destinations (remote hosts) on the network	5-70	Remote host list

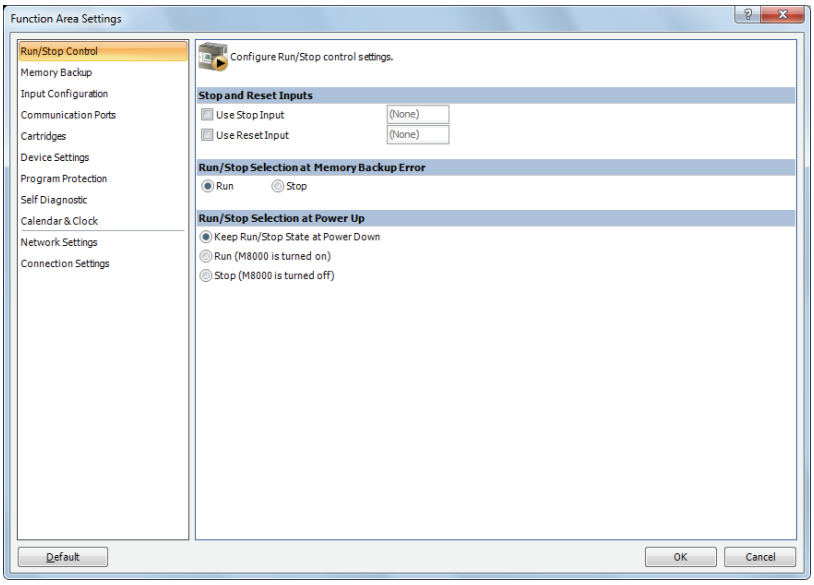
Function Area Settings

The function area settings are the environment settings for the SmartAxis. The operation of the SmartAxis when powered and communication port settings are configured in **Function Area Settings** using the WindLDR PLC programming software (Windows compatible).



From the WindLDR menu bar, select **Configuration** > **Run/Stop Control.**

The Function Area Settings dialog box is displayed.



Function Description

Run/Stop Control	These functions run and stop the SmartAxis when the SmartAxis is powered, when an error occurs, or when an external input turns on. • Stop input • Reset input • Run/stop selection at memory backup error • Run/stop selection at power up
Memory Backup	These functions keep or clear devices (the contents of memory) when a user program starts operation. The following devices can be configured to be kept or cleared. • Internal relays • Shift registers • Counters • Data registers

Input	These options configure the special functions such as the external input filter settings and the high-speed counter. • High-speed counter • Catch input • Interrupt input • Frequency measurement • Input filter • Analog input • Timer interrupt
Communication Ports	These settings configure the ports for the SmartAxis to communicate with external devices equipped with RS232C ports and RS485 ports. • Maintenance communication • User communication • Modbus RTU master/slave
Memory Cartridge	This function downloads user programs on the memory cartridge to the SmartAxis Lite module's ROM.
Device Settings	This setting configures the order to store the upper and lower words for word devices that compose 32-bit data.
Program Protection	This function applies protection to the user program by configuring a password so third-parties cannot inadvertently upload or download it.
Calendar & Clock	The SmartAxis is equipped with an internal clock and its calendar data (year, month, day, day of the week) and clock data (hour, minute, second) can be used in user programs. Daylight savings time can also be configured for the internal clock.
Self Diagnostic	These settings configure the watchdog timer that monitors the operating status of the SmartAxis.
Network Settings	These settings configure connecting the SmartAxis to a network using the Ethernet port.
Connection Settings	These settings configure server/client communication used by the SmartAxis Ethernet port. • Maintenance communication server • User communication server/client • Modbus TCP communication server/client • Remote I/O master

Stop Input and Reset Input

As described on page 4-5, the SmartAxis 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 SmartAxis stops operation. For the system statuses in the stop and reset modes, see page 4-6.

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

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Run/Stop Control**.

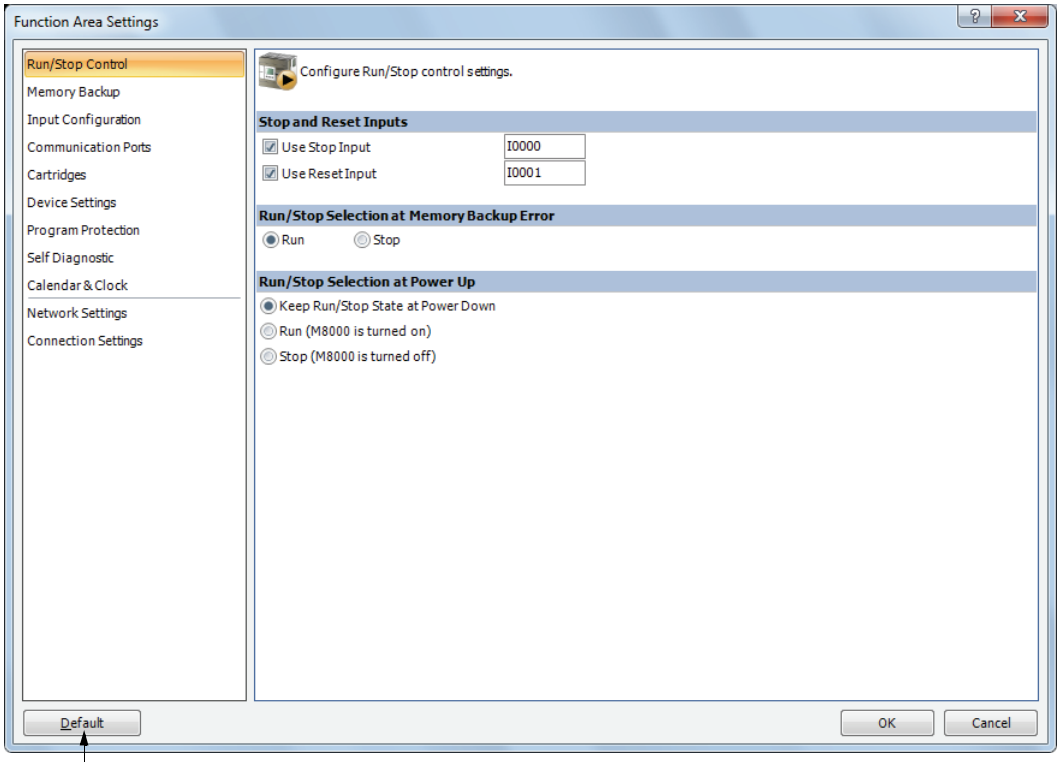
The Function Area Settings dialog box for Run/Stop Control appears.

2. Click the check box under the Stop and Reset Inputs.

Stop Input: Click the check box on the left of Use Stop Input and type a desired input number available on the SmartAXIS in the Stop Input field.

Reset Input: Click the check box on the left of Use Reset Input and type a desired reset number available on the SmartAXIS in the Reset Input field.

This example designates input I0 as a stop input and input I1 as a reset input.



Resets all Function Area Settings values to defaults.

Default: No stop and reset inputs are designated.

3. Click the **OK** button.

Run/Stop Selection at Memory Backup Error

Start control special internal relay M8000 maintains its status when the SmartAXIS is powered down. After the SmartAXIS 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 SmartAXIS when attempting to restart operation after the "keep" data in the SmartAXIS RAM has been lost.

When memory backup error occurs, Run/Stop Selection at Memory Backup Error is preferred than Run/Stop Selection at Power Up.

When a built-in lithium battery is fully charged, data of internal relays, shift registers, counters, and data registers stored in the RAM are maintained for approximately 30 days.

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

Programming WindLDR

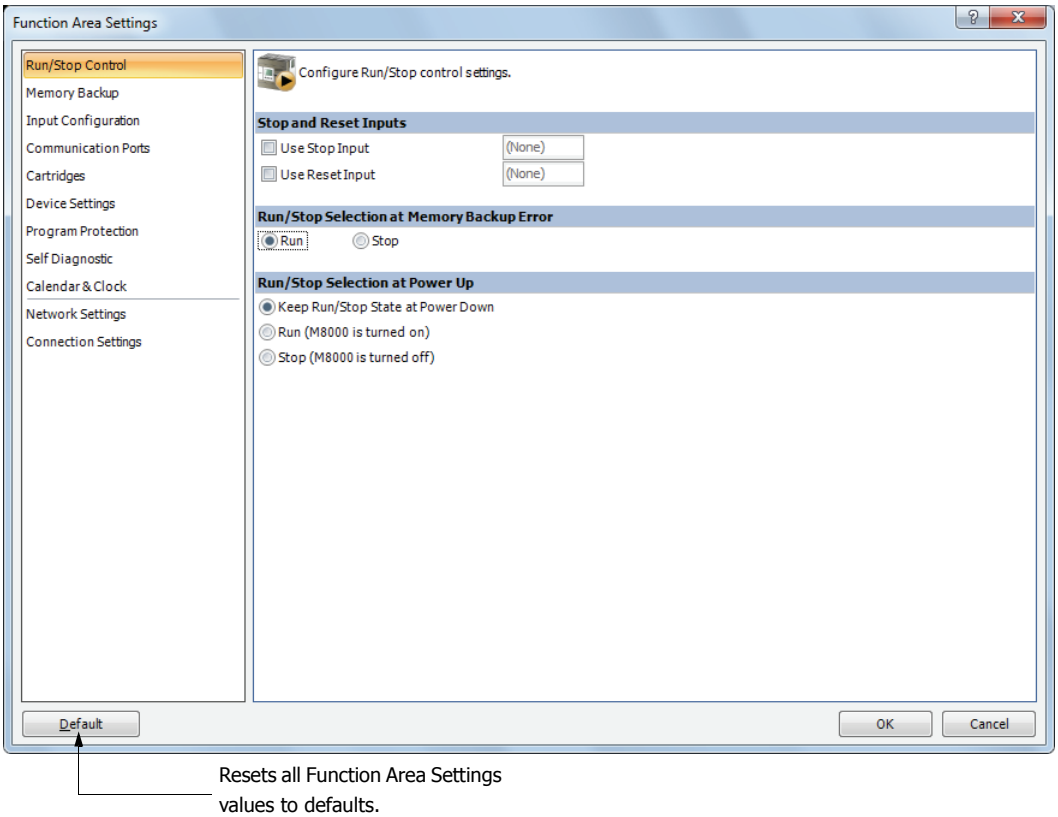
1. From the WindLDR menu bar, select **Configuration** > **Run/Stop Control**.

The Function Area Settings dialog box for Run/Stop Control appears.

2. Click the **Run** or **Stop button**.

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

Stop: Click the button on the right to stop the SmartAXIS when attempting to start at memory backup error. When the SmartAXIS does not start because of the Stop selection, the SmartAXIS cannot be started alone, then the SmartAXIS can still be started by sending a start command from WindLDR to turn on start control special internal relay M8000. For start/stop operation, see page 4-5.



3. Click the **OK** button.

Run/Stop Selection at Power Up

Start control special internal relay M8000 maintains its status when the SmartAXIS is powered down. When powered up, the SmartAXIS is started or stopped according to the M8000 status. The Run/Stop Selection at Power Up is used to select whether to start or stop the SmartAXIS regardless of the M8000 status when the SmartAXIS is powered up.

When a memory cartridge is installed on a SmartAXIS, the SmartAXIS is started or stopped according to the M8000 status of the SmartAXIS. The SmartAXIS can always be started regardless of the M8000 status by using Run/Stop Selection at Power Up. WindLDR software is not needed to start the SmartAXIS.

Stop and Reset inputs have priority over start control special internal relay M8000. When the memory backup error occurs, the SmartAXIS is started or stopped according to Run/Stop Selection at Memory Backup Error regardless of Run/Stop Selection at Power Up. For start/stop operation, see page 4-5.

Since this settings relate to the user program, the user program must be downloaded to the SmartAxis after changing this settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Run/Stop Control**.

The Function Area Settings dialog box for Run/Stop Control appears.

2. Click the button under Run/Stop Selection at Power Up.

Keep Run/Stop State at Power Down (Default)

Click this button to keep the run/stop status at power down when the SmartAXIS is powered up.

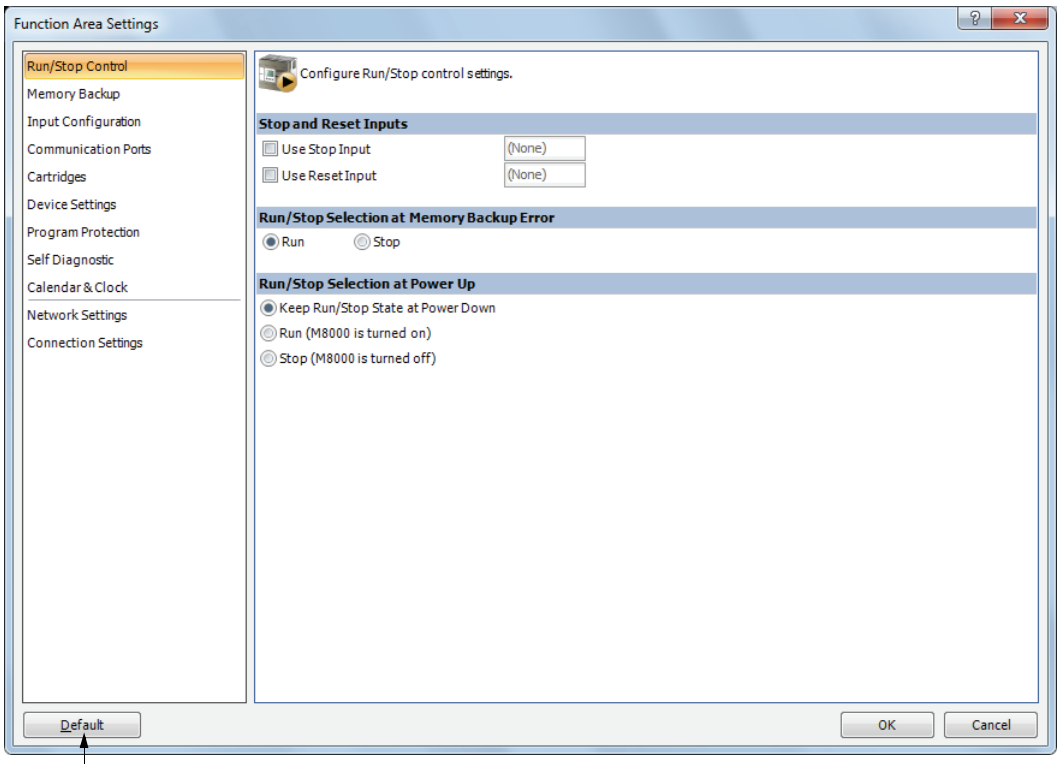
Run (M8000 is turned on):

Click this button to always start the SmartAXIS when the SmartAXIS is powered up.

Stop (M8000 is turned off):

Click this button to always stop the SmartAXIS when the SmartAXIS is powered up.

This example designates Keep Run/Stop Status at Power Down.



Resets all Function Area Settings values to defaults.

3. Click the **OK** button.

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

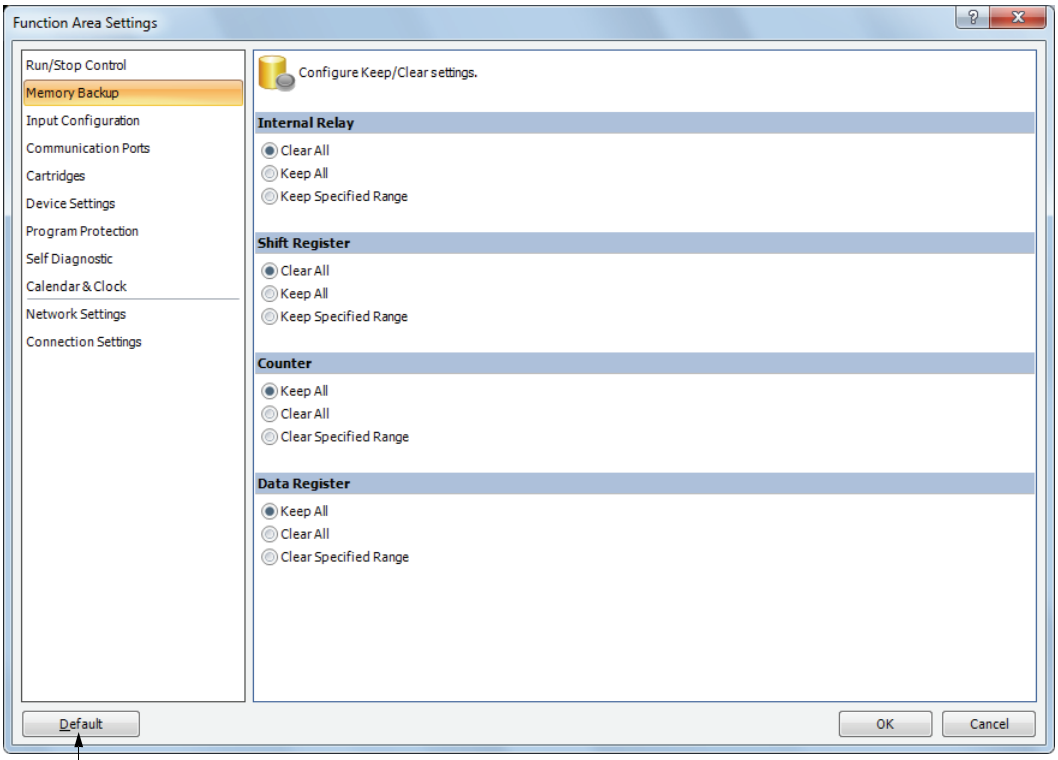
Since these settings relate to the user program, the user program must be downloaded to the SmartAxis after changing any of these settings.

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Memory Backup**.

The Function Area Settings dialog box for Configure Keep/Clear Settings appears.

2. Click the buttons under Internal Relay, Shift Register, Counter, and Data Register to clear all, keep all, or keep/clear specified range as required.



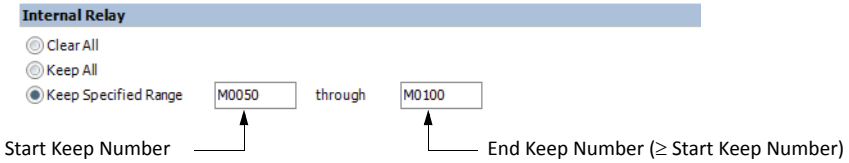
Internal Relay 'Keep' Designation

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

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

Keep Specified Range: A specified range 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 M1277. Special internal relays cannot be designated.



When a range of M50 through M100 is designated as shown in the example above, M50 through M100 are keep types, M0 through M47 and M101 through M1277 are clear types.

Shift Register 'Keep' Designation

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

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

Keep Specified Range: A specified range 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 R127.

When a range of R17 through R32 is designated, R17 through R32 are keep types, R0 through R16 and R33 through R127 are clear types.

Counter 'Clear' Designation

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

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

Clear Specified Range: A specified range 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 C199.

When a range of C0 through C10 is designated, C0 through C10 are clear types, and C11 through C199 are keep types.

Data Register 'Clear' Designation

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

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

Clear Specified Range: A specified range 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 D1999. Special data registers cannot be designated.

When a range of D100 through D1999 is designated, D0 through D99 are keep types, and D100 through D1999 are clear types.

High-Speed Counter

This section describes the high-speed counter for counting high-speed pulses from devices such as rotary encoders and proximity switches. The high-speed counter is a function that counts high-speed pulses with the SmartAxis hardware that cannot be read in the execution of a normal user program. The high-speed counter has a comparator function to compare the current value and a preset value (target value). When the current value and the preset value match, an external output is turned on or an interrupt program is executed.

The high-speed counter has a single-phase high-speed counter and a two-phase high-speed counter.

To use the high-speed counter, the WindLDR function area settings, data registers, special internal relays, and special data registers must be configured.

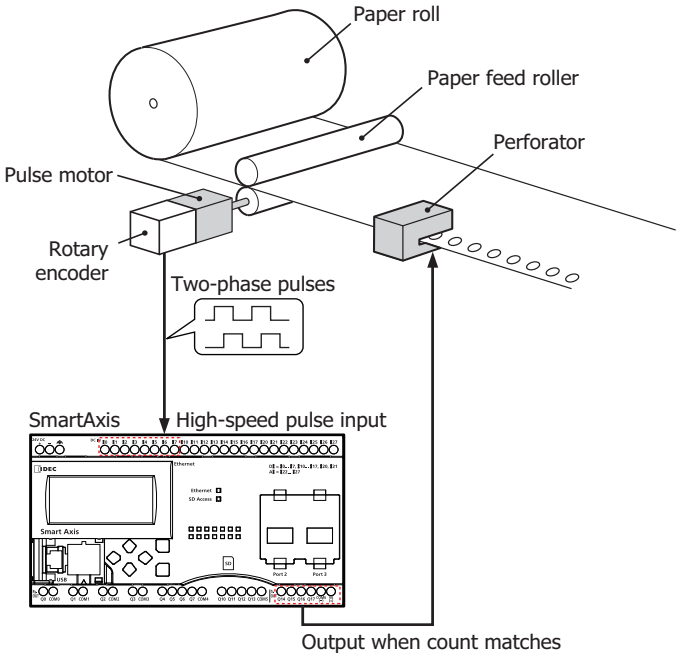
Notes:

- The AC power type does not support the high-speed counter.
- In situations where the high-speed counter function is required, use the DC power type.

- **Application example**

  This application example punches holes into a roll of paper at a regular interval. The two pulses (A-phase, B-phase) that carry the phase difference output from the rotary encoder are counted by the SmartAxis two-phase high-speed counter.

  When the current value reaches the preset value, the specified external output turns on and the perforator punches a hole in the roll of paper.



High-speed counter operation modes

The high-speed counter as the following two operation modes.

- Single-phase high-speed counter
- Two-phase high-speed counter

High-speed counting modes

The high-speed counter as the following four counting modes.

- Adding counter (single-phase high-speed counter)
- Up/down selection reversible counter (single-phase high-speed counter)
- 2-edge count (two-phase high-speed counter)
- 4-edge count (two-phase high-speed counter)

Example: The input allocation when external input group 1 is specified as a two-phase high-speed counter

External input	I0	I1	I2
	↓	↓	↓
High-speed counter	A-phase	B-phase	External clear input (Z-phase)

High-speed Counter External Inputs

The SmartAxis can use a maximum of six single-phase high-speed counters and a maximum of two two-phase high-speed counters. The 12-I/O type can only use a maximum of four single-phase high-speed counters and a maximum of two dual-phase high-speed counters.

Single-phase high-speed counter

The 24-, 40-, and 48-I/O types can use external inputs I6 and I7 as single-phase high-speed counters.

The 12-I/O type cannot use external inputs I6 and I7 as single-phase high-speed counters. External inputs I6 and I7 are normal inputs.

Group	1		2	3		4	5	6
External input	I0	I1	I2	I3	I4	I5	I6	I7
Single-phase high-speed counter	Pulse input	Up/down selection input (Note)	Pulse input/ external clear input	Pulse input	Up/down selection input (Note)	Pulse input/ external clear input	Pulse input	Pulse input

Note: Can only be used when the counting mode is specified as the up/down selection reversible counter.

Two-phase high-speed counter

External inputs I0/I1 (group 1) and I3/I4 (group 3) can be used as two-phase high-speed counters. External inputs I2 and I5 can be used as external clear inputs for group 1 and group 3. In this situation, external inputs I2 and I5 cannot be used as single-phase high-speed counters.

Group	1		2	3		4	5	6
External input	I0	I1	I2	I3	I4	I5	I6	I7
Two-phase high-speed counter	Pulse input (A-phase)	Pulse input (B-phase)	External clear input (Note) (Z-phase)	Pulse input (A-phase)	Pulse input (B-phase)	External clear input (Note) (Z-phase)	—	—

Note: If not used as the external clear input (Z-phase), group 2 and group 4 can be used as single-phase high-speed counters.

High-Speed Counter Operation

The high-speed counter turns on an external output or executes an interrupt program when the current value matches the preset value (target value).

The high-speed counter has two operation modes, the adding counter and the up/down selection reversible counter.

For how to configure the function to turn on an external output, see "Comparison Actions" on page 5-13.

- **Single-phase high-speed counter**

Group 1, group 3 single-phase high-speed counter

- These groups support the adding counter and the up/down selection reversible counter that can count both up and down.
- These groups support 100 kHz maximum pulse input and are capable of counting in a range from 0 to 4,294,967,295 (32 bits).
- When the current value and the preset value match or an overflow or underflow occurs, a comparison output turns on or an interrupt program is executed.
- These groups support resetting the current value by the reset special internal relay or external clear input. When the reset is executed, the current value returns to the reset value specified by the special data registers. For the reset input details, see "Reset input" on page 5-20.

Counting mode	Frequency
Adding counter	Group 1, 3: 100 kHz
Up/down selection reversible counter	Group 1: 100 kHz
	Group 3: 50 kHz

Group 2, group 4, group 5, group 6 single-phase high-speed counter

- These groups only support the adding counter.
- These groups support 100 kHz maximum pulse input and are capable of counting in a range from 0 to 4,294,967,295 (32 bits).
- When the current value and the preset value match or an overflow or underflow occurs, an external output turns on or an interrupt program is executed.
- These groups only support the reset input via a special internal relay. When the reset is executed, the current value returns to the reset value specified by the special data registers.

Counting mode	Frequency
Adding counter	Group 2, 4, 5, 6: 100 kHz

- **Two-phase high-speed counter**

Group 1, group 3 two-phase high-speed counter

- The two-phase high-speed counter counts by the phase difference between the A-phase and B-phase pulse input.
- These groups support 50 kHz maximum pulse input and are capable of counting in a range from 0 to 4,294,967,295 (32 bits).
- Even higher speed counting is possible by specifying 2-edge count or 4-edge count.
- When the current value and the preset value match or an overflow or underflow occurs, an external output turns on or an interrupt program is executed.
- These groups support resetting the current value by the reset special internal relay or external clear input (Z-phase). When the reset is executed, the current value returns to the reset value specified by the special data registers.

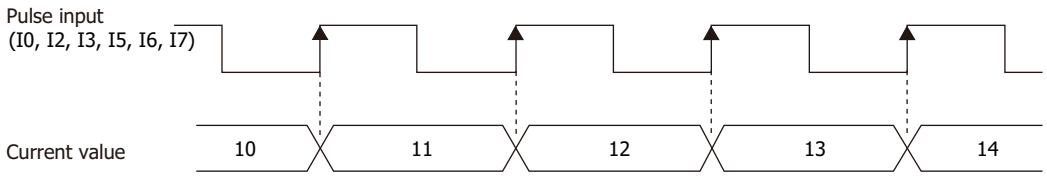
Group	Frequency
Group 1	2-edge count: 50 kHz
	4-edge count: 25 kHz
Group 3	2-edge count: 25 kHz
	4-edge count: 12.5 kHz

Counting mode

The high-speed counter as the following four counting modes.

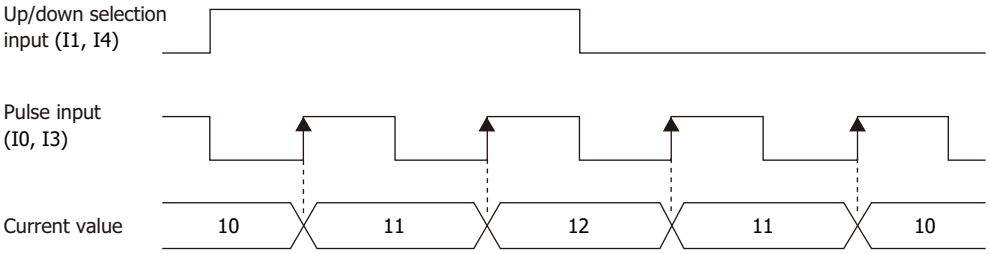
- **Adding counter (single-phase high-speed counter)**

The adding counter counts up with the rise in pulse input.



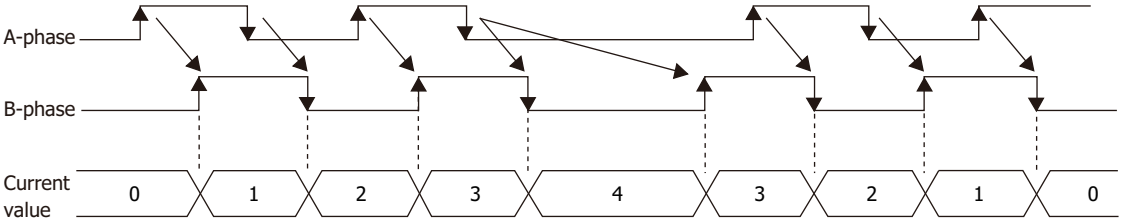
- **Up/down selection reversible counter (single-phase high-speed counter)**

Up/down selection reversible counter can switch between addition and subtraction by pulse input with the up/down selection input. When the up/down selection input is on, the counter counts up with the rise in pulse input. When the up/down selection input is off, the counter counts down with the rise in pulse input.



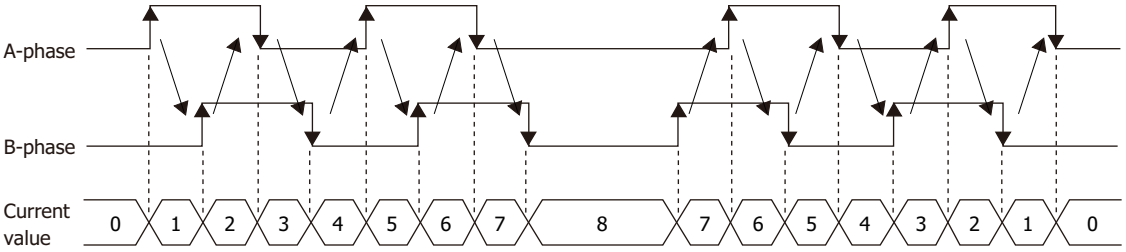
- **2-edge count (two-phase high-speed counter)**

This counter counts by the phase difference between the A-phase and B-phase pulse input. When the A-phase precedes the B-phase, the counter counts up with the rise and fall of the B-phase. When the B-phase precedes the A-phase, the counter counts down with the rise and fall of the B-phase.



- **4-edge count (two-phase high-speed counter)**

This counter counts by the phase difference between the A-phase and B-phase pulse input. When the A-phase precedes the B-phase, the counter counts up with the rise and fall of the A-phase and the B-phase. When the B-phase precedes the A-phase, the counter counts down with the rise and fall of the A-phase and the B-phase.



Comparison Actions

The operating condition when comparing values is configured in the WindLDR **High-speed Counter Settings**, under **Comparison Action**.

The action when comparing values is **Comparison Output** or **Interrupt Program**, so specify an external output number or label number when comparing.

Operation

When the preset value and the current value are compared and the values match, the specified output is turned on or the interrupt program is executed.

A maximum of six high-speed counter preset values can be configured. For one preset value, the current value is compared with the same preset value each time.

When multiple preset values are configured, the preset value is changed each time the current value and preset value match.

For example, if four preset values are configured, when preset value 1 matches the current value, the comparison subject changes to preset value 2 → 3 → 4 in order.

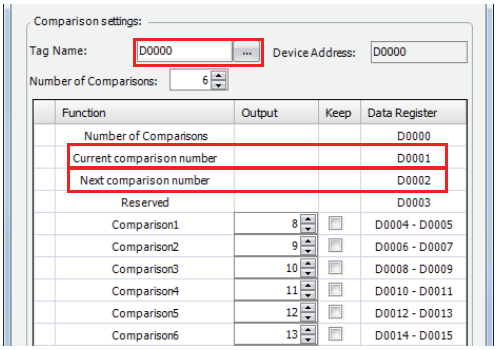
When the final preset value 4 matches the current value, the preset value returns to preset value 1 and the values are compared.

- **Preset value storage locations**

The preset values during high-speed counter operation are stored as 2 words in special data registers.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Preset Value (Upper word)	D8052	D8058	D8064	D8070	D8136	D8142	R
Preset Value (Lower word)	D8053	D8059	D8065	D8071	D8137	D8143	

Specify the data registers to store the preset values in WindLDR and store those preset values in the user program. Specify the start address of the data registers to allocate the data registers to the individual settings in the comparison settings. When the high-speed counter is executed, the preset value with the number stored in **Current Preset Value Number** is active. The active preset value number for each comparison is stored in **Current Preset Value Number** and the next active preset value number is automatically stored in **Next Preset Value Number**. By changing the value of **Next Preset Value Number** in the user program, the next active preset value number can be changed. The active preset value is stored for each group in the special data registers shown in the table above.

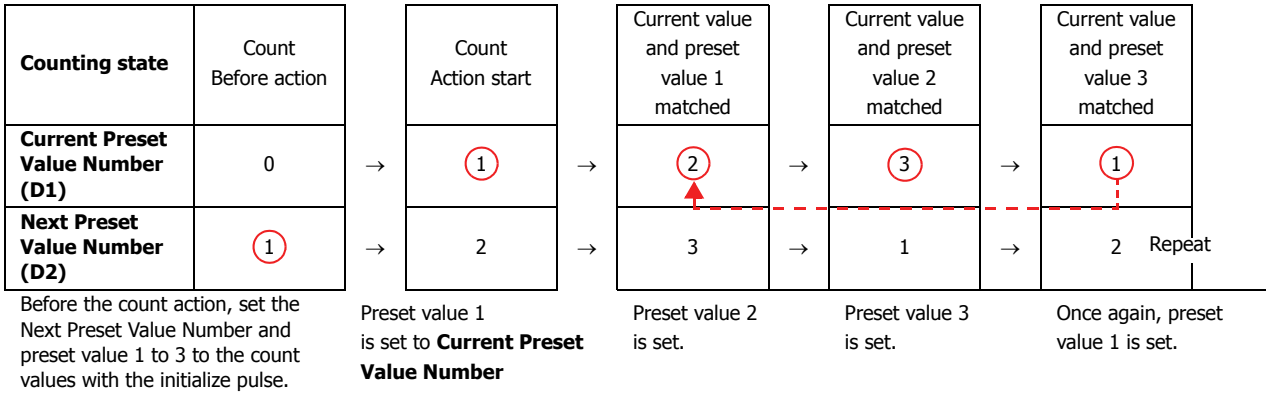


Example: Group 1, number of preset values is 3, set to device address D0

When the current value matches preset value 1, **Current Preset Value Number** becomes 2 and 3 is stored in **Next Preset Value Number**.

When the device address is configured as D0, **Current Preset Value Number** is stored in D1 and **Next Preset Value Number** is stored in D2.

For the group 1 preset value, the value of the data registers (D4, D5) allocated to preset value number 1 is stored in D8052 and D8053 as shown in the table above and it is compared to the current value.



Note: When the **Next Preset Value Number** preset value becomes active, the high-speed counter preset value during execution does not change, even when the preset value for that preset value number is changed. When the current value and the current preset value match, the preset value with the number stored in **Next Preset Value Number** becomes active. Changes to the **Next Preset Value Number** data register must be performed before the preset value becomes active.

Comparison operation flow

The comparison operation flow is as follows.

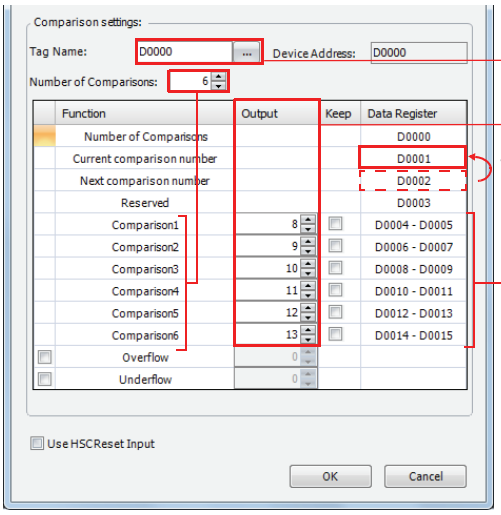
1. Start (run) the SmartAxis.

For the first scan, **Next Preset Value Number** is set to the number for preset value 1 with the initialize pulse.

For the second scan, an I/O refresh is performed in END processing and the value of **Next Preset Value Number** is transferred to **Current Preset Value Number**.

The content of **Next Preset Value Number** becomes the preset value n + 1 ("2" in this example).

When the number of preset values is 1, **Next Preset Value Number** is always "1".



The data register that stores the preset value (target value). Specify the starting address.

The outputs (external outputs) when the values match.

Transfer

The preset value with the number that became active is the comparison subject with the current value and is stored in the special data registers.

Example: For group 1

Storage destination for the preset value that became active.

Stored by group.

Group	Group 1 (I0 to I1)	Read/Write
Preset Value (Upper word)	D8052	R/W
Preset Value (Lower word)	D8053	

2. Start the high-speed counter count operation.

Turn on the gate input to start the count operation.

3. Compare the **Current Preset Value Number** preset value and the current value. When the current value and the preset value match, the next number for the preset value becomes active and the high-speed counter continues counting.

Execute **Comparison Output** or **Interrupt Program**. (**Comparison Output** in this example)

- Turn on the comparison (special internal relay) for only one scan.
- Overwrite **Current Preset Value Number** with **Next Preset Value Number** and start the count with the preset value for **Current Preset Value Number**.
- Add 1 to **Next Preset Value Number**.

4. When the procedure is executed up to preset value 6, repeat again from the beginning with preset value 1.

Note: The **Current Preset Value Number** data register cannot be written to. It is read-only. **Next Preset Value Number** and **Preset Value 1** to **Preset Value 6** can be read and written to.

Programming WindLDR

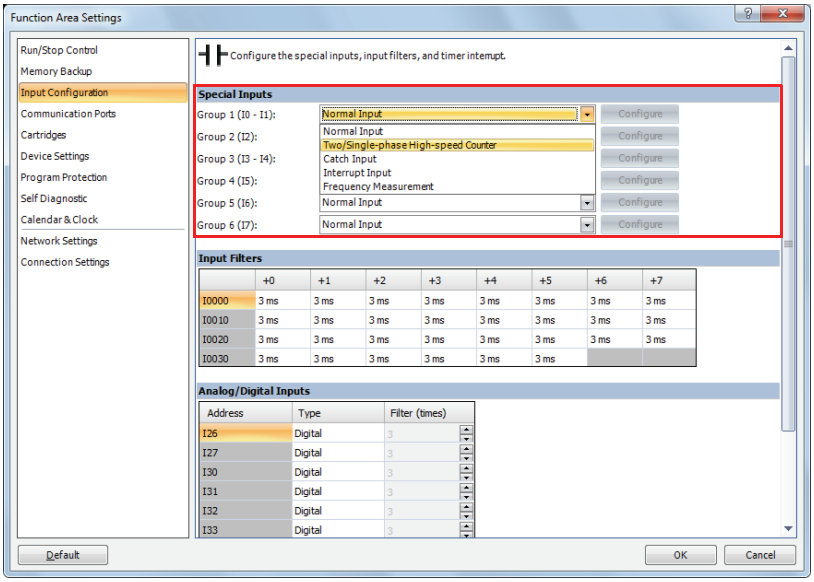
To use the high-speed counter, a normal external input must be specified as **Two/Single-phase High-speed Counter** in the WindLDR **Function Area Settings**. The function for external inputs I0 to I7 on the SmartAxis can be selected as normal input, high-speed counter, catch input, interrupt input, and frequency measurement.

When using normal input, catch input, interrupt input, or frequency measurement, high-speed counter cannot be used.

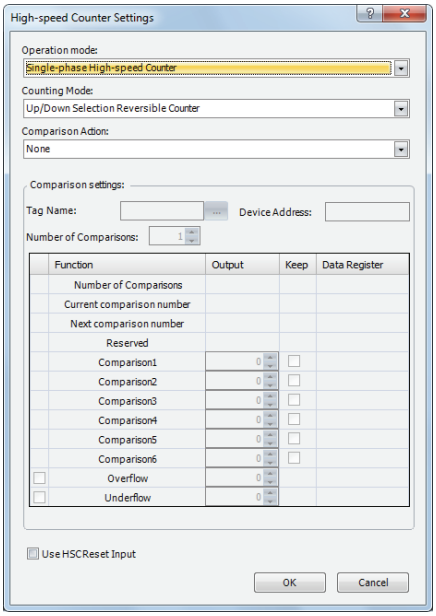
1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.

The Function Area Settings dialog box is displayed.

2. Select **Two/Single-phase High-speed Counter** for the group to use the high-speed counter.



The High-speed Counter Settings dialog box is displayed.



3. Configure the operation mode and the counting mode.

To use comparison actions, configure the comparison settings.

4. Click **OK.**

This concludes configuring the settings.

Settings

- **Operation mode**
  For group 1 and group 3, you can select **Single-phase High-speed Counter** or **Two-phase High-speed Counter**.
  When group 1 is selected as the high-speed counter, group 2 (I2) can be used as the external clear input.
  When group 3 is selected as the high-speed counter, group 4 (I5) can be used as the external clear input.
  The external inputs for group 2, group 4, group 5, and group 6 can only be used as single-phase high-speed counters.

- **Counting mode (single-phase high-speed counter)**
  When the single-phase high-speed counter is specified for **Operation mode** for group 1 or group 3, the counting mode can be selected as **Adding counter** or **Up/down selection reversible counter**. The adding counter can only be used for the group 2, group 4, group 5, and group 6 high-speed counters.

  Adding counter
  The adding counter counts up with the rise in pulse input.

  Up/down selection reversible counter
  Up/down selection reversible counter can switch between addition and subtraction with the up/down selection input. When the up/down selection input is on, the counter counts up with the rise in pulse input. When the up/down selection input is off, the counter counts down with the rise in pulse input.

- **Counting mode (two-phase high-speed counter)**
  When the two-phase high-speed counter is specified for **Operation mode** for group 1 or group 3, the counting mode can be selected as **2-edge count** or **4-edge count**. The two-phase counter cannot be used for the group 2, group 4, group 5, and group 6 high-speed counters.

  2-edge count
  This counter counts at double the frequency of the input pulse.
  This counter counts by the phase difference between the A-phase and B-phase pulse input. When the A-phase precedes the B-phase, the counter counts up with the rise and fall of the B-phase. When the B-phase precedes the A-phase, the counter counts down with the rise and fall of the B-phase.

  4-edge count
  This counter counts at quadruple the frequency of the input pulse.
  This counter counts by the phase difference between the A-phase and B-phase pulse input. When the A-phase precedes the B-phase, the counter counts up with the rise and fall of the A-phase and the B-phase. When the B-phase precedes the A-phase, the counter counts down with the rise and fall of the A-phase and the B-phase.

- **Comparison action**
  The comparison action is a function that compares the high-speed counter's current value with a preset value (target value).
  It can use either the comparison output or an interrupt program.
  - When **Comparison Output** is selected, the specified external output is turned on when the current value and the preset value match.
  - When **Interrupt Program** is selected, the subroutine program with the specified label number is executed as the interrupt program when the current value and the preset value match.

  Overflow and underflow can also be used for the comparison conditions.
  For details on the comparison actions, see "Comparison Actions" on page 5-13.

  Comparison settings
  When using the comparison output or the interrupt program as the comparison action for the high-speed counter, configure the external output number or the label number when there is a match. A maximum of six preset values can be specified for **Number of preset values** (preset value number 1 to 6).

  Tag name
  This setting specifies the starting address of the data register region to store the preset values.

  Device address
  This item shows the address of the data register specified by the tag name.

Number of preset values

You can configure a maximum of six preset values (target values) for the comparison action.

Notes :

- The preset value becomes active by the END processing in the second scan after the SmartAxis starts operation. Store **Preset Value** in the data registers with initialize pulse M8120 input.
- When the preset value (special data register) is changed before the comparison, the preset value currently being used for the comparison is discarded in the program's END processing, and the comparison is performed with the newly configured preset value.

Output

When a comparison action is selected, these are the external outputs specified for preset value 1 to 6.

The external outputs that can be used as comparison outputs are listed by model as follows. Remote outputs cannot be configured.

Model number	Comparison output
12-I/O type	Q0 to Q3
24-I/O type	Q0 to Q7
40-I/O type	Q0 to Q7, Q10 to Q17
48-I/O type	Q0 to Q7, Q10 to Q17, Q20 to Q21

Overflow

Select this check box to use overflow in the comparison action conditions (when the current value exceeds 4,294,967,295).

Underflow

Select this check box to use underflow in the comparison action conditions (when the current value falls below 0).

Note: When the comparison action is **Comparison Output** and either a preset value, overflow, or underflow has been enabled as a comparison condition, the text box to enter the comparison output is enabled. The comparison output can be specified for each of these match conditions.

- **Keep**

  After the current value matches the preset value, select to reset the current value to a reset value or to keep the value. Select this check box to keep the current value.

- **Use HSC Reset Input**

  Select this check box to reset the current value to a reset value with external input (high-speed counter reset input).

  High-speed counter reset input can only be specified for group 1 and group 3.

Group	External input
Group 1	I2
Group 3	I5

When high-speed counter reset input is turned on, the current value is reset to a reset value.

If high-speed counter reset input is not used, I2 and I5 are normal inputs.

High-speed counter devices

The high-speed counter operates according to special internal relay and special data register settings. While the high-speed counter is operating, the current value, control output, and operating status value are reflected in the special internal relays and special data registers with each scan.

The high-speed counter start and stop control signals and the current value, preset values, and reset values are allocated to the special internal relays and special data registers.

Device allocation table

The devices used by the high-speed counter are as follows.

Special internal relay list

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Comparison Output Reset	M8030	M8040	M8045	M8055	M8166	M8173	R/W
Gate Input	M8031	M8041	M8046	M8056	M8167	M8174	
Reset Input	M8032	M8042	M8047	M8057	M8170	M8175	
Reset Status	M8033	—	M8050	—	—	—	R
Comparison ON Status	M8034	M8043	M8051	M8060	M8171	M8176	
Overflow	M8035	M8044	M8052	M8061	M8172	M8177	
Underflow	M8036	—	M8053	—	—	—	
Count Direction flag	M8037	—	M8054	—	—	—	

Special data register list

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Current Value (Upper word)	D8050	D8056	D8062	D8068	D8134	D8140	R
Current Value (Lower word)	D8051	D8057	D8063	D8069	D8135	D8141	
Preset Value (Upper word)	D8052	D8058	D8064	D8070	D8136	D8142	R/W
Preset Value (Lower word)	D8053	D8059	D8065	D8071	D8137	D8143	
Reset Value (Upper word)	D8054	D8060	D8066	D8072	D8138	D8144	
Reset Value (Lower word)	D8055	D8061	D8067	D8073	D8139	D8145	

When using the devices above with instructions where the data type unit can be specified, specify the data type as double word (D). When the 32-bit data storage setting in the function area settings is set to **From Lower Word**, the lower word is stored in the first device.

- **Start/stop high-speed counter**

The high-speed counter can be started and stopped per group by turning the gate input on or off.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Gate Input	M8031	M8041	M8046	M8056	M8167	M8174	R/W

- **Current value storage locations**

The current value for the single-phase high-speed counter is stored in special data registers as 2 words per group.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Current Value (Upper word)	D8050	D8056	D8062	D8068	D8134	D8140	R
Current Value (Lower word)	D8051	D8057	D8063	D8069	D8135	D8141	

When the 32-bit data storage setting in the function area settings is set to **From Lower Word**, the lower word is stored in the first device.

- **Comparison ON status**

When the current value and the preset value match, the special internal relay turns on for only one scan.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Comparison ON Status	M8034	M8043	M8051	M8060	M8171	M8176	R

- **Overflow**

When the current value exceeds 4,294,967,295, the special internal relay turns on for only one scan. When the current value overflows, it becomes 0.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Overflow	M8035	M8076	M8050	M8077	M8086	M8087	R

- **Underflow**

When the current value falls below 0, the special internal relay turns on for only one scan. When the current value underflows, it becomes 4,294,967,295.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Underflow	M8036	—	M8053	—	—	—	R

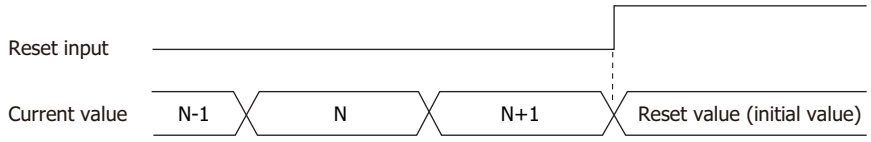
- **Comparison output reset**

When the special internal relay turns on, the comparison output selected on **High-speed Counter Settings** turns off.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Comparison Output Reset	M8030	M8040	M8045	M8055	M8166	M8173	R/W

- **Reset input**

When reset input is turned on, the current value returns to the reset value.



Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Reset Input	M8032	M8042	M8047	M8057	M8170	M8175	R/W

- **Preset value, reset value storage locations**

The preset value and the reset value for the high-speed counter are stored in special data registers as 2 words.

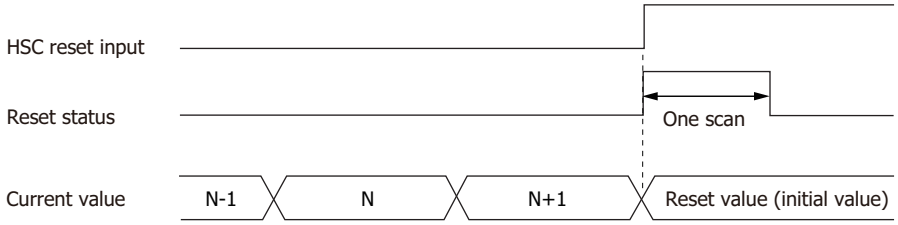
Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Preset Value (Upper word)	D8052	D8058	D8064	D8070	D8136	D8142	R/W
Preset Value (Lower word)	D8053	D8059	D8065	D8071	D8137	D8143	
Reset Value (Upper word)	D8054	D8060	D8066	D8072	D8138	D8144	
Reset Value (Lower word)	D8055	D8061	D8067	D8073	D8139	D8145	

When the 32-bit data storage setting in the function area settings is set to **From Lower Word**, the lower word is stored in the first device.

- **HSC reset input and reset status**

When the HSC reset input is enabled in group 1 or group 3, turn on HSC reset input I2 or I5 to return the current value to the reset value.

In this situation, reset status turns on for only one scan.



Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
HSC Reset Input	I2	—	I5	—	—	—	—
Reset Status	M8033	—	M8050	—	—	—	R

To use the reset input with the group 1 or group 3 single-phase high-speed counter, use I2 (group 2) or I5 (group 4). When not using I2 or I5 as a reset input, they can be used as normal input, high-speed counters, catch input, interrupt input, or frequency measurements.

- **Count direction flag**

These special internal relays maintain whether the group 1 or group 3 current value count is being added or subtracted.

When these special internal relays are on, they indicate addition. When they are off, they indicate subtraction.

Group	1 (I0 to I1)	2 (I2)	3 (I3 to I4)	4 (I5)	5 (I6)	6 (I7)	Read/Write
Count Direction flag	M8037	—	M8054	—	—	—	R

Timing chart 1

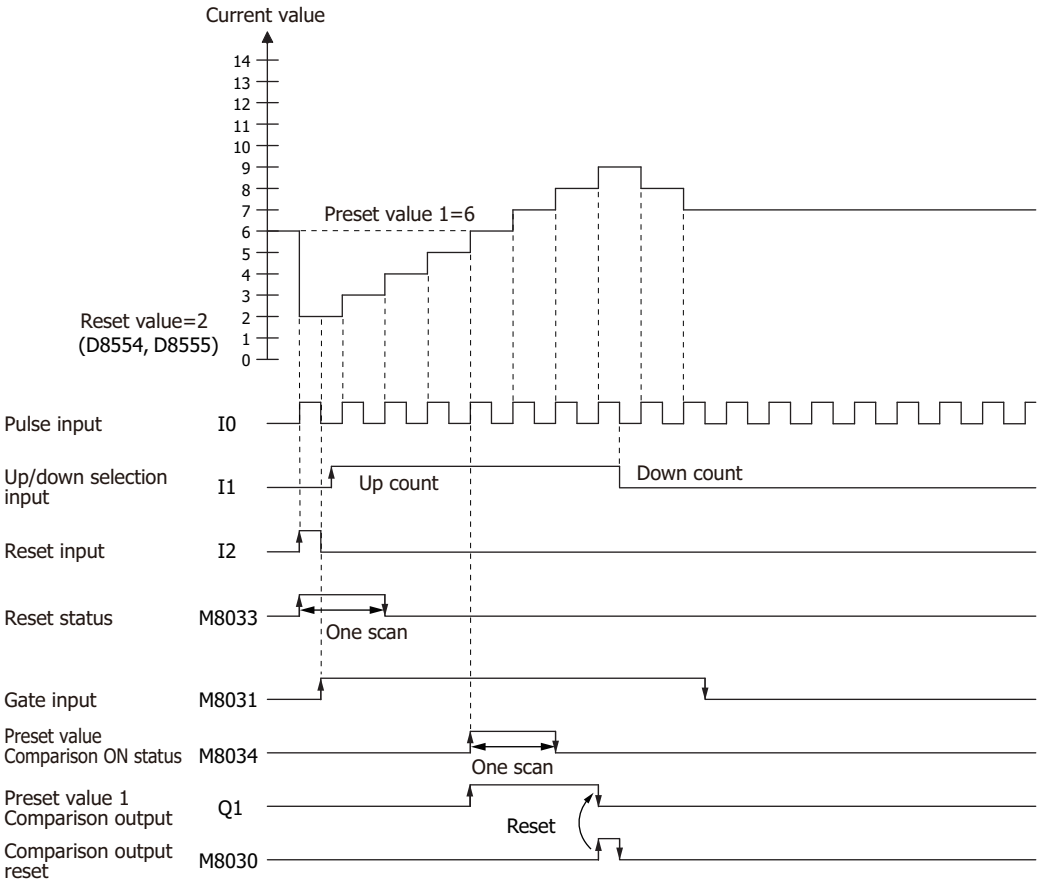
Single-phase high-speed counter (group 1) timing chart

Operating conditions

The counting mode is set to **Up/down selection reversible counter** and reset input (I2) is used.

One preset value is used, and when the values match, output Q1 turns on and the current value is kept.

Overflow and underflow are not used.



1. When reset input (I2) turns on, the reset value (D8054, D8055) is stored in the current value (D8050, D8051). In this situation, reset status (M8033) turns on for only one scan.
2. When gate input (M8031) turns on, the counting begins.
3. The counting direction (count up/count down) is determined by the on/off state of the up/down selection input (I1), and the pulse input (I0) is counted. The current value is updated with each scan.
4. When the current value and preset value 1 (D8052, D8053) match, the preset value 1 comparison output (Q1) and Comparison ON status (M8034) turn on. When the **Keep** check box is selected in the settings in the WindLDR **High-speed Counter Settings**, the current value is kept.
5. Q1 maintains the on state until comparison output reset (M8030) turns on. M8034 turns on for only one scan.
6. When the gate output turns off, counting stops.

Note: High-speed counter usage precautions

The high-speed counter starts the count operation with the following two conditions.

- The SmartAxis starts operation
- The gate input is turned on

To start the count operation, turn the gate input on from off when the SmartAxis is running. When the gate input is already on when the SmartAxis is stopped, the count operation starts when the SmartAxis is switched from stop to run.
When a user program is downloaded during the count operation, the count operation stops. The count operation will restart by setting the SmartAxis to run.

Timing chart 2

Two-phase high-speed counter (group 1) timing chart

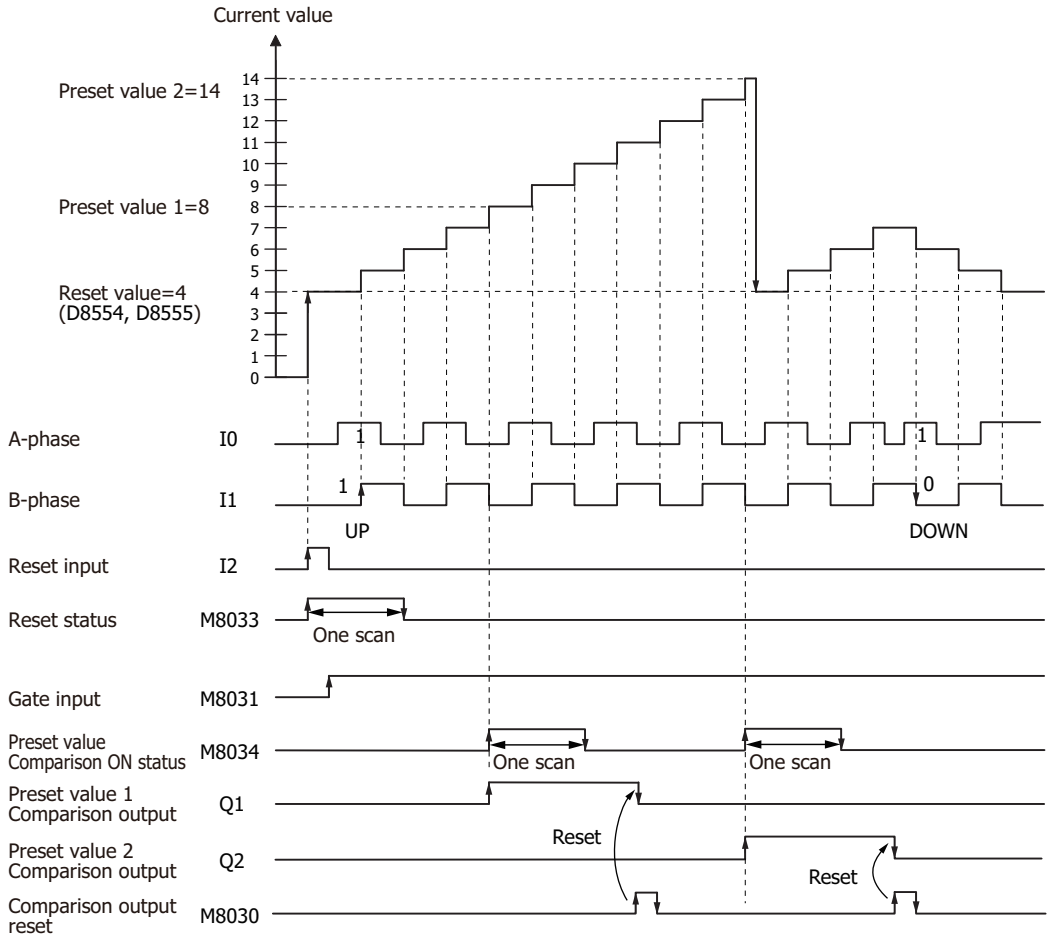
Operating conditions

The counting mode is set to **2-edge count** and reset input (I2) is used.

Two preset values are used, and when preset value 1 matches, output Q1 turns on and the current value is kept.

When preset value 2 matches, output Q2 turns on and the current value is cleared.

Overflow and underflow are not used.



1. When reset input (I2) turns on, the reset value (D8054, D8055) is stored in the current value (D8050, D8051). In this situation, reset status (M8033) turns on for only one scan.

2. When gate input (M8031) turns on, the counting begins.

3. When the A-phase pulse (I0) precedes the B-phase pulse (I1), the count goes up. When the B-phase pulse (I1) precedes the A-phase pulse (I0), the count goes down.

4. When the current value and preset value 1 (D8052, D8053) match, the preset value 1 comparison output (Q1) and setting value match (M8034) turn on.
When preset value 1 matches, preset value 2 is stored in the preset value (D8052, D8053) as the new preset value and counting continues.

5. The preset value 1 comparison output (Q1) maintains the on state until comparison output reset (M8030) turns on. M8034 turns on for only one scan.

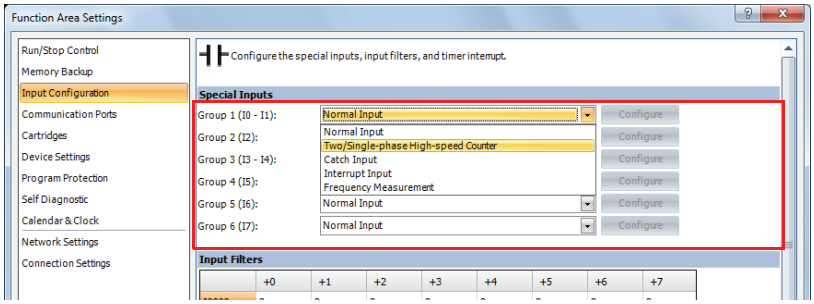
Example program 1

Using the single-phase high-speed counter, this example program turns on external output Q2 when 1000 pulses are input.

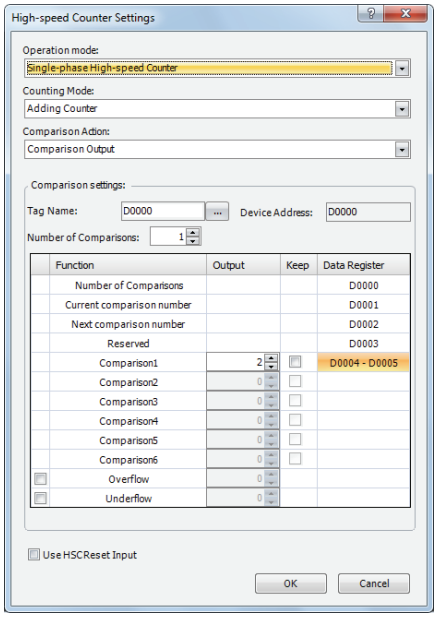
Application description

When pulses are input to external input I0 and the count reaches 1000, external output Q2 is turned on.

In the WindLDR **Function Area Settings**, select **Two/Single-phase High-speed Counter** for **Group 1**.



In **High-speed Counter Settings**, configure the settings as follows.



External input : Group 1 (I0 to I1)

Operation mode : Single-phase High-speed Counter

Counting Mode : Adding Counter

Comparison Action : Comparison Output

Comparison settings

Tag name/device address : D0 (data register)

Number of preset values : 1

Comparison output : Q2 (external output when matched)

Preset value 1 (D4) : 0 (upper word)

Preset value 1 (D5) : 1,000 (lower word)

Keep : Cleared

Reset value (D8054) : 0 (upper word)

Reset value (D8055) : 0 (lower word)

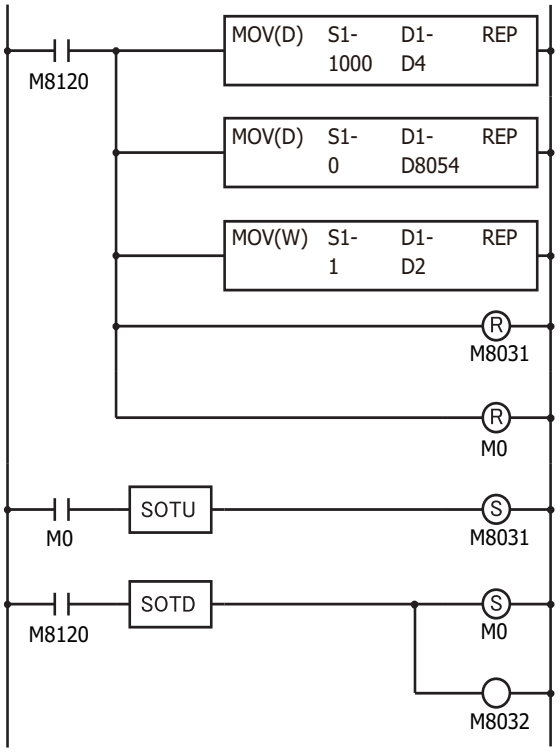
Overflow : Cleared

Underflow : Cleared

Use HSC Reset Input : Cleared

Program

M8120 (initialize pulse) is a special internal relay that turns on when the SmartAxis runs.



1st scan

Store 1,000 in preset value 1 (D4, D5)

Store the reset value in D8054, D8055

Store 1 in the next preset value number (D2)

Turn off gate input (M8031)

Turn off M0

3rd scan

Detect the rising edge of M0, turn on gate input (M8031)
Start high-speed counter counting in the END processing after the 3rd scan is executed

2nd scan

Detect the falling edge of the initialize pulse, M0 and M8032 turn on
Initialize the current value with the reset value in the END processing after the 2nd scan is executed

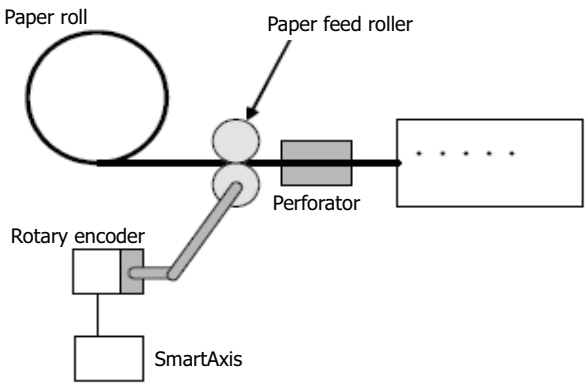
M8032 (reset input) is a special internal relay that stores the preset value (D8054, D8055) in the current value (D8050, D8051).

Example program 2

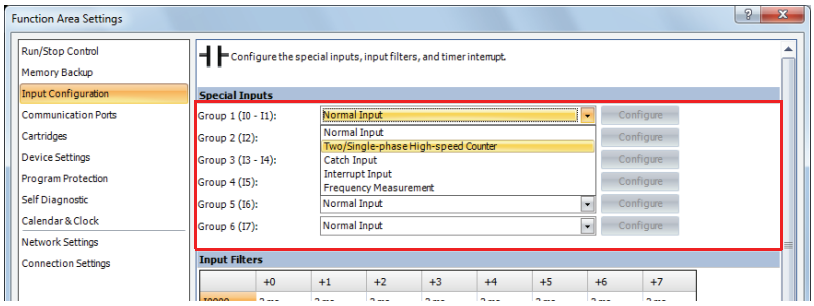
Using the two-phase high-speed counter, the pulses from a rotary encoder are input to the SmartAxis and a continuous workpiece is marked at a regular interval.

Application description

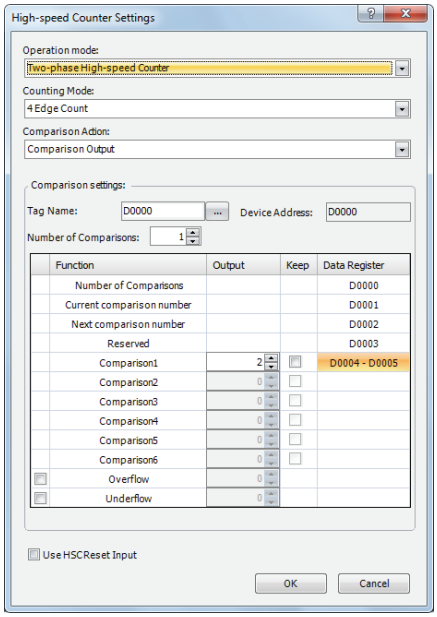
- The rotary encoder pulses are input to external input I0. A continuous sheet of paper is marked (holes are punched) at a regular interval (every 2,700 pulses).
- The rotary encoder is directly connected to the paper feed roller, and output pulses are counted by the high-speed counter and controlled.
- The takt time is the time to count 2,700 pulses.
  When the hole punch time is 0.5 seconds, the operation condition is 2,700 pulse count time > 0.5 seconds.



In the WindLDR **Function Area Settings**, select **Two/Single-phase High-speed Counter** for **Group 1**.



In **High-speed Counter Settings**, configure the settings as follows.



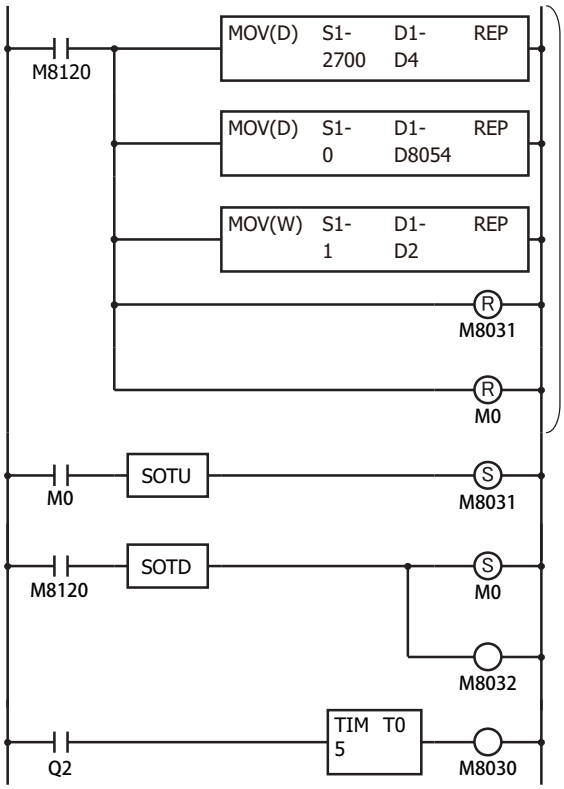
External input	: Group 1 (I0 to I1)
Operation mode	: Two-phase High-speed Counter
Counting Mode	: 4-edge Count
Comparison Action	: Comparison Output

Comparison settings

Tag name/device address	: D0 (data register)
Number of preset values	: 1
Comparison output	: Q2 (external output when matched)
Preset value 1 (D4)	: 0 (upper word)
Preset value 1 (D5)	: 2,700 (lower word)
Keep	: Cleared
Reset value (D8054)	: 0 (upper word)
Reset value (D8055)	: 0 (lower word)
Overflow	: Cleared
Underflow	: Cleared
Use HSC Reset Input	: Cleared

Program

M8120 (initialize pulse) is a special internal relay that turns on when the SmartAxis runs.



1st scan

Store 2,700 in preset value 1 (D4, D5)

Store 0 in the reset value (D8054, D8055)

Store 1 in the next preset value number (D2)

Turn off gate input (M8031)

Turn off M0

3rd scan

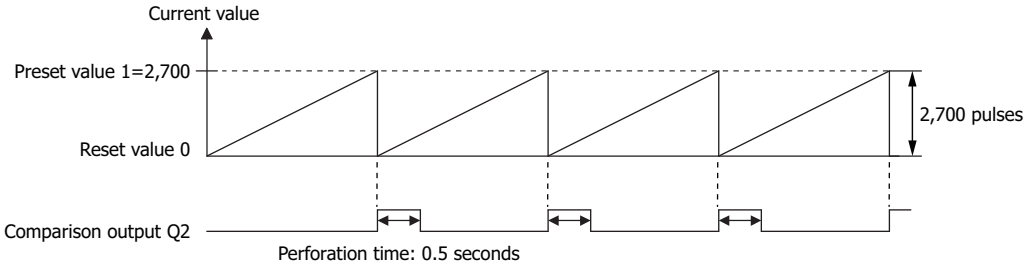
Detect the rising edge of M0, turn on gate input (M8031)

2nd scan

Detect the falling edge of the initialize pulse, M0 and M8032 turn on
Initialize the current value with the reset value in the END processing after the 2nd scan is executed

M8032 (reset input) is a special internal relay that stores the reset value (D8054, D8055) in the current value (D8050, D8051).

When the current value becomes 2,700 pulses, comparison output Q2 turns on
The timer starts and comparison output reset (M8030) turns on after 5 seconds



Note: In this example, Z-phase reset input is not used.

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. Six inputs I0, I2, I3, and I5 through I7 can be designated to catch a rising or falling edge of short input pulses, and the catch input statuses are stored to special internal relays M8090 through M8095, respectively.

The Function Area Settings dialog box is used to designate inputs I0, I2, I3, and I5 through I7 as a catch input.

Normal input signals to 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 SmartAxis after changing any of these settings.

Catch Input Specifications

Minimum Turn ON Pulse Width	5 µs
Minimum Turn OFF Pulse Width	5 µs

Note: Input filter settings have no effect on the catch inputs. For the input filter function, see page 5-53.

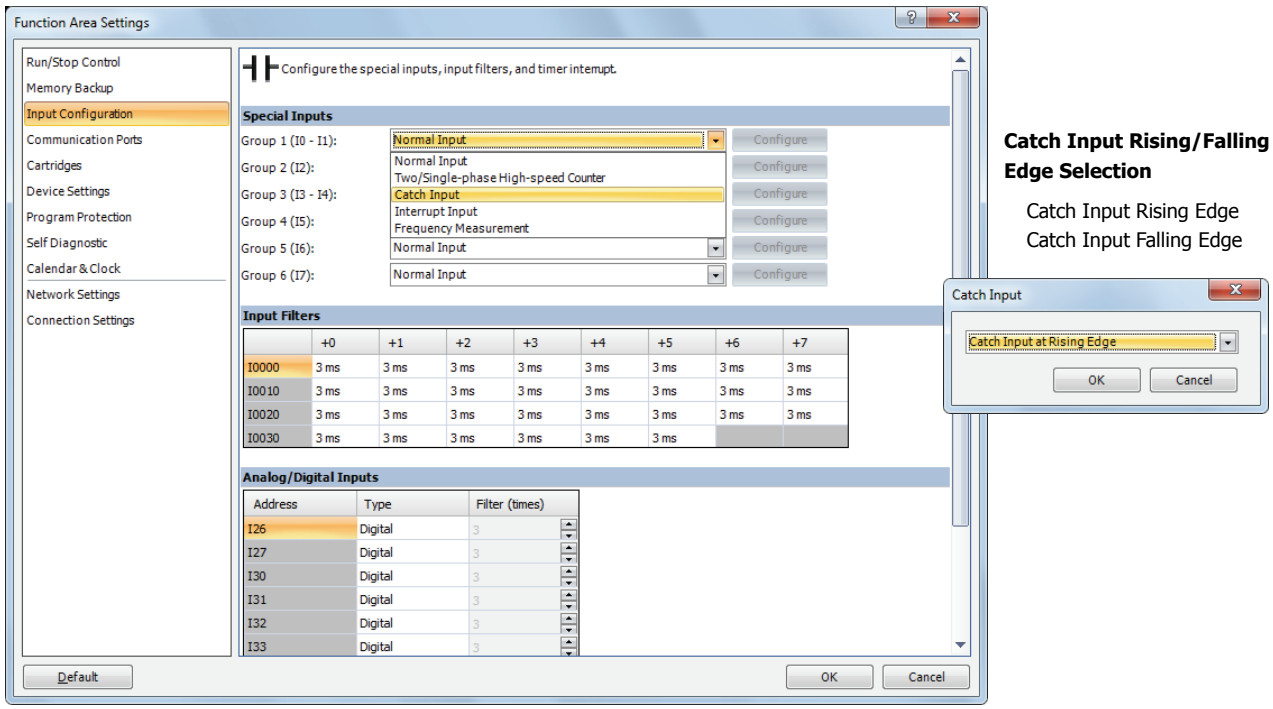
Catch Input Terminals and Special Internal Relays for Catch Inputs

Group	Catch Input No.	Special Internal Relay for Catch Input
Group 1	I0	M8090
Group 2	I2	M8091
Group 3	I3	M8092
Group 4	I5	M8093
Group 5	I6	M8094
Group 6	I7	M8095

Note: Only the 24-, 40-, and 48-I/O types can use external inputs I6 and I7 as catch inputs. The 12-I/O type cannot use external inputs I6 and I7 as catch inputs.

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.
   The Function Area Settings dialog box for Input Configuration appears.

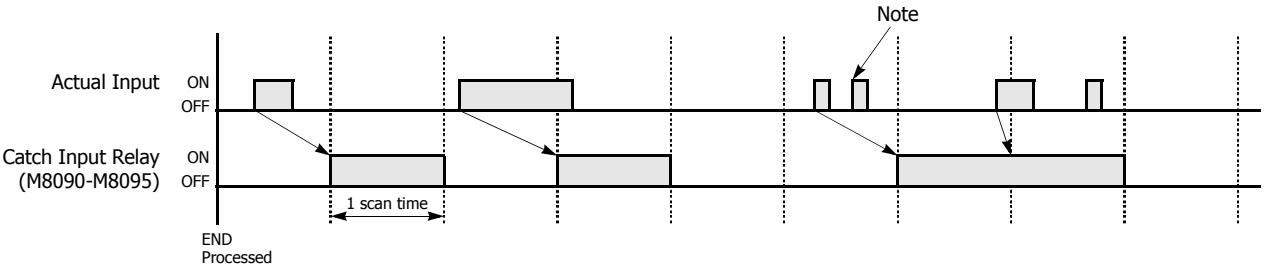


Catch Input Rising/Falling Edge Selection

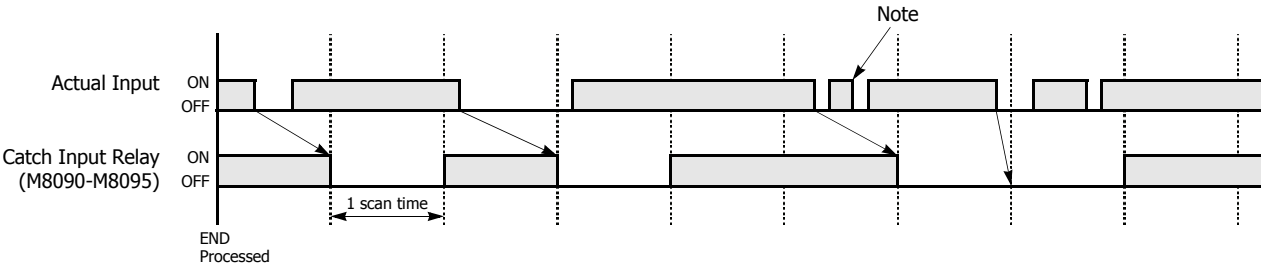
Catch Input Rising Edge
Catch Input Falling Edge

2. Select **Catch Input** in the Groups 1 through 4 pull-down list boxes. The Catch Input dialog box appears.
3. Select **Catch Input Rising Edge** or **Catch Input Falling Edge** in the pull-down list.

Catching Rising Edge of Input Pulse



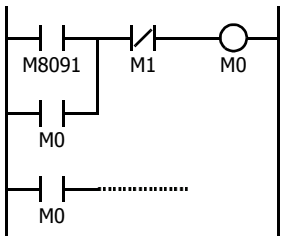
Catching Falling Edge of Input Pulse



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

Example: Maintaining Catch Input

When a catch input is received, the catch 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 I2 is designated as a catch input using the Function Area Settings.

When input I2 is turned on, special internal relay M8091 is turned on, and M0 is maintained in the self-holding circuit.

When NC input M1 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.

Interrupt Input

When a quick response to an external input is required, such as positioning control, the interrupt input can call a subroutine to execute an interrupt program.

Six inputs I0, I2, I3, and I5 through I7 can be designated to execute interrupt at a rising and/or falling edge of input pulses. When an interrupt is initiated by inputs I0, I2, I3, and I5 through I7, program execution immediately jumps to a predetermined label number stored in special data registers D8032 through D8035, D8037, and D8038 respectively. The Function Area Settings dialog box is used to designate inputs I0, I2, I3, and I5 through I7 as an interrupt input, normal input, high-speed counter input, or catch input.

Normal input signals to 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 SmartAxis after changing any of these settings.

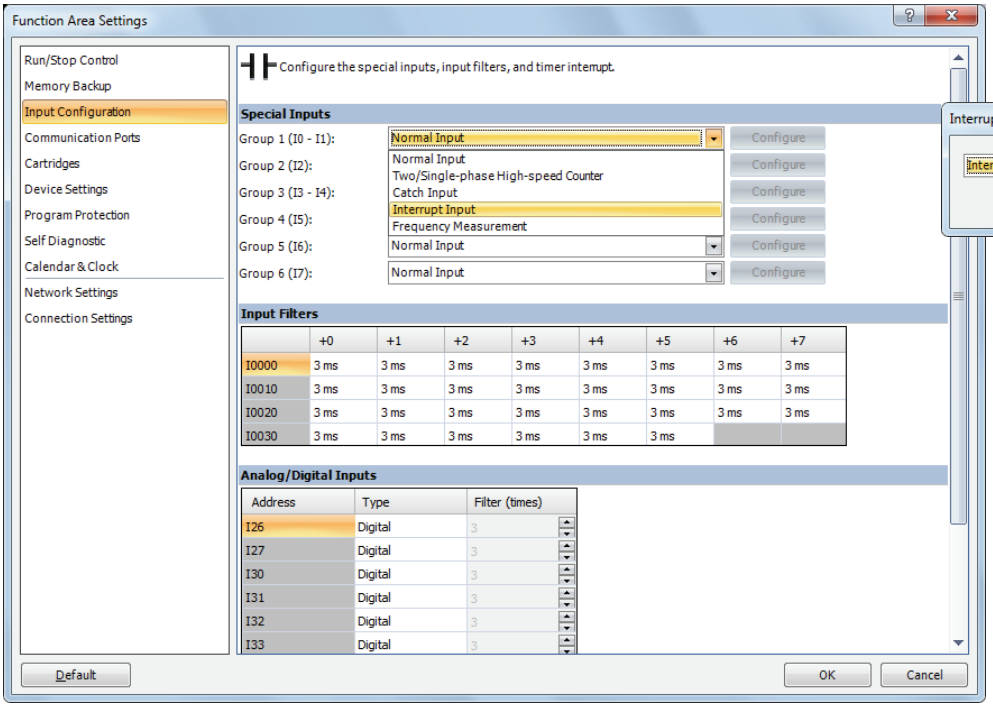
Interrupt Input Terminals, Special Data Registers, and Special Internal Relays for Interrupt Inputs

Group	Interrupt Input No.	Interrupt Input Jump Destination Label No.	Interrupt Input Status
Group 1	I0	D8032	M8070
Group 2	I2	D8033	M8071
Group 3	I3	D8034	M8072
Group 4	I5	D8035	M8073
Group 5	I6	D8037	M8074
Group 6	I7	D8038	M8075

Note: Only the 24-, 40-, and 48-I/O types can use external inputs I6 and I7 as interrupt inputs. The 12-I/O type cannot use external inputs I6 and I7 as interrupt inputs.

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.
   The Function Area Settings dialog box for Input Configuration appears.



Interrupt Input Rising/ Falling Edge Selection

Interrupt at Rising Edge
Interrupt occurs when the interrupt input turns on.

Interrupt at Falling Edge
Interrupt occurs when the interrupt input turns off.

Interrupt at Both Edges
Interrupt occurs when the interrupt input turns on or off.

2. Select **Interrupt Input** in the Groups 1 through 6 pull-down list boxes. the Interrupt Input dialog box appears.

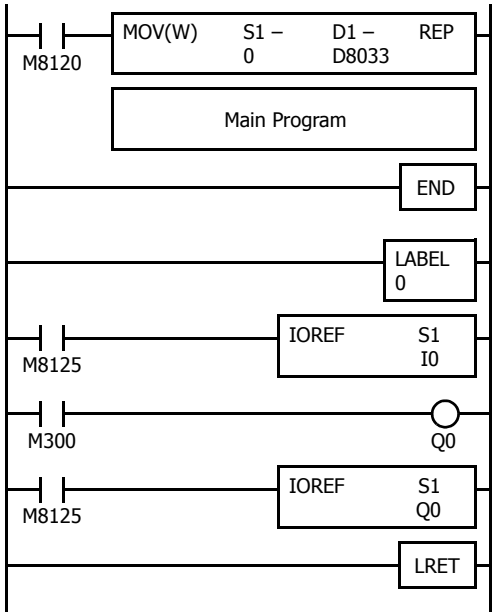
3. Select an interrupt edge in the pull-down list for each group.

Disable and Enable Interrupts

The interrupt inputs I0, I2, I3, and I5 through I7 and timer interrupt are normally enabled while the SmartAXIS is running, and can also be individually disabled using the DI instruction or enabled using the EI instruction. When interrupt inputs I0, I2, I3, and I5 through I7 are enabled, special internal relay M8070 through M8075 are turned on, respectively. See page 11-7 (Advanced Vol.).

Example: Interrupt Input

The following example demonstrates a program of using the interrupt input function, with input I2 designated as an interrupt input. When the interrupt input is turned on, the input I0 status is immediately transferred to output Q0 using the IOREF (I/O refresh) instruction before the END instruction is executed. For the IOREF instruction, see page 11-9 (Advanced Vol.).



M8120 is the initialize pulse special internal relay.

D8033 stores 0 to designate jump destination label 0 for interrupt input I2.

The interrupt program is separated from the main program by the END instruction.

When input I2 is on, program execution jumps to label 0.

M8125 is the in-operation output special internal relay.

IOREF immediately reads input I0 status to internal relay M300.

M300 turns on or off the output Q0 internal memory.

Another IOREF immediately writes the output Q0 internal memory status to actual output Q0.

Program execution returns to the main program.

Insert LRET at the end of the subroutine to return to the main program.

Notes for Using Interrupt Inputs and Timer Interrupt:

- When using an interrupt input or timer interrupt, separate the interrupt program from the main program using the END instruction at the end of the main program.
- When an interrupt program calls another subroutine, a maximum of 3 subroutine calls can be nested. If more than 3 calls are nested, a user program execution error occurs, turning on special internal relay M8004 and the ERR LED.
- When using an interrupt input or timer interrupt, include the label number of the interrupt program to be executed when an interrupt occurs. The label numbers stored in data registers D8032 through D8035, D8037, and D8038 specify the interrupt programs for interrupt inputs I0, I2, I3, and I5 through I7 and timer interrupt, respectively.
- When more than one interrupt input is turned on at the same time, interrupt program execution is given priority to inputs I0, I2, I3, I5, I6, and I7, in that order. If an interrupt is initiated while another interrupt program is executed, the subsequent interrupt program is executed after the prior interrupt is completed. Multiple interrupt programs cannot be executed simultaneously.
- Make sure that the execution time of the interrupt program is shorter than interrupt intervals sufficiently.
- Interrupt programs cannot use the following instructions: SOTU, SOTD, TML, TIM, TMH, TMS, TMLO, TIMO, TMHO, TMSO, CNT, CDP, CUD, CNTD, CDPD, CUDD, SFR, SFRN, WEEK, YEAR, MSG, DI, EI, XYFS, CVXTY, CVYTX, AVRG, PULS, PWM, RAMP, ZRN, ARAMP, DTML, DTIM, DTMH, DTMS, TTIM, FIFOF, NDSRC, HOUR, TXD, RXD, ETXD, ERXD, DLOG, TRACE, and SCRPT.

Frequency Measurement

This section describes frequency measurement, which measures the frequency of pulses input to an external input.

Frequency measurement is a function that measures the frequency of pulses input to an external input.

These input pulses are processed in hardware, so frequencies can be measured with no relation to the scan time. Groups that do not use frequency measurement can be used as normal inputs, high-speed counters, catch input, and interrupt input. The measurement results are stored in special data registers and they are updated with each scan.

Function Specification

The SmartAxis external inputs are used by switching between normal input, high-speed counters, catch input, interrupt input, and frequency measurement. To use frequency measurement, specify the relevant group as **Frequency Measurement** in the WindLDR **Function Area Settings**.

The frequency measurement results are stored in the following special data registers. (Read-only)

Group		**1**	**2**	**3**	**4**	**5**	**6**
External input		I0	I2	I3	I5	I6	I7
Frequency measurement value (32 bits)	**Upper word**	D8050	D8056	D8062	D8068	D8134	D8140
	Lower word	D8051	D8057	D8063	D8069	D8135	D8141
Frequency measurement range		1 Hz to 100 kHz		200 Hz to 100 kHz			
Measurement error		Less than ±0.3% (Truncated after the decimal point)		Less than ±1% (Truncated after the decimal point)			
Calculation cycle		Each scan time					

Notes:

- If the input pulse cycle is longer than the scan time, the measurement results are updated at pulse cycle + 1 scan time.
- The data registers for the upper word and the lower word of the measurement value change according to the 32-bit data storage method specified. For details, see "32-bit Data Storage Setting" on page 5-53.

Applicable Models

- The AC power type does not support frequency measurement. In situations where the frequency measurement function is required, use the DC power type.
- Of the DC power types, only the the 24-, 40-, and 48-I/O types can use external inputs I6 and I7 for frequency measurement. The 12-I/O type cannot use external inputs I6 and I7 as the frequency measurement function.

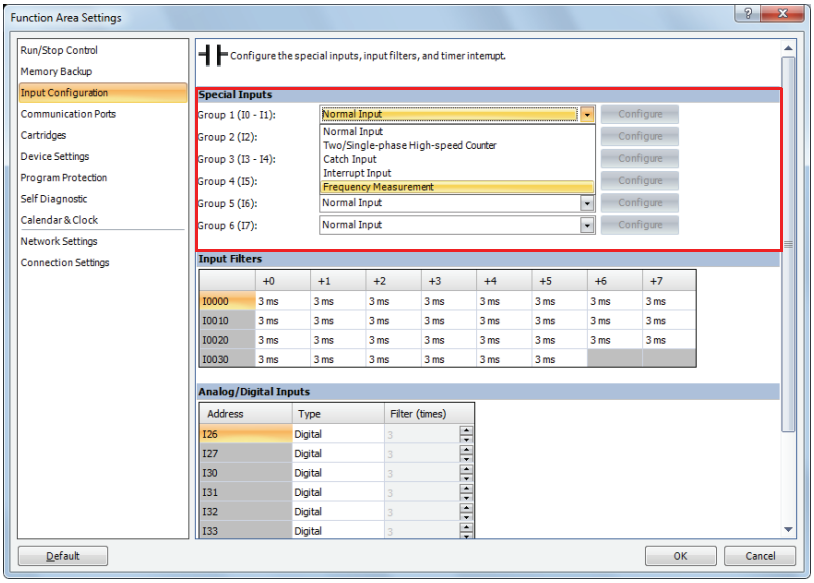
Programming WindLDR

To use frequency measurement, you must configure the **Function Area Settings** in WindLDR and download the user program to the SmartAxis. Frequency measurements will start when you download the user program and set the SmartAxis to run.

1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.

The Function Area Settings dialog box is displayed.

2. Specify **Frequency Measurement** for the group to use frequency measurement.



3. Click **OK**.

This concludes configuring the settings.

Input Filter

The input filter function is used to reject input noises. The catch input function described in the preceding section is used to read short input pulses to special internal relays. On the contrary, the input filter rejects short input pulses when the SmartAxis is used with input signals containing noises.

Different input filter values can be selected for inputs I0 through I7 in four groups using the Function Area Settings. Selectable input filter values to pass input signals are 0 ms, and 3 through 15 ms in 1 ms increments. Default value is 3 ms for all inputs I0 through I7. Inputs I10 and above on SmartAXIS are provided with a fixed filter of 3 ms. The input filter rejects inputs shorter than the selected input filter value minus 2 ms.

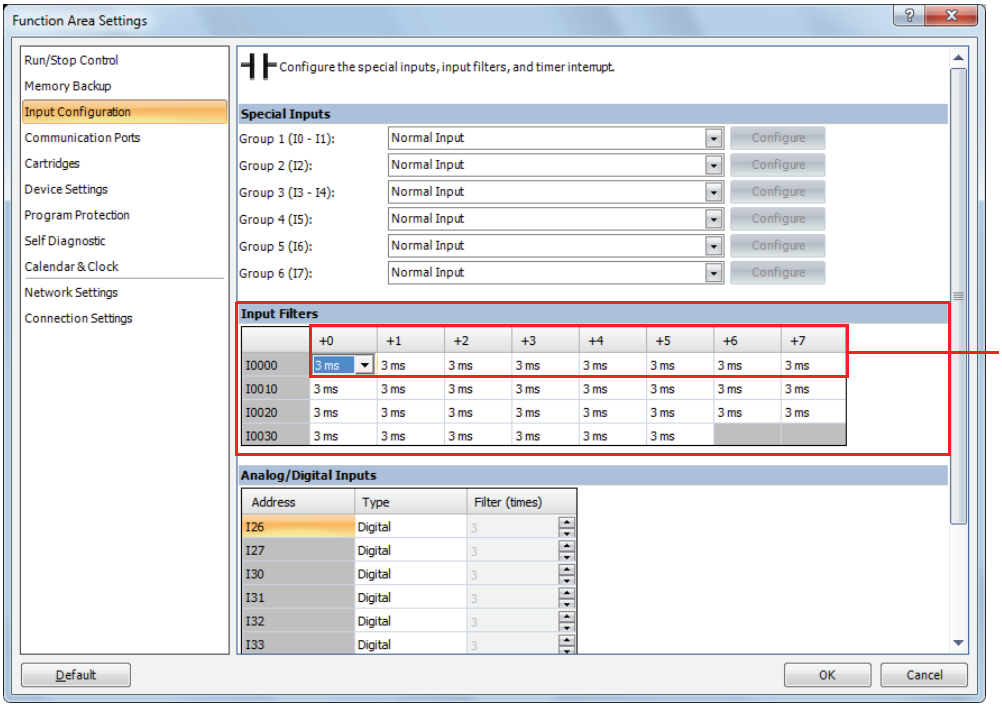
Normal inputs require a pulse width of the filter value plus one scan time to receive input signals. When using the input filter function, select **Normal Input** under Special Inputs on the Input Configuration dialog box in the Function Area Settings.

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

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.

The Function Area Settings dialog box for Input Configuration appears.



The columns displayed next to I0 indicate I0 to I7.

2. Select an input filter value for each group of inputs.

Input Filter Values and Input Operation

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

Reject area:	Input signals do not pass the filter (selected filter value minus 2 ms).
Indefinite area:	Input signals may be rejected or passed.
Pass area:	Input signals pass the filter (selected filter value).

Example: Input Filter 8 ms

To reject input pulses of 6 ms or less, select input filter value of 8 ms. Then input pulses of 8 ms plus one scan time are accepted correctly at the END processing.

	6 ms	8 ms + 1 scan	
Input	Rejected	Indefinite	Accepted

Analog Input

This section describes how to input analog signals such as those from pressure sensors.

The SmartAxis is equipped with an analog input function. This function acquires 0 to 10V DC voltage analog input by converting it to 0 to 1000 digital values. The converted analog signals are stored in special data registers. External inputs that are not specified as analog inputs are digital inputs, and the analog voltage is converted to normal input on/off at the specified threshold value.

For the on/off judgment threshold value when digital input is specified, see Chapter 2 "Module Specifications" on page 2-X.

Note: When analog input is configured as digital input, the input filter is active.

Analog input value storage locations

A maximum of eight analog inputs can be used. The converted analog signals are stored in special data registers (D8040 to D8047: read-only) as values between 0 and 1000. These values are updated with each scan.

Analog input (I)	0	1	2	3	4	5	6	7
Special data register that stores the analog input value	D8040	D8041	D8042	D8043	D8044	D8045	D8046	D8047

Analog Input Filter

The analog input data is averaged by the specified filter count. This can reduce rapid fluctuations in analog input.

The larger this value is set, the slower the tracking of the change in analog input becomes.

Count	Description
0	No filtering
1 to 255	The input value is set as the average value of n samples of analog input data. (n: Count)

When filtering, the input value is calculated with the equation below.

$$\text{Analog input value after filtering} = \frac{\text{Total analog input values for filter count (n) worth of scans}}{\text{Filter count n}}$$

Analog Input Allocation

The analog inputs are shared with the digital inputs. The allocation of analog inputs varies based on to the model.

12-I/O type

Input (I)	0	...	5	6	7
Analog input (AI)	—	—	—	0	1
Special data register that stores the analog input value	—	—	—	D8040	D8041

24-I/O type

Input (I)	0	...	13	14	15	16	17
Analog input (AI)	—	—	—	0	1	2	3
Special data register that stores the analog input value	—	—	—	D8040	D8041	D8042	D8043

40-I/O type

Input (I)	0	...	21	22	23	24	25	26	27
Analog input (AI)	—	—	—	0	1	2	3	4	5
Special data register that stores the analog input value	—	—	—	D8040	D8041	D8042	D8043	D8044	D8045

48-I/O type

Input (I)	0	...	25	26	27	30	31	32	33	34	35
Analog input (AI)	—	—	—	0	1	2	3	4	5	6	7
Special data register that stores the analog input value	—	—	—	D8040	D8041	D8042	D8043	D8044	D8045	D8046	D8047

Applicable Models

The number of inputs that can be used for analog input varies based on the model.

The AC power type does not support analog input. In situations where the analog input function is required, use the DC power type.

Power supply voltage	100 to 240V AC				24V DC			
Type	12-I/O type	24-I/O type	40-I/O type	48-I/O type	12-I/O type	24-I/O type	40-I/O type	48-I/O type
Analog inputs	0				2	4	6	8

Programming WindLDR

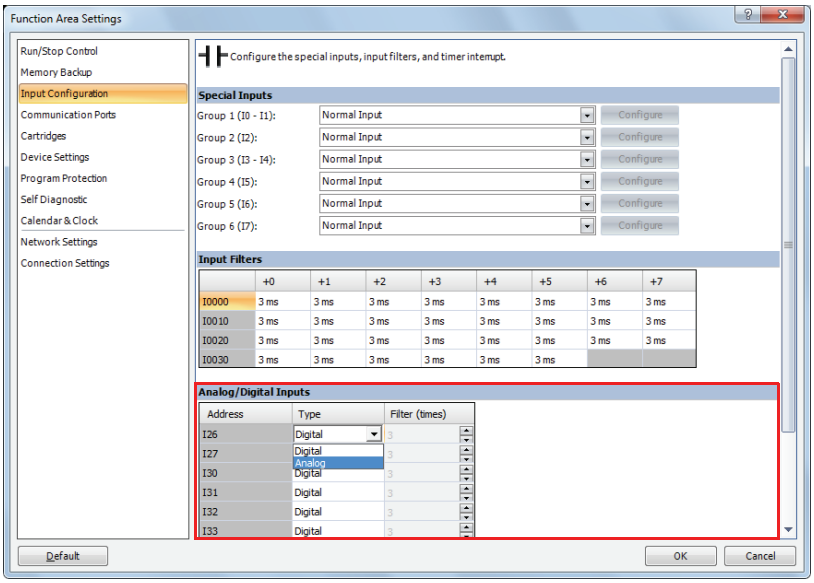
To use analog input, you must configure the Function Area Settings in WindLDR and download the user program to the SmartAxis.

1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.

The Function Area Settings dialog box is displayed.

2. Specify **Analog** for the external input to use as analog input and configure **Filter Count**.

Click **Default** to set all the external inputs to digital.



3. Click **OK**.

This concludes configuring the settings.

Timer Interrupt

In addition to the interrupt input as described in the preceding section, all SmartAXIS have a timer interrupt function. When a repetitive operation is required, the timer interrupt can be used to call a subroutine repeatedly at predetermined intervals of 10 through 140 ms.

The Function Area Settings dialog box is used to enable the timer interrupt and to specify the interval, from 10 to 140 ms, to execute the timer interrupt. When the timer interrupt is enabled, the program execution jumps to the jump destination label number stored in special data register D8036 repeatedly while the SmartAXIS is running. When the interrupt program is completed, the program execution returns to the main program at the address where the interrupt occurred.

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

Special Data Register and Special Internal Relay for Timer Interrupt

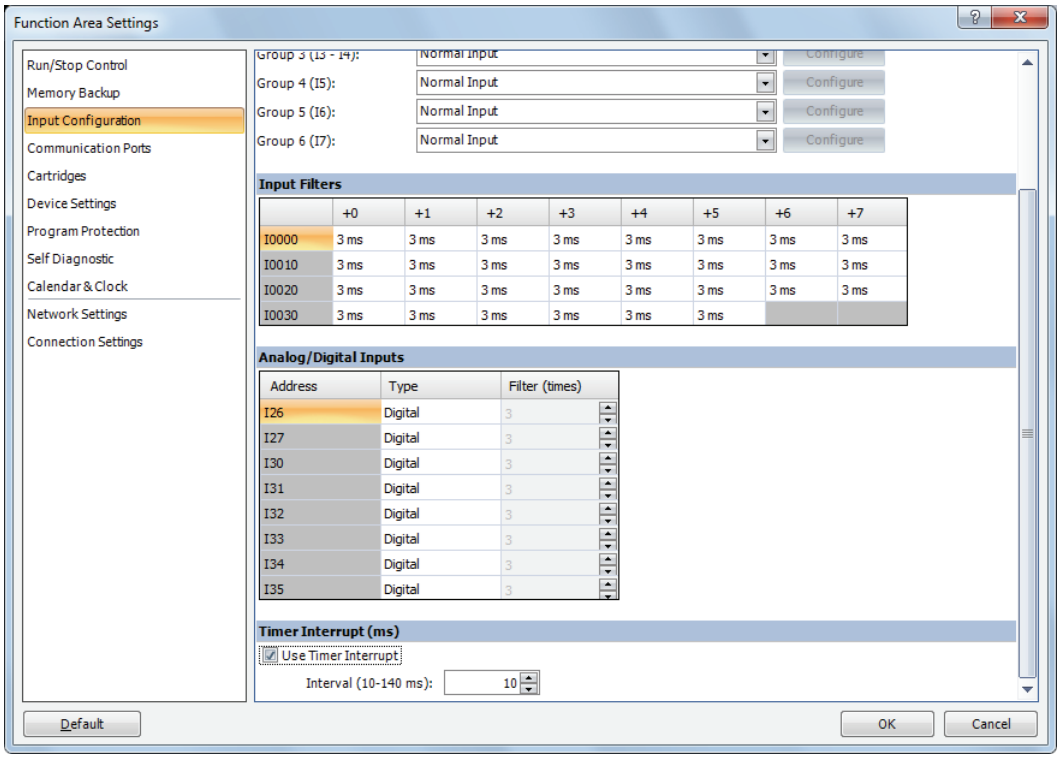
Interrupt	Special Data Register for Timer Interrupt Jump Destination Label No.	Special Internal Relay for Timer Interrupt Status
Timer Interrupt	D8036	M8144

Note: A label is the starting address of the program branch to jump to, and it is specified by the LABEL instruction.

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Input Configuration**.

The Function Area Settings dialog box for Input Configuration appears.



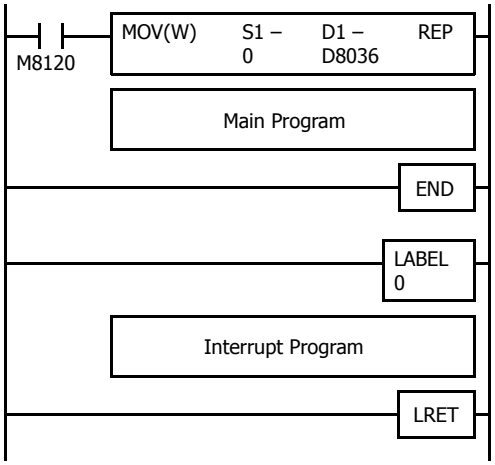
2. Under the Timer Interrupt, click the check box to use the timer interrupt function.
3. Select an interval to execute the timer interrupt, from 10 to 140 ms.

Disable and Enable Interrupts

The timer interrupt and interrupt inputs I0, I2, I3, and I5 through I7 are normally enabled while the SmartAXIS is running, and can also be individually disabled using the DI instruction or enabled using the EI instruction. When timer interrupt is enabled, M8144 is turned on. When disabled, M8144 is turned off. See page 11-7 (Advanced Vol.).

Example: Timer Interrupt

The following example demonstrates a program of using the timer interrupt function. The Function Area Settings must also be completed to use the timer interrupt function as described on the preceding page.



M8120 is the initialize pulse special internal relay.

D8036 stores 0 to designate jump destination label 0 for timer interrupt.

The interrupt program is separated from the main program by the END instruction.

While the SmartAXIS is running, program execution jumps to label 0 repeatedly at intervals selected in the Function Area Settings.

Each time the interrupt program is completed, program execution returns to the main program at the address where timer interrupt occurred.

Insert LRET at the end of the subroutine to return to the main program.

Notes for Using Timer Interrupt and Interrupt Inputs:

- When using a timer interrupt or interrupt input, separate the interrupt program from the main program using the END instruction at the end of the main program.
- When an interrupt program calls another subroutine, a maximum of 3 subroutine calls can be nested. If more than 3 calls are nested, a user program execution error occurs, turning on special internal relay M8004 and the ERR LED.
- When using a timer interrupt or interrupt input, include the label number of the interrupt program to be executed when an interrupt occurs. The label numbers stored in data registers D8032 through D8035, D8037, and D8038 specify the interrupt programs for interrupt inputs I0, I2, I3, and I5 through I7 and timer interrupt, respectively.
- If an interrupt is initiated while another interrupt program is executed, the subsequent interrupt program is executed after the prior interrupt is completed. Multiple interrupt programs cannot be executed simultaneously.
- Make sure that the execution time of the interrupt program is shorter than interrupt intervals sufficiently.
- Interrupt programs cannot use the following instructions: SOTU, SOTD, TML, TIM, TMH, TMS, TMLO, TIMO, TMHO, TMSO, CNT, CDP, CUD, CNTD, CDPD, CUDD, SFR, SFRN, WEEK, YEAR, MSG, DI, EI, XYFS, CVXTY, CVYTX, AVRG, PULS, PWM, RAMP, ZRN, ARAMP, DTML, DTIM, DTMH, DTMS, TTIM, FIFOF, NDSRC, HOUR, TXD, RXD, ETXD, ERXD, DLOG, TRACE, and SCRPT.

Forced I/O

Inputs can be forced on/off regardless of the status of physical inputs, and outputs can be forced on/off regardless of the ladder logic using the forced I/O function in WindLDR. The force input function can be used in monitor or online edit mode to test the ladder logic without the need of wiring the input terminals or turning on the actual inputs. The force output function can be used to turn on/off the outputs to the external devices.

⚠ Caution

- The forced I/O may cause unexpected operation of the SmartAxis. Make sure of safety before forcing inputs or outputs.

Devices

All the inputs and outputs of the SmartAxis can be forced on/off individually.

Type	Device Range	
	Inputs	Outputs
12-I/O type	I0 to I7	Q0 to Q3
24-I/O type	I0 to I17, I40 to I75, I80 to I115, I120 to I155	Q0 to Q7, Q40 to Q61, Q80 to Q101, Q120 to Q141
40-I/O type	I0 to I27, I40 to I75, I80 to I115, I120 to I155	Q0 to Q17, Q40 to Q61, Q80 to Q101, Q120 to Q141
48-I/O type	I0 to I35, I40 to I75, I80 to I115, I120 to I155	Q0 to Q21, Q40 to Q61, Q80 to Q101, Q120 to Q141

Forced I/O Status

Events of the SmartAxis and effects on the forced I/O settings are shown below.

Events	Forced I/O Status
When the SmartAxis starts running	The force settings are retained. The forced inputs and outputs are kept on/off even after the SmartAxis is stopped, regardless of the status of M8025 (maintain outputs while SmartAXIS is stopped).
When the SmartAxis is stopped.	
When the SmartAxis is powered up	The force settings are retained, but the force is suspended. If the battery is dead, the force settings are cleared.
When user program download is executed	The force settings are retained, and whether the force will be suspended or not can be selected in the Download Program dialog box.
When Reset Input is turned on	The force settings are cleared.
When Clear All Devices is executed in the PLC Status dialog box of WindLDR	
When the system software download is executed	

Note: Force function has no effect on high-speed counters, catch inputs, or interrupt inputs. The stop or reset input can be initiated using the force function, but the force settings will be cleared as soon as the reset input is turned on.

Checking the Forced I/O Function Execution State

The state of the forced I/O function (running or stopped) can be checked with WindLDR, with the SmartAxis module power/run status LED (SmartAxis Lite only), or with the RUN or STOP screen on the module's LCD (SmartAxis Pro only). The forced I/O function execution state while stopped cannot be checked with the module's power/run status LED. For the power/run status LED, see Chapter 2 "Product Specifications" on page 2-1.

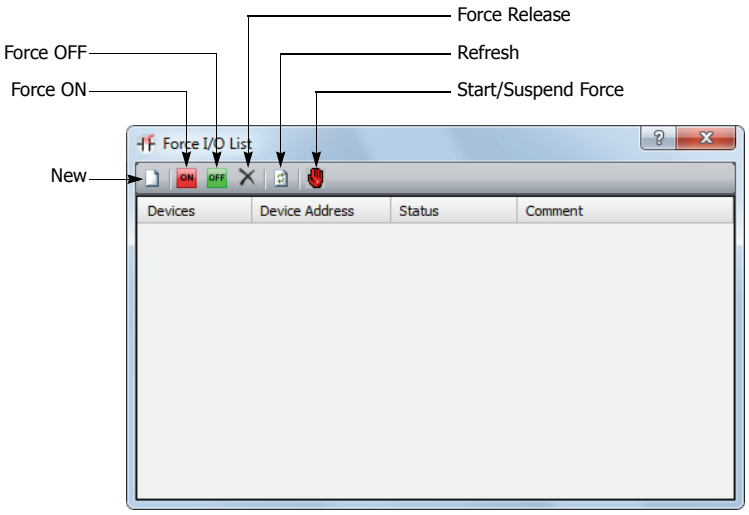
Programming WindLDR

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

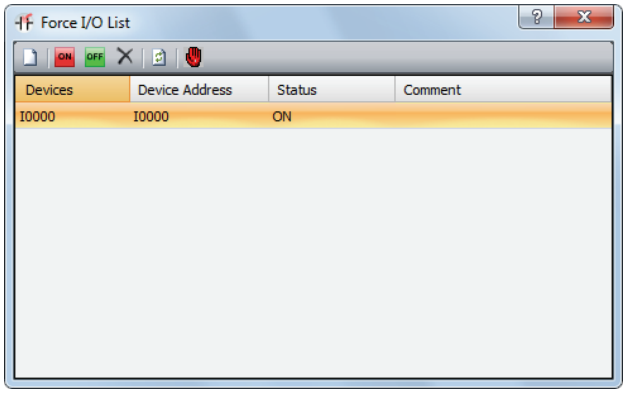
Online mode is activated.

2. From the WindLDR menu bar, select **Online** > **Forced I/O**.

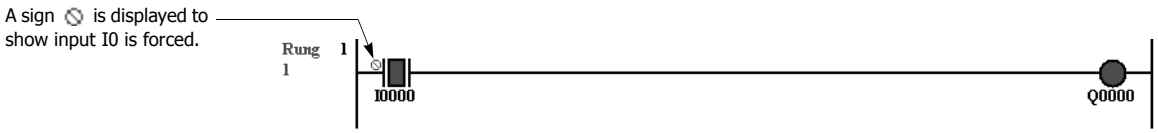
The Forced I/O List dialog box appears and shows a list of forced inputs and outputs. I/O numbers and force I/O statuses can be specified in this dialog box.



3. Click the New button and type an input or output number under Device in the list.
Click the Force On button or Force Off button to force on or off the designated input or output.

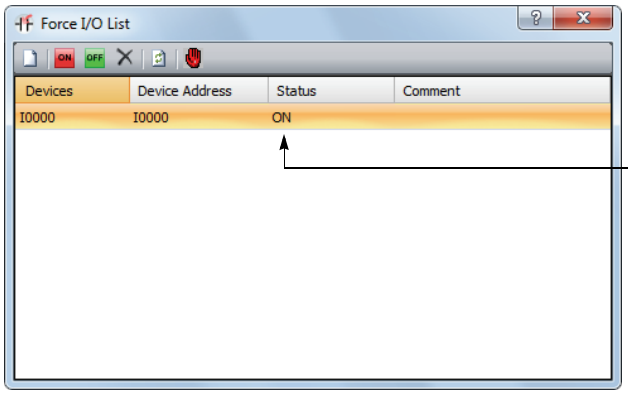


4. To start the forced I/O function, click the Start/Suspend Force button .



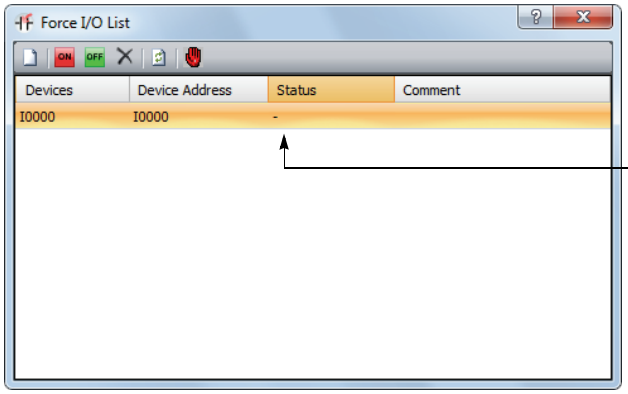
The forced I/O can be suspended temporarily by clicking the Start/Suspend Force button again.

5. To suspend the forced I/O, click the Start/Suspend Force button .



The forced inputs or outputs remain designated until the forced I/O designation is released.

6. To release the forced I/O designation, click the Force Release button .



Now input I0 works as a normal input.

Note: Make sure that all the forced inputs and outputs are released when the test using the forced I/O function is finished. Select **Delete All** from the right click menu in the Forced I/O List dialog box to release all the forced inputs and outputs at once.

Communication Ports

This section describes how to connect the SmartAxis to peripheral devices and how to communicate with them.

The SmartAxis is equipped with a USB port, expansion communication ports (RS232C and RS485), and an Ethernet port. The SmartAxis can communicate with connected devices via maintenance communication, user communication, Modbus communication, and remote I/O by configuring the port and communication method for connected devices.

- **Communication ports**

All models are equipped with a USB port. The 24-, 40-, and 48-I/O types are equipped with expansion communication ports and they can be used by equipping the optional RS232C or RS485 communication cartridges. The 24-, 40-, and 48-I/O types are equipped with an Ethernet port.

USB port	Maintenance communication can be performed by connecting the SmartAxis and a PC with a USB cable.
Ethernet port	The SmartAxis can communicate with Ethernet-compatible devices such as PCs and operator interfaces. Maintenance communication, user communication, Modbus communication, and remote I/O are all possible.
Expansion communication ports	Maintenance communication, user communication, and Modbus RTU communication are all possible.

- **Communication functions**

For details on the communications functions, see the chapter for each function.

Maintenance communication (Chapter 9)	Maintenance communication enables you to check the operating status and I/O status of the SmartAxis, monitor and change device values, and download and upload user programs using a PC or operator interface.
User communication (Chapter 10)	The SmartAxis can communicate with external devices equipped with RS232C, RS485, or Ethernet ports using user communication.
Modbus communication (Chapter 11)	The SmartAxis can send and receive data with Modbus compliant devices on RS232C, RS485, or Ethernet port.
Remote I/O (Chapter 12)	The number of digital inputs and outputs and analog inputs of the SmartAxis can be expanded by connecting separate SmartAxis modules to the SmartAxis as remote I/O slaves over Ethernet.

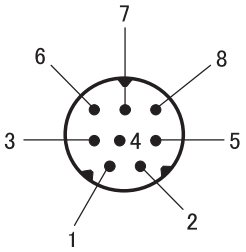
Communication Ports and Communication Methods

The communication methods supported by each communication port are as follows.

Communication Mode		USB Port	Expansion Communication Port (port 2, 3)		Ethernet Port
			RS232C	RS485	
Maintenance communication	**System software downloads**	Yes	No	No	No
	User program downloads/uploads		No	No	Yes
	Monitoring/changing devices		Yes	Yes	Yes
User communication		No	Yes	Yes	Yes
Modbus RTU	**Master**	No	Yes	Yes	No
	Slave				
Modbus TCP	**Client**	No	No	No	Yes
	Server				
Remote I/O	**Master**	No	No	No	Yes
	Slave				

Expansion Communication Port Wiring Diagram

The mini-DIN connector pin assignments and signal names are as follows.



RS232C (FT1A-PC1)

Pin Number	Signal Name		Cable Color	Signal Direction	Peripheral Device (D-SUB)
Cover	Port 2	Port 3	Shield	—	RS232C
1	RS (RTS)	RS (RTS)	Black	→	(DR)
2	ER (DTR)	ER (DTR)	Yellow	→	(CTS)
3	SD (TXD)	SD (TXD)	Blue	→	RD
4	RD (RXD)	RD (RXD)	Green	←	SD
5	DR (DSR)	DR (DSR)	Brown	←	RS
6	SG	SG	Gray	None	SG
7	SG	SG	Red		SG
8	NC	NC	White		NC

RS485 (FT1A-PC2)

Pin Number	Signal Name		Cable Color	Signal Direction	Peripheral Device (D-SUB)
Cover	Port 2	Port 3	Shield	—	RS485
1	A	A	Black	←→	A
2	B	B	Yellow	←→	B
3	NC	NC	Blue		NC
4			Green		
5			Brown		
6			Gray		
7	SG	SG	Red	—	SG
8	NC	NC	White	None	NC

Note: Do not connect cables to NC. There is a risk of malfunction or failure.

Programming WindLDR

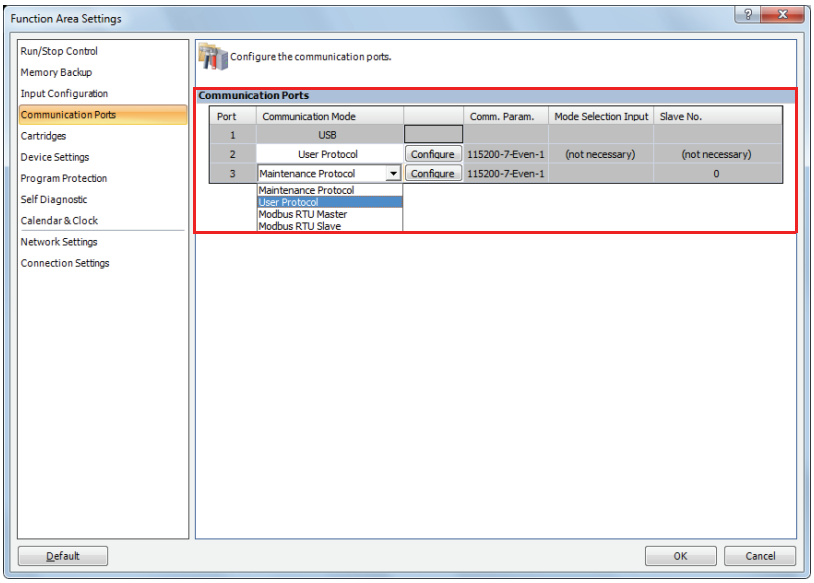
Configure the communication format according to the communication specifications of the peripheral device.

1. From the WindLDR menu bar, select **Configuration** > **Comm**. **Ports**.

The Function Area Settings dialog box is displayed.

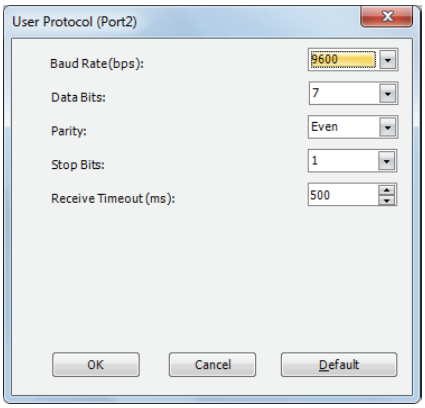
2. In the **Communication Mode** pull-down list for the appropriate port, select the communication mode.

The configuration dialog that corresponds to the communication mode is displayed.



3. Change the settings on the configuration dialog according to the communication format for the destination device.

A user communication example is shown below.



4. Click **OK**.

This concludes configuring the settings.

Memory Cartridge

This section describes the memory cartridge used to save SmartAxis user programs.

A user program can be saved on the memory cartridge. Insert a memory cartridge into the SmartAxis and the user program on that memory cartridge is subject to priority execution over the user program in the SmartAxis module's ROM. If a user program is not saved to the memory cartridge, the user program in the SmartAxis module's ROM is executed.

Memory Cartridge	User Program to Execute
Equipped	The user program on the memory cartridge is executed.
Not equipped	The user program in the SmartAxis module's ROM is executed.

Specifications

Name	Function/Purpose	Model Number
Memory cartridge	User program save memory (One user program can be saved)	FT1A-PM1

Downloading and uploading user programs

The user program on the memory cartridge can be downloaded to the SmartAxis module when the SmartAxis is powered with the function area settings. Or when uploading to the memory card is configured with WindLDR, the user program can be uploaded to the memory cartridge inserted in the SmartAxis.

For the SmartAxis Pro, the user program on the memory cartridge can be downloaded to the SmartAxis Pro module with the LCD and operation buttons on the module itself, and the user program on the SmartAxis Pro module can also be uploaded to the memory cartridge.

Notes:

- Always turn the SmartAxis off before removing or installing a memory cartridge. If the memory cartridge is inserted or removed with the power on, SmartAxis operation cannot be guaranteed. There is a risk of the product failing.
- The memory cartridge may break if dropped. Take care not to drop it when removing it.

SmartAxis system software version

If the user program on the inserted memory cartridge includes instructions or functions not supported by the SmartAxis module's system software, a program error will occur. Update the SmartAxis module's system software to the latest version with WindLDR.

Download Settings

The user program on the memory cartridge will be downloaded to the SmartAxis module. If a user program already exists on the SmartAxis module, that user program is deleted and the downloaded proceeds.

First configure the user program to automatically download to the SmartAxis module in the WindLDR function area settings, then download the user program to the memory cartridge. When a memory cartridge configured with download settings is inserted into the SmartAxis and the power is turned on, the user program on the memory cartridge is automatically downloaded to the SmartAxis. For the SmartAxis Pro, the user program can also be downloaded using the LCD and operation buttons on the module itself.

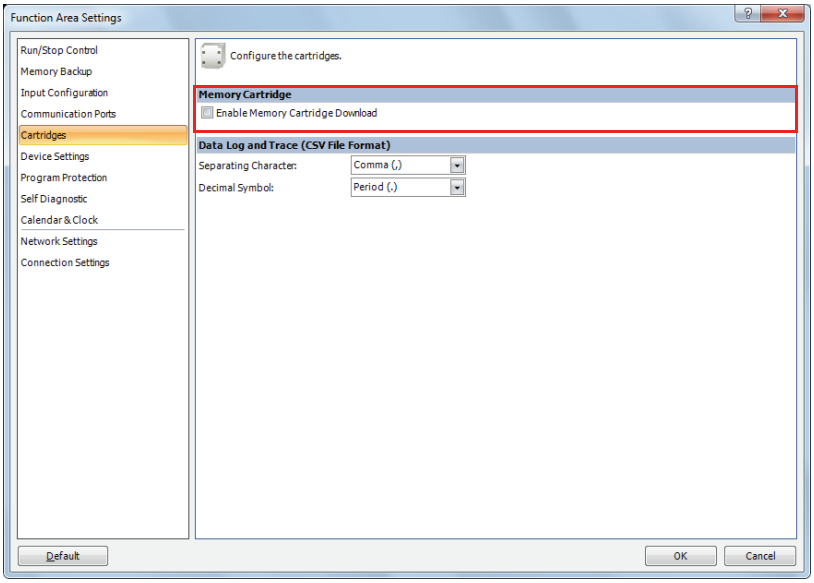
Programming WindLDR

Insert the memory cartridge to configure with download settings into the SmartAxis, turn the power on, and then connect the SmartAxis to the PC (WindLDR).

1. From the WindLDR menu bar, select **Configuration** > **Cartridge**.

The Function Area Settings dialog box is displayed.

2. Select the **Enable memory cartridge download** check box.



3. Click **OK**.

This concludes configuring the settings for the memory cartridge to download the user program to the SmartAxis.

4. Download the user program from the memory cartridge that is inserted in the SmartAxis.
5. Turn off the SmartAxis power and remove the memory cartridge.
6. Insert the memory cartridge into the SmartAxis that you want to download the user program to and turn the power on.

The user program on the memory cartridge is automatically downloaded to the SmartAxis module.

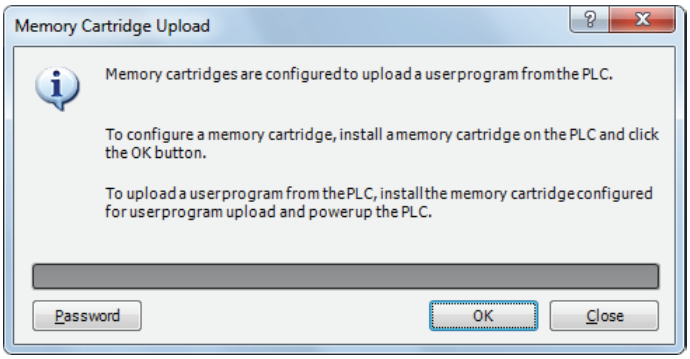
Upload Settings

The SmartAxis module user program can be uploaded to the memory cartridge. First configure the settings for the memory cartridge to automatically upload the user program from the SmartAxis module in WindLDR. If a user program already exists on the memory cartridge, the user program on the memory cartridge is deleted and the upload settings are configured. When a memory cartridge configured with upload settings is inserted in the SmartAxis and the power is turned on, the user program on the SmartAxis module is automatically uploaded to the memory cartridge. The upload to the memory cartridge configured with upload settings is valid only one time. To upload the user program again, configure the settings for the memory cartridge to automatically upload the user program. For the SmartAxis Pro, the user program on the SmartAxis module can be uploaded to the memory cartridge with the LCD and operation buttons on the module itself. If a user program already exists on the memory cartridge, the user program on the memory cartridge is deleted and the user program is uploaded.

Programming WindLDR

1. Insert the memory cartridge to configure with upload settings into the SmartAxis, turn the power on, and then connect the SmartAxis to the PC (WindLDR).
2. From the WindLDR menu bar, select **Online** > **Upload** > **Memory Cartridge Upload**.

The Memory Cartridge Upload dialog box is displayed.



Note: If the user program on the SmartAxis to upload is password protected, click **Password** and enter the password.

3. Click **OK**.

The user program on the memory cartridge is deleted at this time.

4. Turn off the SmartAxis power and remove the memory cartridge.

This concludes configuring the settings for the memory cartridge to upload the user program from the SmartAxis.

5. Insert the memory cartridge with the completed upload settings into the SmartAxis and turn the power on.

The user program is automatically uploaded from the SmartAxis module to the memory cartridge.

Notes:

In the following situations, a memory cartridge transfer error will occur. If the error occurs, the user program is not uploaded to the memory cartridge, and SmartAxis operation stops.

- When the SmartAxis user program upload protection is set to **Prohibited**
- When the SmartAxis user program password protection is set and the memory cartridge password does not match

For user program protection, see "User Program Protection" on page 5-55.

User Program Passwords

When password protection is configured for the SmartAxis module user program, uploads and downloads only happen when the password configured for the memory cartridge and the SmartAxis module user program password match.

For user program protection, see "User Program Protection" on page 5-55.

Type	Password match	Password does not match
SmartAxis Pro	Enter the password with the module's LCD and operation buttons.	Enter the password with the module's LCD and operation buttons.
SmartAxis Lite	Automatic upload/download	Automatic upload/download not possible

SD Memory Card

This section describes how to save log data to the SD memory card.

The 40- and 48-I/O type SmartAxis is equipped with an SD memory card slot and it can use SD memory cards (32 GB max). Device values (log data) can be output to the SD memory card as CSV files using the DLOG (data log) instruction and the TRACE (data trace) instruction. This enables log data to be saved and data to be analyzed when problems occur. The contents of the files saved to the SD memory card can be checked on a PC. The files saved to the SD memory card can also be uploaded using WindLDR.

Function	Description	Reference
Save log data	Specified device values can be saved to the SD memory card as CSV files using the DLOG and TRACE instructions.	5-52
SD memory card maintenance with WindLDR	The SD memory card data can be read to a PC or deleted by using WindLDR. SD memory card data can be managed and checked.	5-53
Format SD memory card with the SmartAxis	The SD memory card can be formatted using the LCD and operation buttons on the module. (SmartAxis Pro only)	5-54

For the SD memory card hardware specifications, see Chapter 2 "SD Memory Card" on page 2-21.

Notes:

- Set the write-protect switch on the SD memory card to the off position before inserting it.
- Insert and remove the SD memory card in the direction indicated on the SmartAxis module.
- Do not remove the SD memory card while it is being accessed. There is a risk of damage to the SD memory card and the data stored on it.

Save Log Data

Using the DLOG (data log) instruction and the TRACE (data trace) instruction, specified device values will be saved to the SD memory card as log data (CSV files). The DLOG instruction outputs the date and time and the values of the specified devices to the CSV file in the specified folder. The TRACE instruction outputs the date and time and the values for the previous number of scans for the specified devices to the CSV file in the specified folder. For details, see Chapter 26 "Data Log Instructions" in the FT1A Series Ladder Programming Manual.

The SmartAxis cannot write data to the SD memory card when its write-protect switch is on. Always set the SD memory card's write-protect switch to off before inserting it in the SmartAxis.

- **CSV file output sample with the DLOG instruction**

Time	D0010	D0011
2011/09/07 15:40:00	12345	1
2011/09/07 15:41:00	1212	3
2011/09/07 15:42:00	345	4

- **CSV file output sample with the TRACE instruction**

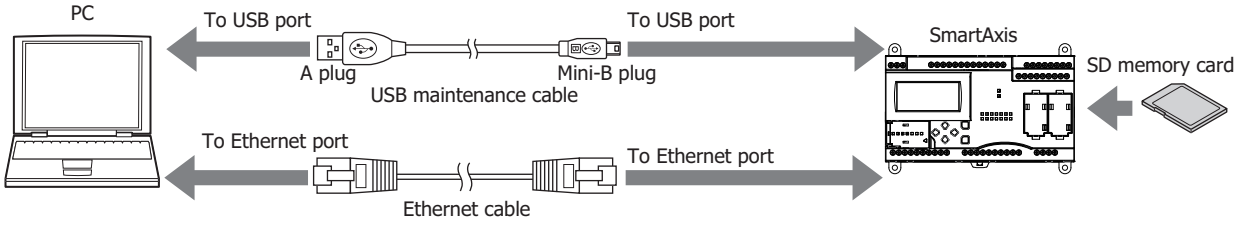
Triggered at:	2011/09/07 15:40		
Scan	D0010	D0011	D0012
Old	1	9	17
	2	10	18
New	3	11	19

SD Memory Card Maintenance with WindLDR

You can check a list of the CSV files saved to the SD memory card inserted in the SmartAxis by using the WindLDR Memory Card Viewer. Using the Memory Card Viewer, you can upload or delete the specified CSV files and format the SD memory card.

To manage and check the data on the SD memory card inserted into the SmartAxis using the Memory Card Viewer, connect the PC and the SmartAxis with either of the following methods.

- Connect the USB port on the PC and the USB port on the SmartAxis with the USB maintenance cable.
- Connect the Ethernet port on the PC and the Ethernet port on the SmartAxis with an Ethernet cable.

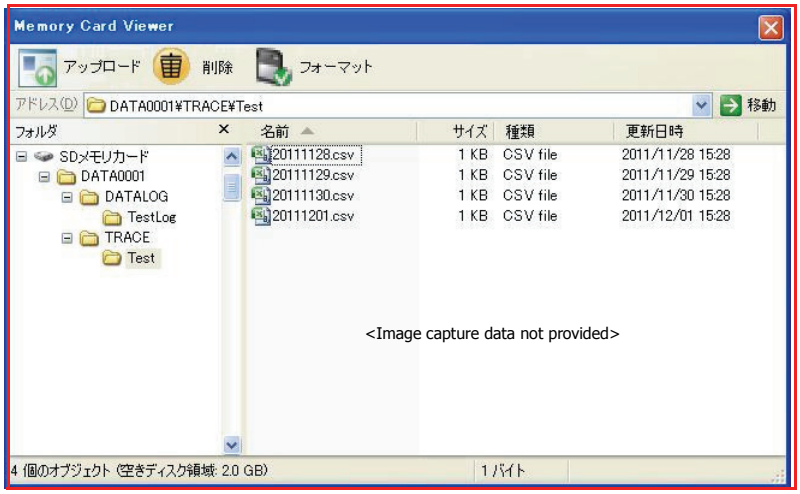


Uploading Log Data

Upload the log data on the SD memory card inserted in the SmartAxis with the WindLDR Memory Card Viewer.

1. From the WindLDR menu bar, select **Online** > **PLC** > **SD Memory Card**.

The Memory Card Viewer opens.



2. Select the CSV file you wish to upload and click **Upload**.

The Save As dialog is displayed.

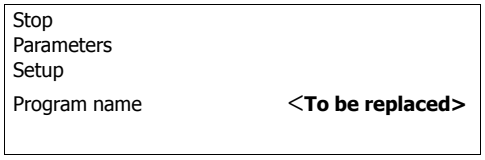
3. Check the file name and click **Save**.

The data on the SD memory card inserted into the SmartAxis is uploaded to the PC.

Format SD Memory Card with the SmartAxis

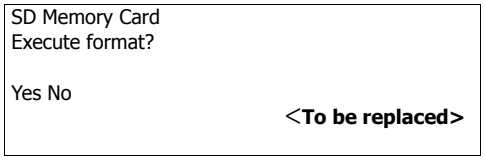
With the SmartAxis Pro, you can format the SD memory card inserted in the SmartAxis by using the LCD and operation buttons on the SmartAxis module.

1. Insert the SD memory card into the SD memory card slot on the SmartAxis.
2. The maintenance screen is displayed.



3. Using the operation buttons, select **Memory Card** > **SD Card** > **Format**.

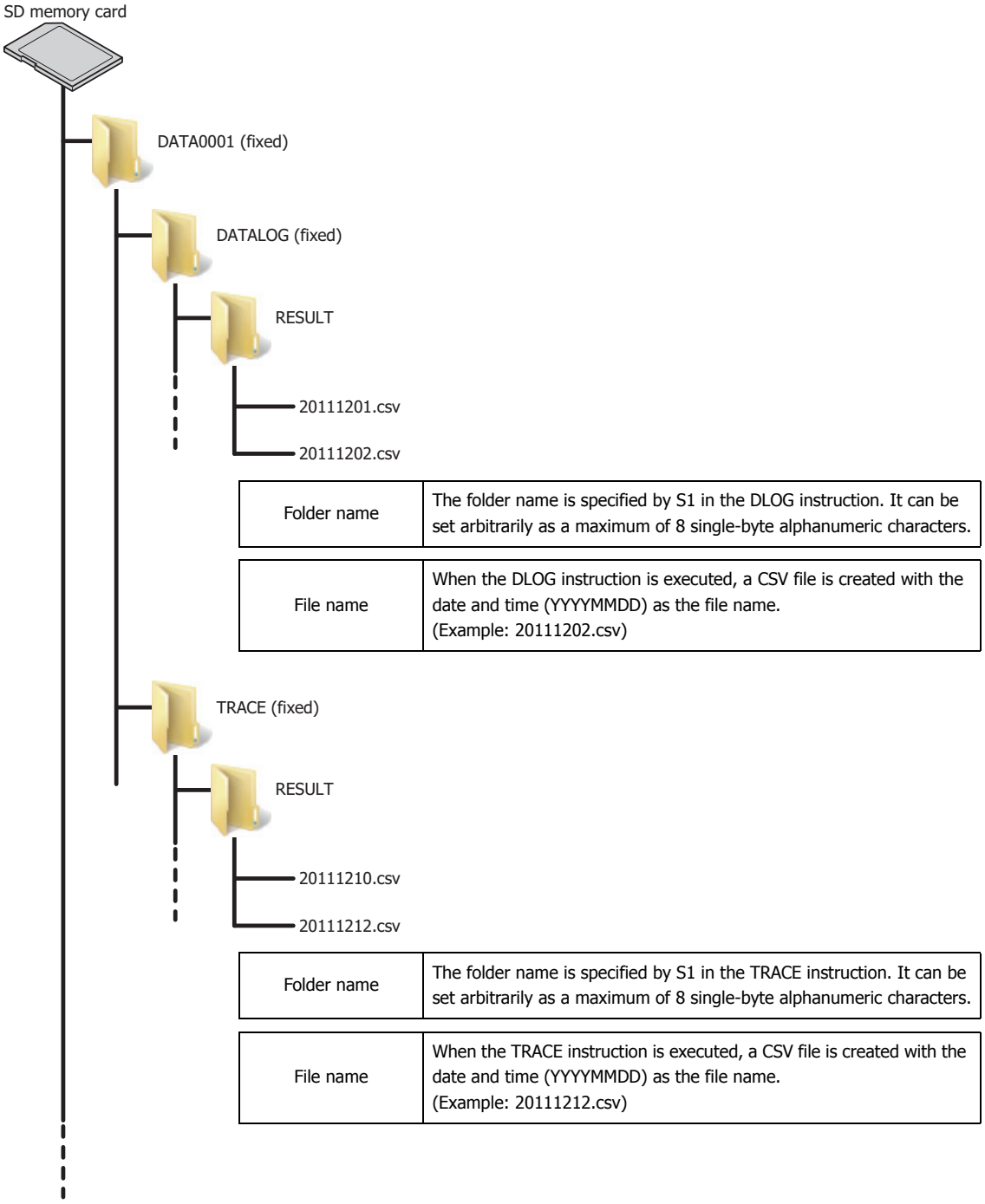
4. A confirmation screen to determine whether or not you want to format the SD memory card is displayed. Select **Yes**.
   The SD memory card is formatted.



5. The SD memory card has been formatted.
   Now you can save log data to the SD memory card.

File Structure

The save destination for log data varies based on the instruction. For the DLOG (data log) instruction, the files are saved at the bottom level under the DATALOG folder. For the TRACE (data trace) instruction, the files are saved at the bottom level under the TRACE folder. The folder name is specified for both the DLOG instruction and the TRACE instruction.



Folder name	The folder name is specified by S1 in the DLOG instruction. It can be set arbitrarily as a maximum of 8 single-byte alphanumeric characters.
File name	When the DLOG instruction is executed, a CSV file is created with the date and time (YYYYMMDD) as the file name. (Example: 20111202.csv)

Folder name	The folder name is specified by S1 in the TRACE instruction. It can be set arbitrarily as a maximum of 8 single-byte alphanumeric characters.
File name	When the TRACE instruction is executed, a CSV file is created with the date and time (YYYYMMDD) as the file name. (Example: 20111212.csv)

SD Memory Card Status LED and SD Memory Card States

The status LED turns on or flashes when the SD memory card is being formatted or during reading and writing.

SD memory card status LED	SD memory card state	Operation
On	The standby state where the SD memory card can be written or read	The SD memory card can be removed.
Slow flashing (1 second interval)	• When the SmartAxis is recognizing the SD memory card • When the SmartAxis is stopping access due to SD memory card access stop flag (M8076) turning on (slow flashing, then off)	Do not remove the SD memory card.
Rapid flashing (100 millisecond interval)	Reading or writing to the SD memory card	
Off	• When the SD memory card is not inserted • When an unsupported or unformatted SD memory card was inserted • When access to the SD memory card was stopped by SD memory card access stop flag (M8076) • When the SmartAxis power is off	The SD memory card can be removed.

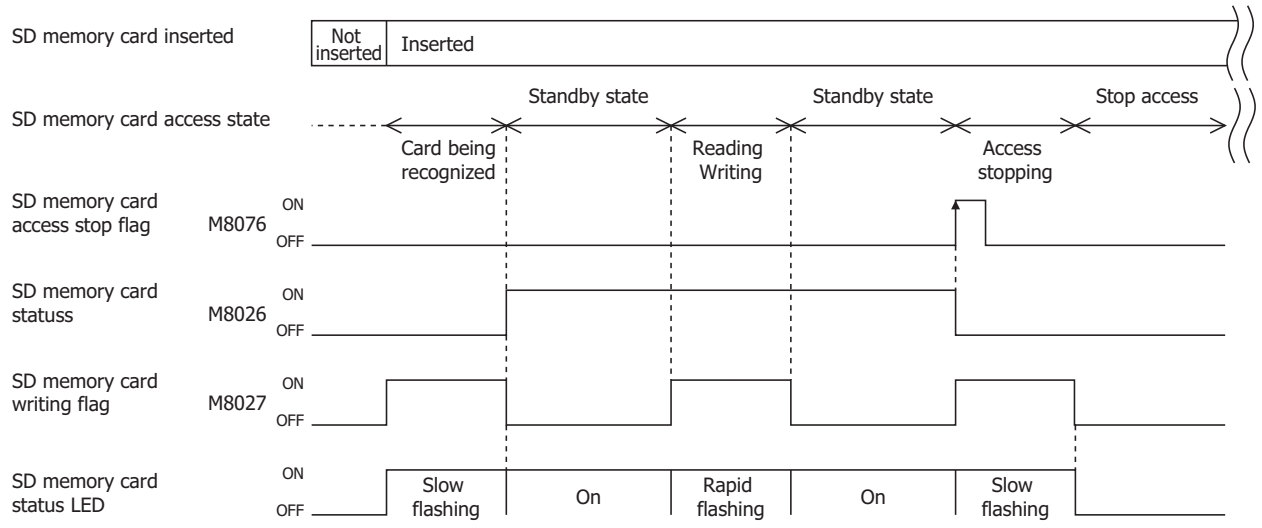
Special Internal Relays for the SD Memory Card

The special internal relays (M8026, M8027) turn on and off according to the whether or not the SD memory card is inserted and the access state. Access to the SD memory card is stopped by special internal relay M8076.

Address	Function	Description	Read/Write
M8026	SD Memory Card Status	This special internal relay turns on when the SD memory card has been inserted into the SmartAxis, the card has been recognized, and the card is in a usable state. This special internal relay turns off when the SD memory card is not inserted or when the SD memory card is not recognized.	R
M8027	SD Memory Card Writing Flag	This special internal relay turns on when the SD memory card is being accessed. This special internal relay turns off when the access has finished.	
M8076	SD Memory Card Access Stop Flag	When this special internal relay changes from off to on, access to the SD memory card is stopped. To make an SD memory card accessible that has had access to it stopped, insert the card into the SmartAxis once again.	R/W

Timing Chart

The special internal relays turn on and off according to the whether or not the SD memory card is inserted and the access state as shown below.



32-bit Data Storage Setting

When the double-word, long, or float data type is selected for the source or destination device, the data is loaded from or stored to two consecutive data registers. The order of two devices can be selected from the following two settings in the Function Area Settings.

Setting	Description
From Upper Word (Default)	When a data register, timer, or counter is used as a double-word device, the high-word data is loaded from or stored to the first device selected. The low-word data is loaded from or stored to the subsequent device. This is identical with the 32-bit data storage of OpenNet Controller and FC4A/FC5A MicroSmart.
From Lower Word	When a data register, timer, or counter is used as a double-word device, the low-word data is loaded from or stored to the first device selected. The high-word data is loaded from or stored to the subsequent device.

Devices

When the devices listed below are used as a double-word device, two consecutive devices are processed according to the 32-bit data storage settings.

Device	Device Address
Data Register	D0 - D1999
Special Data Register	D8000 - D8199
Timer	T0 - T199
Counter	C0 - C199

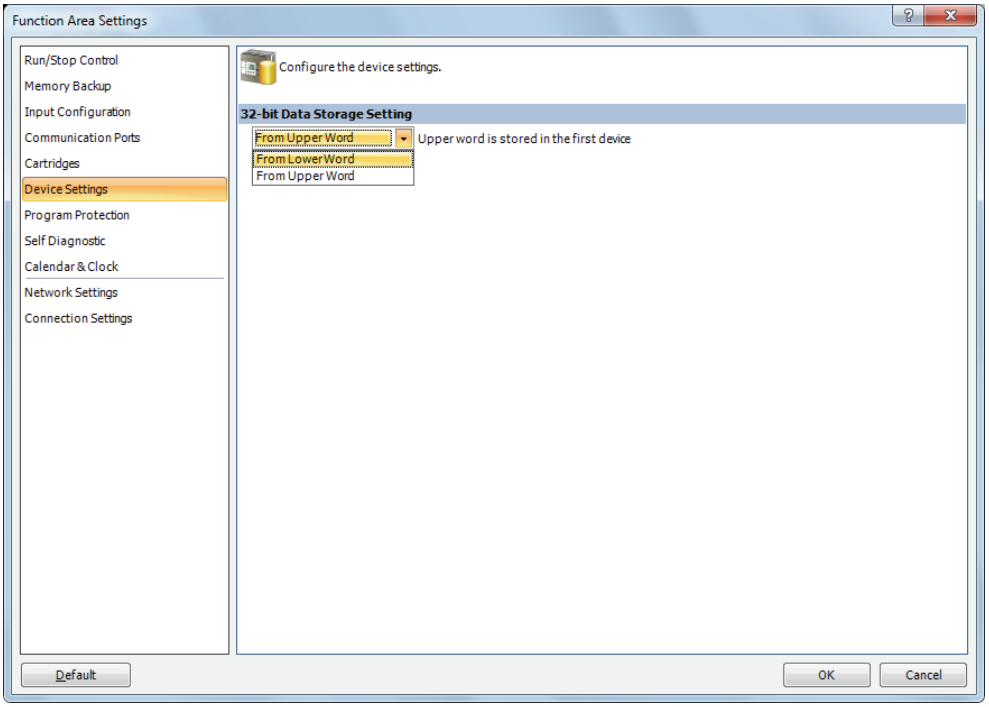
Data : The following data composed of 32 bits is subject to this setting.

- Device values of advanced instructions with the data processing units D (double word), L (long), F (float)
- Pulse output preset values and current values
- High-speed counter function current values, preset values, and reset values
- Frequency measurement values in frequency measurement
- Double word counter instruction preset values

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Device Settings**.

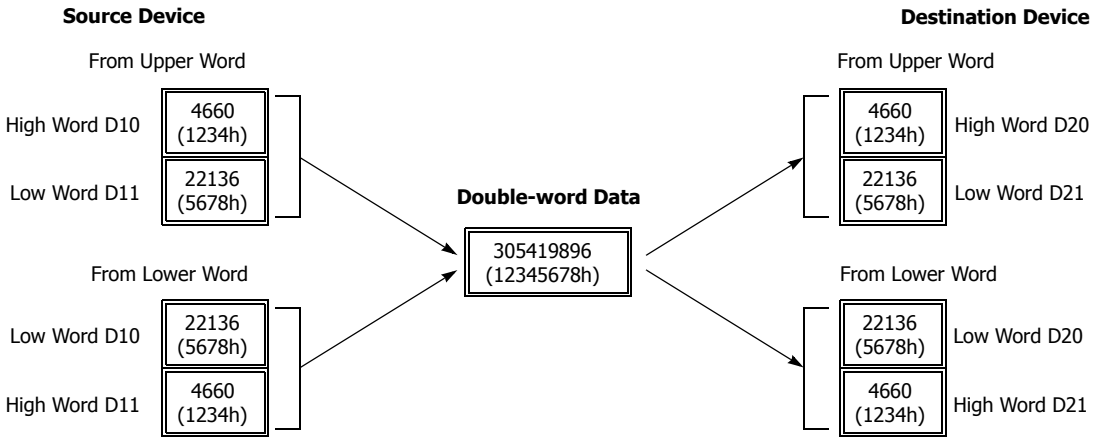
The Function Area Settings dialog box for Device Settings appears.



2. Under **32-bit Data Storage Setting**, select **From Upper Word** or **From Lower Word** in the pull-down list.

Example: 32-bit Data Storage Setting

When data register D10 is designated as a double-word source device and data register D20 is designated as a double word destination device, the data is loaded from or stored to two consecutive devices according the 32-bit data storage setting as illustrated below.



User Program Protection

With user program protection, you can apply protection against user program editing by the LCD and operation buttons on the SmartAxis module (SmartAxis Pro only) and against uploading and downloading user programs with WindLDR. This enables you to prevent third parties from altering, deleting, or stealing your SmartAxis user programs.

User program protection can be individually configured for user program uploads and downloads and for editing user programs with the LCD and operation buttons on the module. There are three types of protection modes, which are detailed as follows.

Mode	Description
Unprotected	The user program is unprotected.
Password protected	A password must be entered when downloading or uploading the user program. The password is single-byte alphanumeric characters (8 characters max), and one password can be configured for one user program. When applying password protection to both user program uploads and downloads, the same password is used.
Prohibited	The user program cannot be uploaded. **Prohibited** protection can only be configured for user program uploads. User program downloads cannot be prohibited.

If the user program is protected, you will be prompted to enter your password when executing a download or an upload. The download or upload can be executed by entering the correct password.

Note: Protection is also enabled when transferring user programs between the memory cartridge and the SmartAxis.
For the SmartAxis Lite, the password for the user program on the memory cartridge and the password for the user program on the SmartAxis must match. For the SmartAxis Pro, the password must be entered with the LCD and operation buttons on the module.

Warning

- Before 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 SmartAxis is write- or read/write-protected, the user program cannot be changed without the protect code.

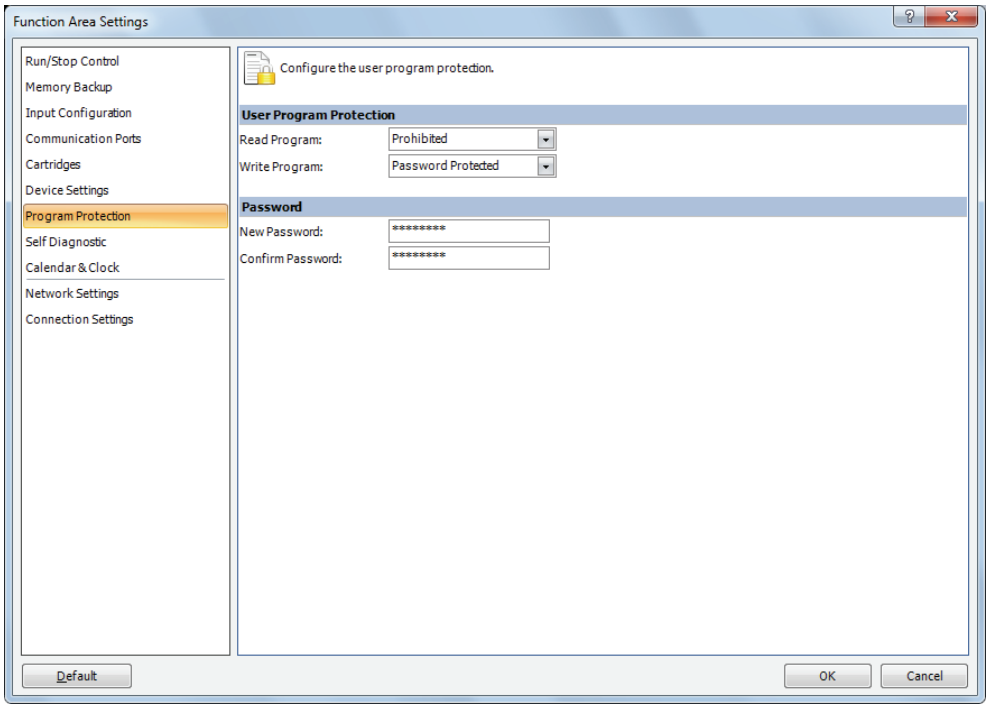
Caution

- If the user program is read-protected without using a password, the read protection cannot be temporarily disabled using the password, thus the user program cannot be read out by any means. To disable the read protection, download another user program without user program protection.

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Program Protection**.

The Function Area Settings dialog box for Program Protection appears.



2. Under **User Program Protection**, select required protect modes for **Read Program** and **Write Program** in the pull-down list.

Unprotected:	The user program in the SmartAXIS can be read and written without a password.
Password Protected:	Prevents unauthorized copying or inadvertent replacement of the user program. The protection can be temporarily disabled using a predetermined password.
Prohibited:	Prevents copying of the user program completely. This option is available for read protection only and can not be temporarily disabled using a password.

3. After selecting a required protect mode, enter a password of 1 through 8 ASCII characters from the key board in the **New Password** field, and enter the same password in the **Confirm Password** field.
4. Click the **OK** button and download the user program to the SmartAxis after changing any of these settings.

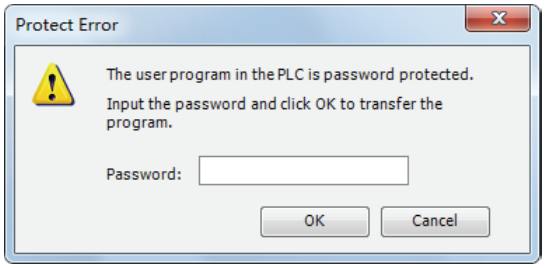
Disabling Protection

When the user program is password-protected against read and/or write, the protection can be temporarily disabled using WindLDR.

If the user program is read-prohibited, the read protection cannot be disabled, thus the user program cannot be read out by any means. To disable the read protection, download another user program without user program protection.

1. From the WindLDR menu bar, select **Online** > **Download or Upload**.

When the user program in the SmartAXIS is read and/or write protected, the Protect Error dialog box appears. When program verification or online edit is attempted, the Protect Error dialog box appears.



2. Enter the password and click the **OK** button.

The user program protection is disabled only temporarily. When the SmartAXIS is powered up again, the protection designated in the user program takes effect again.

To disable or change the protection permanently, change the protection settings and download the user program.

Watchdog Timer Setting

This section describes watchdog timer setting.

A watchdog error occurs when the processing time for one scan exceeds the allowed time while the user program is running.

If a watchdog error occurs, the system is reset with the purpose of returning the system to normal operation.

If the watchdog error occurs frequently, you can assume that there is a hardware problem and that the SmartAxis requires replacement.

Some of the reasons why a watchdog timer will occur are problems with the SmartAxis hardware and the length of the processing time in the ladder logic program. If the processing time for one scan of the ladder logic program exceeds the time configured for the watchdog timer, place a NOP (no operation) instruction in the ladder logic program. The watchdog timer is reset when the NOP instruction is executed.

Watchdog timer setting time

The watchdog timer setting time can be changed in the function area settings. Decide on the watchdog timer setting time in either of the following two ways.

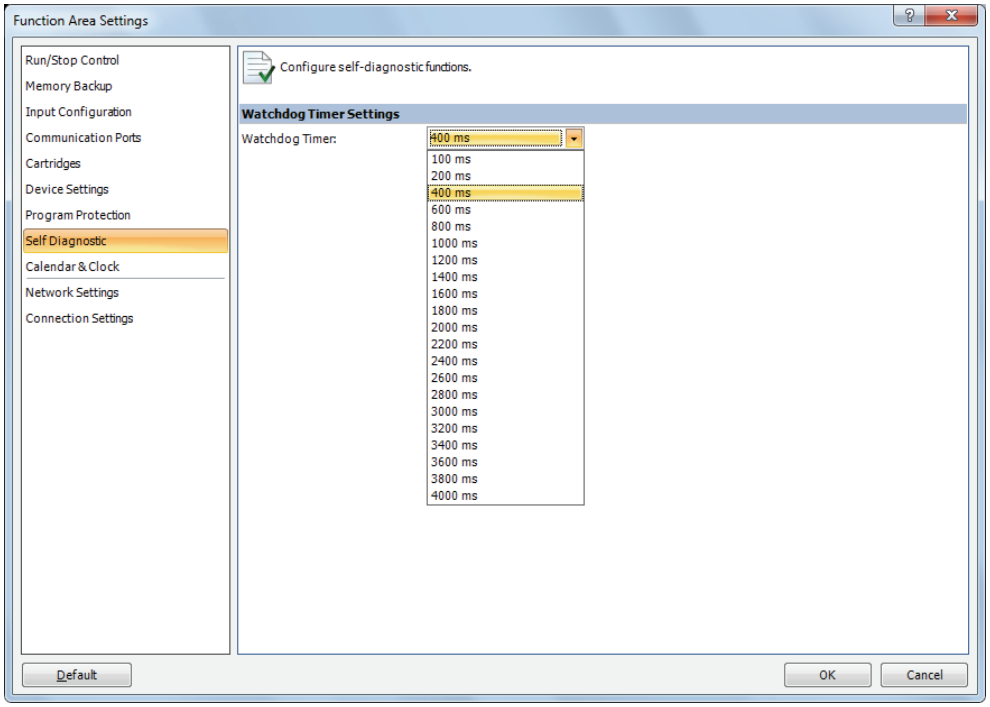
- **Decide by user system specification**
  Determine the maximum on time (milliseconds) so the output signals do not stay on if the SmartAxis loses control and set that value as the watchdog timer setting time. However, if the ladder logic program processing time takes longer than the design specification, use a NOP (no operation) instruction in the ladder logic program. For example, when the watchdog timer is set to 100 ms and the maximum value for one scan is 500 ms, insert five NOP instructions in the ladder logic program to ensure that the error does not occur.
- **Match the ladder logic program processing time**
  Check the maximum value for one scan (D8024) and set the watchdog timer value as a value with a safety margin added to the maximum value.

Note: When changing the watchdog timer setting value, select an appropriate value that fully takes into consideration the safety of the system. The maximum value of one scan while the SmartAxis is running can be checked with special data register D8024.

Programming WindLDR

1. Select **Configuration** from the WindLDR menu bar, and then click **Self Diagnostic**.

The Function Area settings dialog box appears.



Watchdog timer Settings

Select the watch dog timer setting between 100 ms and 4000 ms. The default time is 400 ms.

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 ms.

The scan time error is ±1 ms 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.

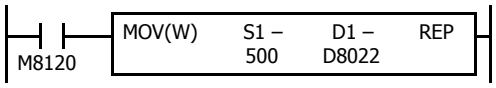
Special Data Registers for Scan Time

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 ms)
D8023	Scan Time Current Value (ms)
D8024	Scan Time Maximum Value (ms)
D8025	Scan Time Minimum Value (ms)

Example: Constant Scan Time

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



M8120 is the initialize pulse special internal relay.

When the SmartAXIS starts operation, the MOV (move) instruction stores 500 to special data register D8022.

The scan time is set to a constant value of 500 ms.

Daylight Savings Time

This section describes the function that automatically adjusts the SmartAxis time according to the daylight savings time settings.

For regions where the SmartAxis is used that implement daylight savings time, this function can automatically adjust the SmartAxis clock using the daylight savings time settings. When the time becomes the daylight savings time start time, the clock is set an hour forward. When the time becomes the the daylight savings time end time, the clock is set an hour back.

The SmartAxis adjusts the clock for daylight savings time on the start day and the end day. However, the clock is also adjusted for daylight savings time under the following conditions.

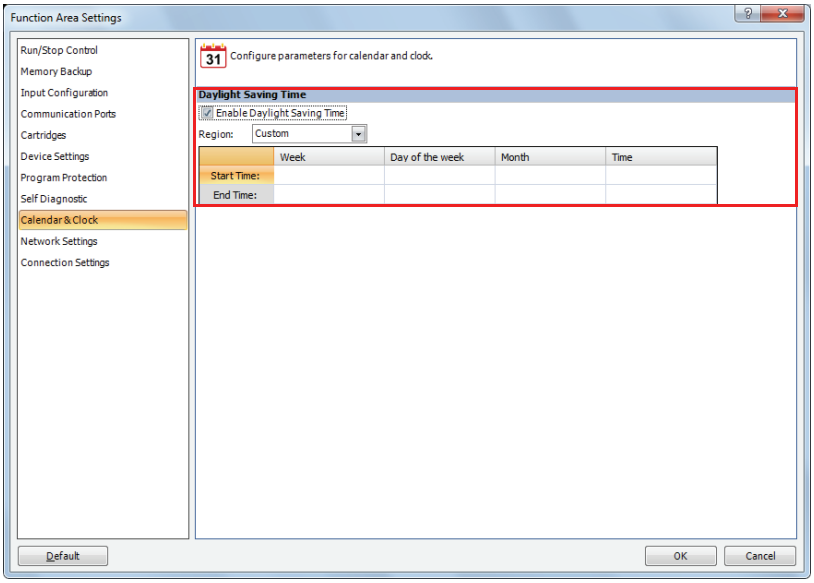
- When a user program was downloaded to the SmartAxis.
- When the SmartAxis power was turned on.

When the current time of the SmartAxis' internal clock is set using WindLDR or the operator interface, the time is not adjusted for daylight savings time, even if the time after it was set is within the daylight savings time period. Set the time to the time adjusted for daylight savings time. The set date and time becomes the date and time after being adjusted for daylight savings time.

Programming WindLDR

Configure daylight savings time on the SmartAxis.

1. From the WindLDR menu bar, select **Configuration** > **Calendar & Clock**.
   The Function Area Settings dialog box is displayed.
2. Select the **Enable daylight savings time** check box.



3. Configure the start time and the end time. Specify the region using the **Region** list box.
   If you select **Custom**, you are able to select any desired start time and end time.

Region	Start time	End time
Custom	User specified	User specified
USA or Canada	March, 2nd Sunday, 2:00 AM	November, 1st Sunday, 2:00 AM
Europe	March, last Sunday, 1:00 AM	October, last Sunday, 1:00 AM
Australia	October, 1st Sunday, 2:00 AM	April, 1st Sunday, 3:00 AM

4. Click **OK**.
   This concludes configuring the settings.

Clock Function

This section describes the internal clock function on the SmartAxis.

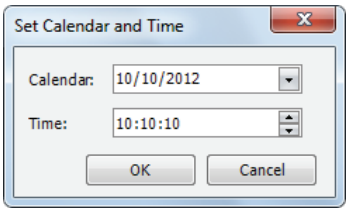
This function enables you to control the time schedule for lighting or air conditioning equipment using the current time data stored in special data registers. The internal clock data is backed up by a secondary lithium battery. The current time is reset when the backup data is lost, so the current time will need to be set again.

Function	Description
Read clock	The current time (calendar, clock) is updated every 500 ms and automatically stored in the special data registers.
Set clock	Sets the current time (calendar, clock). Set the current time with WindLDR or a user program that uses the special data registers.
Adjust function	When clock data write flag M8021 is turned on from off, the seconds for the current time are rounded up or rounded down based on 30 seconds to correct the seconds data for the internal clock. If the current seconds are between 0 and 29 seconds, the seconds are set to 0 when M8021 is turned on from off. If the current seconds are between 30 and 59 seconds, the minutes are set to + 1 and the seconds are set to 0 when M8021 is turned on from off.
Calendar/clock error	M8013: This relay turns on if clock write processing or a clock adjust processing could not be executed normally. M8014: This relay turns on if an error occurs while calendar/clock data is read from the internal clock to the special data registers (D8008 to D8014).

Setting the Clock with WindLDR

Set the current time on the SmartAxis with WindLDR.

1. From the WindLDR menu bar, select **Online** > **Monitor** > **Monitor**.
   WindLDR enters monitor mode.
2. Select **Online** > PLC > **Status**.
   The PLC Status dialog box is displayed.
3. Click **Change** for **Calendar**.
   The Calendar Settings dialog box is displayed. The current time on the PC is displayed in the dialog box as the initial value. The settings can also be changed as necessary.



4. Click **OK**.
   The date and time configured in the dialog box is written to the SmartAxis.

Setting the Clock with a User Program

A user program can write the clock data from an operator interface without using WindLDR by using special data registers D8015 to D8021. Undefined values are stored in special data registers D8015 to D8021. Always store an appropriate value before turning on M8016, M8017, or M8020.

Calendar Data Write Flag (M8016)

After writing data to the write calendar special data registers (D8015 to D8018), turn M8016 on from off to set the internal clock with the data in D8015 to D8018 as the calendar data (year, month, day, day of the week).

Clock Data Write Flag (M8017)

After writing data to the write clock special data registers (D8019 to D8021), turn M8017 on from off to set the internal clock with the data in D8019 to D8021 as the clock data (hour, minute, second).

Calendar/Clock Data Write Flag (M8020)

After writing data to the write calendar/clock special data registers (D8015 to D8021), turn M8020 on from off to set the internal clock with the data in D8015 to D8021 as the calendar data (year, month, day, day of the week) and the clock data (hour, minute, second).

Calendar and clock data storage locations

The calendar/clock data is stored in the following special data registers.

Special data register	Description		Range	Setting timing
D8008	Calendar/Clock Current Data (Read only)	Year	0 to 99	Every 500 ms (Note)
D8009		Month	1 to 12	
D8010		Day	1 to 31	
D8011		Day of the week	0 to 6	
D8012		Hour	0 to 23	
D8013		Minute	0 to 59	
D8014		Second	0 to 59	
D8015	Calendar/Clock New Data (Write only)	Year	0 to 99	—
D8016		Month	1 to 12	
D8017		Day	1 to 31	
D8018		Day of the week	0 to 6	
D8019		Hour	0 to 23	
D8020		Minute	0 to 59	
D8021		Second	0 to 59	

Note: If the scan time is 500 ms or longer, D8008 to D8014 are updated with each scan.

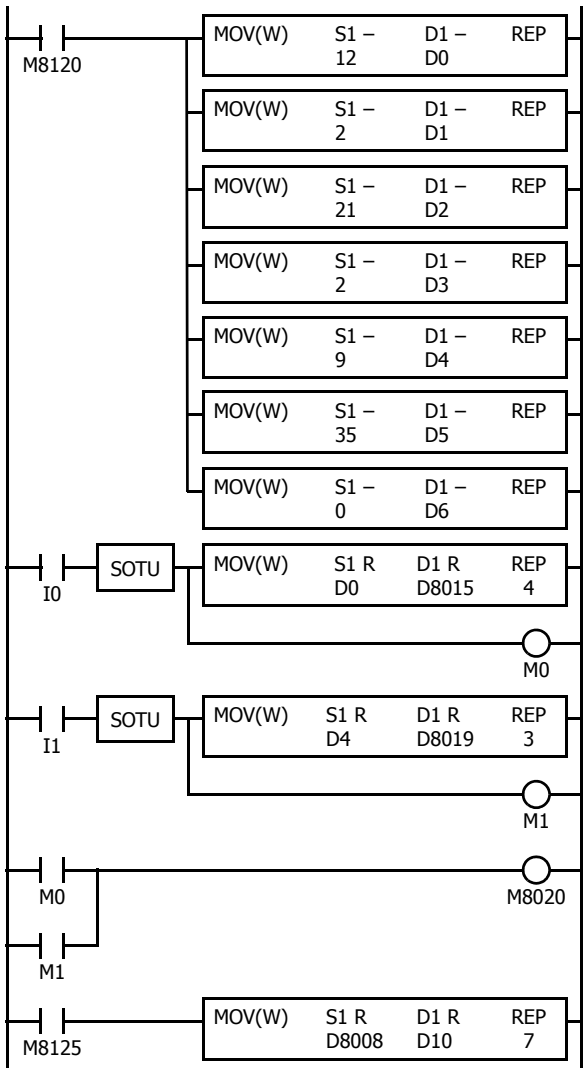
For the day of the week data, the values below are stored in the special data registers.

Day of the week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Value	0	1	2	3	4	5	6

Example program 1

This example sets the calendar and clock in a user program.

If you turn on M8020 with the new calendar/clock data set in the write-only data registers D8015 to D8021, the internal clock on the SmartAxis is updated with the current time (calendar, clock). In this example, the SmartAxis internal clock is set to 9:35:00 on Tuesday February 21, 2012.



M8120 is the initialize pulse that turns on for only one scan at the start of operation.
When the SmartAxis starts operating, the new calendar/clock data is stored in D0 to D6 with the MOV (move) instruction.

When external input I0 turns on, the new calendar data is stored in special data registers D8015 to D8018.
Internal relay M0 turns on for one scan only.

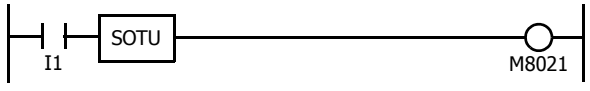
When external input I1 turns on, the new clock data is stored in special data registers D8019 to D8021.
Internal relay M1 turns on for one scan only.

When external input M0 or M1 turns on, M8020 turns on and the calendar/clock data is written to the internal clock.
(M8020: Calendar/Clock Data Write Flag)

M8125 is a special internal relay that is always on during operation.
While the SmartAxis is running, the current time (calendar, clock) is stored in D10 to D16 with the MOV instruction.

Example program 2

When I1 turns on from off, the seconds on the internal clock are corrected to 0 seconds.



When input I1 turns on, clock data adjust flag M8021 turns on to correct the seconds on the internal clock.

Note: The internal clock backup time is approximately 30 days (25°C TYP). If the power loss time exceeds the backup time, the retained clock data is lost and the current time is initialized as 00:00:00 on January 1, 2000.

Network Settings

This section describes the network settings of the SmartAxis.

These settings are used to configure the network to use the SmartAxis Ethernet port. All SmartAxis models are equipped with an Ethernet port except for the 12-I/O type. Configure the SmartAxis network settings in the same manner as the network settings for a PC.

The network settings can be configured with either of the methods below.

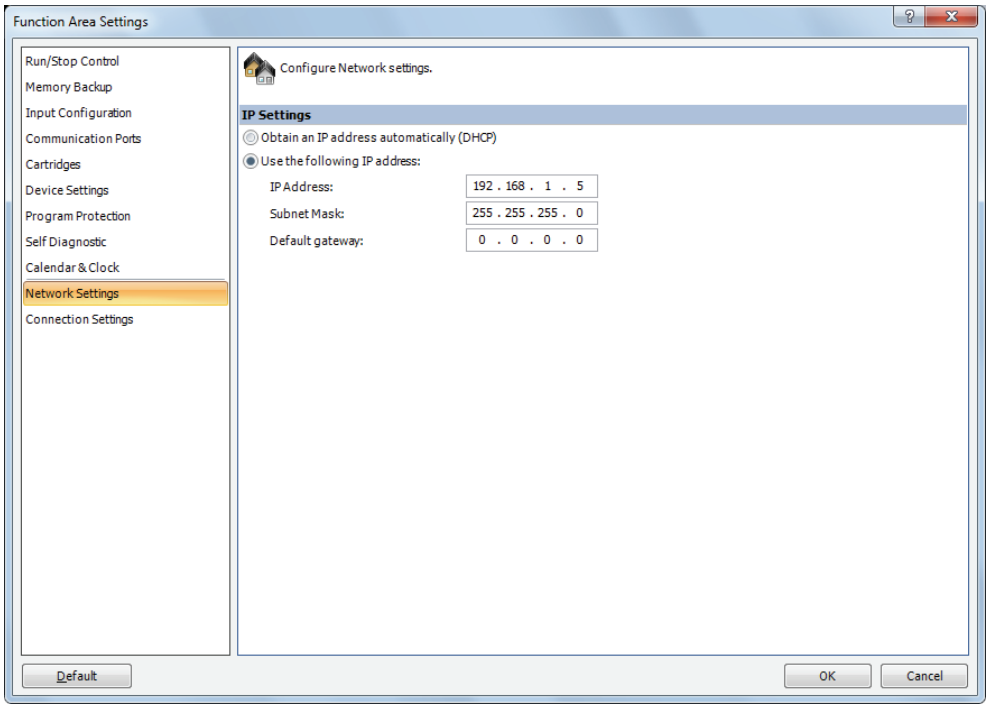
- Automatically acquire an IP address (DHCP)
  A DHCP server must be present on the network where the SmartAxis is located. The SmartAxis automatically acquires its network settings from the DHCP server. The network settings are acquired from the DHCP server when the user program is finished downloading and when the SmartAxis is turned on.
- Use the following IP address
  Enter the SmartAxis network settings as a fixed IP address, subnet mask, and default gateway. The network settings are applied when the user program is finished downloading. Consult the network administrator regarding the IP address to configure.

Note: The SmartAxis default settings are: IP address 192.168.1.5, subnet mask 255.255.255.0, default gateway 0.0.0.0.

Programming WindLDR

1. Select **Configuration** from the WindLDR menu bar, and then click **Network Settings**.

The Function Area settings dialog box appears.



2. Select **Automatically acquire an IP address (DHCP)** or **Use the following IP address**.

When **Use the following IP address** is selected, enter the IP address, subnet mask, and default gateway.

3. Click **OK**.

This concludes configuring the settings.

Connection Settings

This section describes the configurations for client/server connections of the SmartAxis module.

Applications

The SmartAxis supports Ethernet communication functions with a maximum of three connections. Using those connections, maintenance communication, Modbus TCP communication, user communication, and remote I/O communication can be used. Those communications can be configured in the Function Area Settings dialog box.

Description of functions

The SmartAxis has a maximum of three connections for the maintenance communication server, user communication server, Modbus TCP communication server, user communication client, Modbus TCP communication client and remote I/O master.

To limit the access to the SmartAxis, IP address flittering can be used. By specifying the IP address that can access the SmartAxis, anonymous access can be limited.

Connection Status and Connected IP Address

The connection status of connections with remote hosts can be confirmed with special internal relays M8110 to M8112. When a connection with a remote host is established, the corresponding special internal relay is turned on. When the connection is disconnected, the corresponding special internal relay is turned off. The IP addresses of the remote hosts can be confirmed with special data registers D8110 to D8121.

Special Internal Relays

Device Address	Description	Details
M8110	Connection 1 Status	While a connection is established with a remote host, the special internal relay will be on. When no connection is established, it will be off.
M8111	Connection 2 Status	
M8112	Connection 3 Status	

Special Data Registers

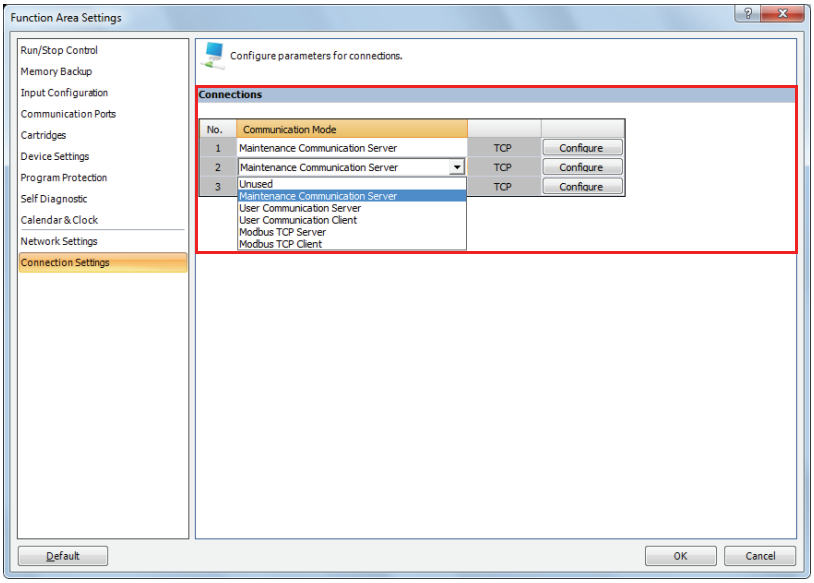
Device Address	Description	Details
D8110-D8113	Connection 1 Connected IP Address	IP address is stored in the corresponding special data registers. For example, when the IP address is aaa.bbb.ccc.ddd, each value is stored as follows: D8110=aaa, D8111=bbb, D8112=ccc, and D8113=ddd.
D8114-D8117	Connection 2 Connected IP Address	
D8118-D8121	Connection 3 Connected IP Address	

Programming WindLDR

1. From the WindLDR menu bar, select **Configuration** > **Connection Settings**.

The Function Area Settings dialog box is displayed.

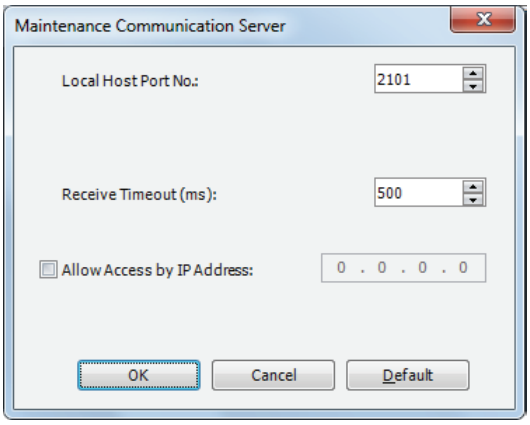
2. Select **Communication Mode** for the connection to use.



Configure the communication mode allocated to a maximum of three connections that can be used as client or server. Each connection can be set to a different port number. Set connections that are not used to **Unused**.

3. Select **Maintenance Communication Server**.

The Maintenance Communication Server dialog box is displayed.



4. Specify the parameters.

Click **OK**.
This concludes configuring the settings.

Remote Host List

This chapter describes how to configure a list of network devices (remote hosts) in the network to which the SmartAxis communicates.

Applications

When the SmartAxis accesses and communicates with other network devices in the network, the remote host device should be specified. The remote host list is required to use the following functions:

- ETXD/ERXD Instructions (User communication over Ethernet)
- Modbus TCP Client

Description of Functions

The remote host consists of an **IP Address** or a **Host Name** and a **Port Number**.

When a remote host is specified with an IP address, the SmartAxis establishes connection with the remote host that has the specified IP address and the corresponding port number, then communication is started.

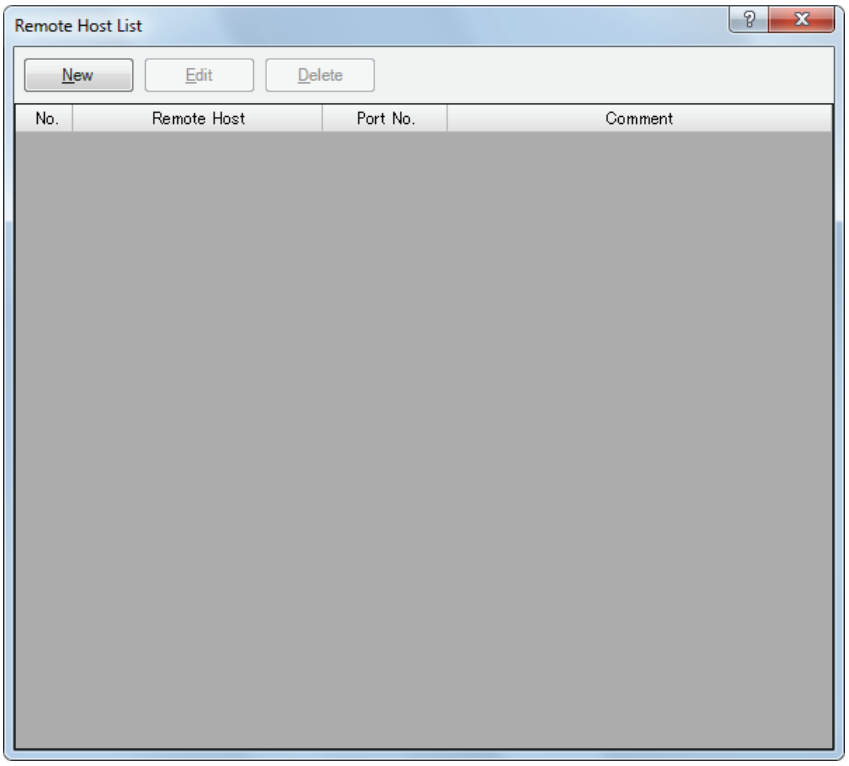
When a remote host is specified with a host name, the SmartAxis tries to obtain the IP address from the specified host name using the DNS server. If the IP address is successfully obtained, the SmartAxis establishes connection with the remote host that has the specified IP address and the corresponding port number, then communication is started.

For details about DNS server settings, see Network Settings in the Function Area Settings.

Programming WindLDR

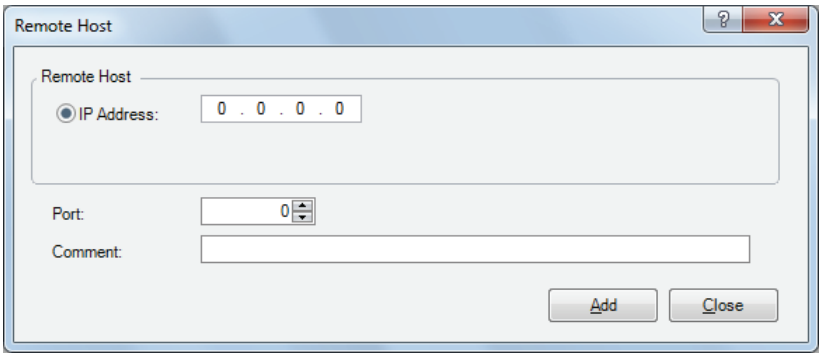
1. Double-click on the Remote Host List in the **Project Window**.

The **Remote Host List** dialog box appears.



2. Click **New** button or select an existing remote host and click **Edit** button.

The Remote Host dialog box appears.



IP Address:	Specify the remote host with an IP address.
Port Number:	Specify the port number of the remote host. This port number is the TCP communication port number. It differs from the SmartAxis USB port number (port 1) and the expansion communication port numbers (port 2, 3).
Comment:	The comment for the remote host can be assigned. The contents or the length of the comment has no effect on the SmartAXIS operation.

3. Configure the parameters in the Remote Host dialog box and then click on **Add** button.
A new remote host will be added in the Remote Host List dialog box. If you want to add additional remote hosts, repeat the same procedure. After adding remote hosts has been completed, click on **Close** button.

4. If you want to delete an unused remote host, select that remote host in the Remote Host List dialog box and click on **Delete** button.
Once a remote host is deleted, the remote host numbers of the following remote hosts are changed. As a result, the functions referring to those remote hosts, such as Modbus TCP client, or User communication client, will be affected,

7: DEVICE ADDRESSES

Introduction

This chapter describes device addresses available for the SmartAxis to program basic and advanced instructions. Special internal relays and special data registers are also described.

The SmartAxis is programmed using devices such as inputs, outputs, remote inputs, remote outputs, internal relays, timers, counters, shift registers, and data registers.

Inputs (I) are relays to receive input signals through the input terminals.
Remote inputs (I) are relays to receive input signals from external devices connected to the remote I/O slaves.
Outputs (Q) are relays to send the processed results of the user program to the output terminals.
Remote outputs (O) are relays to send output signals to external devices connected to the remote I/O slaves.
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-ms, 10-ms, and 1-ms 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.

Special data registers (D) are dedicated to special functions.

Device Addresses

Available I/O numbers depend on the type of the SmartAxis CPU module.

Device	FT1A-12		FT1A-24		FT1A-40		FT1A-48		FT1A-Touch	
	Device Address	Points	Device Address	Points	Device Address	Points	Device Address	Points	Device Address	Points
Input (I)	I0 - I7	8	I0 - I7 I10 - I17	16	I0 - I7 I10 - I17 I20 - I27	24	I0 - I7 I10 - I17 I20 - I27 I30 - I35	30	I0 - I7	8
Remote Input (I)	—	—	I40 - I75 I80 - I115 I120 - I155	90	I40 - I75 I80 - I115 I120 - I155	90	I40 - I75 I80 - I115 I120 - I155	90	—	—
Output (Q)	Q0 - Q3	4	Q0 - Q7	8	Q0 - Q7 Q10 - Q17	16	Q0 - Q7 Q10 - Q17 Q20, Q21	18	Q0 - Q3	4
Remote Output (Q)	—	—	Q40 - Q61 Q80 - Q101 Q120 - Q141	54	Q40 - Q61 Q80 - Q101 Q120 - Q141	54	Q40 - Q61 Q80 - Q101 Q120 - Q141	54	—	—
Internal Relay (M)	M0 - M317	256	M0 -M1277	1024	M0 -M1277	1024	M0 - M1277	1024	M0 - M1277	1024
Special Internal Relay (M)	M8000 - M8177	144	M8000 - M8177	144	M8000 - M8177	144	M8000 - M8177	144	M8000 - M8177	144
Shift Register (R)	R0 - R127	128	R0 - R127	128	R0 - R127	128	R0 - R127	128	R0 - R127	128
Timer (T)	T0 - T99	100	T0 - T199	200	T0 - T199	200	T0 - T199	200	T0 - T199	200
Counter (C)	C0 - C99	100	C0 - C199	200	C0 - C199	200	C0 - C199	200	C0 - C199	200
Data Register (D)	D0 - D399	400	D0 - D1999	2000	D0 - D1999	2000	D0 - D1999	2000	D0 - D1999	2000
Special Data Register (D)	D8000 - D8199	200	D8000 - D8199	200	D8000 - D8199	200	D8000 - D8199	200	D8000 - D8199	200

Notes:

- The least significant digit of input, output, internal relay, and special internal relay device address is an octal number (0 through 7). Upper digits are decimal numbers.
- Out of data registers D0 through D1999, D1000 through D1999 cannot be designated as "keep" types. Retained in STOP→RUN, but zeroed out when the power is turned on.

Special Internal Relays

Special internal relays M8000 through M8177 are used for controlling the CPU operation and communication and for indicating the CPU statuses. All special internal relays cannot be used as destinations of advanced instructions.

Internal relays M300 through M335 are used to read input device statuses of the IOREF (I/O refresh) instruction.

Caution

- Do not change the status of reserved special internal relays, otherwise the SmartAxis may not operate correctly.

Special Internal Relay Device Addresses

Device Address	Description		CPU Stopped	Power OFF	Read/Write
M8000	Start Control		Maintained	Maintained	Write
M8001	1-sec Clock Reset		Cleared	Cleared	Write
M8002	All Outputs OFF		Cleared	Cleared	Write
M8003	Carry (Cy) or Borrow (Bw)		Cleared	Cleared	Read
M8004	User Program Execution Error		Cleared	Cleared	Read
M8005	Remote I/O Slave 1 Communication Error		Operating	Cleared	Read
M8006	Remote I/O Slave 2 Communication Error		Operating	Cleared	Read
M8007	Remote I/O Slave 3 Communication Error		Operating	Cleared	Read
M8010-M8012	— Reserved —		—	—	—
M8013	Calendar/Clock Data Write/Adjust Error Flag		Operating	Cleared	Read
M8014	Calendar/Clock Data Read Error Flag		Operating	Cleared	Read
M8015	— Reserved —		—	—	—
M8016	Calendar Data Write Flag		Operating	Cleared	Write
M8017	Clock Data Write Flag		Operating	Cleared	Write
M8020	Calendar/Clock Data Write Flag		Operating	Cleared	Write
M8021	Clock Data Adjust Flag		Operating	Cleared	Write
M8022	User Communication Receive Instruction Cancel Flag (Port 2)		Cleared	Cleared	Write
M8023	User Communication Receive Instruction Cancel Flag (Port 3)		Cleared	Cleared	Write
M8024	BMOV/WSFT Executing Flag		Maintained	Maintained	Read
M8025	Maintain Outputs While CPU Stopped		Maintained	Cleared	Write
M8026	SD Memory Card Status		Maintained	Cleared	Read
M8027	SD Memory Card Writing Flag		Maintained	Cleared	Read
M8030	High-speed Counter (Group 1/I0)	Comparison Output Reset	Cleared	Cleared	Read/Write
M8031		Gate Input	Maintained	Cleared	Read/Write
M8032		Reset Input	Maintained	Cleared	Read/Write
M8033		Reset Status	Maintained	Cleared	Read
M8034		Comparison ON Status	Maintained	Cleared	Read
M8035		Overflow	Maintained	Cleared	Read
M8036		Underflow	Maintained	Cleared	Read
M8037		Count Direction	Maintained	Cleared	Read
M8040	High-speed Counter (Group 2/I2)	Comparison Output Reset	Cleared	Cleared	Read/Write
M8041		Gate Input	Maintained	Cleared	Read/Write
M8042		Reset Input	Maintained	Cleared	Read/Write
M8043		Comparison ON Status	Maintained	Cleared	Read
M8044		Overflow	Maintained	Cleared	Read
M8045	High-speed Counter (Group 3/I3)	Comparison Output Reset	Cleared	Cleared	Read/Write
M8046		Gate Input	Maintained	Cleared	Read/Write
M8047		Reset Input	Maintained	Cleared	Read/Write
M8050		Reset Status	Maintained	Cleared	Read
M8051		Comparison ON Status	Maintained	Cleared	Read
M8052		Overflow	Maintained	Cleared	Read
M8053		Underflow	Maintained	Cleared	Read
M8054		Count Direction	Maintained	Cleared	Read

Device Address	Description		CPU Stopped	Power OFF	Read/Write
M8055	High-speed Counter (Group 4/I5)	Comparison Output Reset	Cleared	Cleared	Read/Write
M8056		Gate Input	Maintained	Cleared	Read/Write
M8057		Reset Input	Maintained	Cleared	Read/Write
M8060		Comparison ON Status	Maintained	Cleared	Read
M8061		Overflow	Maintained	Cleared	Read
M8062-M8067	— Reserved —		—	—	—
M8070	Interrupt Input I0 Status	(ON: Allowed, OFF: Prohibited)	Cleared	Cleared	Read
M8071	Interrupt Input I2 Status		Cleared	Cleared	Read
M8072	Interrupt Input I3 Status		Cleared	Cleared	Read
M8073	Interrupt Input I5 Status		Cleared	Cleared	Read
M8074	Interrupt Input I6 Status		Cleared	Cleared	Read
M8075	Interrupt Input I7 Status		Cleared	Cleared	Read
M8076	SD Memory Card Access Stop Flag		Operating	Cleared	Write
M8077	— Reserved —		—	—	—
M8080	Interrupt Input I0 Edge	(ON: Rising, OFF: Falling)	Cleared	Cleared	Read
M8081	Interrupt Input I2 Edge		Cleared	Cleared	Read
M8082	Interrupt Input I3 Edge		Cleared	Cleared	Read
M8083	Interrupt Input I5 Edge		Cleared	Cleared	Read
M8084	Interrupt Input I6 Edge		Cleared	Cleared	Read
M8085	Interrupt Input I7 Edge		Cleared	Cleared	Read
M8086 M8087	— Reserved —		—	—	—
M8090	Catch Input ON/OFF Status	Group 1/I0	Maintained	Cleared	Read
M8091		Group 2/I2	Maintained	Cleared	Read
M8092		Group 3/I3	Maintained	Cleared	Read
M8093		Group 4/I5	Maintained	Cleared	Read
M8094		Group 5/I6	Maintained	Cleared	Read
M8095		Group 6/I7	Maintained	Cleared	Read
M8096 M8097	— Reserved —		—	—	—
M8100	User Communication Receive Instruction Cancel Flag	Connection 1	Cleared	Cleared	Write
M8101		Connection 2	Cleared	Cleared	Write
M8102		Connection 3	Cleared	Cleared	Write
M8103-M8107	— Reserved —		—	—	—
M8110	Connection Status	Connection 1 (ON: Connected, OFF: Not Connected)	Operating	Cleared	Read
M8111		Connection 2 (ON: Connected, OFF: Not Connected)	Operating	Cleared	Read
M8112		Connection 3 (ON: Connected, OFF: Not Connected)	Operating	Cleared	Read
M8113-M8117	— Reserved —		—	—	—
M8120	Initialize Pulse		Cleared	Cleared	Read
M8121	1-sec Clock		Operating	Cleared	Read
M8122	100-ms Clock		Operating	Cleared	Read
M8123	10-ms Clock		Operating	Cleared	Read
M8124	— Reserved —		—	—	—
M8125	In-operation Output		Cleared	Cleared	Read
M8126 M8127	— Reserved —		—	—	—
M8130	Disconnect User Communication Connection	Connection 1	Maintained	Cleared	Read/Write
M8131		Connection 2	Maintained	Cleared	Read/Write
M8132		Connection 3	Maintained	Cleared	Read/Write
M8133-M8143	— Reserved —		—	—	—

Device Address	Description		CPU Stopped	Power OFF	Read/Write
M8144	Timer Interrupt Status (ON: Allowed, OFF: Prohibited)		Cleared	Cleared	Read
M8145-M8147	— Reserved —		—	—	—
M8150	Comparison Result Greater Than		Maintained	Cleared	Read
M8151	Comparison Result Less Than		Maintained	Cleared	Read
M8152	Comparison Result Equal To		Maintained	Cleared	Read
M8153-M8157	— Reserved —		—	—	—
M8160	Key Input Status	ESC Key + Up Key	Cleared	Cleared	Read
M8161		ESC Key + Down Key	Cleared	Cleared	Read
M8162		ESC Key + Left Key	Cleared	Cleared	Read
M8163		ESC Key +Right Key	Cleared	Cleared	Read
M8164 M8165	— Reserved —		—	—	—
M8166	High-speed Counter (Group5/I6)	Comparison Output Reset	Cleared	Cleared	Read/Write
M8167		Gate Input	Maintained	Cleared	Read/Write
M8170		Reset Input	Maintained	Cleared	Read/Write
M8171		Comparison ON Status	Maintained	Cleared	Read
M8172		Overflow	Maintained	Cleared	Read
M8173	High-speed Counter (Group 6/I7)	Comparison Output Reset	Cleared	Cleared	Read/Write
M8174		Gate Input	Maintained	Cleared	Read/Write
M8175		Reset Input	Maintained	Cleared	Read/Write
M8176		Comparison ON Status	Maintained	Cleared	Read
M8177		Overflow	Maintained	Cleared	Read

M8000 Start Control

M8000 is used to control the operation of the CPU. The CPU 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.

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 **Configuration** > **Run/Stop Control** > **Run/Stop Selection at Memory Backup Error**. For details on SmartAxis Pro/Lite start control, see Chapter 4 "Operation Basics" – "Start/Stop Operation" in the FT1A Series Pro/Lite User's Manual. For details on SmartAxis Touch start control, see Chapter # "FT1A Series Touch Overview" – "#.# Start/Stop Operation" in the FT1A Series Touch User's Manual.

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 and remote outputs 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. For the causes of carry (CY) and borrow (BW), see Chapter 4 "Instructions Reference" – "Carry and Borrow" on page 4-21.

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** > **Monitor,** then **Online** > **Status** > **Error Status** > **Details**.

For a list of Pro/Lite user program execution errors, see Chapter 13 "Troubleshooting" – "User Program Execution Error" on page 13-6. For a list of Touch user program execution errors, see Chapter ## "Troubleshooting" – "Troubleshooting" – "User Program Execution Errors" in the FT1A Series Touch User's Manual.

M8005 Remote I/O Slave 1 Communication Error

When an error occurs during communication with remote I/O slave 1, M8005 turns on. When the error is cleared, M8005 turns off.

M8006 Remote I/O Slave 2 Communication Error

When an error occurs during communication with remote I/O slave 2, M8006 turns on. When the error is cleared, M8006 turns off.

M8007 Remote I/O Slave 3 Communication Error

When an error occurs during communication with remote I/O slave 3, M8007 turns on. When the error is cleared, M8007 turns off.

M8013 Calendar/Clock Data Write/Adjust Error Flag

When an error occurs while calendar/clock data is written or clock data is adjusted, M8013 turns on. If calendar/clock data is written or clock data is adjusted successfully, M8013 turns off.

M8014 Calendar/Clock Data Read Error Flag

When an error occurs while calendar/clock data is read from the internal clock to the special data registers (D8008 to D8014), M8014 turns on. If calendar/clock data is read successfully, M8014 turns off.

M8016 Calendar Data Write Flag

When M8016 is turned on, data in data registers D8015 through D8018 (calendar new data) are set to the internal clock. See page 9-7 (Advanced Vol.).

M8017 Clock Data Write Flag

When M8017 is turned on, data in data registers D8019 through D8021 (clock new data) are set to the internal clock. See page 9-7 (Advanced Vol.).

M8020 Calendar/Clock Data Write Flag

When M8020 is turned on, data in data registers D8015 through D8021 (calendar/clock new data) are set to the internal clock. See page 9-7 (Advanced Vol.).

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 by one. See page 9-7 (Advanced Vol.).

M8022 User Communication Receive Instruction Cancel Flag (Port 2)
When M8022 is turned on, all RXD2 instructions ready for receiving user communication through port 2 are disabled.

M8023 User Communication Receive Instruction Cancel Flag (Port 3)
When M8023 is turned on, all RXD3 instructions ready for receiving user communication through port 3 are disabled.

M8024 BMOV/WSFT Executing Flag
While the BMOV or WSFT is executed, M8024 turns on. When completed, M8024 turns off. If the CPU is powered down while executing BMOV or WSFT, M8024 remains on when the CPU is powered up again.

M8025 Maintain Outputs While CPU Stopped
Outputs are normally turned off when the CPU is stopped. M8025 is used to maintain the output statuses when the CPU is stopped. When the CPU is stopped with M8025 turned on, the output ON/OFF statuses are maintained. When the CPU restarts, M8025 is turned off automatically.

M8026 SD Memory Card Status
When an SD memory card is inserted into the SmartAxis, M8026 turns on. When an SD memory card is not inserted, M8026 turns off.

M8027 SD Memory Card Writing Flag
While logging data is written to the SD memory card, M8027 turns on. When writing logging data is finished, M8027 turns off.

M8030-M8061 Special Internal Relays for High-speed Counter
Special internal relays used for the high-speed counter.

For details on the Pro/Lite high-speed counter, see Chapter 5 "Special Functions" – "High-speed Counter" in the FT1A Series Pro/Lite User's Manual. For details on the Touch high-speed counter, see Chapter # "Project Settings" – "#.## Functions" – "High-speed Counter" in the FT1A Series Touch User's Manual.

M8070-M8075 Interrupt Input Status
Turns on when the corresponding user interrupt is allowed. When interrupt inputs are disabled, these internal relays are turned off.

M8070=Interrupt input I0 status, M8071=Interrupt input I2 status, M8072=Interrupt input I3 status

M8073=Interrupt input I5 status, M8074=Interrupt input I6 status, M8075=Interrupt input I7 status

M8076 SD Memory Card Access Stop Flag
Access to the SD memory card is stopped when M8076 is turned off to on.

M8080-M8085 Interrupt Input Edge (ON: Rising, OFF: Falling)
This flag indicates whether the interrupt input is triggered with a rising edge or falling edge.

M8090-M8095 Catch Input ON/OFF Status
When a rising or falling input edge is detected during a scan, the input statuses of catch inputs Group 1/I0 through Group 6/I7 at the moment are set to M8090 through M8095, respectively, without regard to the scan status. Only one edge is detected in one scan. For the catch input function, see page 5-32.

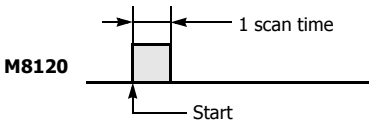
M8100-M8102 User Communication Receive Instruction Cancel Flag
When M8100, M8101, or M8102 is turned on, all ERXD instructions ready for receiving user communication through connection 1, connection 2, or connection 3 are disabled, respectively.

M8110-M8112 Connection Status
When SmartAxis and a network device are connected via the maintenance communication server, user communication server/client, or Modbus TCP server/client, the connection status turns on. When no network devices are connected, the connection status turns off.

These relays are always off for the 12-I/O type (CPU modules without Ethernet port).

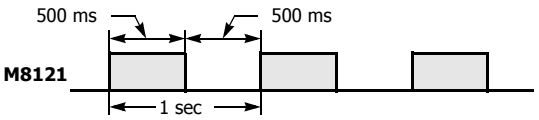
M8120 Initialize Pulse

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



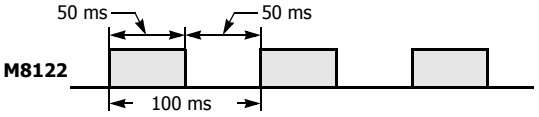
M8121 1-sec Clock

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



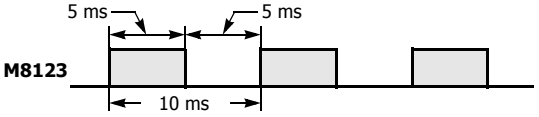
M8122 100-ms Clock

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



M8123 10-ms Clock

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



M8125 In-operation Output

M8125 remains on while the CPU is running.

M8130-M8132 Disconnect User Communication Connection

When SmartAxis is connected to a remote host with the user communication client and a special internal relay corresponding to the connection is turned off to on, the connection is disconnected. Special internal relays M8130 through M8132 are allocated to connections 1 through 3, respectively.

These relays are enabled only when user communication client is used. These relays have no effect for the user communication server. Nothing happens for the 12-I/O type (CPU modules without Ethernet port) when these relays are turned on.

M8144 Timer Interrupt Status

When timer interrupt is enabled, M8144 is turned on. When disabled, M8144 is turned off.

M8150 Comparison Result Greater Than

When the CMP= instruction is used, M8150 is turned on when the value of device designated by S1 is greater than that of device designated by S2 (S1 > S2). See page 4-2 (Advanced Vol.).

When the ICMP>= instruction is used, M8150 is turned on when the value of device designated by S2 is greater than that of device designated by S1 (S2 < S1). See page 4-6 (Advanced Vol.).

M8151 Comparison Result Equal To

When the CMP= instruction is used, M8151 is turned on when the value of device designated by S1 is equal to that of device designated by S2 (S1 = S2). See page 4-2 (Advanced Vol.).

When the ICMP>= instruction is used, M8151 is turned on when the value of device designated by S3 is greater than that of device designated by S2 (S3 > S2). See page 4-6 (Advanced Vol.).

M8152 Comparison Result Less Than

When the CMP= instruction is used, M8152 is turned on when the value of device designated by S1 is less than that of device designated by S2 (S1 < S2). See page 4-2 (Advanced Vol.).

When the ICMP>= instruction is used, M8152 is turned on when the value of device designated by S2 is less than that of device designated by S1 and greater than that of device designated by S3 (S1 > S2 > S3). See page 4-6 (Advanced Vol.).

M8160-M8163 Button Input Status

While the ESC button and direction buttons on the SmartAxis Pro are simultaneously pressed, the corresponding special internal relays M8160 through M8163 turn on. When no buttons are pressed, M8160 through M8163 turn off.

M8166-M8177 Special Internal Relays for High-speed Counter

Special internal relays used for the high-speed counter.

For details on the Pro/Lite high-speed counter, see Chapter 5 "Special Functions" – "High-speed Counter" on page 5-9. For details on the Touch high-speed counter, see Chapter # "Project Settings" – "#.## Functions" – "High-speed Counter" in the FT1A Series Touch User's Manual.

Special Data Registers

Caution

- Do not change the data of reserved special data registers, otherwise the SmartAxis may not operate correctly.

Special Data Register Device Addresses

Device Address	Description		Updated	See Page
D8000	Quantity of Inputs		When I/O initialized	7-11
D8001	Quantity of Outputs		When I/O initialized	7-11
D8002	CPU Module Type Information		Power-up	7-11
D8003	Memory Cartridge Information		Power-up	7-11
D8004	— Reserved —		—	—
D8005	General Error Code		When error occurred	Basoc Vol. 13-3
D8006	User Program Execution Error Code		When error occurred	13-6
D8007	— Reserved —		—	3-25
D8008	Calendar/Clock Current Data (Read only)	Year	Every 500 ms	Advanced Vol. 9-6
D8009		Month	Every 500 ms	Advanced Vol. 9-6
D8010		Day	Every 500 ms	Advanced Vol. 9-6
D8011		Day of Week	Every 500 ms	Advanced Vol. 9-6
D8012		Hour	Every 500 ms	Advanced Vol. 9-6
D8013		Minute	Every 500 ms	Advanced Vol. 9-6
D8014		Second	Every 500 ms	Advanced Vol. 9-6
D8015	Calendar/Clock New Data (Write only)	Year	—	Advanced Vol. 9-6
D8016		Month	—	Advanced Vol. 9-6
D8017		Day	—	Advanced Vol. 9-6
D8018		Day of Week	—	Advanced Vol. 9-6
D8019		Hour	—	Advanced Vol. 9-6
D8020		Minute	—	Advanced Vol. 9-6
D8021		Second	—	Advanced Vol. 9-6
D8022	Scan Time Data	Constant Scan Time Preset Value (1 to 1,000 ms)	—	5-50
D8023		Scan Time Current Value (ms)	Every scan	5-50
D8024		Scan Time Maximum Value (ms)	At occurrence	5-50
D8025		Scan Time Minimum Value (ms)	At occurrence	5-50
D8026	Communication Mode Information (Port 2 and Port 3)		Every scan	7-11
D8027	Port 2 Slave Number		Every scan	Advanced Vol. 21-2
D8028	Port 3 Slave Number		Every scan	Advanced Vol. 21-2
D8029	System Software Version		Power-up	7-12
D8030	Communication Adapter Information		Power-up	7-12
D8031	Optional Cartridge Information		Power-up	7-12
D8032	Interrupt Input Jump Destination Label No. (I0)		—	5-34
D8033	Interrupt Input Jump Destination Label No. (I2)		—	5-34
D8034	Interrupt Input Jump Destination Label No. (I3)		—	5-34
D8035	Interrupt Input Jump Destination Label No. (I5)		—	5-34
D8036	Timer Interrupt Jump Destination Label No.		—	5-36
D8037	Interrupt Input Jump Destination Label No. (I6)		—	3-26
D8038	Interrupt Input Jump Destination Label No. (I7)		—	
D8039	SD Memory Card Capacity (Megabytes)		Every 1 sec	
D8040	Analog Input Value (AI0)		Every scan	
D8041	Analog Input Value (AI1)		Every scan	
D8042	Analog Input Value (AI2)		Every scan	
D8043	Analog Input Value (AI3)		Every scan	
D8044	Analog Input Value (AI4)		Every scan	
D8045	Analog Input Value (AI5)		Every scan	
D8046	Analog Input Value (AI6)		Every scan	
D8047	Analog Input Value (AI7)		Every scan	

Device Address	Description			Updated	See Page
D8048-D8049	— Reserved —			—	—
D8050	High-speed Counter (Group 1/I0)	High Word	Current Value / Frequency Measurement Value (I0)	Every scan	
D8051		Low Word			
D8052		High Word	Preset Value	—	
D8053		Low Word			
D8054		High Word	Reset Value	—	
D8055		Low Word			
D8056	High-speed Counter (Group 2/I2)	High Word	Current Value / Frequency Measurement Value (I2)	Every scan	
D8057		Low Word			
D8058		High Word	Preset Value	—	
D8059		Low Word			
D8060		High Word	Reset Value	—	
D8061		Low Word			
D8062	High-speed Counter (Group 3/I3)	High Word	Current Value / Frequency Measurement Value (I3)	Every scan	
D8063		Low Word			
D8064		High Word	Preset Value	—	
D8065		Low Word			
D8066		High Word	Reset Value	—	
D8067		Low Word			
D8068	High-speed Counter (Group 4/I5)	High Word	Current Value / Frequency Measurement Value (I5)	Every scan	
D8069		Low Word			
D8070		High Word	Preset Value	—	
D8071		Low Word			
D8072		High Word	Reset Value	—	
D8073		Low Word			
D8074-D8076	— Reserved —			—	—
D8077	Out of Analog Input Range Status			—	
D8078	MAC Address (Read only)			Every 1 sec	
D8079					
D8080					
D8081					
D8082					
D8083					
D8084	IP Address (Current Data) Read only			Every 1 sec	
D8085					
D8086					
D8087					
D8088	Subnet Mask (Current Data) Read only			Every 1 sec	
D8089					
D8090					
D8091					
D8092	Default Gateway (Current Data) Read only			Every 1 sec	
D8093					
D8094					
D8095					
D8096-D8103	— Reserved —			—	—
D8104	RS232C Control Signal Status (Ports 2 and 3)			Every scan	10-34
D8105	RS232C DSR Input Control Signal Option (Ports 2 and 3)			When sending/ receiving data	10-36
D8106	RS232C DTR Output Control Signal Option (Ports 2 and 3)			When sending/ receiving data	10-37
D8107-D8109	— Reserved —			—	—
D8110	Connection 1 Connected IP Address			Every 1 sec	
D8111					
D8112					
D8113					

Device Address	Description			Updated	See Page
D8114	Connection 2 Connected IP Address			Every 1 sec	
D8115					
D8116					
D8117					
D8118	Connection 3 Connected IP Address			Every 1 sec	
D8119					
D8120					
D8121					
D8122-D8129	— Reserved —			—	—
D8130	Connection 1 Connected Port Number			Every 1 sec	
D8131	Connection 2 Connected Port Number			Every 1 sec	
D8132	Connection 3 Connected Port Number			Every 1 sec	
D8133	— Reserved —			—	—
D8134	High-speed Counter (Group 5/I6)	High Word	Current Value / Frequency Measurement Value (I6)	Every scan	
D8135		Low Word			
D8136		High Word	Preset Value	—	
D8137		Low Word			
D8138		High Word	Reset Value	—	
D8139		Low Word			
D8140	High-speed Counter (Group 6/I7)	High Word	Current Value / Frequency Measurement Value (I7)	Every scan	
D8141		Low Word			
D8142		High Word	Preset Value	—	
D8143		Low Word			
D8144		High Word	Reset Value	—	
D8145		Low Word			
D8146	— Reserved —			—	
D8147					
D8148	Remote I/O Slave 1	Communication Error Status		When error occurred	
D8149		Analog Input (AI10)		Every scan	
D8150		Analog Input (AI11)		Every scan	
D8151		Analog Input (AI12)		Every scan	
D8152		Analog Input (AI13)		Every scan	
D8153		Analog Input (AI14)		Every scan	
D8154		Analog Input (AI15)		Every scan	
D8155		Analog Input (AI16)		Every scan	
D8156		Analog Input (AI17)		Every scan	
D8157	Remote I/O Slave 2	Communication Error Status		When error occurred	
D8158		Analog Input (AI20)		Every scan	
D8159		Analog Input (AI21)		Every scan	
D8160		Analog Input (AI22)		Every scan	
D8161		Analog Input (AI23)		Every scan	
D8162		Analog Input (AI24)		Every scan	
D8163		Analog Input (AI25)		Every scan	
D8164		Analog Input (AI26)		Every scan	
D8165		Analog Input (AI27)		Every scan	
D8166	Remote I/O Slave 3	Communication Error Status		When error occurred	
D8167		Analog Input (AI30)		Every scan	
D8168		Analog Input (AI31)		Every scan	
D8169		Analog Input (AI32)		Every scan	
D8170		Analog Input (AI33)		Every scan	
D8171		Analog Input (AI34)		Every scan	
D8172		Analog Input (AI35)		Every scan	
D8173		Analog Input (AI36)		Every scan	
D8174		Analog Input (AI37)		Every scan	
D8175-D8199	— Reserved —			—	—

D8000 Quantity of Inputs

The total of input points provided on the CPU module is stored to D8000.

D8001 Quantity of Outputs

The total of output points provided on the CPU module is stored to D8001.

D8002 CPU Module Type Information

Information about the CPU module type is stored to D8002.

0: SmartAxis Pro/Lite 12-I/O type
1: SmartAxis Pro/Lite 24-I/O type
2: SmartAxis Pro/Lite 40-I/O type
3: SmartAxis Pro/Lite 48-I/O type
4: SmartAxis Touch

D8003 Memory Cartridge Information

When an optional memory cartridge is installed on the CPU module cartridge connector, information about the user program stored on the memory cartridge is stored to D8003.

0: SmartAxis Pro/Lite 12-I/O type
1: SmartAxis Pro/Lite 24-I/O type
2: SmartAxis Pro/Lite 40-I/O type
3: SmartAxis Pro/Lite 48-I/O type
255: The memory cartridge does not store any user program.

D8005 General Error Code

SmartAxis general error information is stored to D8005. When a general error occurs, the bit corresponding to the error occurred turns on.

The general error and user program execution error can be cleared by writing "1" to the most significant bit of D8005 using a user program.

For details on Pro/Lite general error codes, see Chapter 13 "Troubleshooting" in the FT1A Series Pro/Lite User's Manual. For details on Touch general error codes, see Chapter ## "Troubleshooting" - "##.# Troubleshooting" in the FT1A Series Touch User's Manual.

D8006 User Program Execution Error Code

SmartAxis user program execution error information is stored to D8006. When a user program execution error occurs, the error code corresponding to the error occurred is stored to D8006.

For details on Pro/Lite user program execution error codes, see Chapter 13 "Troubleshooting" in the FT1A Series Pro/Lite User's Manual. For details on Touch user program execution error codes, see Chapter ## "Troubleshooting" - "##.# Troubleshooting" in the FT1A Series Touch User's Manual.

D8008-D8021 Calendar/Clock Data

D8008 through D8021 are used for reading calendar/clock data from the internal clock and for writing calendar/clock data to the internal clock.

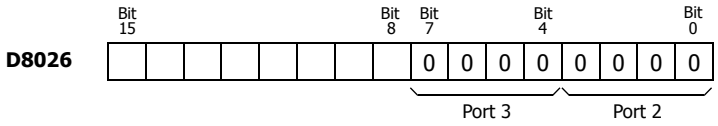
D8022-D8025 Scan Time Data

D8022 through D8025 are special data registers for checking the scan time and configuring the constant scan time.

For details on the SmartAxis Pro/Lite scan time, see Chapter 5 "Special Functions" – "Constant Scan Time" in the FT1A Series Pro/Lite User's Manual. For details on the SmartAxis Touch scan time, see Chapter # "Project Settings" – "#.## Functions" – "Constant Scan Time" in the FT1A Series Touch User's Manual.

D8026 Communication Mode Information (Port 2 and Port 3)

Communication mode information of port 2 and port 3 is stored to D8026.



0: Maintenance Communication
1: User Communication
2: Modbus RTU Master
3: Modbus RTU Slave

D8027-D8028 Slave Number

The slave number is stored to D8027 and D8028 when the communication mode of port 2 and 3 is maintenance communication or Modbus RTU slave.

The slave number can be specified with either a constant or a data register in the function area settings. When data register is specified, the slave number can be changed by storing the slave number in D8027 and D8028.

D8027: Port 2 Slave Number

D8028: Port 3 Slave Number

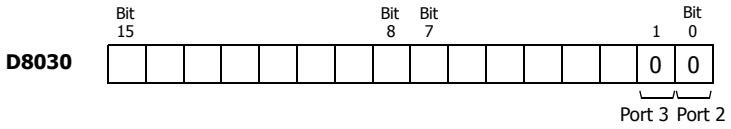
For SmartAxis Pro/Lite maintenance communication, see Chapter 9 "Maintenance Communication" - "Maintenance Communication via Serial Communication" in the FT1A Series Pro/Lite User's Manual. For Modbus RTU slaves, see Chapter 11 "Modbus Communication" - "Modbus Communication via Serial Communication" in the FT1A Series Pro/Lite User's Manual. For SmartAxis Touch maintenance communication and Modbus RTU slaves, see Chapter # "Project Settings" - "# Project Settings Dialog Box" - "#.## System Settings" in the FT1A Series Touch User's Manual.

D8029 System Software Version

The PLC system software version number is stored to D8029. This value is indicated in the PLC status dialog box called from the WindLDR menu bar. Select **Online** > **Monitor** > **Monitor**, then select **Online** > **Status**. See page 13-1.

D8030 Communication Adapter Information

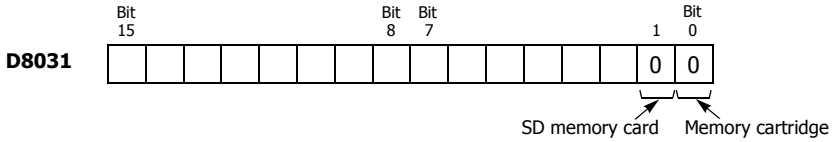
Information about the communication adapters installed on the port 2 and port 3 connectors is stored to D8030.



0: RS232C communication adapter is installed
1: RS485 communication adapter is installed or no communication adapter is installed

D8031 Optional Cartridge Information

Information about the optional cartridge installed on the CPU module is stored to D8031.



0: No optional cartridge is installed
1: Memory cartridge is installed
2: SD memory card is installed
3: Memory cartridge and SD memory card are installed

D8032-D8035, D8037, D8038 Interrupt Input Jump Destination Label No.

Jump destination label numbers for interrupt inputs are stored in these special data registers. To use interrupt inputs, store the label number that corresponds to the special data register allocated to the interrupt input.

D8032=I0, D8033=I2, D8034=I3, D8035=I5, D8037=I6, D8038=I7

For details on SmartAxis Pro/Lite interrupt inputs, see Chapter 5 "Special Functions" – "Interrupt Inputs" in the FT1A Series Pro/Lite User's Manual. For details on SmartAxis Touch interrupt inputs, see Chapter # "Project Settings" – "#.## Functions" – "Interrupt Inputs" in the FT1A Series Touch User's Manual.

D8036 Timer Interrupt Jump Destination Label No.

The jump destination label number when the timer interrupt occurs is stored in D8036. To use the timer interrupt, store the corresponding label number.

For details on the SmartAxis Pro/Lite timer interrupt, see Chapter 5 "Special Functions" – "Timer Interrupt" in the FT1A Series Pro/Lite User's Manual. For details on the SmartAxis Touch timer interrupt, see Chapter # "Project Settings" – "#.## Functions" – "Timer Interrupt" in the FT1A Series Touch User's Manual.

D8039 SD Memory Card Capacity

The capacity of the inserted SD or SDHC (maximum size 32 GB) memory card in megabytes is stored to D8039.

D8040-D8047 Analog Input Value

The analog input values (0 to 10 VDC) to the analog input terminals are converted to digital values (0 to 1000) and stored to the corresponding special data registers.

D8040=AI0, D8041=AI1, D8042=AI2, D8043=AI3, D8044=AI4, D8045=AI5, D8046=AI6, D8047=AI7

D8050-D8073, D8134-D8145 High-speed Counter

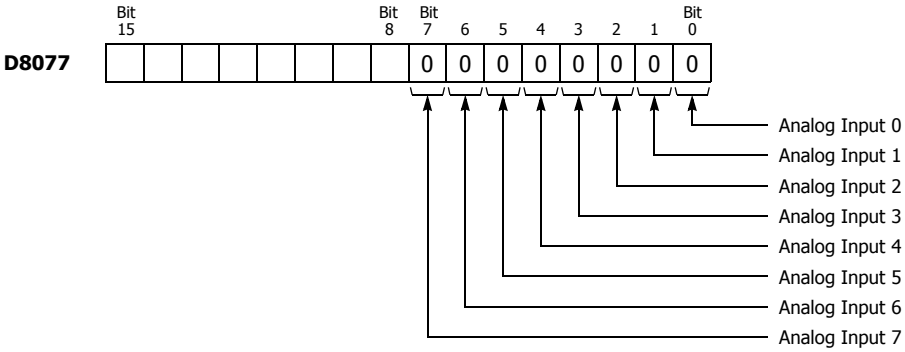
These special data registers are used with the high-speed counter function and the frequency measurement function.

For details on the SmartAxis Pro/Lite high-speed counter, see Chapter 5 "Special Functions" – "High-speed Counter" in the FT1A Series Pro/Lite User's Manual. For details on the SmartAxis Touch high-speed counter, see Chapter # "Project Settings" – "#.## Functions" – "High-speed Counter" in the FT1A Series Touch User's Manual.

D8077 Out of Analog Input Range Status

When an analog input value is 11V or higher, the corresponding bit of D8077 turns on. When an analog input value is lower than 11V, the corresponding bit of D8077 turns off.

The assignment of each analog input is as follows.



D8078-D8083 MAC Address (Read only)

MAC address of the SmartAxis is stored to the special data registers in hexadecimal as shown below.

Example) MAC address: AA-BB-CC-DD-EE-FF

D8078=AAh, D8079=BBh, D8080=CCh, D8081=DDh, D8082=EEh, D8083=FFh

D8084-D8087 IP Address (Current Data) Read only

IP address of the SmartAxis is stored to the special data registers as shown below.

Example) IP address: aaa.bbb.ccc.ddd

D8084=aaa, D8085=bbb, D8086=ccc, D8087=ddd

D8088-D8091 Subnet Mask (Current Data) Read only

Subnet mask of the SmartAxis is stored to the special data registers as shown below.

Example) Subnet mask: aaa.bbb.ccc.ddd

D8088=aaa, D8089=bbb, D8090=ccc, D8091=ddd

D8092-D8095 Default Gateway (Current Data) Read only

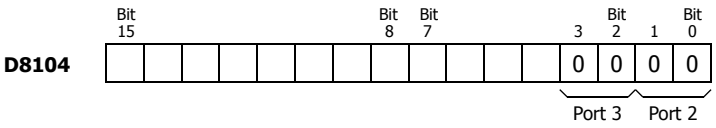
Default gateway of the SmartAxis is stored to the special data registers as shown below.

Example) Default gateway: aaa.bbb.ccc.ddd

D8092=aaa, D8093=bbb, D8094=ccc, D8095=ddd

D8104 RS232C Control Signal Status (Port 2 and Port 3)

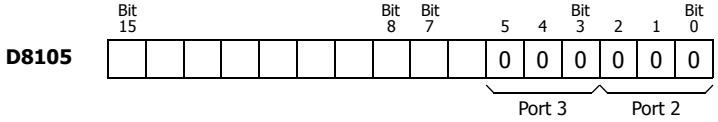
RS232C control signal status of port 2 and port 3 is stored to D8104.



00: Both DSR and DTR are off
01: DSR is off, DTR is on
10: DSR is on, DTR is off
11: Both DSR and DTR are on

D8105 RS232C DSR Input Control Signal Option (Port 2 and Port 3)

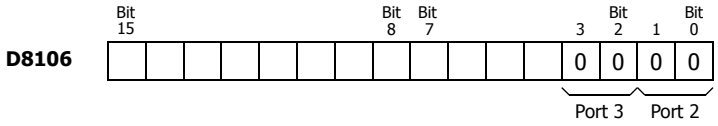
Special data register D8105 is used to control data flow between the SmartAxis RS232C port 2 and port 3 and the remote terminal depending on the DSR (data set ready) signal sent from the remote terminal.



000: DSR is not used for data flow control
001: When DSR is on, SmartAxis can transmit and receive data
010: When DSR is off, SmartAxis can transmit and receive data
011: When DSR is on, SmartAxis can transmit data (busy control)
100: When DSR is off, SmartAxis can transmit data
Others: Same as 000

D8106 RS232C DTR Output Control Signal Option (Port 2 and Port 3)

Special data register D8106 is used to control the DTR (data terminal ready) signal to indicate the SmartAxis operating status or transmitting/receiving status.



00: DTR is on (off while SmartAxis is stopped)
01: DTR is off
10: DTR is on while SmartAxis can receive data (auto switching)
11: Same as 00

D8110-D8121 Connection (1 through 3) Connected IP Address

The IP address of the remote host accessing the connection 1 through 3 is stored in special data registers.

Example) Connection 1 Connected IP Address: aaa.bbb.ccc.ddd

D8110=aaa, D8111=bbb, D8112=ccc, D8113=ddd

D8130-D8132 Connection Connected Port Number

When connections are established with other network devices, the port numbers of the connected network devices are stored in these special data registers.

D8130 : Connection 1 Connected Port Number

D8131 : Connection 2 Connected Port Number

D8132 : Connection 3 Connected Port Number

D8148, D8157, D8166 Remote I/O Communication Error Status

When a communication error occurs between the remote I/O communication slave and master, the details of the communication error are stored in these special data registers.

D8148 : Remote I/O Slave 1 Communication Error Status

D8157 : Remote I/O Slave 2 Communication Error Status

D8166 : Remote I/O Slave 3 Communication Error Status

D8149-D8156, D8158-D8165, D8167-D8174 Remote I/O Analog Input Values

The analog input values (0 to 10 VDC) to the remote I/O analog inputs are converted to digital values (0 to 1000) and stored in the special data registers allocated to each remote I/O slave.

- D8149=AI10, D8150=AI11, D8151=AI12, D8152=AI13, D8153=AI14, D8154=AI15, D8155=AI16, D8156=AI17
- D8158=AI20, D8159=AI21, D8160=AI22, D8161=AI23, D8162=AI24, D8163=AI25, D8164=AI26, D8165=AI27
- D8167=AI30, D8168=AI31, D8169=AI32, D8170=AI33, D8171=AI34, D8172=AI35, D8173=AI36, D8174=AI37

8: INSTRUCTIONS REFERENCE

Introduction

SmartAxis instructions are divided into basic instructions, which perform sequencing, and advanced instructions, which perform moves, comparisons, Boolean computations, binary arithmetic operations, bit shifts, and other operations. For details, see the FT1A Series Ladder Programming Manual.

Basic Instruction List

Symbol	Name	Function	See Page
AND	And	Series connection of NO contact	Basic Vol. 7-5
AND LOD	And Load	Series connection of circuit blocks	Basic Vol. 7-6
ANDN	And Not	Series connection of NC contact	Basic Vol. 7-5
BPP	Bit Pop	Restores the result of bit logical operation which was saved temporarily	Basic Vol. 7-7
BPS	Bit Push	Saves the result of bit logical operation temporarily	Basic Vol. 7-7
BRD	Bit Read	Reads the result of bit logical operation which was saved temporarily	Basic Vol. 7-7
CC=	Counter Comparison (=)	Equal to comparison of counter current value	Basic Vol. 7-19
CC≥	Counter Comparison (≥)	Greater than or equal to comparison of counter current value	Basic Vol. 7-19
CDP	Dual Pulse Reversible Counter	Dual pulse reversible counter (0 to 65,535)	Basic Vol. 7-12
CDPD	Double-word Dual Pulse Reversible Counter	Double-word dual pulse reversible counter (0 to 4,294,967,295)	Basic Vol. 7-16
CNT	Adding Counter	Adding counter (0 to 65,535)	Basic Vol. 7-12
CNTD	Double-word Adding Counter	Double-word adding counter (0 to 4,294,967,295)	Basic Vol. 7-15
CUD	Up/Down Selection Reversible Counter	Up/down selection reversible counter (0 to 65,535)	Basic Vol. 7-14
CUDD	Double-word Up/Down Selection Reversible Counter	Double-word up/down selection reversible counter (0 to 4,294,967,295)	Basic Vol. 7-17
DC=	Data Register Comparison (=)	Equal to comparison of data register value	Basic Vol. 7-21
DC≥	Data Register Comparison (≥)	Greater than or equal to comparison of data register value	Basic Vol. 7-21
END	End	Ends a program	Basic Vol. 7-31
JEND	Jump End	Ends a jump instruction	Basic Vol. 7-30
JMP	Jump	Jumps a designated program area	Basic Vol. 7-30
LOD	Load	Stores intermediate results and reads contact status	Basic Vol. 7-3
LODN	Load Not	Stores intermediate results and reads inverted contact status	Basic Vol. 7-3
MCR	Master Control Reset	Ends a master control	Basic Vol. 7-28

Symbol	Name	Function	See Page
MCS	Master Control Set	Starts a master control	Basic Vol. 7-28
OR	Or	Parallel connection of NO contact	Basic Vol. 7-5
OR LOD	Or Load	Parallel connection of circuit blocks	Basic Vol. 7-6
ORN	Or Not	Parallel connection of NC contact	Basic Vol. 7-5
OUT	Output	Outputs the result of bit logical operation	Basic Vol. 7-3
OUTN	Output Not	Outputs the inverted result of bit logical operation	Basic Vol. 7-3
RST	Reset	Resets output, internal relay, or shift register bit	Basic Vol. 7-4
SET	Set	Sets output, internal relay, or shift register bit	Basic Vol. 7-4
SFR	Shift Register	Forward shift register	Basic Vol. 7-23
SFRN	Shift Register Not	Reverse shift register	Basic Vol. 7-23
SOTD	Single Output Down	Falling-edge differentiation output	Basic Vol. 7-27
SOTU	Single Output Up	Rising-edge differentiation output	Basic Vol. 7-27
TIM	100-ms Timer	Subtracting 100-ms timer (0 to 6553.5 sec)	Basic Vol. 7-8
TIMO	100-ms Off-delay Timer	Subtracting 100-ms off-delay timer (0 to 6553.5 sec)	Basic Vol. 7-11
TMH	10-ms Timer	Subtracting 10-ms timer (0 to 655.35 sec)	Basic Vol. 7-8
TMHO	10-ms Off-delay Timer	Subtracting 10-ms off-delay timer (0 to 655.35 sec)	Basic Vol. 7-11
TML	1-sec Timer	Subtracting 1-sec timer (0 to 65535 sec)	Basic Vol. 7-8
TMLO	1-sec Off-delay Timer	Subtracting 1-sec off-delay timer (0 to 65535 sec)	Basic Vol. 7-11
TMS	1-ms Timer	Subtracting 1-ms timer (0 to 65.535 sec)	Basic Vol. 7-8
TMSO	1-ms Off-delay Timer	Subtracting 1-ms off-delay timer (0 to 65.535 sec)	Basic Vol. 7-11

Advanced Instruction List

Group	Symbol	Name	Valid Data Type					See Page
			W	I	D	L	F	
NOP	NOP	No Operation						4-14
Move	MOV	Move	X	X	X	X	X	3-1
	MOVN	Move Not	X	X	X	X		3-5
	IMOV	Indirect Move	X		X		X	3-6
	IMOVN	Indirect Move Not	X		X			3-8
	BMOV	Block Move	X					3-9
	IBMV	Indirect Bit Move	X					3-10
	IBMVN	Indirect Bit Move Not	X					3-12
	NSET	N Data Set	X	X	X	X	X	3-13
	NRS	N Data Repeat Set	X	X	X	X	X	3-14
	XCHG	Exchange	X		X			3-15
	TCCST	Timer/Counter Current Value Store	X		X			3-16
Data Comparison	CMP=	Compare Equal To	X	X	X	X	X	4-1
	CMP<>	Compare Unequal To	X	X	X	X	X	4-1
	CMP<	Compare Less Than	X	X	X	X	X	4-1
	CMP>	Compare Greater Than	X	X	X	X	X	4-1
	CMP<=	Compare Less Than or Equal To	X	X	X	X	X	4-1
	CMP>=	Compare Greater Than or Equal To	X	X	X	X	X	4-2
	ICMP>=	Interval Compare Greater Than or Equal To	X	X	X	X	X	4-6
	LC=	Load Compare Equal To	X	X	X	X	X	4-8
	LC<>	Load Compare Unequal To	X	X	X	X	X	4-8
	LC<	Load Compare Less Than	X	X	X	X	X	4-8
	LC>	Load Compare Greater Than	X	X	X	X	X	4-8
	LC<=	Load Compare Less Than or Equal To	X	X	X	X	X	4-8
	LC>=	Load Compare Greater Than or Equal To	X	X	X	X	X	4-8
Binary Arithmetic	ADD	Addition	X	X	X	X	X	5-1
	SUB	Subtraction	X	X	X	X	X	5-1
	MUL	Multiplication	X	X	X	X	X	5-1
	DIV	Division	X	X	X	X	X	5-1
	INC	Increment	X	X	X	X		5-13
	DEC	Decrement	X	X	X	X		5-13
	ROOT	Root	X		X		X	5-15
	SUM	Sum (ADD)	X	X	X	X	X	5-16
		Sum (XOR)	X					
Boolean Computation	ANDW	AND Word	X		X			6-1
	ORW	OR Word	X		X			6-1
	XORW	Exclusive OR Word	X		X			6-1
Shift and Rotate	SFTL	Shift Left						7-1
	SFTR	Shift Right						7-3
	BCDLS	BCD Left Shift			X			7-5
	WSFT	Word Shift	X					7-7
	ROTL	Rotate Left	X		X			7-8
	ROTR	Rotate Right	X		X			7-10

Group	Symbol	Name	Valid Data Type					See Page
			W	I	D	L	F	
Data Conversion	HTOB	Hex to BCD	X		X			8-1
	BTOH	BCD to Hex	X		X			8-3
	HTOA	Hex to ASCII	X					8-5
	ATOH	ASCII to Hex	X					8-7
	BTOA	BCD to ASCII	X		X			8-9
	ATOB	ASCII to BCD	X		X			8-12
	ENCO	Encode						8-15
	DECO	Decode						8-16
	BCNT	Bit Count						8-17
	ALT	Alternate Output						8-18
	CVDT	Convert Data Type	X	X	X	X	X	8-19
	DTDV	Data Divide	X					8-21
	DTCB	Data Combine	X					8-22
	SWAP	Data Swap	X		X			8-23
Week Programmer	WEEK	Weekly Timer						9-1
	YEAR	Yearly Timer						9-2
Interface	MSG	Message						10-1
User Communication	TXD2	Transmit 2						Basic Vol. 10-6
	TXD3	Transmit 3						Basic Vol. 10-6
	RXD2	Receive 2						Basic Vol. 10-15
	RXD3	Receive 3						Basic Vol. 10-15
Program Branching	LABEL	Label						11-1
	LJMP	Label Jump						11-1
	LCAL	Label Call						11-3
	LRET	Label Return						11-3
	DJNZ	Decrement Jump Non-zero						11-5
	DI	Disable Interrupt						11-7
	EI	Enable Interrupt						11-7
	IOREF	I/O Refresh						11-9
	HSCRF	High-speed Counter Refresh						11-11
Coordinate Conversion	XYFS	XY Format Set	X	X				12-1
	CVXTY	Convert X to Y	X	X				12-2
	CVYTX	Convert Y to X	X	X				12-3
	AVRG	Average	X	X	X	X	X	12-7
Pulse	PULS1	Pulse Output 1						13-2
	PULS2	Pulse Output 2						13-2
	PULS3	Pulse Output 3						13-2
	PULS4	Pulse Output 4						
	PWM1	Pulse Width Modulation 1						13-8
	PWM2	Pulse Width Modulation 2						13-8
	PWM3	Pulse Width Modulation 3						13-8
	PWM4	Pulse Width Modulation 4						
	RAMP1	Ramp Pulse Output 1						13-14
	RAMP2	Ramp Pulse Output 2						13-14
	ZRN1	Zero Return 1						13-26
	ZRN2	Zero Return 2						13-26
	ARAMP1	Advanced Ramp 1						13-26
	ARAMP2	Advanced Ramp 2						13-26
Dual / Teaching Timer	DTML	1-sec Dual Timer						15-1
	DTIM	100-ms Dual Timer						15-1
	DTMH	10-ms Dual Timer						15-1
	DTMS	1-ms Dual Timer						15-1
	TTIM	Teaching Timer						15-3

Group	Symbol	Name	Valid Data Type					See Page
			W	I	D	L	F	
Trigonometric Function	RAD	Degree to Radian					X	17-1
	DEG	Radian to Degree					X	17-2
	SIN	Sine					X	17-3
	COS	Cosine					X	17-4
	TAN	Tangent					X	17-5
	ASIN	Arc Sine					X	17-6
	ACOS	Arc Cosine					X	17-7
	ATAN	Arc Tangent					X	17-8
Logarithm / Power	LOGE	Natural Logarithm					X	18-1
	LOG10	Common Logarithm					X	18-2
	EXP	Exponent					X	18-3
	POW	Power					X	18-4
File Data Processing	FIFOF	FIFO Format	X					19-1
	FIEX	First-In Execute	X					19-3
	FOEX	First-Out Execute	X					19-3
	NDSRC	N Data Search	X	X	X	X	X	19-5
Clock	TADD	Time Addition						20-1
	TSUB	Time Subtraction						20-5
	HTOS	HMS to Sec						20-9
	STOH	Sec to HMS						20-10
	HOUR	Hour Meter						20-11
Ethernet Instructions	ETXD	Transmit over Ethernet						
	ERXD	Receive over Ethernet						
Data Logging	DLOG	Data Logging						
	TRACE	Data Trace						
Script	SCRPT	Script						

Advanced Instruction Applicable CPU Modules

Applicable advanced instructions depend on the type of CPU modules as listed in the table below.

Group	Symbol	FT1A-12		FT1A-24		FT1A-40		FT1A-48		FT1A-Touch
		AC	DC	AC	DC	AC	DC	AC	DC	
NOP	NOP	X	X	X	X	X	X	X	X	X
Move	MOV	X	X	X	X	X	X	X	X	X
	MOVN	X	X	X	X	X	X	X	X	X
	IMOV	X	X	X	X	X	X	X	X	X
	IMOVN	X	X	X	X	X	X	X	X	X
	BMOV	X	X	X	X	X	X	X	X	X
	IBMV	X	X	X	X	X	X	X	X	X
	IBMVN	X	X	X	X	X	X	X	X	X
	NSET	X	X	X	X	X	X	X	X	X
	NRS	X	X	X	X	X	X	X	X	X
	XCHG	X	X	X	X	X	X	X	X	X
	TCCST	X	X	X	X	X	X	X	X	X
Data Comparison	CMP=	X	X	X	X	X	X	X	X	X
	CMP<>	X	X	X	X	X	X	X	X	X
	CMP<	X	X	X	X	X	X	X	X	X
	CMP>	X	X	X	X	X	X	X	X	X
	CMP<=	X	X	X	X	X	X	X	X	X
	CMP>=	X	X	X	X	X	X	X	X	X
	ICMP>=	X	X	X	X	X	X	X	X	X
	LC=	X	X	X	X	X	X	X	X	X
	LC<>	X	X	X	X	X	X	X	X	X
	LC<	X	X	X	X	X	X	X	X	X
	LC>	X	X	X	X	X	X	X	X	X
	LC<=	X	X	X	X	X	X	X	X	X
	LC>=	X	X	X	X	X	X	X	X	X
Binary Arithmetic	ADD	X	X	X	X	X	X	X	X	X
	SUB	X	X	X	X	X	X	X	X	X
	MUL	X	X	X	X	X	X	X	X	X
	DIV	X	X	X	X	X	X	X	X	X
	INC	X	X	X	X	X	X	X	X	X
	DEC	X	X	X	X	X	X	X	X	X
	ROOT	X	X	X	X	X	X	X	X	X
	SUM	X	X	X	X	X	X	X	X	X
Boolean Computation	ANDW	X	X	X	X	X	X	X	X	X
	ORW	X	X	X	X	X	X	X	X	X
	XORW	X	X	X	X	X	X	X	X	X
Shift and Rotate	SFTL	X	X	X	X	X	X	X	X	X
	SFTR	X	X	X	X	X	X	X	X	X
	BCDLS	X	X	X	X	X	X	X	X	X
	WSFT	X	X	X	X	X	X	X	X	X
	ROTL	X	X	X	X	X	X	X	X	X
	ROTR	X	X	X	X	X	X	X	X	X

Group	Symbol	FT1A-12		FT1A-24		FT1A-40		FT1A-48		FT1A-Touch
		AC	DC	AC	DC	AC	DC	AC	DC	
Data Conversion	HTOB	X	X	X	X	X	X	X	X	X
	BTOH	X	X	X	X	X	X	X	X	X
	HTOA	X	X	X	X	X	X	X	X	X
	ATOH	X	X	X	X	X	X	X	X	X
	BTOA	X	X	X	X	X	X	X	X	X
	ATOB	X	X	X	X	X	X	X	X	X
	ENCO	X	X	X	X	X	X	X	X	X
	DECO	X	X	X	X	X	X	X	X	X
	BCNT	X	X	X	X	X	X	X	X	X
	ALT	X	X	X	X	X	X	X	X	X
	CVDT	X	X	X	X	X	X	X	X	X
	DTDV	X	X	X	X	X	X	X	X	X
	DTCB	X	X	X	X	X	X	X	X	X
	SWAP	X	X	X	X	X	X	X	X	X
Week Programmer	WEEK	X	X	X	X	X	X	X	X	X
	YEAR	X	X	X	X	X	X	X	X	X
Interface	MSG	X (Note)	X (Note)	X (Note)	X (Note)	X (Note)	X (Note)	X (Note)	X (Note)	
User Communication	TXD2			X	X	X	X	X	X	
	TXD3					X	X	X	X	
	RXD2			X	X	X	X	X	X	
	RXD3					X	X	X	X	
Program Branching	LABEL	X	X	X	X	X	X	X	X	X
	LJMP	X	X	X	X	X	X	X	X	X
	LCAL	X	X	X	X	X	X	X	X	X
	LRET	X	X	X	X	X	X	X	X	X
	DJNZ	X	X	X	X	X	X	X	X	X
	DI	X	X	X	X	X	X	X	X	X
	EI	X	X	X	X	X	X	X	X	X
	IOREF	X	X	X	X	X	X	X	X	X
	HSCRF		X		X		X		X	X
Coordinate Conversion	XYFS	X	X	X	X	X	X	X	X	X
	CVXTY	X	X	X	X	X	X	X	X	X
	CVYTX	X	X	X	X	X	X	X	X	X
	AVRG	X	X	X	X	X	X	X	X	X

Note: MSG instructions can be used with Pro series only.

Group	Symbol	FT1A-12		FT1A-24		FT1A-40		FT1A-48		FT1A-Touch
		AC	DC	AC	DC	AC	DC	AC	DC	
Pulse	PULS1						X	X	X	
	PULS2						X	X	X	
	PULS3						X	X	X	
	PULS4						X	X	X	
	PWM1						X	X	X	
	PWM2						X	X	X	
	PWM3						X	X	X	
	PWM4						X	X	X	
	RAMP1						X	X	X	
	RAMP2						X	X	X	
	ZRN1						X	X	X	
	ZRN2						X	X	X	
	ARAMP1						X	X	X	
	ARAMP2						X	X	X	
Dual / Teaching Timer	DTML	X	X	X	X	X	X	X	X	X
	DTIM	X	X	X	X	X	X	X	X	X
	DTMH	X	X	X	X	X	X	X	X	X
	DTMS	X	X	X	X	X	X	X	X	X
	TTIM	X	X	X	X	X	X	X	X	X
Trigonometric Function	RAD	X	X	X	X	X	X	X	X	X
	DEG	X	X	X	X	X	X	X	X	X
	SIN	X	X	X	X	X	X	X	X	X
	COS	X	X	X	X	X	X	X	X	X
	TAN	X	X	X	X	X	X	X	X	X
	ASIN	X	X	X	X	X	X	X	X	X
	ACOS	X	X	X	X	X	X	X	X	X
	ATAN	X	X	X	X	X	X	X	X	X
Logarithm / Power	LOGE	X	X	X	X	X	X	X	X	X
	LOG10	X	X	X	X	X	X	X	X	X
	EXP	X	X	X	X	X	X	X	X	X
	POW	X	X	X	X	X	X	X	X	X
File Data Processing	FIFOF	X	X	X	X	X	X	X	X	X
	FIEX	X	X	X	X	X	X	X	X	X
	FOEX	X	X	X	X	X	X	X	X	X
	NDSRC	X	X	X	X	X	X	X	X	X
Clock	TADD	X	X	X	X	X	X	X	X	X
	TSUB	X	X	X	X	X	X	X	X	X
	HTOS	X	X	X	X	X	X	X	X	X
	STOH	X	X	X	X	X	X	X	X	X
	HOUR	X	X	X	X	X	X	X	X	X
Ethernet Instructions	ETXD			X	X	X	X	X	X	
	ERXD			X	X	X	X	X	X	
Data Logging	DLOG					X	X	X	X	
	TRACE					X	X	X	X	
Script	SCRPT	X	X	X	X	X	X	X	X	

Notes:

- When using RAMP1 in single-pulse output mode, PULS3 and PWM3 cannot be used. When using RAMP2 in single-pulse output mode, PULS4 and PWM4 cannot be used.
- When using RAMP1 and ARAMP1 in dual-pulse output mode, RAMP2 and ARAMP2 cannot be used.

9: MAINTENANCE COMMUNICATION

Introduction

This chapter describes the SmartAxis maintenance communication function.

Maintenance communication is a communication protocol dedicated for IDEC programmable controllers. It is used when WindLDR or an operator interface communicates with the SmartAxis.

Maintenance communication of SmartAxis is available on USB port, expansion communication ports, and Ethernet port, allowing the optimum communication method to be selected for a variety of system configurations.

Maintenance Communication Functions

When performing maintenance communication with the SmartAxis, the following functions can be used:

Function	Description
Download user programs	User programs created in WindLDR can be downloaded to the SmartAxis. See ##"Operation Basics"## - ##"Downloading User Programs"## on page xx-xx.
Upload user programs	User programs stored in the SmartAxis can be uploaded to WindLDR.
Monitor/change device values	The user program and the device values of the SmartAxis can be monitored and the device values can be changed using WindLDR. See ##"Operation Basics"## - ##"Confirming Operation"## on page xx-xx.
Download system software	System software can be downloaded to the SmartAxis. See ##"Downloading System Software"## on page xx-xx.

Note: To use maintenance communication, see ##"Operation Basics"## -##"Start WindLDR and PLC Selection"## on page xx-xx and perform setup.

Communication Ports Used For Maintenance Communication

SmartAxis supports the following communication ports:

Type	USB Port (Port 1)	Expansion Communication Ports (Note)		Ethernet Port
		Port 2	Port 3	
12-I/O type	Yes	No	No	No
24-I/O type	Yes	Yes	No	Yes
40-I/O type	Yes	Yes	Yes	Yes
48-I/O type	Yes	Yes	Yes	Yes

Note: Communication cartridges are required in order to use expansion communication ports.

Maintenance communication supports the following functions on each communication port:

Communication Port	Standard/Option	No. of Ports	Communication Settings
USB port	Standard	1	None
Expansion communication ports	Options FT1A-PC1: EIA RS232C (Mini DIN) FT1A-PC2: EIA RS485 (Mini DIN) FT1A-PC3: EIA RS485 (Terminal block)	12-I/O type: 0 24-I/O type: 1 40-I/O type: 2 48-I/O type: 2	Function area settings See "Maintenance Communication via Expansion Communication Port" on page 9-3.
Ethernet Port	12-I/O type: - 24-I/O type: Standard 40-I/O type: Standard 48-I/O type: Standard	1	Function area settings See "Maintenance Communication via Ethernet Port" on page 9-5.

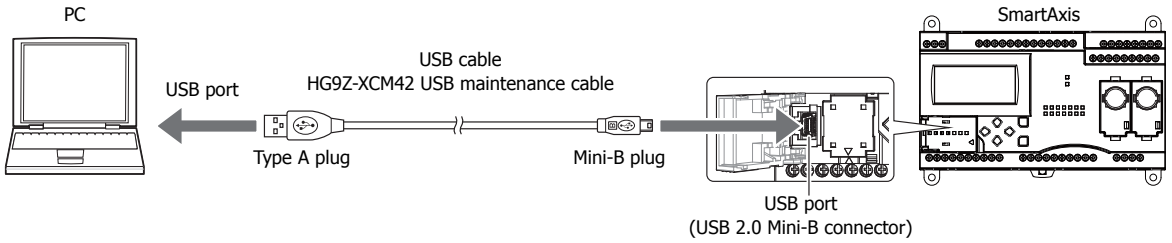
Communication Port	Maintenance Communication Functions		
	Monitor/Change Device Values	Download/Upload User Programs	Download System Software
USB port	Yes	Yes	Yes
Expansion communication ports	Yes	No	No
Ethernet port	Yes	Yes	No

Maintenance Communication via USB Port

Applicable CPU Modules

FT1A-12	FT1A-24	FT1A-40	FT1A-48
X	X	X	X

Using the USB port, it is possible to connect SmartAxis to a PC on which WindLDR is installed, and monitor and change device values, download and upload user programs, and download system software. Connect the PC and the SmartAxis using a USB cable (recommended cable: HG9Z-XCM42).



Maintenance Communication Specifications for the USB Port

Item	Specifications/Functions
Cable	Recommended cable: HG9Z-XCM42
Maintenance communication functions	Monitor/change device values Download/upload user programs Download system software

See the following pages for details on each maintenance communication function:

- Monitor/change device values: ##"Operation Basics"## - ##"Confirming Operation"## on page xx-xx
- Download/upload user programs: ##"Operation Basics"## - ##"Downloading User Programs"## on page xx-xx
- Download system software: ##"Download System Software"## on page xx-xx

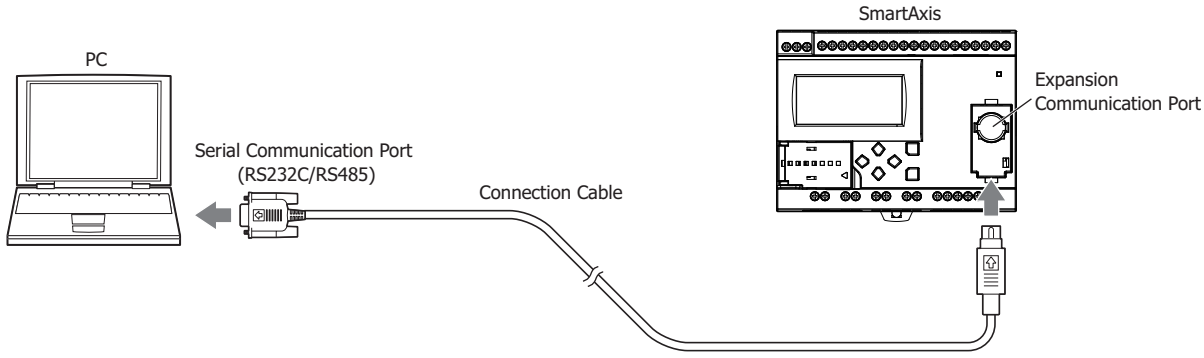
Maintenance Communication via Expansion Communication Port

Applicable CPU Modules

FT1A-12	FT1A-24	FT1A-40	FT1A-48
—	X (Port 2)	X (Port 2 and 3)	X (Port 2 and 3)

By installing a RS232C or RS485 communication cartridge to a expansion communication port on the SmartAxis, it is possible to connect SmartAxis to a PC or an operator interface with an RS232C or RS485 port and monitor and change device values of SmartAxis.

For details on communication cables, see ##"Cables"## on page xx-xx.



Maintenance Communication Specifications for Expansion Communication Ports

Item	Specifications/Functions
Communication cartridge	FT1A-PC1: RS232C communication cartridge (Mini DIN type) FT1A-PC2: RS485 communication cartridge (Mini DIN type) FT1A-PC3: RS485 communication cartridge (Terminal block type) (Note)
Cable	FC2A-KC4C: RS232C communication cable (Mini DIN type) FC2A-KP1C: RS485 communication cable (Mini DIN type)
Maintenance communication functions	Monitoring/changing device values

Note: Use shielded twisted-pair cables.

See the following pages for details on the maintenance communication function:

- Monitor/change device values: ##"Operation Basics"## - ##"Confirming Operation"## on page xx-xx

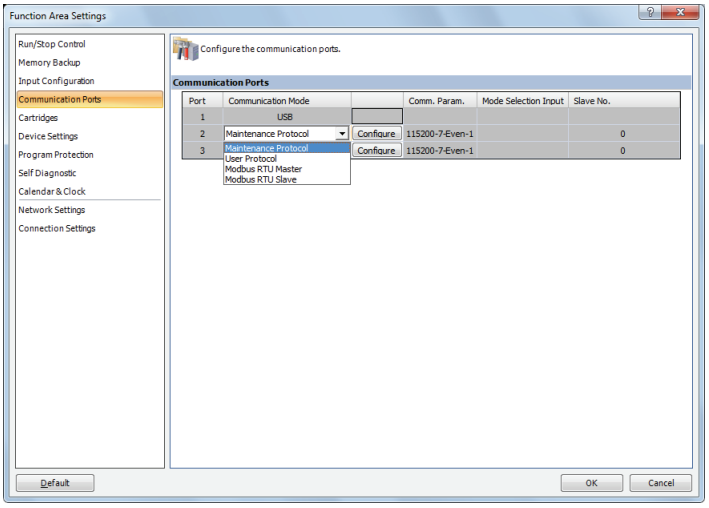
Programming WindLDR

Configure the settings for maintenance communication.

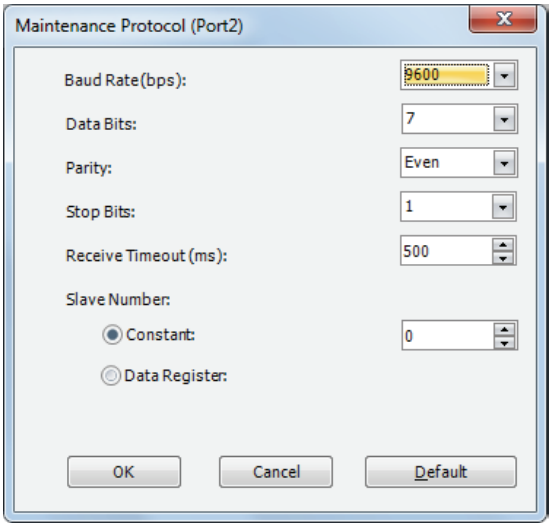
Setting Procedure

1. From the WindLDR menu bar, select **Configuration** > **Comm**. **Ports**.
   The Function Area Settings dialog box appears.

2. In the **Communication Mode** pull-down list for Port 2, select **Maintenance Protocol**.
   The Maintenance Communication (Port 2) dialog box appears.



3. Configure the parameters to match the communication settings of the PC or operator interface.



Baud Rate (bps):	115200 bps (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200)
Data Bits:	7 (7 or 8)
Parity:	Even (None, Even, Odd)
Stop Bits:	1 (1 or 2)
Receive Timeout (ms):	500 (10 to 2550)
Slave Number	0 (0 to 31) Slave number can be specified by either a constant or a data register.

Type	Details
Constant	Set within the range of 0 to 31
Data register	Store the slave numbers 0 to 31 in the following special data registers Port 2: D8027 Port 3: D8028

Notes:

- Values not in parentheses are the default settings.
- The following configuration cannot be selected: Data Bits: 7, Parity: None

4. Click **OK**.
   Configuring the maintenance communication for the expansion communication port is now complete.

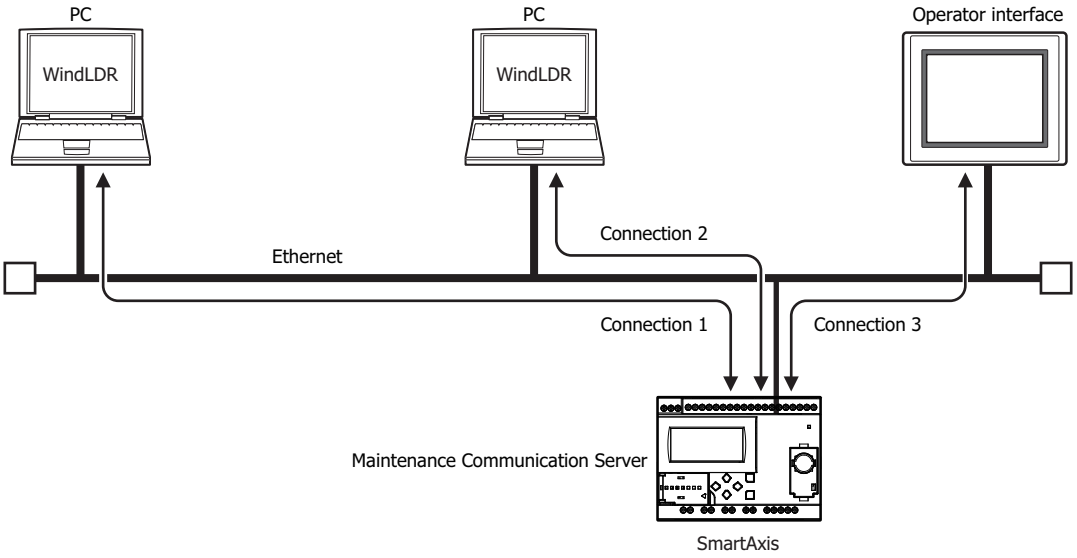
Maintenance Communication via Ethernet Port

Applicable CPU Modules

FT1A-12	FT1A-24	FT1A-40	FT1A-48
—	X	X	X

Network devices such as PCs or operator interfaces can communicate with SmartAxis via Ethernet. External devices on the network can monitor or change the device values and download or upload user programs.

It is possible to use the maintenance communication sever and other communications simultaneously by assigning a separate communication function such as a maintenance communication server or Modbus TCP communication to each of the three connections on the SmartAxis.



Maintenance Communication Specifications for the Ethernet Port

Item	Specifications/Functions
Cable	LAN cable
Maintenance communication functions	Monitor/change device values Download/upload user programs

See the following pages for details on each maintenance communication function:

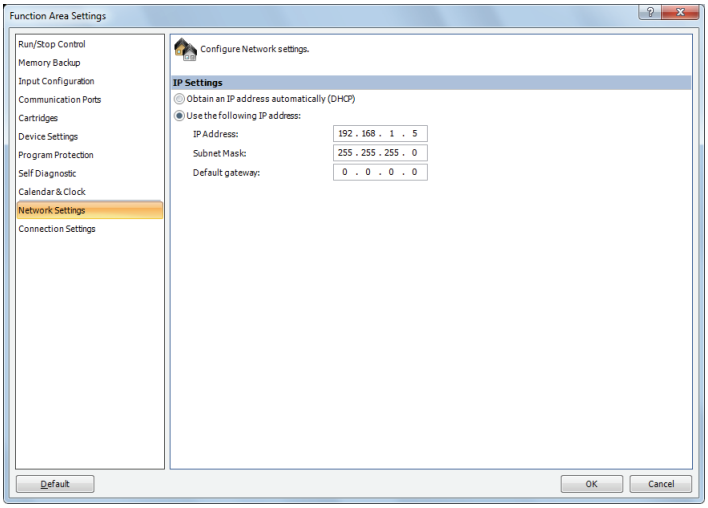
- Monitor/change device values: ##"Operation Basics"## - ##"Confirming Operation"## on page xx-xx
- Download/upload user programs: ##"Operation Basics"## - ##"Downloading User Programs"## on page xx-xx

Programming WindLDR

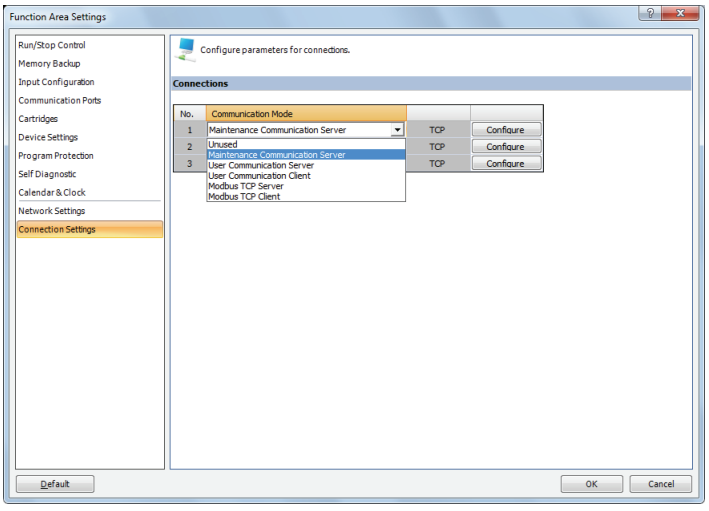
This section describes the procedures to configure maintenance communication server for the Ethernet port and communicate with the SmartAxis via Ethernet.

Configure Maintenance Communication Server

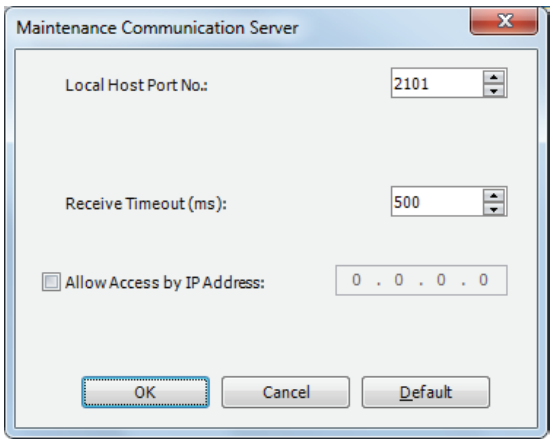
1. From the WindLDR menu bar, select **Configuration** > **Network Settings**.
   The Function Area Settings dialog box appears.
2. Enter the IP address, subnet mask, and default gateway.



3. Click **Connection Settings**.
4. In the **Communication Mode** pull-down list for the connection to configure, select **Maintenance Communication Server**.
   The Maintenance Communication Server dialog box appears.



5. Set the parameters to match the communication settings of the PC or operator interface.



Local Host Port No.:	2101 (The port number that the SmartAxis uses for the maintenance communication server)
Receive Timeout (ms):	2000 (100 to 25500 ms)
Allow Access by IP Address:	Disabled (Enabling this option makes it possible to prevent access from devices having any IP addresses other than the one entered.)

Notes:

- Settings not in parentheses are the default values.
- The number of clients that can be connected to the SmartAxis simultaneously is one client per a connection. If connections 1 to 3 are all set to the maintenance communication server, three clients can connect to the SmartAxis at the same time.

6. Click **OK**.
This completes maintenance communications settings.

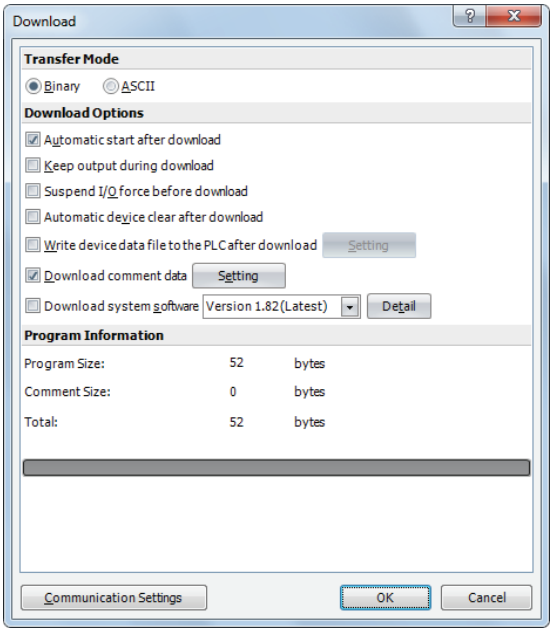
Download User Program and Confirm IP Addresses via USB Port

Before starting Ethernet communication, configure the function area settings and download the user program to the SmartAxis via USB.

7. Connect the PC and the SmartAxis using a USB cable.

8. From the WindLDR menu bar, select **Online** > **Transfer** > **Download**.
The Download dialog box appears.

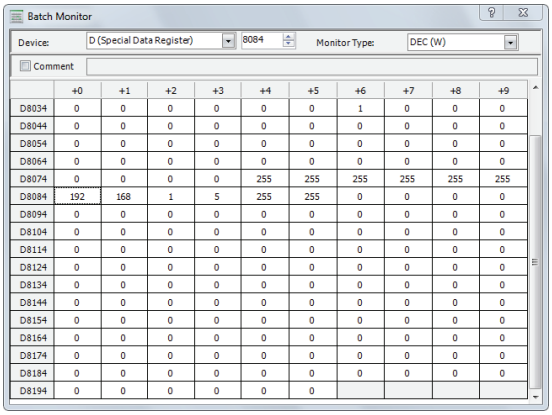
9. Click **OK**.
The user program is downloaded to the SmartAxis.



10. After the user program has been successfully downloaded, go to the monitor mode to check the status of the SmartAxis. Select **Online** > **Monitor** > **Monitor** from the WindLDR menu bar.

11. From the WindLDR menu bar, select **Online** > **Monitor** > **Batch**.
The Batch Monitor dialog box appears.

12. Confirm that the IP address entered in step 2 is correctly shown in D8084 to D8087.



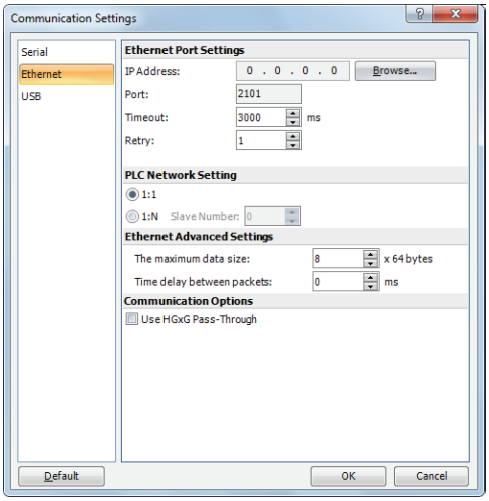
	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
D8034	0	0	0	0	0	0	1	0	0	0
D8044	0	0	0	0	0	0	0	0	0	0
D8054	0	0	0	0	0	0	0	0	0	0
D8064	0	0	0	0	0	0	0	0	0	0
D8074	0	0	0	0	255	255	255	255	255	255
D8084	192	168	1	5	255	255	0	0	0	0
D8094	0	0	0	0	0	0	0	0	0	0
D8104	0	0	0	0	0	0	0	0	0	0
D8114	0	0	0	0	0	0	0	0	0	0
D8124	0	0	0	0	0	0	0	0	0	0
D8134	0	0	0	0	0	0	0	0	0	0
D8144	0	0	0	0	0	0	0	0	0	0
D8154	0	0	0	0	0	0	0	0	0	0
D8164	0	0	0	0	0	0	0	0	0	0
D8174	0	0	0	0	0	0	0	0	0	0
D8184	0	0	0	0	0	0	0	0	0	0
D8194	0	0	0	0	0	0				

Monitor SmartAxis via the Ethernet

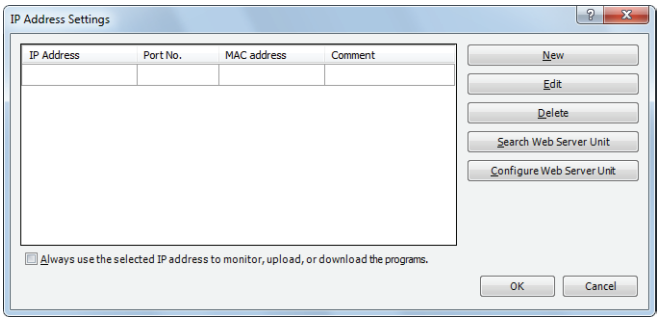
Monitor the SmartAxis via Ethernet using WindLDR.

13. From the WindLDR menu bar, select **Online** > **Communication** > **Set Up**.
The Communication Settings dialog box appears.

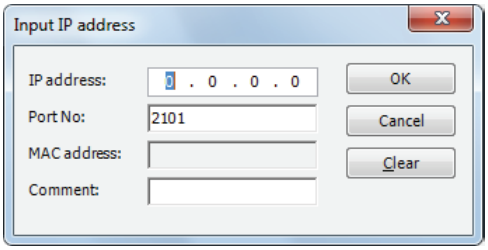
14. Select the **Ethernet** tab and click **Browse**.
The IP Address Settings dialog box appears.



15. Click **New**.
The Input IP Address dialog box appears.

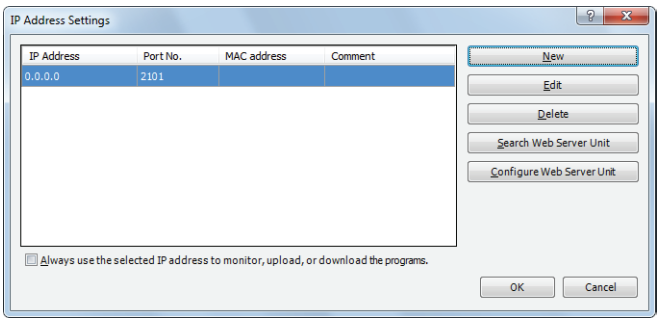


16. Enter the IP address entered in step 2 and click **OK**.



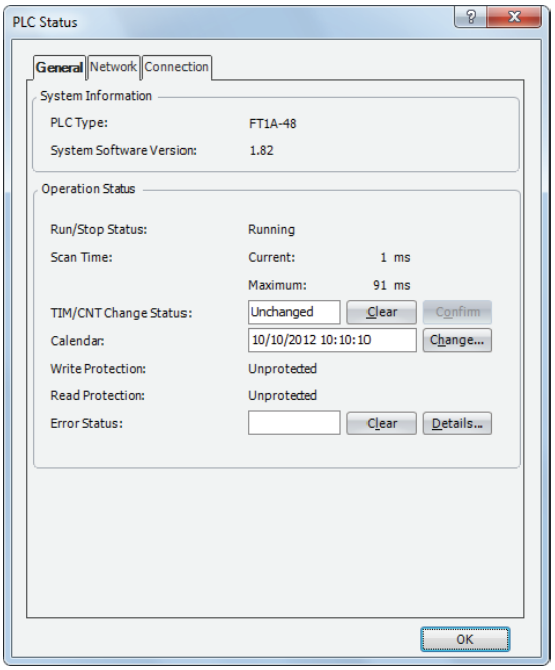
17. From the WindLDR menu bar, select **Online** > **Monitor** > **Monitor**.
The IP Address Settings dialog box appears.

18. Select the IP address you entered and click **OK**.



19. From the WindLDR menu bar, select **Online** > **PLC** > **Status**.
The PLC Status dialog box appears.

20. Check that the SmartAxis module type and system software version are displayed correctly.



Configuring the initial setup for the maintenance communication server for the Ethernet is now complete. You can download and upload user programs and monitor and change device values via Ethernet.

10: USER COMMUNICATION INSTRUCTIONS

Introduction

This chapter describes user communication that converts the specified data to the data type for the external devices connected to the SmartAxis and sends and receives that data.

User communication allows the following two types of communication methods.

- Serial communication with an external device connected to the RS232C port or the RS485 port
- Ethernet communication with an external device connected by the Ethernet port

User Communication via Serial Communication

This section describes the user communication function for communication between the SmartAxis and external devices with an RS232C or RS485 port, such as a computer, modem, printer, or barcode reader. The SmartAXIS uses user communication instructions for transmitting and receiving communication to and from external devices.

For details about expansion RS232C/RS485 communication on port 2 to port 3, see page 25-1 (Advanced VI.).

User Communication Overview

By installing a communication cartridge on the SmartAxis expansion communication port, the CPU module can communicate with two external devices simultaneously.

When using an RS485 communication cartrigde, SmartAXIS modules can communicate with a maximum of 31 RS485 devices using the user communication.

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.

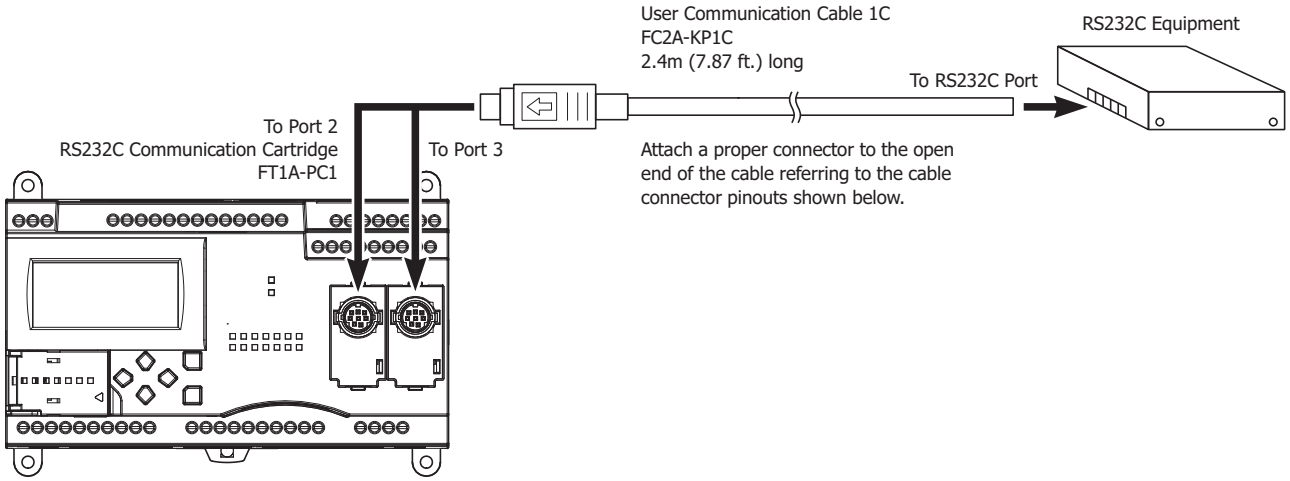
User Communication Mode Specifications

Type	RS232C User Communication	RS485 User Communication
Communication Port	Port 2 and Port 3	Port 2 and Port 3
Maximum Nodes	1 per port	31 maximum
Standards	EIA RS232C	EIA RS485
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps (Default: 115200)	
Data Bits	7 or 8 bits (Default: 7) (Note)	
Parity	Odd, Even, None (Default: Even) (Note)	
Stop Bits	1 or 2 bits (Default: 1)	
Receive Timeout	10 to 2540 ms (10 ms increments) or none (Receive timeout is disabled when 2550 ms is selected.) The receive timeout has an effect when using RXD instructions.	
Communication Method	Start-stop synchronization system	
Maximum Cable Length	3 m	200 m
Maximum Transmit Data	200 bytes	
Maximum Receive Data	200 bytes	
BCC Calculation	XOR, ADD, ADD-2comp *, Modbus ASCII *, Modbus RTU * (* For calculation examples, see page 10-28.)	

Note: The following configuration cannot be selected: Data Bits: 7, Parity: None

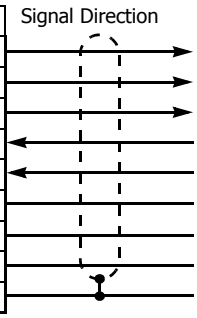
RS232C User Communication System Setup

To connect an RS232C communication device to the port 2 or 3 on the SmartAxis, use the user communication cable 1C (FC2A-KP1C). One end of the user communication cable 1C is not provided with a connector, and can be terminated with a proper connector to plug in to communicate with the RS232C port. See the figure on page 10-2.



Cable Connector Pinouts

Pin	Port 2, Port 3	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

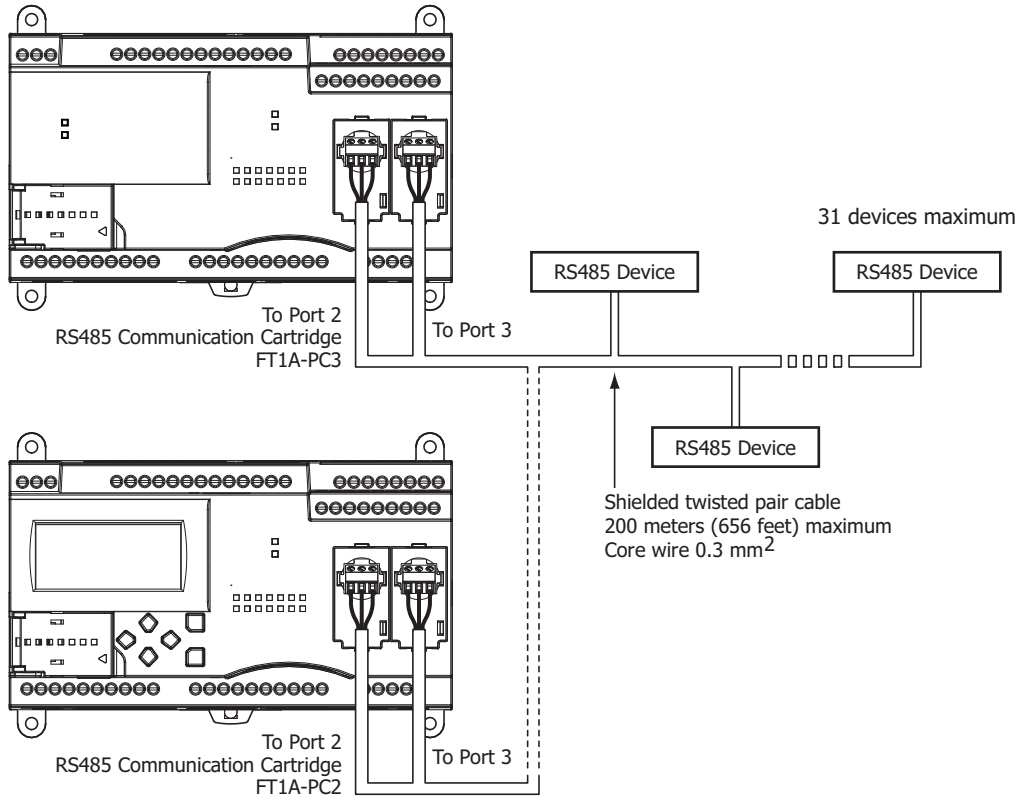


RS485 User Communication System Setup

Using the RS485 user communication, a maximum of 31 RS485 devices can be connected to the SmartAxis.

When using port 2 or 3 for RS485 communication on the SmartAXIS, install the RS485 communication cartridge (FT1A-PC2 or FT1A-PC3) to the expansion communication port.

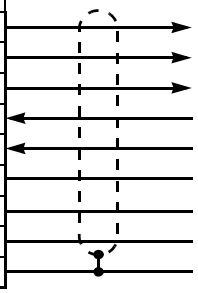
Connect RS485 device to the RS485 terminals A, B, and SG of port 2 or 3 on the SmartAxis using a shielded twisted pair cable as shown below. When using the RS485 communication cartridge (FT1A-PC2) to the expansion communication port, use the user communication cable 1C (FC2A-KP1C). One end of the user communication cable 1C is not provided with a connector, and can be terminated with a proper connector to plug in to communicate with the RS232C port.



Cable Connector Pinouts

Pin	Port 2, Port 3	AWG#		Color
1	B	28	Twisted	Black
2	A	28		Yellow
3	NC (no connection)	28		Blue
4	NC (no connection)	28		Green
5	NC (no connection)	28		Brown
6	NC (no connection)	28		Gray
7	SG (signal ground)	26	Twisted	Red
8	NC (no connection)	26		White
Cover	—	—		Shield

Signal Direction



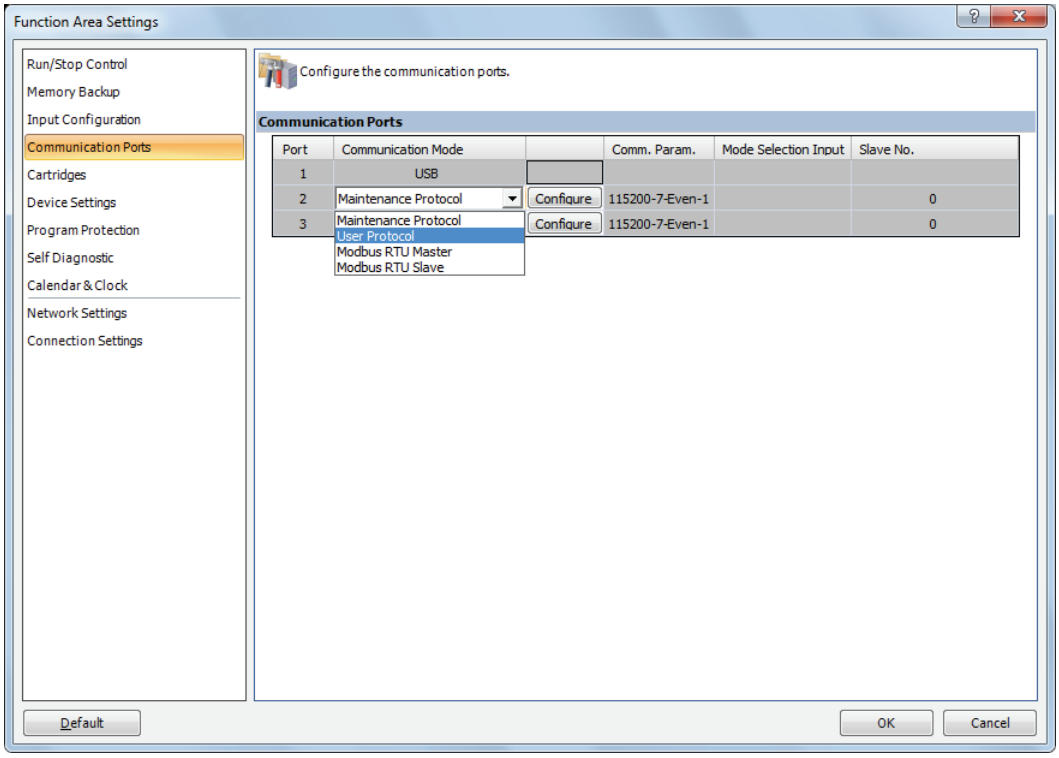
Programming WindLDR

When using the user communication function to communicate with an external RS232C or RS485 device, set the communication parameters for the SmartAxis 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 SmartAxis after changing any of these settings.

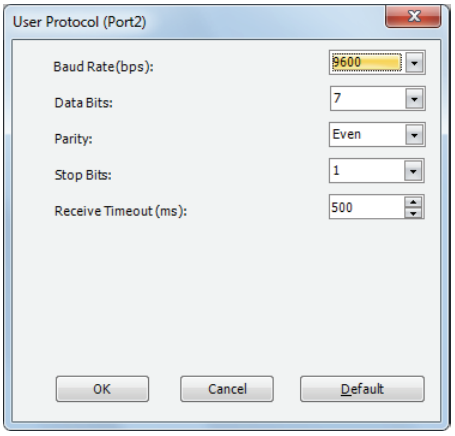
1. From the WindLDR menu bar, select **Configuration** > **Communication Ports**.

The Function Area Settings dialog box for Communication Ports appears.



2. In the Communication Mode pull-down list for Port 2 and Port 3, select **User Protocol**. (Click the **Configure** button when changing previous settings.)

The User Protocol dialog box appears.



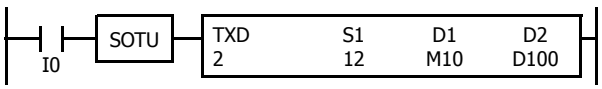
When **2550 ms** is selected in the Receive Timeout box, the receive timeout function is disabled.

3. Select communication parameters to the same values for the device to communicate with.
4. Click the **OK** button.

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:

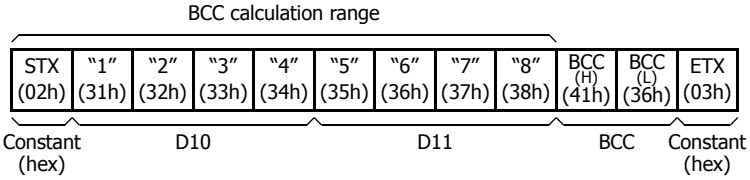


Communication port:	Port 2
Transmit completion output:	M10
Transmit status register:	D100
Transmit data byte count:	D101

Data register contents:

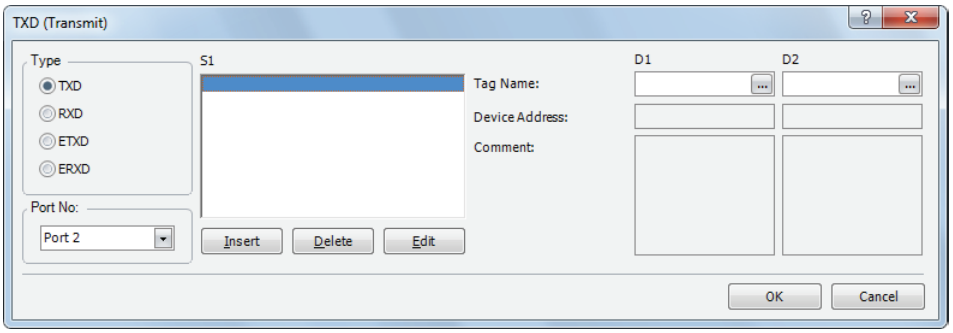
D10	04D2h	= 1234
D11	162Eh	= 5678

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.

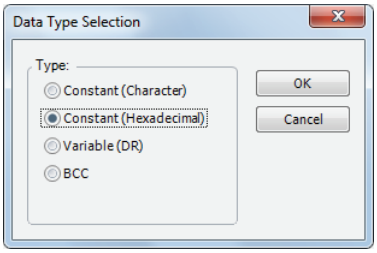
The Transmit instruction dialog box appears.

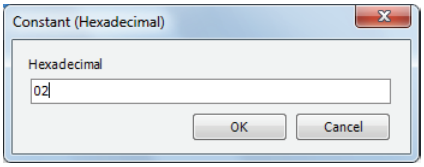


2. Check that **TXD** is selected in the Type box and select **Port 2** in the Port box. Then, click **Insert**.

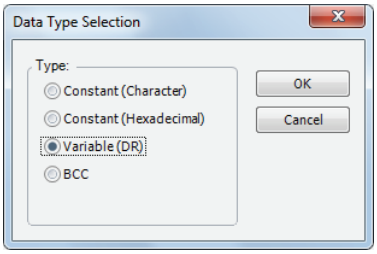
The Data Type Selection dialog box appears. You will program source device S1 using this dialog box.

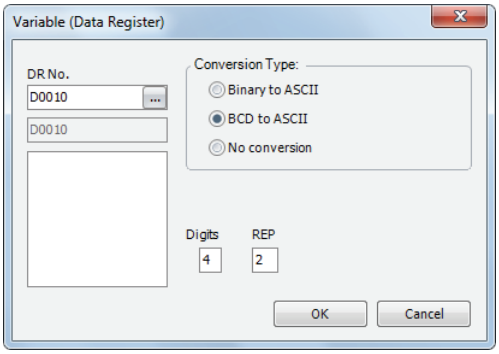
3. Click **Constant (Hexadecimal)** in the Type box and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **02** to program the start delimiter STX (02h). When finished, click **OK**.



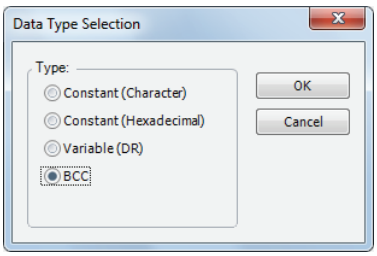


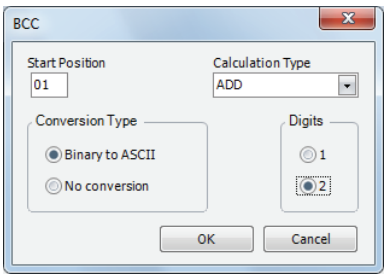
4. Since the Transmit instruction dialog box reappears, repeat the above procedure. In the Data Type Selection dialog box, click **Variable (DR)** and click **OK**. Next, in the Variable (Data Register) dialog box, type **D10** in the DR No. box and click **BCD to ASCII** to select the BCD to ASCII conversion. Enter **4** in the Digits box (4 digits) and **2** in the REP box (2 repeat cycles). When finished, click **OK**.



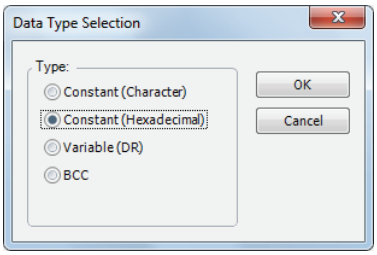


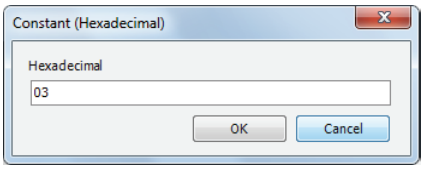
5. Again in the Data Type Selection dialog box, click **BCC** and click **OK**. Next, in the BCC dialog box, enter **1** in the Calculation Start Position box, select **ADD** for the Calculate Type, click **Binary to ASCII** for the Conversion Type, and click **2** for the Digits. When finished, click **OK**.



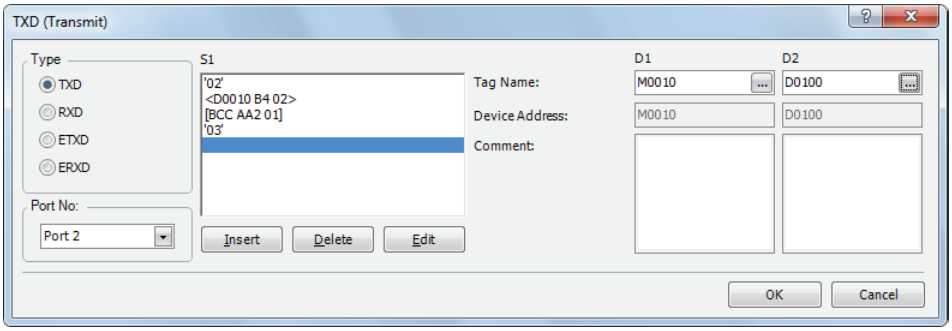


6. Once again in the Data Type Selection dialog box, click **Constant (Hexadecimal)** and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **03** to program the end delimiter ETX (03h). When finished, click **OK**.

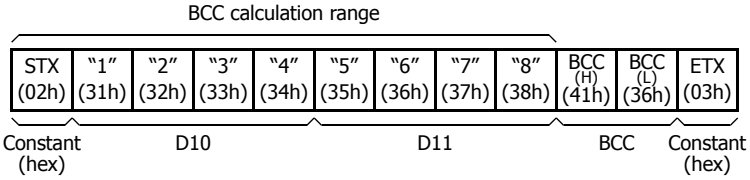




7. In the Transmit instruction dialog box, type **M10** in the destination D1 box and type **D100** in the destination D2 box. When finished, click **OK**.



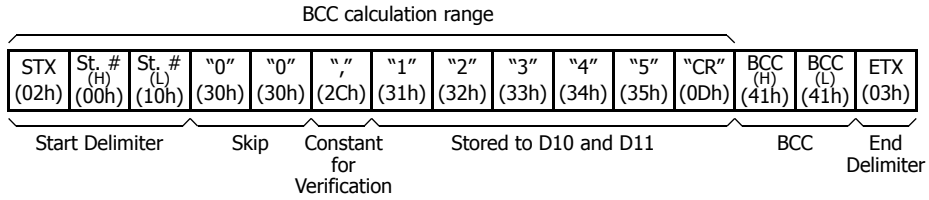
Programming of the TXD2 instruction is complete and the transmit data is specified as follows:



Programming RXD Instruction Using WindLDR

The following example demonstrates how to program a RXD instruction including a start delimiter, skip, constant for verification, BCC, and end delimiter using WindLDR. Converted data is stored to data registers D10 and D11. Internal relay M100 is used as destination D1 for the receive completion output. Data register D1000 is used as destination D2 for the receive status, and data register D1001 is used to store the receive data byte count.

Receive data example:

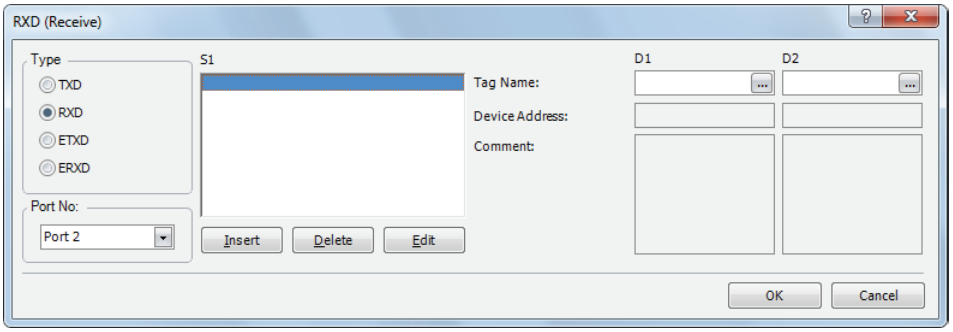


RXD sample program:

Communication port:	Port 2
Receive completion output:	M100
Receive status register:	D1000
Receive data byte count:	D1001

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.

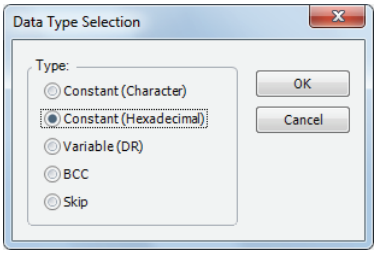
The Receive instruction dialog box appears.

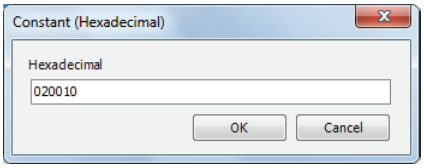


2. Check that **RXD** is selected in the Type box and select **Port 2** in the Port box. Then, click **Insert**.

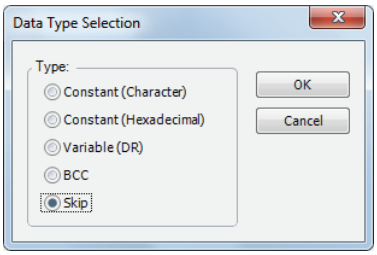
The Data Type Selection dialog box appears. You will program source device S1 using this dialog box.

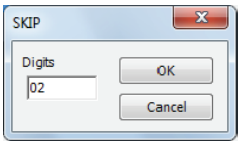
3. Click **Constant (Hexadecimal)** in the Type box and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **020010** to program the start delimiter STX (02h), Station No. H (00h), and Station No. L (10h). When finished, click **OK**.



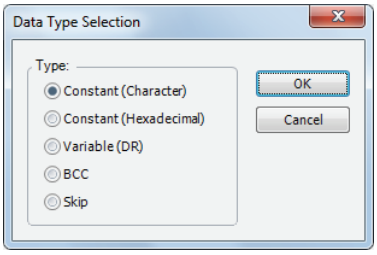


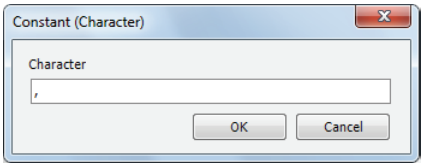
4. Since the Receive instruction dialog box reappears, repeat the above procedure. In the Data Type Selection dialog box, click **Skip** and click **OK**. Next, in the Skip dialog box, type **02** in the Digits box and click **OK**.



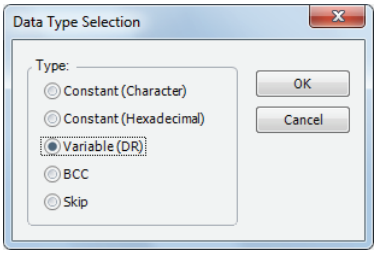


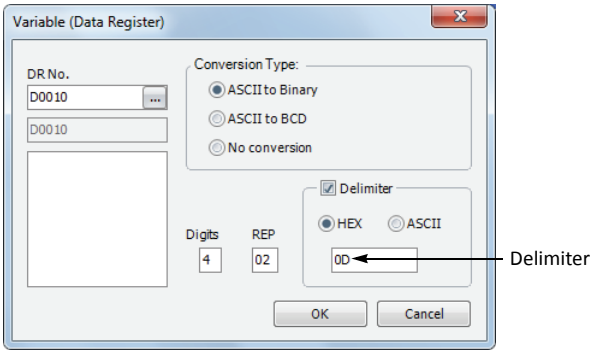
5. Again in the Data Type Selection dialog box, click **Constant (Character)** and click **OK**. Next, in the Constant (Character) dialog box, type **, (2Ch)** in the Character box to program a comma as a constant to verify. When finished, click **OK**.



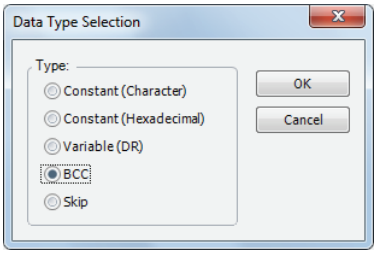


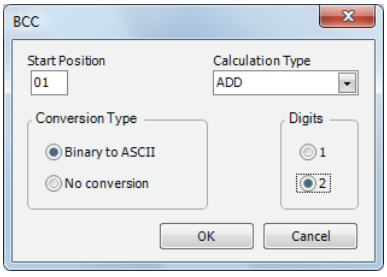
6. Again in the Data Type Selection dialog box, click **Variable (DR)** and click **OK**. Next, in the Variable (Data Register) dialog box, type **D10** in the DR No. box and click **ASCII to Binary** to select ASCII to binary conversion. Enter **4** in the Digits box (4 digits) and **2** in the REP box (2 repeat cycles). Click **Variable**, select **HEX**, and type **0D** to designate a delimiter. When finished, click **OK**.



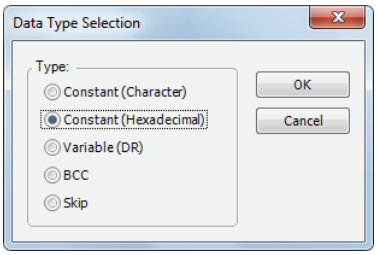


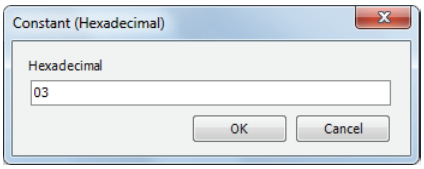
7. Again in the Data Type Selection dialog box, click **BCC** and click **OK**. Next, in the BCC dialog box, enter **1** in the Calculation Start Position box, select **ADD** for the Calculation Type, click **Binary to ASCII** for the Conversion Type, and click **2** for the Digits. When finished, click **OK**.



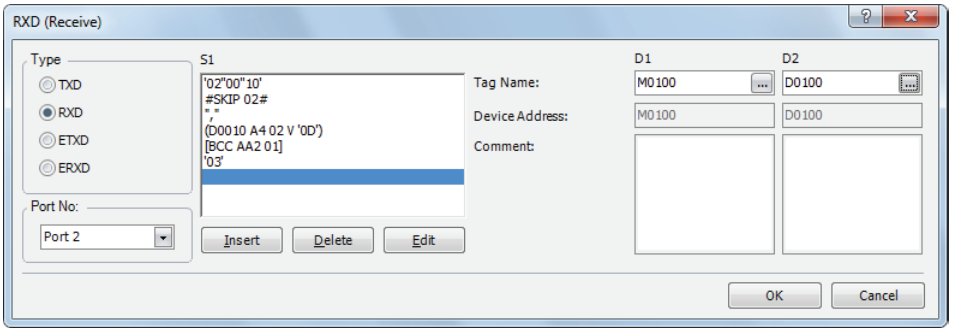


8. Once again in the Data Type Selection dialog box, click **Constant (Hexadecimal)** and click **OK**. Next, in the Constant (Hexadecimal) dialog box, type **03** to program the end delimiter ETX (03h). When finished, click **OK**.





9. In the Receive instruction dialog box, type **M100** in the destination D1 box and type **D1000** in the destination D2 box. When finished, click **OK**.



Programming of the RXD instruction is complete and the receive data will be stored as follows:

D10	1234h	= 4660
D11	0005h	= 5

RS232C Line Control Signals

While the SmartAxis is in the user communication mode, special data registers can be used to enable or disable DSR and DTR control signal options for port 2 through port 3. The DSR and DTR control signal options cannot be used for port 1.

The RTS signal line of port 2 through port 3 remains on.

In the maintenance communication mode, DSR has no effect and DTR remain on.

Special Data Registers for Port 2 to Port 3 RS232C Line Control Signals

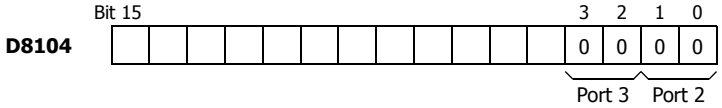
Special data registers D8104 through D8106 are allocated for RS232C line control signals.

Communication Port	DR No.	Data Register Function	Data Register Value Updated	R/W
Port 2 to Port 3	D8104	Control signal status	Every scan	R
	D8105	DSR input control signal option	When sending/receiving data	R/W
	D8106	DTR output control signal option	When sending/receiving data	R/W

Control Signal Status D8104

Special data register D8104 stores a value to show that DSR and DTR are on or off at port 2 through port 3.

The data of D8104 is updated at every END processing.



D8104 2-bit Binary Value	DTR	DSR	Description
00	OFF	OFF	Both DSR and DTR are off
01	OFF	ON	DSR is on
10	ON	OFF	DTR is on
11	ON	ON	Both DSR and DTR are on

DSR Control Signal Status in RUN and STOP Modes

Communication Mode	D8105 3-bit Binary Value	DSR (Input) Status	
		RUN Mode	STOP Mode
User Communication Mode	000 (default)	No effect	No effect (TXD/RXD disabled)
	001	ON: Enable TXD/RXD OFF: Disable TXD/RXD	No effect (TXD/RXD disabled)
	010	ON: Disable TXD/RXD OFF: Enable TXD/RXD	No effect (TXD/RXD disabled)
	011	ON: Enable TXD OFF: Disable TXD	No effect (TXD/RXD disabled)
	100	ON: Disable TXD OFF: Enable TXD	No effect (TXD/RXD disabled)
	≥ 101	No effect	No effect (TXD/RXD disabled)
Maintenance Mode	—	No effect	No effect

DTR Control Signal Status in RUN and STOP Modes

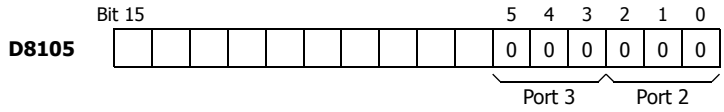
Communication Mode	D8106 2-bit Binary Value	DTR (Output) Status	
		RUN Mode	STOP Mode
User Communication Mode	00 (default)	ON	OFF
	01	OFF	OFF
	10	RXD enabled: ON RXD disabled: OFF	OFF
	11	ON	OFF
Maintenance Mode	—	ON	ON

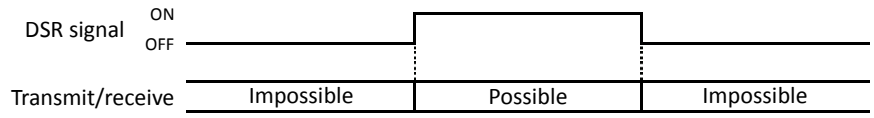
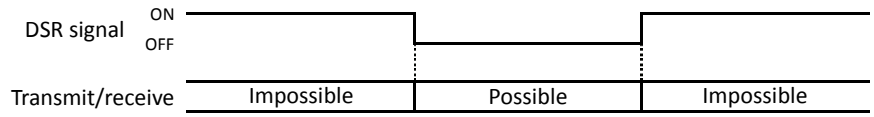
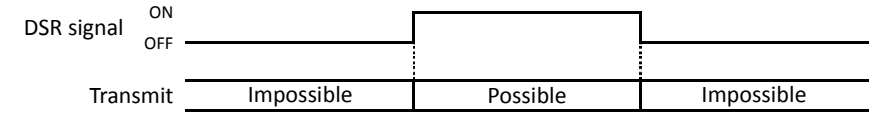
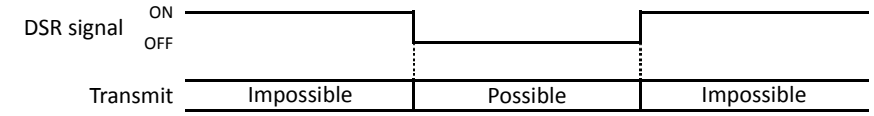
DSR Input Control Signal Option D8105

Special data register D8105 is used to control data flow between the SmartAxis RS232C port 2 through port 3 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 SmartAxis to determine the status of the remote terminal. The remote terminal informs the SmartAxis 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 2 to port 3.

The control status of each port is allocated as shown below:



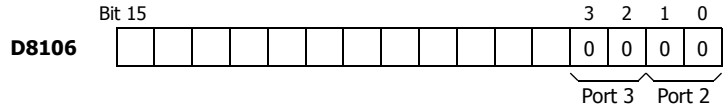
D8105 3-bit Binary Value	Description
000	DSR is not used for data flow control. When DSR control is not needed, set 0 to D8105.
001	When DSR is on, the SmartAxis can transmit and receive data. 
010	When DSR is off, the SmartAxis can transmit and receive data. 
011	When DSR is on, the SmartAxis can transmit 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. 
100	When DSR is off, the SmartAxis can transmit data. 
≥ **101**	Same as D8105 = 000. DSR is not used for data flow control.

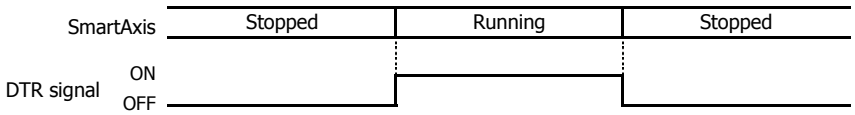
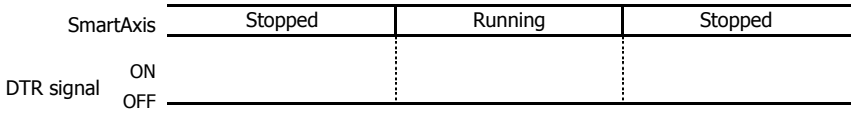
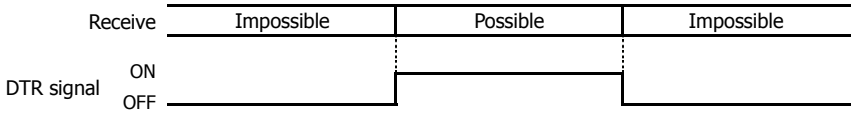
DTR Output Control Signal Option D8106

Special data register D8106 is used to control the DTR (data terminal ready) signal to indicate the SmartAxis operating status or transmitting/receiving status.

The DTR control signal option can be used only for the user communication through the RS232C port 2 to port 3.

The control status of each port is allocated as shown below:



D8106 2-bit Binary Value	Description
00	While the SmartAxis is running, DTR is on whether the SmartAxis is transmitting or receiving data. While the SmartAxis is stopped, DTR remains off. Use this option to indicate the SmartAxis operating status. 
01	Whether the SmartAxis is running or stopped, DTR remains off. 
10	While the SmartAxis can receive data, DTR is turned on. While the SmartAxis can not receive data, DTR remains off. Use this option when flow control of receive data is required. 
11	Same as D8106 = 00.

User Communication via Ethernet Communication

This section describes the Ethernet user communication. Ethernet user communication works on TCP/IP protocol. The SmartAxis can be used as a user communication client/server. With Ethernet user communication instructions (ETXD and ERXD instructions), the SmartAxis can exchange the data with devices on the network.

Except for the port number and the allocation of user communication receive instruction cancel flags, Ethernet user communication instructions (ETXD and ERXD instructions) are identical to TXD and RXD instructions. For details about TXD and RXD instructions, see chapter 25 of the FT1A Series Ladder Programming Manual.

Ethernet User Communication Overview

The SmartAxis can be used as an Ethernet user communication client/server. It can be used simultaneously with the maintenance communication server, Modbus TCP server, and Modbus TCP client.

When using the SmartAxis user communication client, the SmartAxis can access and communicate with the server devices using the protocol of the server device. A maximum of three client connections of the SmartAxis can be allocated to user communication.

User communication client functions and configuration are described in "To use the SmartAxis as a user communication client" on page 10-15. User communication server functions and configuration are described in "User Communication Server" on page 10-19.

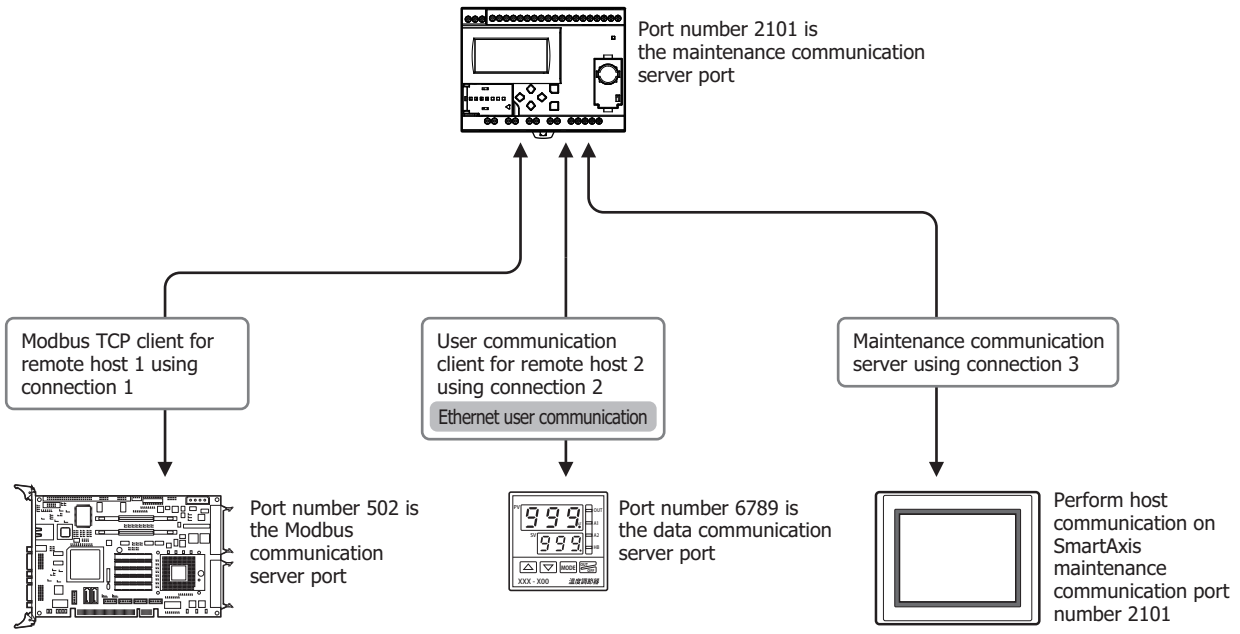
The SmartAxis supports the TCP/IP protocol.

The SmartAxis can send data to and receive data from devices on a network by using the ETXD (Ethernet user communication transmit) instruction and the ERXD (Ethernet user communication receive) instruction.

The SmartAxis can be used as both an Ethernet user communication client and server.

Each of the three connections possessed by the SmartAxis can be allocated to different types of communication. Ethernet user communication can simultaneously use the maintenance communication server, Modbus TCP server, and Modbus TCP client.

[Ethernet communication example using three connections]



SmartAxis function area settings connection settings

Connection	Communication protocol	Other settings
1	Modbus TCP client	Destination: Remote host 1
2	User communication client	Destination: Remote host 2
3	Maintenance communication server	Port number: 2101

Remote host table

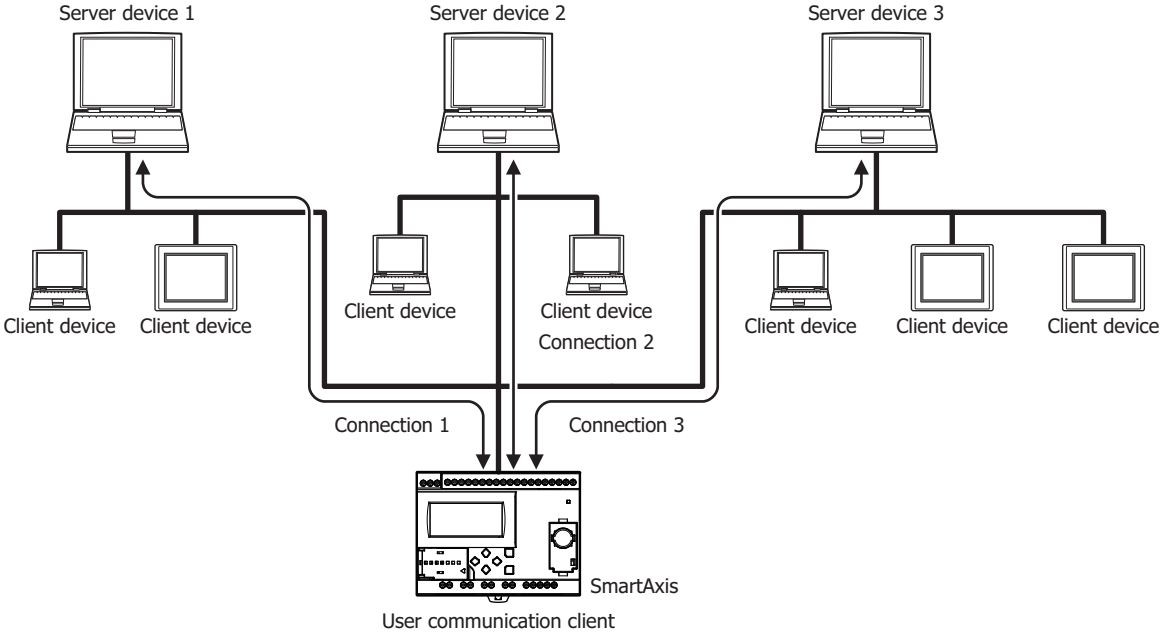
Remote host number	IP address	Port number
1	192.168.0.12	502
2	192.168.0.13	6789

To use the SmartAxis as a user communication client

Connect the SmartAxis to the server device via the network and communicate with the server device using the Ethernet user communication instructions.

A maximum of three connections can be allocated to user communication clients. The SmartAxis can simultaneously connect to and communicate with three different server devices.

[When three connections are allocated to user communication client]

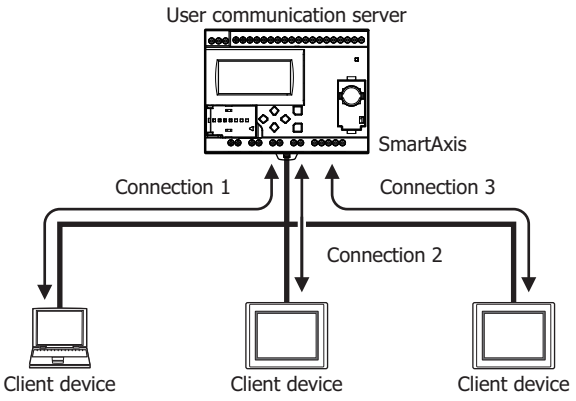


To use the SmartAxis as a user communication server

The client devices connect to the SmartAxis and the SmartAxis communicates with the client devices using Ethernet user communication instructions.

A maximum of three connections can be allocated to user communication servers. A maximum of three client devices can simultaneously connect to and communicate with the SmartAxis.

[When three connections are allocated to user communication server]



User Communication Client

When a client connection is configured as the user communication client, the SmartAxis communicates with the specified server device according to the settings configured in the ETXD and ERXD instructions that are programmed for the client connection. The remote host number and other communication settings can be configured in the Connection Settings tab in the Function Area Settings dialog box.

Specifications (User Communication Client)

Item	User Communication Client
Remote host number	1 to 255
Establish connection	• When ETXD/ERXD Instructions are executed • When the SmartAxis starts to run (Note 1)
Disconnect connection	• When the SmartAxis is stopped • When special internal relays (M8130 to M8132) are turned on
Number of remote hosts that the CPU module can communicate simultaneously	One remote host per a user communication client
Receive timeout	100 to 25500 ms (100 ms increments); Default: 1000 ms

Note 1: The settings can be configured in the Connection Settings tab in the Function Area Settings dialog box.

Establishing/Disconnecting User Communication Client Connections

When user communication clients are configured, connections are established on TCP/IP protocol. The connections are established when ETXD/ERXD instructions are executed or when the SmartAxis is started to run (See Note 1 above). After a connection has been established, the connection will be kept open until either the SmartAxis is stopped or a special internal relay allocated to the connection is turned on.

Device Address	Description	Operation
M8130	Connection 1 Disconnect	When the reply is turned on, the corresponding connection is disconnected.
M8131	Connection 2 Disconnect	
M8132	Connection 3 Disconnect	

User Communication Client Receive Instruction (ERXD) Cancel Flag

The allocation of the user communication receive instruction cancel flags for each client connection is shown in the table below. For details about the user communication receive instruction cancel flag, see chapter 25 of the FT1A Series Ladder Programming Manual.

Device Address	Description
M8100	User Communication Receive Instruction Cancel Flag (Connection 1)
M8101	User Communication Receive Instruction Cancel Flag (Connection 2)
M8102	User Communication Receive Instruction Cancel Flag (Connection 3)

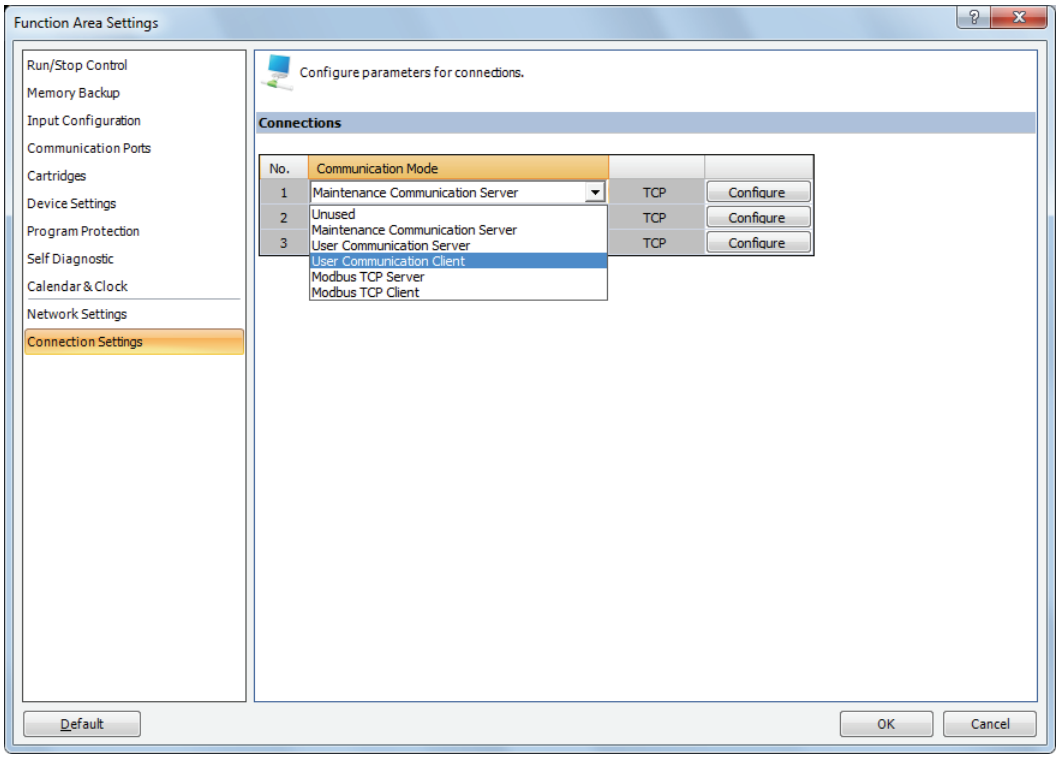
Programming WindLDR (User Communication Client)

To use the user communication client, configure the user client communication settings in the Function Area Settings dialog box and then download the user program to the SmartAXIS.

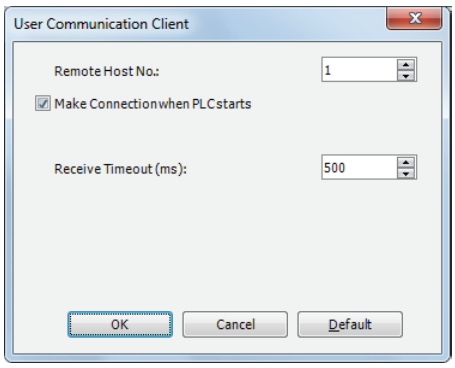
1. Select **Configuration** from the WindLDR menu bar, and then click **Connection Settings**.

The Function Area settings dialog box appears.

2. Select the **User Communication Client** as the communication mode for the client connection 1.



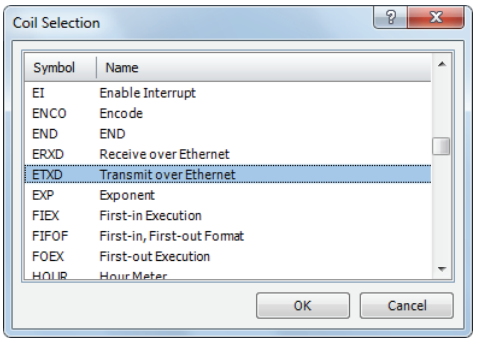
The User Communication Client dialog box appears.



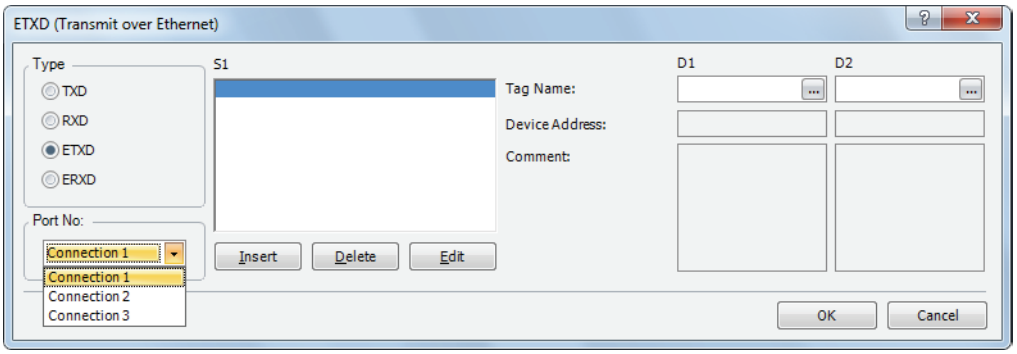
Configure the remote host number and receive timeout. If you want the SmartAxis to establish the connection when it starts to run, select "Make Connection when PLC starts." Click **OK** button to close the dialog box.

3. Edit the user program.

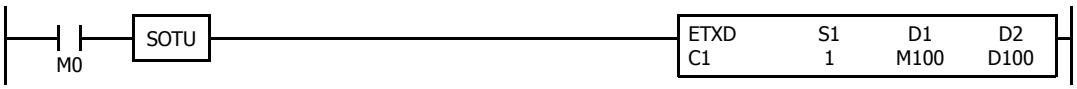
To insert Ethernet user communication instructions to the ladder editor, select the Ethernet user communication instructions (ETXD or ERXD instructions) in the Coil Selection dialog box.



The Ethernet User Communication Instruction dialog box appears.



Select ETXD (Transmit over Ethernet) to transmit data or ERXD (Receive over Ethernet) to receive data as the instruction type. Select the client connection from 1 through 3 and designate S1, D1, and D2. Click **OK** button to close the dialog box.



4. Download the user program.

The settings for the user communication client have been finished.

The specifications of Ethernet user communication instructions (ETXD and ERXD instructions) are identical to TXD and RXD instructions. For details about TXD and RXD instructions, see chapter 25 of the FT1A Series Ladder Programming Manual.

User Communication Server

When a server connection is configured as the user communication server, a client device can access and communicate with the SmartAxis. The SmartAxis communicates with the client device according to the settings configured in the ETXD and ERXD instructions that are programmed for the server connection. The local host number and other communication settings can be configured in the **Connection Settings** tab in the Function Area Settings dialog box.

Specifications (User Communication Server)

Item	User Communication Server
Local host port number	2101 to 2103 (Can be changed between 0 and 65535)
Number of clients that can simultaneously communicate with the CPU module	One client per a user communication server
Receive timeout	100 to 25500 ms (100 ms increments)

User Communication Server Receive Instruction (ERXD) Cancel Flag

The allocation of the user communication receive instruction cancel flags for each server connection is shown in the table below. For details about the user communication receive instruction cancel flag, see chapter 25 of the FT1A Series Ladder Programming Manual.

Device Address	Description
M8100	User Communication Receive Instruction Cancel Flag (Connection 1)
M8101	User Communication Receive Instruction Cancel Flag (Connection 2)
M8102	User Communication Receive Instruction Cancel Flag (Connection 3)

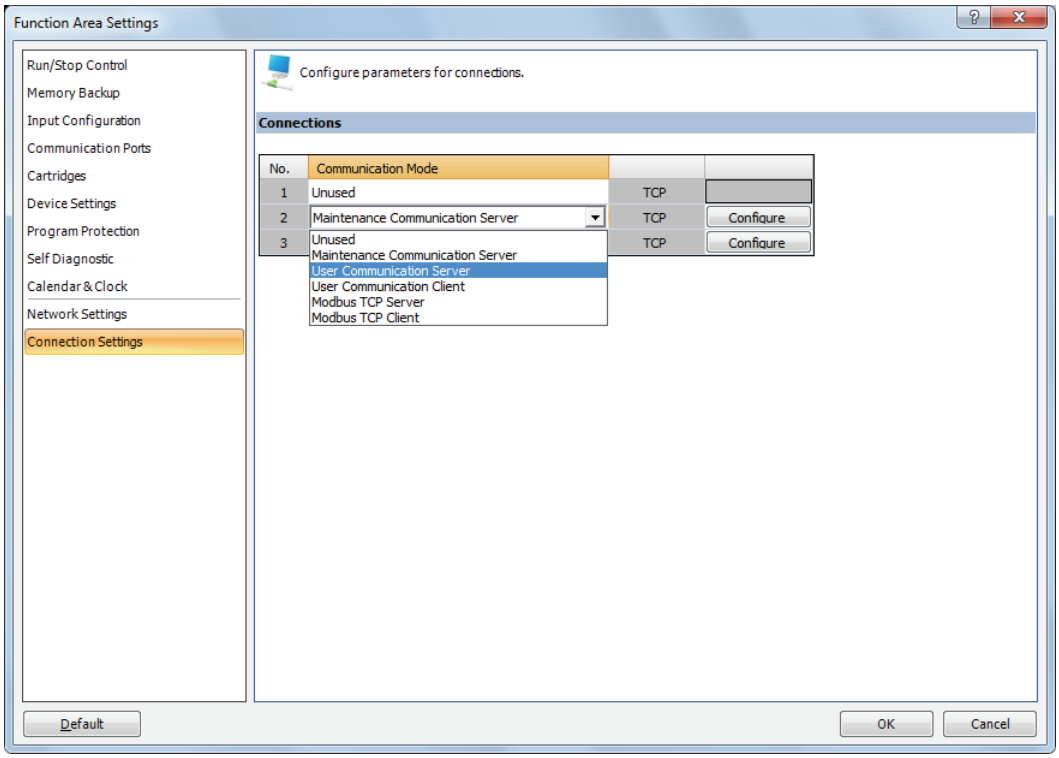
Programming WindLDR (User Communication Server)

To use the user communication server, configure the user communication server settings in the Function Area Settings dialog box and then download the user program to the SmartAXIS.

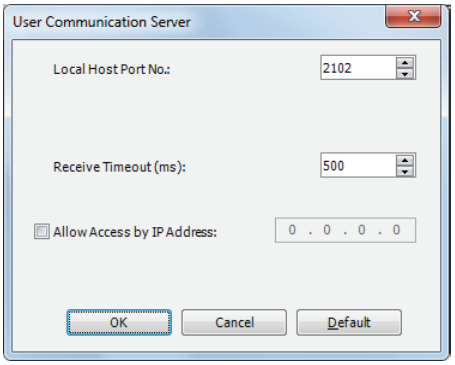
1. Select **Configuration** from the WindLDR menu bar, and then click **Connection Settings**.

The Function Area settings dialog box appears.

2. Select the **User Communication Server** as the communication mode for the server connection 1.



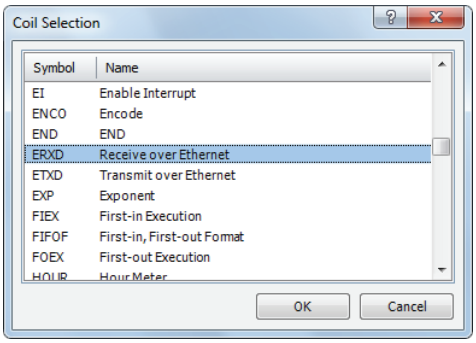
The User Communication Server dialog box appears.



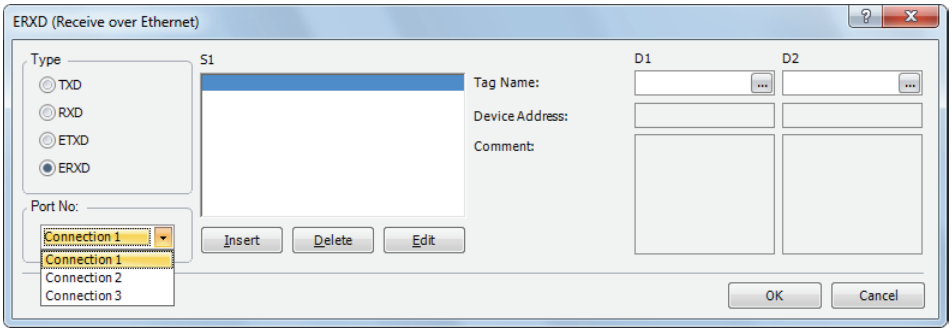
Configure the local host port number and receive timeout. If you want to restrict the access using IP address, configure the allowed IP address.

3. Edit the user program.

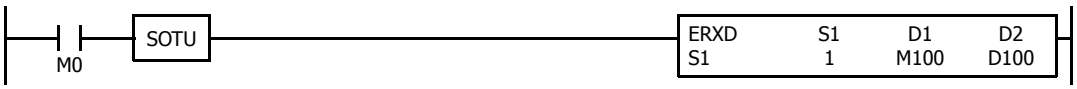
To insert Ethernet user communication instructions to the ladder editor, select the Ethernet user communication instructions (ETXD or ERXD instructions) in the Coil Selection dialog box.



The Ethernet User Communication Instruction dialog box appears.



Select **ETXD** (Transmit over Ethernet) to transmit data and **ERXD** (Receive over Ethernet) to receive data as the instruction type. Select the server connection from 1 through 8 and designate S1, D1, and D2. Click **OK** button to close the dialog box.



4. Download the user program.

The settings for the user communication server have been finished.

The specifications of Ethernet user communication instructions (ETXD and ERXD instructions) are identical to TXD and RXD instructions. For details about TXD and RXD instructions, see chapter 25 of the FT1A Series Ladder Programming Manual.

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 19-11 and 19-28.

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	The transmit completion output goes on.
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	While a RXD instruction with a start delimiter is executed, another RXD instruction with the same start delimiter is executed.	No effect on the receive completion output.
7	The first bytes of received data do 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	Constants including the end delimiter code specified in the RXD instruction do not match the received constants.	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 off.
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	A user communication instruction was used even though the port settings or the connection settings were not set to user communication mode.	No effect on the completion output.

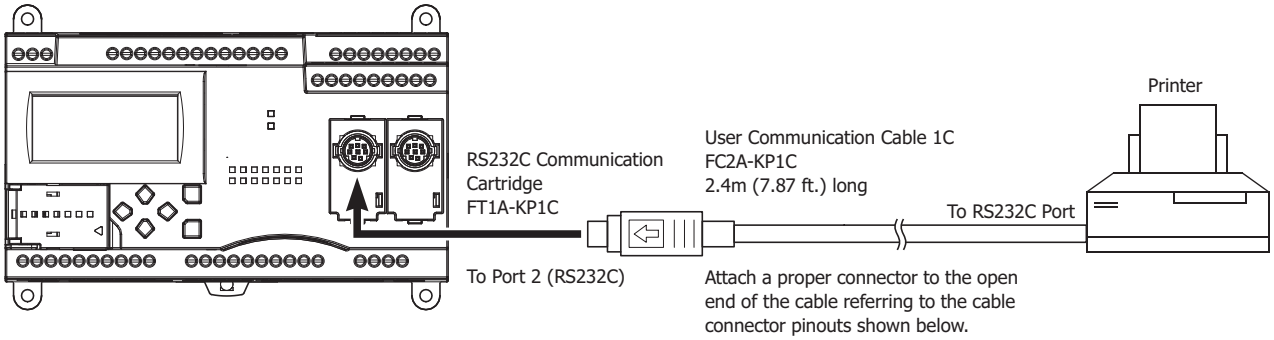
ASCII Character Code Table

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

Sample Program – User Communication TXD

This example demonstrates a program to send data to a printer using the user communication TXD2 (transmit) instruction, with the optional RS232C communication cartridge installed on the port 2 connector of the 24-I/O type CPU module.

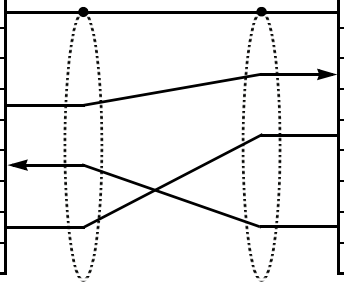
System Setup



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**
NC	No Connection	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 SmartAxis 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 D8105 is used to monitor the BUSY signal and to control the transmission of print data.

Special DR	Value	Description
D8105	3 (011)	While DSR is on (not busy), the SmartAXIS sends data. While DSR is off (busy), the SmartAXIS 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 19-11 and 10-22.

The SmartAxis monitors the DSR signal to prevent the receive buffer of the printer from overflowing. For the DSR signal, see page 10-12.

Setting User Communication Mode in WindLDR Function Area Settings

Since this example uses the RS232C port 2, select User Protocol for Port 2 in the Function Area Settings using WindLDR. See page 10-4.

Setting Communication Parameters

Set the communication parameters to match those of the printer. See page 10-4. For details of the communication parameters of the printer, see the user's manual for the printer. An example is shown below:

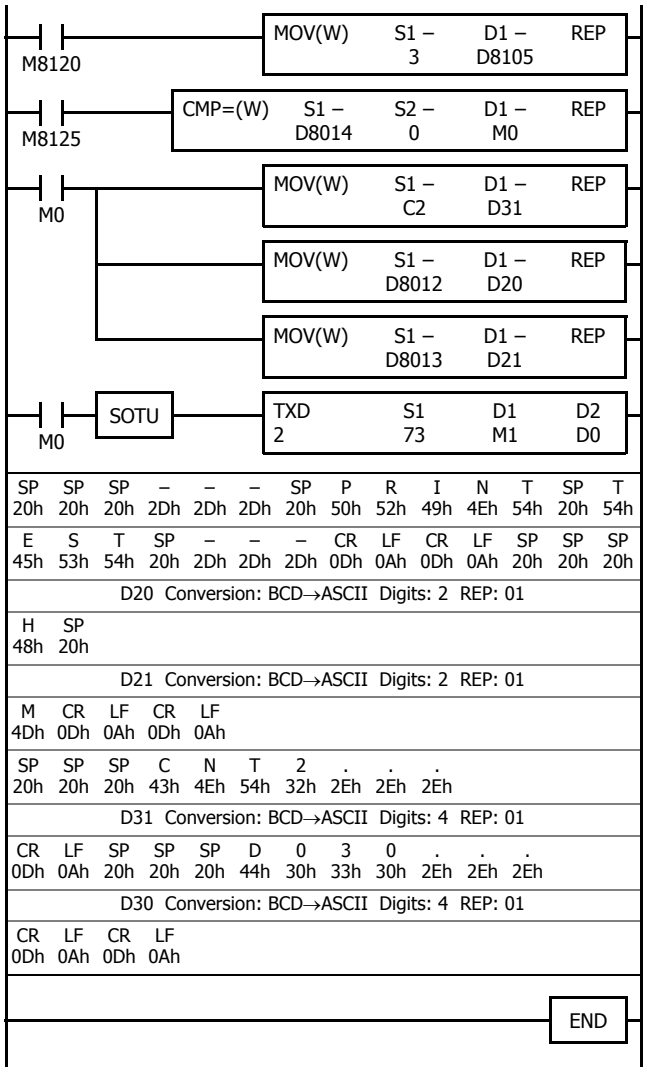
Communication Parameters:

Baud rate	9600 bps
Data bits	8
Parity check	None
Stop bits	1

Note: 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 → D8105 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

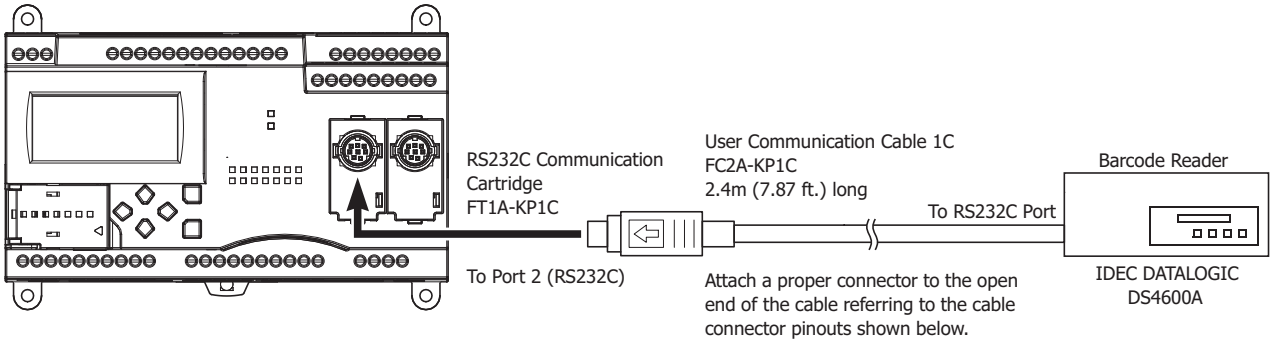
D31 counter C2 data is converted from BCD to ASCII, and 4 digits are sent.

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 RXD2 (receive) instruction.

System Setup



Mini DIN Connector Pinouts

Description		Color	Pin
Shield		—	**Cover**
NC	No Connection	Black	**1**
NC	No Connection	Yellow	**2**
TXD	Transmit Data	Blue	**3**
RXD	Receive Data	Green	**4**
NC	No Connection	Brown	**5**
NC	No Connection	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 SmartAxis 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 SmartAxis through the RS232C port 2 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.

Setting User Communication Mode in WindLDR Function Area Settings

Since this example uses the RS232C port 2, select User Protocol for Port 2 in the Function Area Settings using WindLDR. See page 10-4.

Setting Communication Parameters

Set the communication parameters to match those of the barcode reader. See page 10-4. 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.

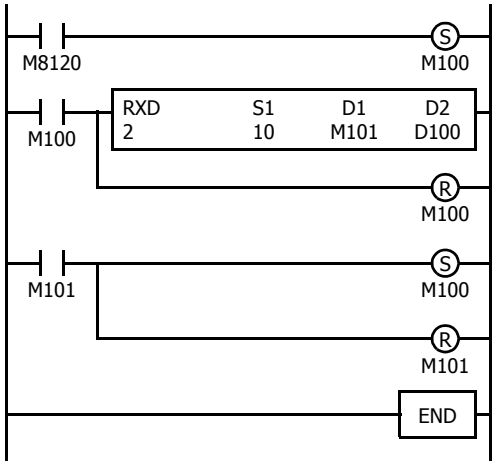
Synchronization mode	Auto			
Read mode	Single read or multiple read			
Communication parameter	Baud rate:	9600 bps	Data bits:	7
	Parity check:	Even	Stop bit:	1
Other communication settings	Header:	02h	Terminator:	03h
	Data echo back:	No	BCR data output:	Yes
	Output timing:	Output priority 1	Character suppress:	No
	Data output filter:	No	Main serial input:	No
	Sub serial:	No		
Comparison preset mode	Not used			

Device Addresses

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 SmartAxis starts operation, the RXD2 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 RXD2 instruction to wait for another incoming data.



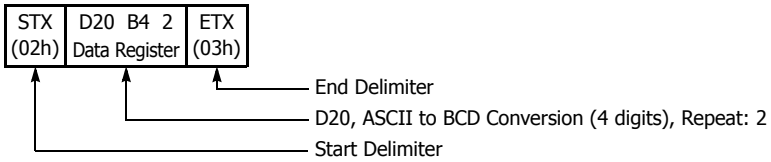
M8120 is the initialize pulse special internal relay used to set M100.

At the rising edge of M100, RXD2 is executed to be ready for receiving data.

Even after M100 is reset, RXD2 still waits for incoming data.

When data receive is complete, M101 is turned on, then M100 is set to execute RXD2 to receive the next incoming data.

RXD2 Data



BCC Calculation Examples

The FT1A SmartAxis CPU modules can use three new BCC calculation formulas of ADD-2comp, Modbus ASCII, and Modbus RTU for transmit instructions TXD2 and TXD3 and receive instructions RXD2 and RXD3. These block check characters are calculated as described below.

ADD-2comp

Add the characters in the range from the BCC calculation start position to the byte immediately before the BCC, then invert the result bit by bit, and add 1.

1. Add the characters in the range from the BCC calculation start position to the byte immediately before the BCC.

2. Invert the result bit by bit, and add 1 (2's complement).

3. Store the result to the BCC position according to the designated conversion type (Binary to ASCII conversion or No conversion) and the designated quantity of BCC digits.

Example: Binary to ASCII conversion, 2 BCC digits

When the result of step **2** is 175h, the BCC will consist of 37h, 35h.

Modbus ASCII — Calculating the LRC (longitudinal redundancy check)

Calculate the BCC using LRC (longitudinal redundancy check) for the range from the BCC calculation start position to the byte immediately before the BCC.

1. Convert the ASCII characters in the range from the BCC calculation start position to the byte immediately before the BCC, in units of two characters, to make 1-byte hexadecimal data. (Example: 37h, 35h → 75h)

2. Add up the results of step **1**.

3. Invert the result bit by bit, and add 1 (2's complement).

4. Convert the lowest 1-byte data to ASCII characters. (Example: 75h → 37h, 35h)

5. Store the two digits to the BCC (LRC) position.

If the BCC calculation range consists of an odd number of bytes, the BCC calculation results in an indefinite value. Modbus protocol defines that the BCC calculation range is an even number of bytes.

Modbus RTU — Calculating the CRC-16 (cyclic redundancy checksum)

Calculate the BCC using CRC-16 (cyclic redundancy checksum) for the range from the BCC calculation start position to the byte immediately before the BCC. The generation polynomial is: $X^{16} + X^{15} + X^2 + 1$.

1. Take the exclusive OR (XOR) of FFFFh and the first 1-byte data at the BCC calculation start position.

2. Shift the result by 1 bit to the right. When a carry occurs, take the exclusive OR (XOR) of A001h, then go to step **3**. If not, directly go to step **3**.

3. Repeat step **2**, shifting 8 times.

4. Take the exclusive OR (XOR) of the result and the next 1-byte data.

5. Repeat step **2** through step **4** up to the byte immediately before the BCC.

6. Swap the higher and lower bytes of the result of step **5**, and store the resultant CRC-16 to the BCC (CRC) position. (Example: 1234h → 34h, 12h)

11: MODBUS COMMUNICATION

Introduction

The SmartAxis supports the Modbus communications protocols.

When a communication cartridge is installed on the expansion communication port, Modbus RTU protocol can be used. The SmartAxis can communicate with hardware devices supporting Modbus RTU protocol via RS-232C/RS-485.

Modbus TCP protocol can also be used on built-in Ethernet port. The SmartAxis can communicate with hardware devices supporting Modbus TCP protocol via Ethernet.

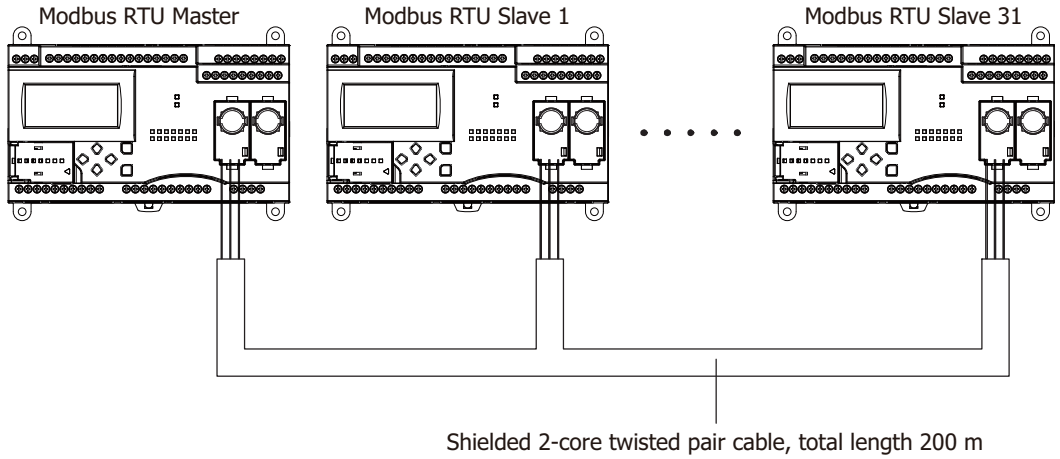
Modbus Communication via RS-232C/RS-485

Applicable CPU Modules

FT1A-12	FT1A-24	FT1A-40	FT1A-48
—	X	X	X

The SmartAxis supports the Modbus RTU protocol and can be used as the Modbus RTU master and the Modbus RTU slave. When configured as a Modbus RTU master, the SmartAxis can monitor and change the data of Modbus RTU slave devices. When the SmartAxis is configured as a Modbus RTU slave, the device data of the SmartAxis can be monitored and changed from the Modbus RTU master device.

For the Modbus RTU master function and how to configure it, see "Modbus RTU Master" in this chapter on page 11-2. For the Modbus RTU slave function and how to configure it, see "Modbus RTU Slave" in this chapter on page 11-7.



Notes:

- Modbus communication of the SmartAxis does not support ASCII mode. Configure all the Modbus devices to communicate with as in RTU mode.
- The 24-I/O type has one expansion communication port. The 40- and 48-I/O types have two expansion communication ports. The 12-I/O type has no expansion communication port.

Modbus Master Communication

When configured as a Modbus master, the SmartAxis sends communication requests to Modbus slaves to read/write data. Each communication request is sent to a Modbus slave according to the configured request table.

Modbus master communication settings and request tables for Modbus slave stations can be programmed using the WindLDR Function Area Settings. Communication with slave stations are performed in synchronism with user program execution, and the communication data are processed at the END processing in the order of request numbers specified in the request table. When request execution devices are designated, requests are executed only when the corresponding request execution device is turned on. When request execution devices are not designated, all requests are executed continuously.

Modbus Master Communication Specifications

Item	Description
Baud Rate (bps)	9600, 19200, 38400, 57600, 115200
Data Bits	8 bits (fixed)
Stop bits	1, 2 bits
Parity	Even, Odd, None
Slave Number	1 to 247 (0: broadcast slave number) *1
Maximum Number of Slaves	31
Receive Timeout *2	10 to 2550 ms (in increments of 10 ms)
Timeout between Characters	10 ms
Transmission Wait Time	1 to 5000 ms (in increments of 1 ms)
Retry Cycles	1 to 10

*1: A communication request becomes the broadcast when slave number 0 is specified. The broadcast communication request is received by all Modbus RTU slaves. Modbus RTU slave does not reply to the broadcast communication. Broadcast can be used to write the same data to all Modbus RTU slaves.

*2: Specifies the period of time before receiving a response frame from a slave.

Modbus Master Communication Start and Stop

When request execution devices are designated in the Modbus master request table, internal relays or data register bits as many as the request quantity are allocated to execute Modbus master communication. The internal relays or data register bits are allocated in the order of requests. For example, when internal relay M0 is designated as the request execution device, M0 is allocated to request No. 1, M1 to request No. 2, and so on. To execute a request, turn on the corresponding request execution device.

When communication is completed, the request execution device turns off automatically. When it is required to send requests continuously, keep the corresponding request execution device on using a SET or OUT instruction.

When request execution devices are not designated, all requests programmed in the request table are executed continuously.

Communication Completion and Communication Error

Modbus communication finishes when a read or write process is completed successfully or when a communication error occurs. Communication error occurs when communication failure has repeated more than the designated retry cycles or when the master station does not receive response within the designated receive timeout period. When a communication error occurs, the request is canceled and the next request is processed. When the error status data register is designated, the communication status of each request can be confirmed.

Note: Modbus master processes a maximum of one Modbus request per scan.

Communication Error Data

When Error Status is configured in the Request Table from the Function Area Settings, the error data of each request can be confirmed.

Use a single DR for all communication requests	Error data of each communication request
Unchecked	Error data, the remote host number (high-order byte) and error code (low-order byte), of each request in the entire request table can be confirmed. Data registers as many as the quantity of requests are reserved for storing error data. When an error occurs for a request, error data is stored to the corresponding data register.
Checked	A single data register is shared by all requests. When an error occurs for a request, error data is stored to the data register and the old error data is overwritten.

Bit Allocation	
Remote Host Number (high-order byte)	1 to 255
Error Code (low-order byte)	00h: Normal completion 01h: Function code error (unsupported function code) 02h: Access destination error (address out of range, address+device quantity out of range) 03h: Device quantity error, 1-bit write data error (specified device quantity of 1-bit write is unsupported) 12h: Frame length error (frame length of transmitted request is out of range) 13h: BCC error (BCC does not match) 14h: Slave number error (received slave number is invalid) 16h: Timeout error (timeout occurs)

Communication Error Data of Each Request

Error data of each request in the entire request table can be confirmed. To confirm error data of each request, select to use Error Status in the Request Table from the Function Area Settings and enter the data register number.

When Use a single DR for all communication requests is not selected, starting with the data register number, data registers as many as the quantity of requests are reserved for storing error data. When an error occurs for a request, an error code is stored to a corresponding data register.

When Use a single DR for all communication requests is selected, the same data register is shared by all requests. When an error occurs for a request, an error code is stored to the data register and the old value is overwritten.

Number of Requests in Modbus Master

The number of requests that can be programmed in a request table is shown in the table below:

Port	Port 2 and Port 3
No. of requests	255

Note: 8 bytes of the user program area are needed per each request.

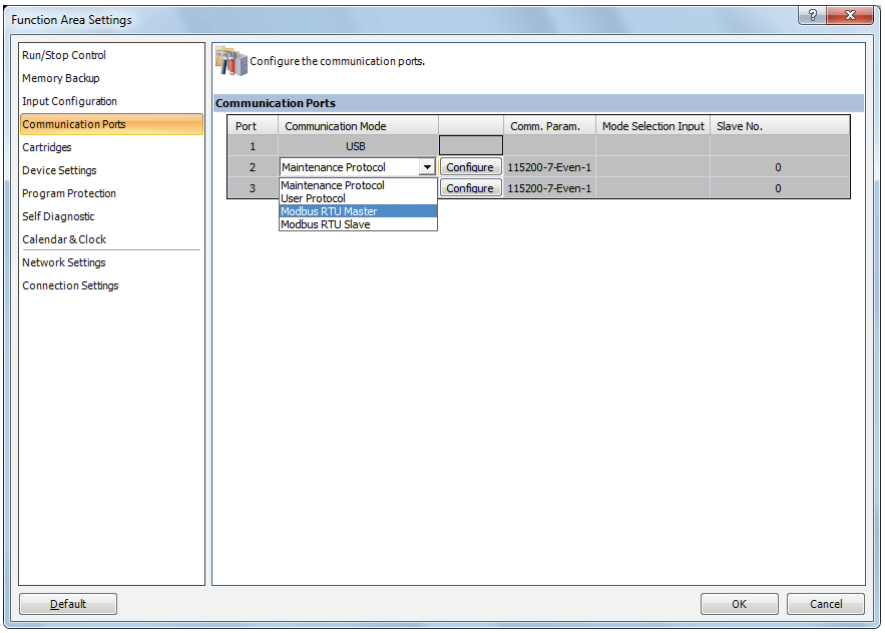
Programming Modbus Master Using WindLDR

Modbus master communication is programmed for Modbus RTU mode using WindLDR. Since these settings relate to the user program, the user program must be downloaded to the SmartAxis after changing any of these settings.

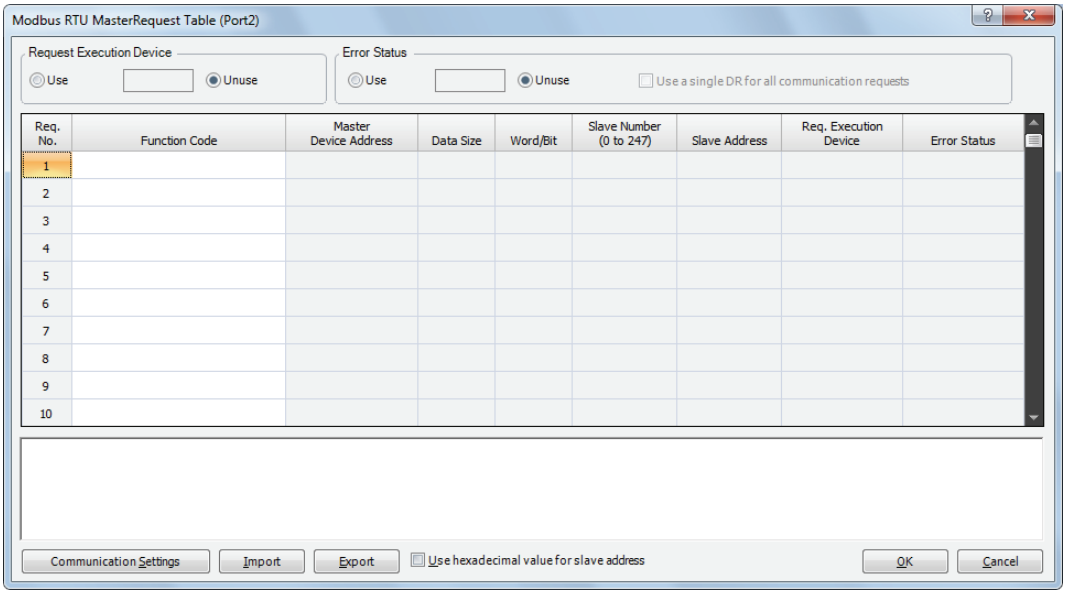
1. From the WindLDR menu bar, select **Configuration** > **Comm. Ports**.

The Function Area Settings dialog box for Communication Ports appears.

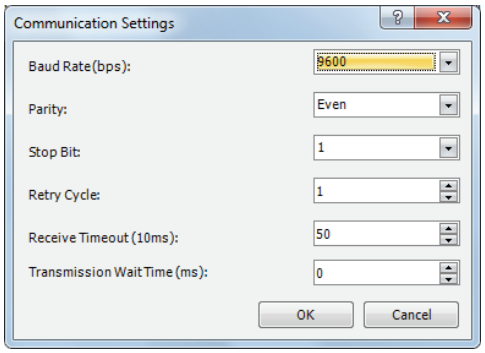
2. In the Communication Mode pull-down list for Port 2, select **Modbus RTU Master**.



3. Click the **Configure** button for Port 2. The Modbus RTU Master Request Table appears.



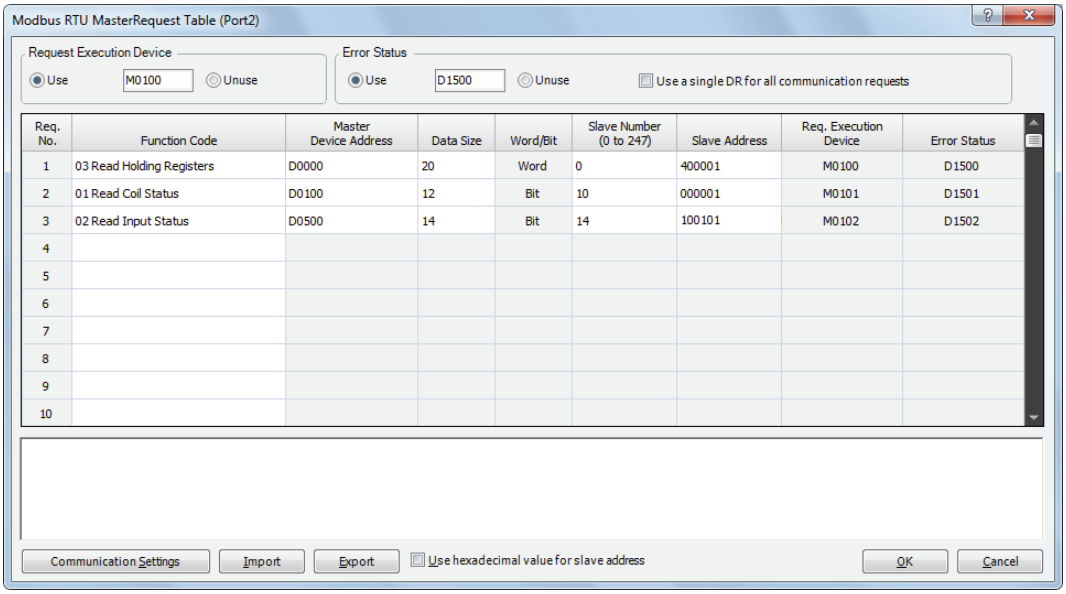
4. Click the **Communication Settings** button. The Communication Settings dialog box appears. Change settings, if required.



Baud Rate (bps)	9600, 19200, 38400, 57600, 115200
Parity	Even, Odd, None
Stop Bits	1 or 2
Retry Cycle	1 to 10
Receive Timeout	1 to 255 (×10 ms)
Transmission Wait Time	0 to 5000 (ms)

5. Click the **OK** button to return to the Modbus RTU Master Request Table. Designate requests under the Function Code. A maximum of 255 requests can be entered in one request table.

   Choose to use Request Execution Devices and Error Status data registers if necessary. When using Request Execution Devices and Error Status data registers, enter the first number of the devices.



Notes for Editing the Request Table

Request execution devices and error status data registers are allocated in the order of request numbers. When deleting a request or changing the order of requests, the relationship of the request to the request execution devices and error status data register is changed. If the internal relay or data register is used in the user program, the device addresses must be changed accordingly. After completing the changes, download the user program again.

6. When editing the Master Request Table is complete, click the **OK** button to save changes.
7. Download the user program to the CPU module.

Now, programming for the Modbus master is complete. Details about parameters and valid values are as follows.

Function Code

The Modbus RTU of the SmartAxis supports eight function codes as listed in the table below. Supported function codes and valid slave addresses vary with each Modbus slave device to communicate with. Configure the function codes according to the specifications of the Modbus slave devices.

Function Code	Data Size	Slave Address	SmartAxis as Modbus Slave
01 Read Coil Status	1 to 128 bits	000001 - 065535	Reads bit device statuses of Q (output), R (shift register), or M (internal relay).
02 Read Input Status	1 to 128 bits	100001 - 165535	Reads bit device statuses of I (input), T (timer contact), or C (counter contact).
03 Read Holding Registers	1 to 64 words	400001 - 465535	Reads word device data of D (data register), T (timer preset value), or C (counter preset value).
04 Read Input Registers	1 to 64 words	300001 - 365535	Reads word device data of T (timer current value) or C (counter current value).
05 Force Single Coil	1 bit	000001 - 065535	Changes a bit device status of Q (output), R (shift register), or M (internal relay).
06 Preset Single Register	1 word	400001 - 465535	Changes word device data of D (data register).
15 Force Multiple Coils	1 to 128 bits	000001 - 065535	Changes multiple bit device statuses of Q (output), R (shift register), or M (internal relay).
16 Preset Multiple Registers	1 to 64 words	400001 - 465535	Changes multiple word device data of D (data register).

Master Device Address

When function code 01, 02, 03, or 04 is selected to read data from Modbus slaves, designate the first data register or internal relay number to store the data received from the Modbus slave. When function code 05, 06, 15, or 16 is selected to write data to Modbus slaves, designate the first data register or internal relay number to store the data to write to the Modbus slave. Data registers and internal relays can be designated as the master device address.

Data Size and Word/Bit

Designate the quantity of data to read or write. The valid data size depends on the function code. When function code 01, 02, 05, or 15 is selected, designate the data size in bits. When function code 03, 04, 06, or 16 is selected, designate the data size in words. For valid data sizes, see the table above.

Slave No.

Designate slave numbers 0 through 247. The same slave number can be designated repeatedly for different request numbers which can be 1 through 255. In the Modbus communication, slave number 0 is used for a broadcast slave number. The broadcast can be used to write the same data to all Modbus slaves.

Slave Address

Designate data memory addresses of Modbus slaves. The valid slave address range depends on the function code. For valid slave addresses, see the table above. The allocations of memory addresses vary with each Modbus slave device. Refer to manuals for each Modbus slave device.

Request Execution Device

To use request execution devices, click the radio button for "Use" and designate the first internal relay in the Modbus RTU Master Request Table. Devices used for executing requests are automatically listed in the table. To execute a request, turn on the corresponding request execution device.

Data registers can also be designated as the Request Execution Device. When the first data register is designated as the Request Execution Device, data register bits as many as the number of requests are allocated from the least significant bit of the first data register. Data register bits assigned as the execution relays are automatically listed in the Request Table.

When request execution devices are not designated, all requests programmed in the Request Table are executed continuously.

Error Status Data Register

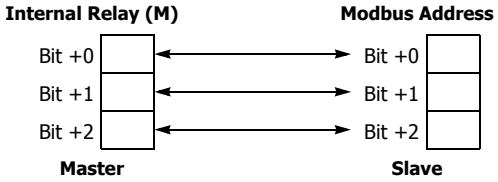
To use error status data registers, click the radio button for "Use" and designate the first data register in the Modbus RTU Master Request Table. Data registers used for storing error statuses are automatically listed in the table. When Use a single DR for all communication requests is selected, the first data register is shared by all requests.

Processing Requests

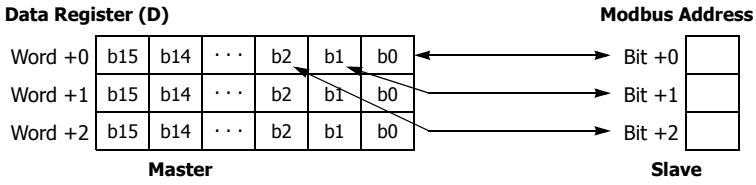
The data for Modbus communication are processed between the master and slaves as shown below.

Bit Data at Slaves (Function Codes 01, 02, 05, and 15)

- **Master Device Address: Internal Relay**

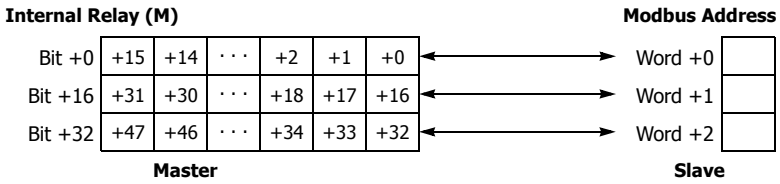


- **Master Device Address: Data Register**

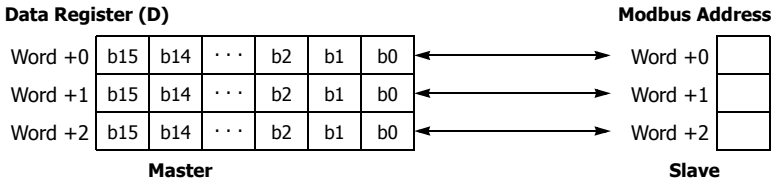


Word Data at Slaves (Function Codes 03, 04, 06, and 16)

- **Master Device Address: Internal Relay**



- **Master Device Address: Data Register**



Modbus Slave Communication

Modbus slave communication is made possible by selecting Modbus RTU Slave for port 2 and port 3 in the WindLDR Function Area Settings. When a Modbus slave receives a request from the Modbus master, the Modbus slave reads or writes data according to the request. The request is processed at the END processing of the user program.

Modbus slaves do not reply to the Modbus master for the broadcast requests.

Modbus Slave Communication Specifications

Item	Description	
Baud Rate (bps)	9600, 19200, 38400, 57600, 115200	
Data Bits	8 bits (fixed)	
Stop bits	1, 2 bits	
Parity	Odd, even, none	
Slave Number	Constant	1 to 247
	Data register	The value in D8027 (port 2) or D8028 (port 3) is used
Timeout between Characters *1	1.5 characters minimum *2	
Timeout between Frames *1	3.5 characters minimum *3	

*1: When timeout occurs, the SmartAxis discards the received data and waits for the first frame of the next valid communication.

*2: For communication at 19200 bps or higher, the timeout between characters needs to be a minimum of 0.75 ms.

*3: For communication at 19200 bps or higher, the timeout between frames needs to be a minimum of 1.75 ms.

Address Map

Modbus Device Name	Modbus Address Map (Decimal) *1	Communication Frame Address *2	SmartAxis Device *3	Applicable Function Code
Coil (000000 and above)	000001 - 000112	0000 - 006F	Q0 - Q141	1, 5, 15
	000701 - 000828	02BC - 033B	R0 - R127	
	001001 - 002024	03E8 - 07E7	M0 - M1277	
	009001 - 009144	2328 - 23B7	M8000 - M8177	
Input Relay (100000 and above)	100001 - 100126	0000 - 007D	I0 - I155	2
	101001 - 101200	03E8 - 04AF	T0 - T199 (timer contact)	
	101501 - 101700	05DC - 06A3	C0 - C199 (counter contact)	
Input Register (300000 and above)	300001 - 300200	0000 - 00C7	T0 - T199 (timer current value)	4
	300501 - 300700	01F4 - 02BB	C0 - C199 (counter current value)	
Holding Register (400000 and above)	400001 - 400200	0000 - 07CF	D0 - D1999	3, 6, 16
	408001 - 408200	1F40 - 2007	D8000 - D8199	
	409001 - 409200	2328 - 23EF	T0 - T199 (timer preset value)	3
	409501 - 409700	251C - 25E3	C0 - C199 (counter preset value)	

*1: Addresses generally used for Modbus communication. Calculation method of Modbus addresses for SmartAxis devices are described below.

*2: These 4-digit addresses are used in the communication frame. To calculate the address used in communication frame, extract lower 5 digits of the Modbus address, subtract 1 from the value, and convert the result into hexadecimal.

*3: Access within the device range for the CPU module type used.

Calculating Modbus Addresses for SmartAxis Devices

SmartAxis Device		Calculating Modbus Address	Calculation Example
I, Q, M	M XXX X (2): Octal (1): Decimal	((1) − (4)) × 8 + (2) + (5) Minimum address Offset	Example: M325 (32 − 0) × 8 + 5 + 1001 = 1262 Modbus address: 1262 1262 − 1 = 1261 = 04ED Communication frame address: 04ED
R, T, C, D	D XXXXX (3): Decimal	((3) − (4)) + (5) Minimum address Offset	Example: D756 (756 − 0) + 400001 = 400757 Modbus address: 400757 Extract lower 5 digits → 757 757 − 1 = 756 = 02F4 Communication frame address: 02F4

Modbus Device Name	SmartAxis Device	Minimum Address (4)	Offset (5)
Coil	Q0 - Q141	0	1
	R0 - R127	0	701
	M0 - M1277	0	1001
	M8000 - M8177	8000	9001
Input Relay	I0 - I155	0	100001
	T0 - T199 (timer contact)	0	101001
	C0 - C199 (counter contact)	0	101501
Input Register	T0 - T199 (timer current value)	0	300001
	C0 - C199 (counter current value)	0	300501
Holding Register	D0 - D1999	0	400001
	D8000 - D8199	8000	408001
	T0 - T199 (timer preset value)	0	409001
	C0 - C199 (counter preset value)	0	409501

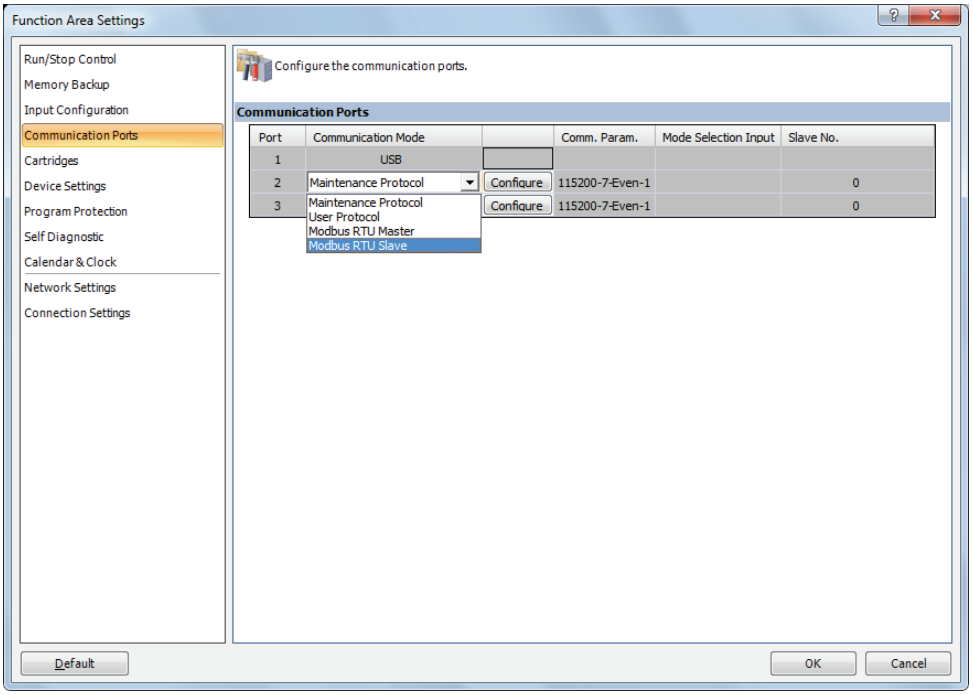
Programming Modbus Slave Using WindLDR

Modbus slave communication is programmed for Modbus RTU mode using WindLDR. Since these settings relate to the user program, the user program must be downloaded to the SmartAxis after changing any of these settings.

1. From the WindLDR menu bar, select **Configuration** > **Comm. Ports**.

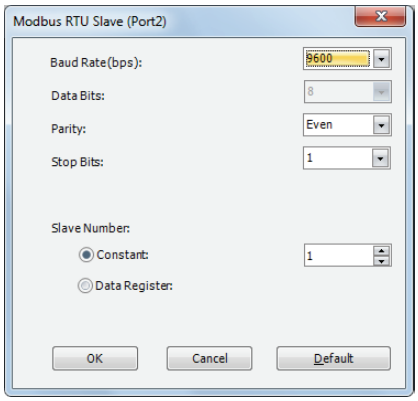
The Function Area Settings dialog box for Communication Ports appears.

2. In the Communication Mode pull-down list for Port 2, select **Modbus RTU Slave**.



3. Click the **Configure** button. The Communication Parameters dialog box appears. Change settings, if required.

Modbus RTU Slave



Baud Rate (bps)	9600 19200 38400 57600 115200	
Data Bits	8	
Parity	Even, Odd, None	
Stop Bits	1 or 2	
Slave Number	Constant	1 to 247
	Data register	The value in D8027 (port 2) or D8028 (port 3) is used

4. Click the **OK** button to save changes.

5. Download the user program to the CPU module.

Now, programming for the Modbus slave is complete. Details about parameters and valid values are as follows.

Communication Protocol

This section describes the communication frame format used for Modbus RTU communication.

Communication Frame Format

Request from Modbus Master

Idle 3.5 characters	Slave No.	Function Code	Data	CRC	Idle 3.5 characters
	1 byte	1 byte		2 bytes	

ACK Reply from Modbus Slave

Idle 3.5 characters	Slave No.	Function Code	Data	CRC	Idle 3.5 characters
	1 byte	1 byte		2 bytes	

NAK Reply from Modbus Slave

Idle 3.5 characters	Slave No.	Function Code + 80H	Error Code	CRC	Idle 3.5 characters
	1 byte	1 byte	1 byte	2 bytes	

Note: Note: Idle means no data flowing on the communication line.

Communication Frame Format

RTU mode requires a minimum of 3.5-character-long idle time between frames to determine the beginning of a frame. The SmartAxis Modbus master sends requests at idle intervals of 5 ms, which can be changed in the Function Area Settings dialog box.

Slave No.

The SmartAxis can be assigned slave numbers 1 through 247. In the 1:1 communication using RS232C, the same slave number must be set in the master and the SmartAxis.

Slave No. 0 is reserved for broadcast slave number and is used to write the same data to all Modbus slaves. In this case, the Modbus slaves do not send a reply to the master.

Modbus Communication NG Reply Error Code

One of the following error codes is stored in NAK reply.

01h: Function code error (unsupported function code)

02h: Access destination error (address out of range, address+device quantity out of range)

03h: Device quantity error, 1-bit write data error

CRC

RTU mode uses CRC check codes.

- **Modbus RTU Mode — Calculating the CRC-16 (cyclic redundancy checksum)**

Calculate the BCC using CRC-16 for the range from the slave number to the byte immediately before the BCC. The generation polynomial is: $X^{16} + X^{15} + X^2 + 1$.

1. Take the exclusive OR (XOR) of FFFFh and the first 1-byte data at the slave number.

2. Shift the result by 1 bit to the right. When a carry occurs, take the exclusive OR (XOR) of A001h, then go to step **3**. If not, directly go to step **3**.

3. Repeat step **2**, shifting 8 times.

4. Take the exclusive OR (XOR) of the result and the next 1-byte data.

5. Repeat step **2** through step **4** up to the byte immediately before the BCC.

6. Swap the higher and lower bytes of the result of step **5**, and store the resultant CRC-16 to the BCC (CRC) position. (Example: 1234h → 34h, 12h)

Communication Format

This section describes the communication format for each function code from the slave number up to immediately before the check code.

Function Code 01 (Read Coil Status) and Function Code 02 (Read Input Status)

Function code 01 reads bit device statuses of Q (output), R (shift register), or M (internal relay). One through 128 consecutive bits can be read out.

Function code 02 reads bit device statuses of I (input), T (timer contact), or C (counter contact). One through 128 consecutive bits can be read out.

Communication Frame

Request from Modbus Master

Slave No.	Function Code	Address	No. of Bits
xxh	01h / 02h	xxxxh	xxxxh

ACK Reply from Modbus Slave

Slave No.	Function Code	Quantity of Data	First 8 Bits	Second 8 Bits		Last 8 Bits
xxh	01h / 02h	xxh	xxh	xxh		xxh

NAK Reply from Modbus Slave

Slave No.	Function Code	Error Code
xxh	81h / 82h	xxh

Communication Example

Purpose	Read 15 bits starting at output Q10. Q10 → (1 – 0) × 8 + 0 + 1 = 9 Modbus address: 9 9 – 1 = 8 = 8h Communication frame address: 0008h
Condition	Slave No. 8 Q10 through Q27 binary data: 1234h

- **RTU Mode**

Request from Modbus Master	08 01 0008 0010 (CRC)
ACK Reply from Modbus Slave	08 01 02 34 12 (CRC)
NAK Reply from Modbus Slave	08 81 xx (CRC)

Function Code 03 (Read Holding Registers) and Function Code 04 (Read Input Registers)

Function code 03 reads word device data of D (data register), T (timer preset value), or C (counter preset value). One through 64 consecutive words can be read out.

Function code 04 reads word device data of T (timer current value) or C (counter current value). One through 64 consecutive words can be read out.

Communication Frame

Request from Modbus Master

Slave No.	Function Code	Address	No. of Words
xxh	03h / 04h	xxxxh	xxxxh

ACK Reply from Modbus Slave

Slave No.	Function Code	Quantity of Data	First High Byte	First Low Byte		Last Low Byte
xxh	03h / 04h	xxh	xxh	xxh		xxh

NAK Reply from Modbus Slave

Slave No.	Function Code	Error Code
xxh	83h / 84h	xxh

Communication Example

Purpose	Read 2 words starting at data register D1710. D1710 → (1710 – 0) + 400001 = 401711 Modbus address: 401711 Extract lower 5 digits → 1711 1711 – 1 = 1710 = 6AEh Communication frame address: 06AEh
Condition	Slave No. 8 D1710 data: 1234h D1711 data: 5678h

- **RTU Mode**

Request from Modbus Master	08 03 06AE 0002 (CRC)
ACK Reply from Modbus Slave	08 03 04 12 34 56 78 (CRC)
NAK Reply from Modbus Slave	08 83 xx (CRC)

Function Code 05 (Force Single Coil)

Function code 05 changes a bit device status of Q (output), R (shift register), or M (internal relay).

Communication Frame

Request from Modbus Master

Slave No.	Function Code	Address	OFF: 0000h ON: FF00h
xxh	05h	xxxxh	xxxxh

ACK Reply from Modbus Slave

Slave No.	Function Code	Address	OFF: 0000h ON: FF00h
xxh	05h	xxxxh	xxxxh

NAK Reply from Modbus Slave

Slave No.	Function Code	Error Code
xxh	85h	xxh

Communication Example

Purpose	Force internal relay M1320 on. M1320 → (132 – 0) × 8 + 0 + 1001 = 2057 Modbus address: 2057 2057 – 1 = 2056 = 808h Communication frame address: 0808h
Condition	Slave No. 8

- **RTU Mode**

Request from Modbus Master	08 05 0808 FF00 (CRC)
ACK Reply from Modbus Slave	08 05 0808 FF00 (CRC)
NAK Reply from Modbus Slave	08 85 xx (CRC)

Function Code 06 (Preset Single Register)

Function code 06 changes word device data of D (data register).

Communication Frame

Request from Modbus Master

Slave No.	Function Code	Address	New Data
xxh	06h	xxxxh	xxxxh

ACK Reply from Modbus Slave

Slave No.	Function Code	Address	Acknowledge Data
xxh	06h	xxxxh	xxxxh

NAK Reply from Modbus Slave

Slave No.	Function Code	Error Code
xxh	86h	xxh

Communication Example

Purpose	Write 8000 to data register D1708. D1708 → (1708 – 0) + 400001 = 401709 Modbus address: 401709 Extract lower 5 digits → 1709 1709 – 1 = 1708 = 6ACh Communication frame address: 06ACh
Condition	Slave No. 8

- **RTU Mode**

Request from Modbus Master	08 06 06AC 1F40 (CRC)
ACK Reply from Modbus Slave	08 06 06AC 1F40 (CRC)
NAK Reply from Modbus Slave	08 86 xx (CRC)

Function Code 15 (Force Multiple Coils)

Function code 15 changes bit device statuses of Q (output), R (shift register), or M (internal relay). One through 128 consecutive bits can be changed.

Communication Frame

Request from Modbus Master

Slave No.	Function Code	Address	No. of Bits	Quantity of Data	First 8 Bits	Second 8 Bits		Last 8 Bits
xxh	0Fh	xxxxh	xxxxh	xxh	xxh	xxh		xxh

ACK Reply from Modbus Slave

Slave No.	Function Code	Address	No. of Bits
xxh	0Fh	xxxxh	xxxxh

NAK Reply from Modbus Slave

Slave No.	Function Code	Error Code
xxh	8Fh	xxh

Communication Example

Purpose	Write the following bit statuses to internal relays M605 through M624. M605 (ON) M606 (0N) M607 (OFF) M610 (ON) M611 (OFF) M612 (ON) M613 (ON) M614 (OFF) M615 (OFF) M616 (0N) M617 (OFF) M620 (OFF) M621 (OFF) M622 (OFF) M623 (OFF) M624 (OFF) M605 (LSB) through M614 (MSB) binary data: 6B M615 (LSB) through M624 (MSB) binary data: 02 M605 $\rightarrow$ (60 – 0) $\times$ 8 + 5 + 1001 = 1486 Modbus address: 1486 1486 – 1 = 1485 = 5CDh Communication frame address: 05CDh
Condition	Slave No. 8

- **RTU Mode**

Request from Modbus Master	08 0F 05CD 0010 02 6B 02 (CRC)
ACK Reply from Modbus Slave	08 0F 05CD 0010 (CRC)
NAK Reply from Modbus Slave	08 8F xx (CRC)

Function Code 16 (Preset Multiple Registers)

Function code 16 changes word device data of D (data register). One through 64 consecutive words can be changed.

Communication Frame

Request from Modbus Master

Slave No.	Function Code	Address	No. of Words	Quantity of Data	First High Byte	First Low Byte		Last Low Byte
xxh	10h	xxxxh	xxxxh	xxh	xxh	xxh		xxh

ACK Reply from Modbus Slave

Slave No.	Function Code	Address	No. of Words
xxh	10h	xxxxh	xxxxh

NAK Reply from Modbus Slave

Slave No.	Function Code	Error Code
xxh	90h	xxh

Communication Example

Purpose	Write the following data to four data registers D1708 through D1711. D1708 (1234h) D1709 (5678h) D1710 (ABCDh) D1711 (EF01h) D1708 → (1708 – 0) + 400001 = 401709 Modbus address: 401709 Extract lower 5 digits → 1709 1709 – 1 = 1708 = 6ACh Communication frame address: 06ACh
Condition	Slave No. 8

- **RTU Mode**

Request from Modbus Master	08 10 06AC 0004 08 12 34 56 78 AB CD EF 01 (CRC)
ACK Reply from Modbus Slave	08 10 06AC 0004 (CRC)
NAK Reply from Modbus Slave	08 90 xx (CRC)

Modbus Communication via Ethernet Communication

Applicable CPU Modules

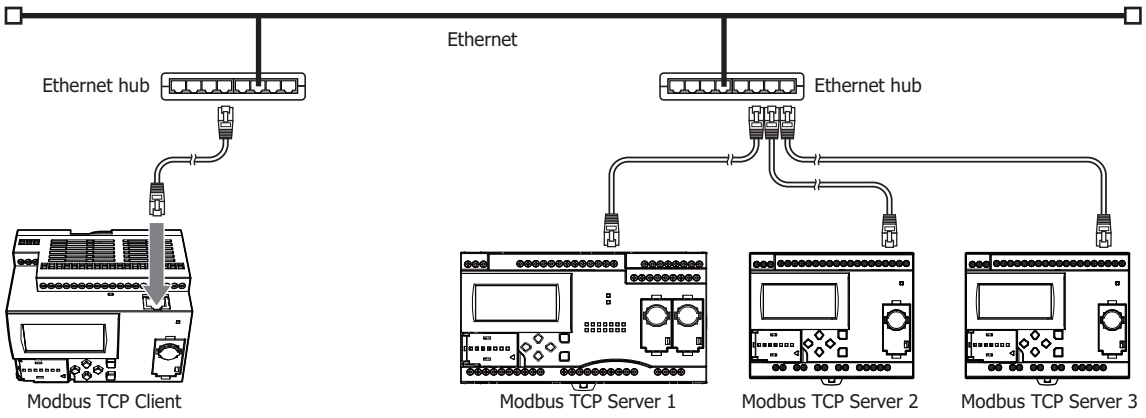
FT1A-12	FT1A-24	FT1A-40	FT1A-48
—	X	X	X

The SmartAxis supports Modbus TCP clients and Modbus TCP servers. Connect the Ethernet port on the SmartAxis to enable the SmartAxis to communicate with Modbus TCP complaint devices.

When configured as a Modbus TCP client, the SmartAxis can monitor and change the data memory of the network devices supporting Modbus TCP server. A maximum of three connections can be allocated to Modbus TCP clients. Each connection can communicate with one Modbus TCP server device.

When the SmartAxis is configured as a Modbus TCP server, the device data of the SmartAxis can be monitored and changed from Modbus TCP client devices. The SmartAxis can allocate a maximum of three connections to Modbus TCP servers.

For the Modbus TCP client function and how to configure it, see "Modbus TCP Client" in this chapter on page 11-15. For the Modbus TCP server function and how to configure it, see "Modbus TCP Server" in this chapter on page 11-20.



Modbus TCP Client

When configured as a Modbus TCP client, the SmartAxis sends communication requests to a Modbus TCP server to read/write data. Each communication request is sent to a Modbus Server according to the configured request table.

Modbus TCP client communication settings and request tables for Modbus TCP servers can be programmed using the WindLDR Function Area Settings. The SmartAxis communicate with the Modbus TCP servers according to those settings.

Communication with Modbus TCP servers are performed in synchronism with user program execution, and the communication data are processed at the END processing in the order of request numbers specified in the request table.

Modbus TCP Client Specifications

Parameter	Modbus TCP Client
Slave Number	1 to 247
Maximum Number of Servers	3 (one server per one connection)
Receive Timeout *1	100 to 25,500 ms (in increments of 100 ms)

*1: Specifies the period of time before receiving a response frame from a server.

Modbus TCP Client Start and Stop

When request execution devices are designated in the Modbus TCP Client request table, internal relays or data register bits as many as the request quantity are allocated to execute Modbus TCP Client communication. The internal relays or data register bits are allocated in the order of requests. For example, when internal relay M0 is designated as the request execution device, M0 is allocated to request No. 1, M1 to request No. 2, and so on. To execute a request, turn on the corresponding request execution device.

When communication is completed, the request execution device turns off automatically. When it is required to send requests continuously, keep the corresponding request execution device on using a SET or OUT instruction.

When request execution devices are not designated, all requests programmed in the request table are executed continuously.

Communication Completion and Communication Error

Modbus communication finishes when a read or write process is completed successfully or when a communication error occurs. Communication error occurs when communication failure has repeated three times. When a communication error occurs, the request is canceled and the next request is processed. When the error status data register is designated, the communication status of each request can be confirmed.

Communication Error Data

When Error Status is configured in the Request Table from the Function Area Settings, the error data of each request can be confirmed.

Use a single DR for all communication requests	Error data of each communication request
Unchecked	Error data, the remote host number (high-order byte) and error code (low-order byte), of each request in the entire request table can be confirmed. Data registers as many as the quantity of requests are reserved for storing error data. When an error occurs for a request, error data is stored to the corresponding data register.
Checked	A single data register is shared by all requests. When an error occurs for a request, error data is stored to the data register and the old error data is overwritten.

Bit Allocation	
Remote Host Number (high-order byte)	1 to 255
Error Code (low-order byte)	00h: Normal completion 01h: Function code error (unsupported function code) 02h: Access destination error (address out of range, address+device quantity out of range) 03h: Device quantity error, 1-bit write data error (specified device quantity of 1-bit write is unsupported) 12h: Frame length error (frame length of transmitted request is out of range) 13h: BCC error (BCC does not match) 14h: Slave number error (received slave number is invalid) 16h: Timeout error (timeout occurs)

Modbus TCP Communication Request Table

A maximum of 255 requests can be configured in the Modbus TCP Client Request Table.

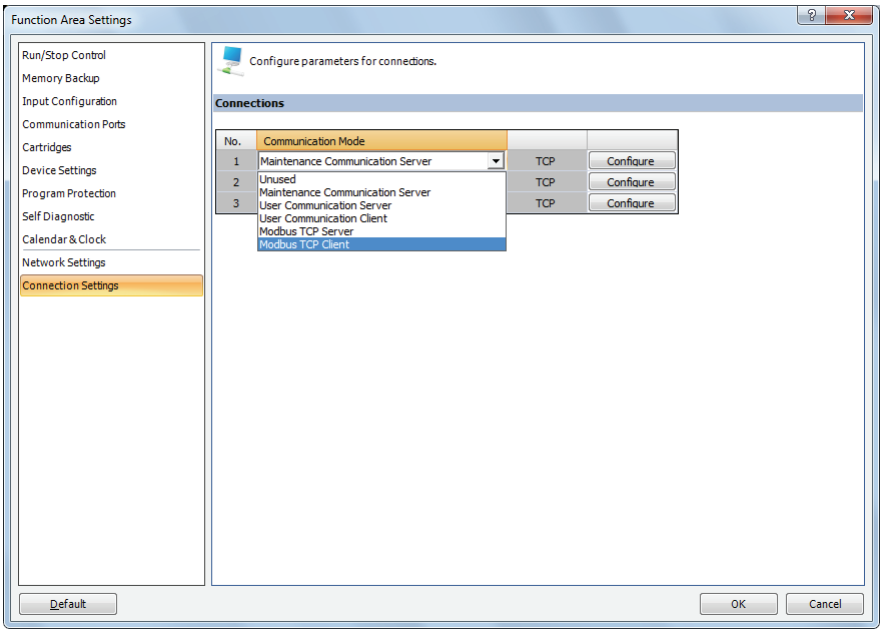
Notes:

- 10 bytes of the user program area are needed per each request.
- Request execution devices and error status data registers are allocated in the order of request numbers. When deleting a request or changing the order of requests, the relationship of the request to the request execution devices and error status data register is changed. If the allocated internal relays or data registers are used in the user program, those device addresses must be updated accordingly.

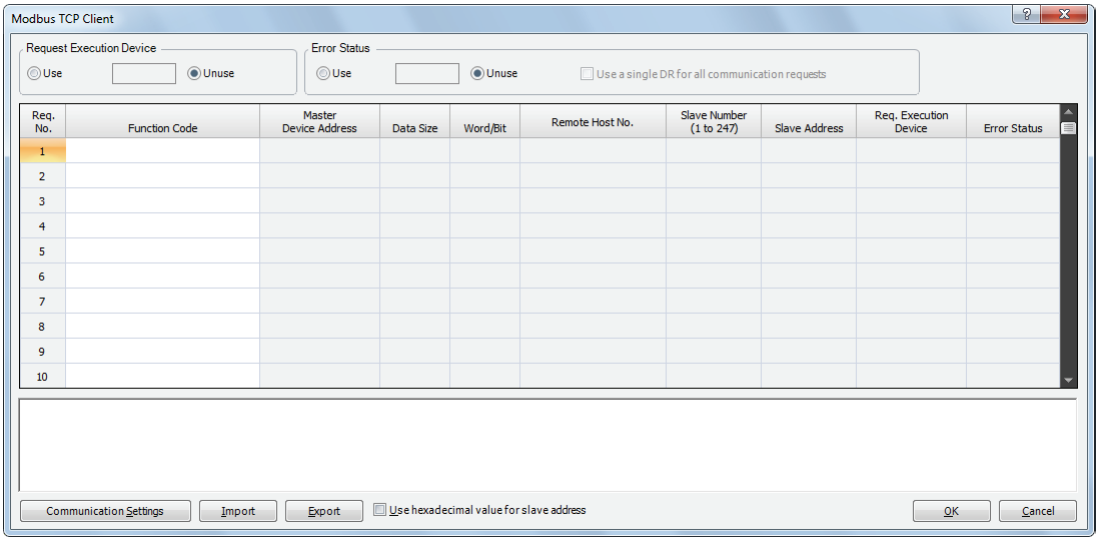
Programming WindLDR (Modbus TCP Client)

In order to use Modbus TCP client, configure the Modbus TCP client in the Function Area Settings dialog box and then download the user program to the CPU module.

1. From the WindLDR menu bar, select **Configuration** > **Connection Settings**.
   The Function Area Settings dialog box appears.
2. Select **Modbus TCP Client** as the communication mode for the connection 1.

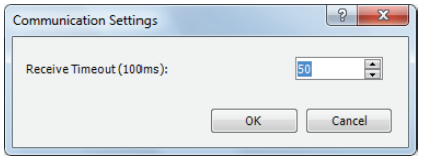


The Modbus TCP Client Request Table dialog box appears.



3. Click on the **Communication Settings** button.

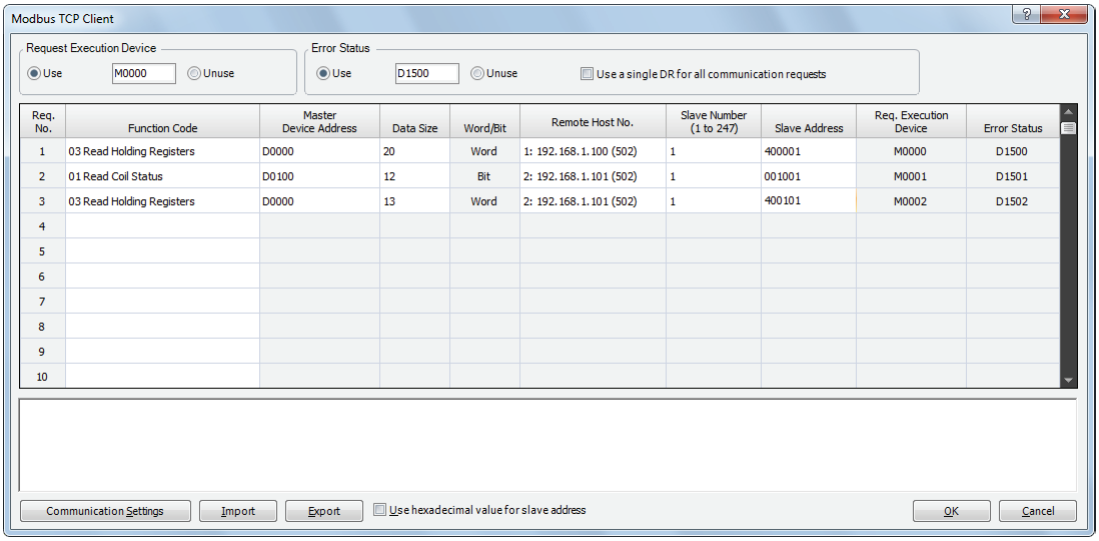
The Communication Settings dialog box appears. Configure the timeout and click **OK** button to close the Communication Settings dialog box.



4. Configure the requests of the Modbus TCP Client.

A maximum of 255 requests can be entered in one request table. Specify the Modbus TCP servers with the remote host numbers. After all requests are configured, click **OK** button to close the dialog box.

Choose to use Request Execution Devices and Error Status data registers if necessary. When using Request Execution Devices and Error Status data registers, enter the first number of the devices.



5. Download the user program to the CPU module.

Now, programming for the Modbus TCP client is complete. Details about parameters and valid values are as follows.

Function Code

The Modbus TCP of the SmartAxis supports eight function codes as listed in the table below. Supported function codes and valid slave addresses vary with each Modbus server device to communicate with. Configure the function codes according to the specifications of the Modbus server devices.

Function Code	Data Size	Slave Address	SmartAxis as Modbus Slave
01 Read Coil Status	1 to 128 bits	000001 - 065535	Reads bit device statuses of Q (output), R (shift register), or M (internal relay).
02 Read Input Status	1 to 128 bits	100001 - 165535	Reads bit device statuses of I (input), T (timer contact), or C (counter contact).
03 Read Holding Registers	1 to 64 words	400001 - 465535	Reads word device data of D (data register), T (timer preset value), or C (counter preset value).
04 Read Input Registers	1 to 64 words	300001 - 365535	Reads word device data of T (timer current value) or C (counter current value).
05 Force Single Coil	1 bit	000001 - 065535	Changes a bit device status of Q (output), R (shift register), or M (internal relay).
06 Preset Single Register	1 word	400001 - 465535	Changes word device data of D (data register).
15 Force Multiple oils	1 to 128 bits	000001 - 065535	Changes multiple bit device statuses of Q (output), R (shift register), or M (internal relay).
16 Preset Multiple Registers	1 to 64 words	400001 - 465535	Changes multiple word device data of D (data register).

Master Device Address
When function code 01, 02, 03, or 04 is selected to read data from Modbus servers, designate the first data register or internal relay number to store the data received from the Modbus server. When function code 05, 06, 15, or 16 is selected to write data to Modbus servers, designate the first data register or internal relay number to store the data to write to the Modbus server. Data registers and internal relays can be designated as the master device address.

Data Size and Word/Bit
Designate the quantity of data to read or write. The valid data size depends on the function code. When function code 01, 02, 05, or 15 is selected, designate the data size in bits. When function code 03, 04, 06, or 16 is selected, designate the data size in words. For valid data sizes, see "Function Code" on page 11-22.

Remote Host No.
Designate the remote host number configured in the Remote Host List dialog box. In the Remote Host List dialog box, IP address and port number are configured for each remote host. The default port number of Modbus TCP communication is 502. If the Modbus TCP server uses a different port number, configure that port number in the Remote Host List dialog box.

Slave No.
Designate slave numbers 1 through 247. The same slave number can be designated repeatedly for different request numbers which can be 1 through 255. The slave number is usually not referred by Modbus TCP server. Configure the slave number if Modbus TCP server requires.

Slave Address
Designate data memory addresses of Modbus servers. The valid slave address range depends on the function code. For valid slave addresses, see the table above. The allocations of memory addresses vary with each Modbus server device. Refer to manuals for each Modbus server device.

Request Execution Device
To use request execution devices, click the radio button for "Use" and designate the first internal relay or data register in the Modbus TCP Client Request Table. Internal relays or data register bits used for executing requests are automatically listed in the table. To execute a request, turn on the corresponding request execution device.

When request execution devices are not designated, all requests programmed in the Request Table are executed continuously.

Error Status Data Register
To use error status data registers, click the radio button for "Use" and designate the first data register in the Modbus TCP Client Request Table. Data registers used for storing error statuses are automatically listed in the table. When Use a single DR for all communication requests is selected, the first data register is shared by all requests.

Modbus TCP Server

When the SmartAxis is configured as the Modbus TCP server, Modbus TCP client devices can read/write the data of the SmartAxis. When the SmartAxis receives a valid request from a Modbus TCP client device, the data is read or written according to the request received. The communication data received from Modbus TCP clients are processed at the END processing of the user program.

Modbus TCP Server Specifications

Parameter	Modbus TCP Server
Slave Number	Ignored
Response Time	1.5 ms
Number of Clients that can Access Simultaneously	3 (1 client per 1 connection)
Port Number	502 (can be changed between 0 and 65535)
Supported Function Code	01 Read Coil Status 02 Read Input Status 03 Read Holding Registers 04 Read Input Registers 05 Force Single Coil 06 Preset Single Register 15 Force Multiple oils 16 Preset Multiple Registers

Address Map

Modbus TCP client can access the Modbus devices (Coil, Input Relay, Input Register, and Holding Register) of Modbus server to read or write the device data (I, Q, M, R, T, C, and D) of SmartAxis. Refer to the following table to configure the Modbus TCP clients.

Modbus Device Name	Modbus Address Map (Decimal)	Communication Frame Address *1	SmartAxis Device *2	Applicable Function Code
Coil (000000 and above)	000001 - 000112	0000 - 006F	Q0 - Q141	1, 5, 15
	000701 - 000828	02BC - 033B	R0 - R127	
	001001 - 002024	03E8 - 07E7	M0 - M1277	
	009001 - 009144	2328 - 23B7	M8000 - M8177	
Input Relay (100000 and above)	100001 - 100126	0000 - 007D	I0 - I155	2
	101001 - 101200	03E8 - 04AF	T0 - T199 (timer contact)	
	101501 - 101700	05DC - 06A3	C0 - C199 (counter contact)	
Input Register (300000 and above)	300001 - 300200	0000 - 00C7	T0 - T199 (timer current value)	4
	300501 - 300700	01F4 - 02BB	C0 - C199 (counter current value)	
Holding Register (400000 and above)	400001 - 400200	0000 - 07CF	D0 - D1999	3, 6, 16
	408001 - 408200	1F40 - 2007	D8000 - D8199	
	409001 - 409200	2328 - 23EF	T0 - T199 (timer preset value)	3
	409501 - 409700	251C - 25E3	C0 - C199 (counter preset value)	

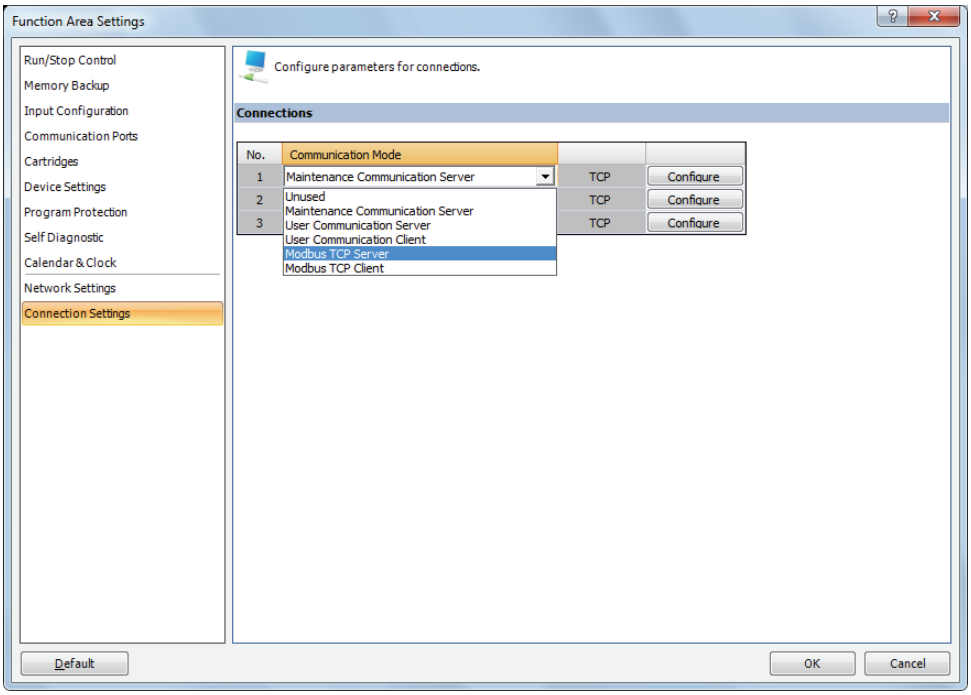
*1: These 4-digit addresses are used in the communication frame. To calculate the address used in communication frame, extract lower 5 digits of the Modbus address, subtract 1 from the value, and convert the result into hexadecimal. For details, see "Modbus Slave Communication" on page 11-8.

*2: Access within the device range for the CPU module type used.

Programming WindLDR (Modbus TCP Server)

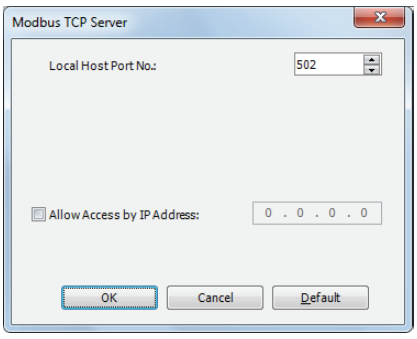
In order to use Modbus TCP server, configure the Modbus TCP server in the Function Area Settings dialog box and then download the user program to the CPU module.

1. From the WindLDR menu bar, select **Configuration** > **Connection Settings**.
   The Function Area Settings dialog box appears.
2. Select **Modbus TCP Server** as the communication mode for the connection 1.



The Modbus TCP Server dialog box appears.

3. Configure the parameters and click on **OK** button.



Note: For details about each parameter, see the following page.

4. Download the user program to the CPU module.

Now, programming for the Modbus TCP server is complete.

Modbus TCP Server Communication Settings

Local Host Port No.

Configure the local host port number between 0 and 65,535. The same local host port number can be used with multiple connection numbers.

If the same port number is used with multiple connections, Modbus TCP clients as many as the number of the connections can communicate with SmartAxis through the same port number.

Allow Access by IP Address

You can set the IP address for a device to permit access. By setting the allowed IP address, only the device with the specified IP address can establish a connection with the SmartAxis and communicate with the Modbus TCP server. When the same local host port number is configured in multiple connections, all the allowed IP address settings are effective. If a connection in which the allowed IP address it not configured uses the same local host port number, arbitrary access is allowed through the port.

Example 1: If two connections use the same local port number and an allowed IP address is not configured for both connections, access from a total of two clients with any IP addresses is accepted.

Example 2: If two connections use the same local port number and 192.168.1.101 and 192.168.1.102 are configured as the allowed IP addresses, access from a total of two clients whose IP addresses are 192.168.1.101 and 192.168.1.102 is accepted.

Example 3: If connection 1 and 2 use the same local port number, an allowed IP address 192.168.1.101 is configured for connection 1, and the allowed IP address is not configured for connections, access from a total of two clients with any IP addresses is accepted.

Modbus TCP Communication Format

This section describes the communication format used for Modbus TCP client and server communication. Modbus TCP communication format starts with the Modbus TCP header followed by the RTU mode communication format without the idle 3.5 characters at both ends and CRC as shown below.

Modbus TCP Communication Format

Transaction ID	Protocol ID	Message Length (bytes)	Unit ID	Function Code	Data
2 bytes	2 bytes	2 bytes	1 byte	1 byte	N bytes

Modbus TCP Header

RTU Mode Communication Format	Idle 3.5 characters	Slave No.	Function Code	Data	CRC	Idle 3.5 characters
		1 byte	1 byte	N bytes	2 bytes	

Transaction ID

The Modbus TCP server (slave) returns the request ID sent from the client (master) without any change. When receiving the returned request ID, the client can confirm to which request the response was returned. When confirmation is not required, designate 0 as a transaction ID.

Protocol ID

Designate 0 to identify Modbus TCP protocol.

Message Length

Designate the length of the following message in bytes.

Unit ID

The ID for identifying the device. Store the slave number of the Modbus TCP server. The SmartAxis Modbus TCP server accepts and processes requests when the unit ID of the received request is not 0. When the unit ID is 0, the received request is processed as broadcast communication and no response is returned to the Modbus TCP client.

Function Code

Designate a function code, such as 01 (read coil status) and 02 (read input status).

Data

Designate required data for each function.

13: 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 SmartAxis.

The SmartAxis 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 devices and other data are rejected. User program syntax errors are found during compilation on WindLDR. When an incorrect program is downloaded to the SmartAxis, user program syntax errors are still checked. Errors are also checked at starting and during operation of the SmartAxis. When an error occurs, the error is reported by turning on the ERR LED on the SmartAxis and an error message can be viewed on WindLDR.

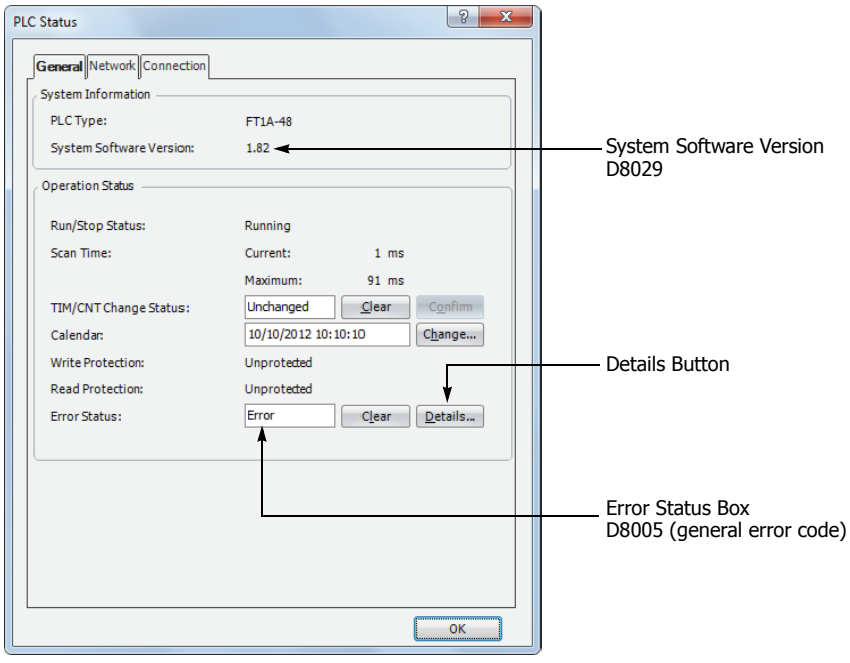
Reading Error Data

When any error occurs during the SmartAxis operation, "Error" is indicated and error details can be read using WindLDR on a computer.

Monitoring WindLDR

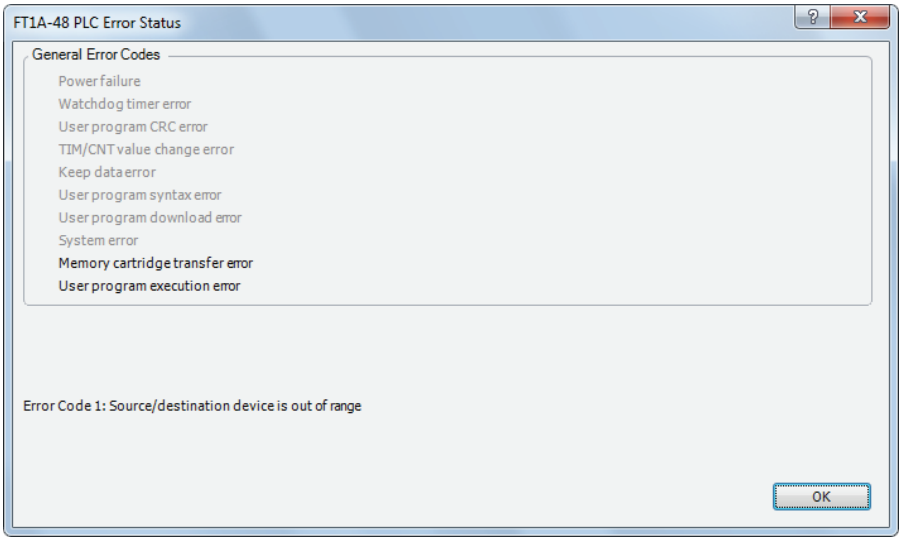
1. From the WindLDR menu bar, select **Online** > **Monitor** > **Monitor**. The monitor mode is enabled.
2. From the WindLDR menu bar, select **Online** > **Status**. The PLC Status dialog box appears.

When any error exists, "Error" is displayed in the error status box.



3. On the right of the Error Status in the PLC Status dialog box, click the **Details** button.

The PLC Error Status screen appears.

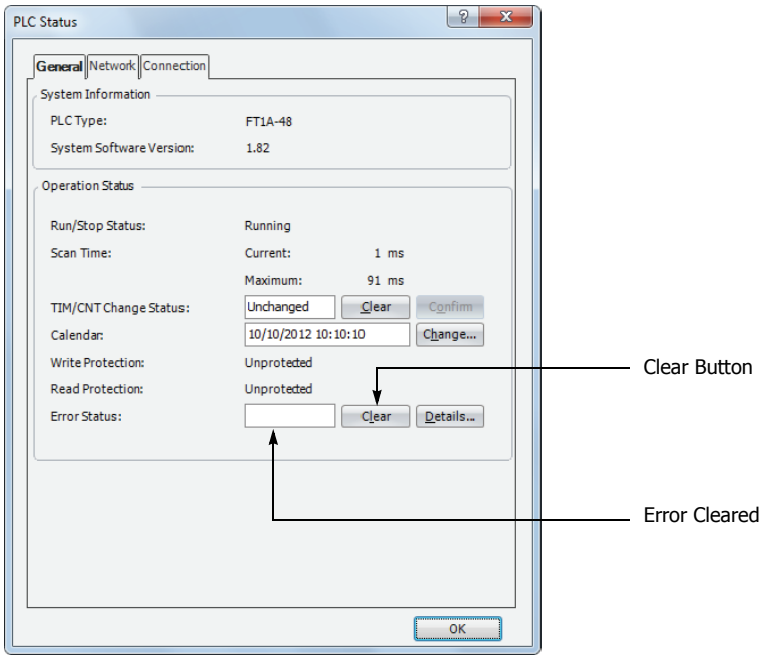


Clearing Error Codes from WindLDR

After removing the cause of the error, clear the error code using the following procedure:

1. From the WindLDR menu bar, select **Online** > **Monitor** > **Monitor**. The monitor mode is enabled.
2. From the WindLDR menu bar, select **Online** > **Status**. The PLC Status dialog box appears.
3. On the right of the **Error Status** in the PLC Status dialog box, click the **Clear** button.

This procedure clears the error code from special data register D8005 (general error code), and the error is cleared from the PLC Status dialog box.

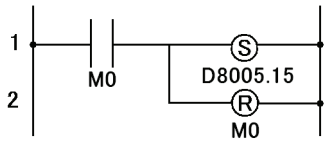


Special Data Registers for Error Information

Two data registers are assigned to store information on errors.

D8005	General Error Code
D8006	User Program Execution Error Code

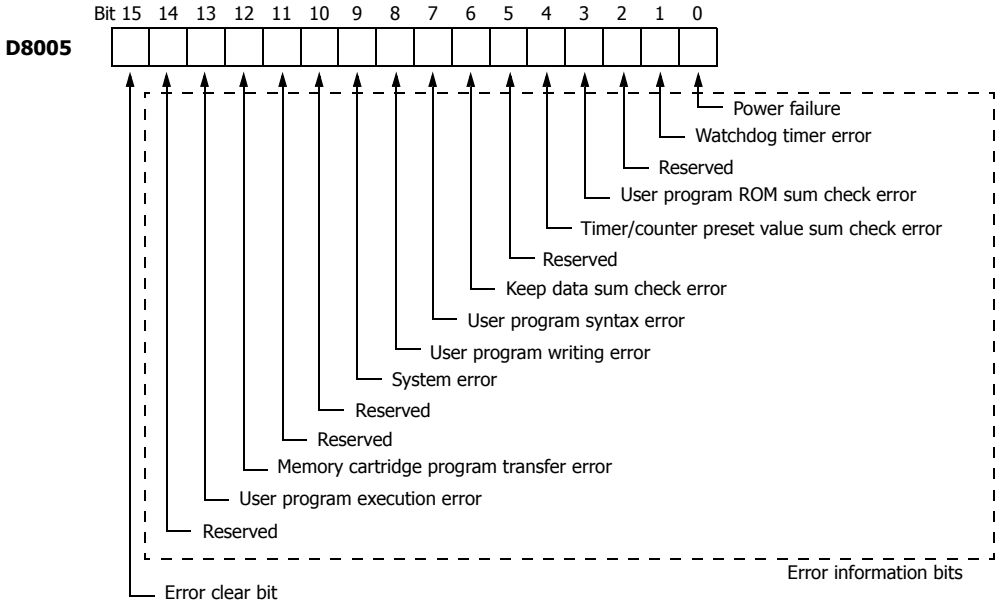
Example: This ladder program clears the error information using the error clear bit of special data register D8005.



Turn on M0 and turn on the upper bit of D8005.
The error information is cleared at the end of the ladder scan.

General Error Codes

The error code is stored in special data register D8005.
If '1' is stored in each bit of D8005, the corresponding error is occurring.



CPU Module Operating Status, Output, and ERR LED during Errors

Error Items	Operating Status	Output	ERR LED	Checked at
Power failure	Stop	OFF	OFF	Any time
Watchdog timer error	Stop	OFF	ON	Any time
User program ROM sum check error	Stop	OFF	ON	Starting operation
TIM/CNT preset value sum check error	Maintained	Maintained	ON	When checking a change in timer/counter settings
Keep data error	Maintained/ Stop *1	Maintained/OFF *1	OFF	Turning power on
User program syntax error	Stop	OFF	ON	Downloading user program
User program writing error	Stop	OFF	ON	Downloading user program
System error	Stop	OFF	ON	Turning power on
Memory cartridge program transfer error	Stop	OFF	ON	Turning power on
User program execution error	Maintained	Maintained	ON	Executing user program

*1: Operation starts to run and outputs are turned on or off according to the user program as default, but it is also possible to stop operation and turn off outputs using the Function Area Settings on WindLDR. See page 5-3.

*2: The SmartAxis Pro has no error status LED.

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 the allowed time, the watchdog timer indicates an error. Clear the error code using WindLDR on a computer. If this error occurs frequently, the SmartAxis has to be replaced.

0008h: User Program ROM Sum Check Error

The user program stored in the SmartAxis ROM is broken. Download a correct user program to the SmartAxis, and clear the error code using WindLDR on a computer.

When a memory cartridge is installed on the SmartAXIS, the user program in the memory cartridge 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 changed 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. Data of counters and data registers are also cleared. Clear the error code using WindLDR on a computer.

If this error occurs in a short period of power interruption after the battery has been charged as specified, the battery is defective and the SmartAXIS 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 SmartAxis. The error code is cleared when a correct user program is transferred.

0100h: User Program Writing Error

This error indicates a failure of writing into the SmartAxis 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 SmartAxis has to be replaced.

When a memory cartridge is installed on the SmartAXIS, writing into the memory cartridge is checked.

0200h: System Error

This error is issued when the ROM is not found. When this error occurred, turn power off and on. Clear the error code using WindLDR on a computer. If this error occurs frequently, the SmartAxis has to be replaced.

1000h: Memory Cartridge Program Transfer Error

This error indicates that the user program cannot be downloaded to/uploaded from SmartAXIS using the memory cartridge. The memory cartridge program transfer fails when one of the following conditions is met:

- When the user program in the SmartAXIS is password-protected and the password of the user program in the memory cartridge does not match. Configure the correct password to the user program in the memory cartridge. For details on entering the password, see page 2-93.
- When uploading the user program from the SmartAXIS is prohibited. Upload cannot be executed.

2000h: User Program Execution Error

This error indicates that invalid data is found during execution of a user program. When this error occurs, special internal relay M8004 (user program execution error) are also turned on.

Referring to the next page, fix the cause of the error and clear the error code.

User Program Execution Error

This error indicates that invalid data is found during execution of a user program. When this error occurs, the ERR 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).

User Program Execution Error Code (D8006)	Error Details
1	Source/destination device 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	S1 is 10,000 or higher in the HTOB(W) instruction, or S1 is 100,000,000 or higher in the HTOB(D) instruction.
6	BTOH has any digit of S1 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	In the WEEK instruction, the ON time data is out of range (hour data is 24 or higher, minute data is 60 or higher), or the OFF time data is out of range (hour data is 25 or higher, minute data is 60 or higher).
10	In the YEAR instruction, the month and day data is out of range (month data is 13 or higher, day data is 32 or higher).
12	CVXTY/CVYTX is executed without matching XYFS. XYFS and CVXTY/CVYTX have the same S1, but have different data types.
13	CVXTY/CVYTX has S2 exceeding the value specified in XYFS.
14	Label in LJMP, LCAL, or DJNZ is not found.
18	Attempt was made to execute an instruction that cannot be used in an interrupt program: SOTU, SOTD, TML, TIM, TMH, TMS, CNT, CDP, CUD, SFR, SFRN, WEEK, YEAR, MSG, TXD, RXD, DI, EI, XYFS, CVXTY, CVYTX, AVRG, PULS, PWM, RAMP, ZRN, ARAMP, DTML, DTIM, DTMH, DTMS, TTIM, FIFOF, NDSRL, HOUR, ETXD, ERXD, DLOG, TRACE, and SCRPT (see page 5-36).
19	Attempt was made to execute an instruction that is not available for the PLC.
20	PULS, PWM, RAMP, ZRN, or ARAMP has an invalid value in control registers.
21	DECO has S1 exceeding 255.
22	BCNT has S2 exceeding 256.
23	ICMP>= has S1 < S3.
25	BCDLS has S2 exceeding 7.
26	DI or EI is executed when interrupt input or timer interrupt is not programmed in the Function Area Settings.
27	Work area is broken when using DTML, DTIM, DTMH, DTMS, or TTIM.
28	S1 for trigonometric function instruction is invalid.
29	Result of F (float) data type instruction is out of the data type range.
30	N_B for SFTL/SFTR is out of range.
31	In the FIFOF instruction, the FIEX instruction or the FOEX instruction was executed before the FIFO data file was registered.
32	TADD, TSUB, HOUR, or HTOS has invalid data for source device S1.
34	NDSRC has invalid data for source device S3.
35	In the SUM instruction, the execution result exceeds the valid range for the selected data type, or S2 data is 0.

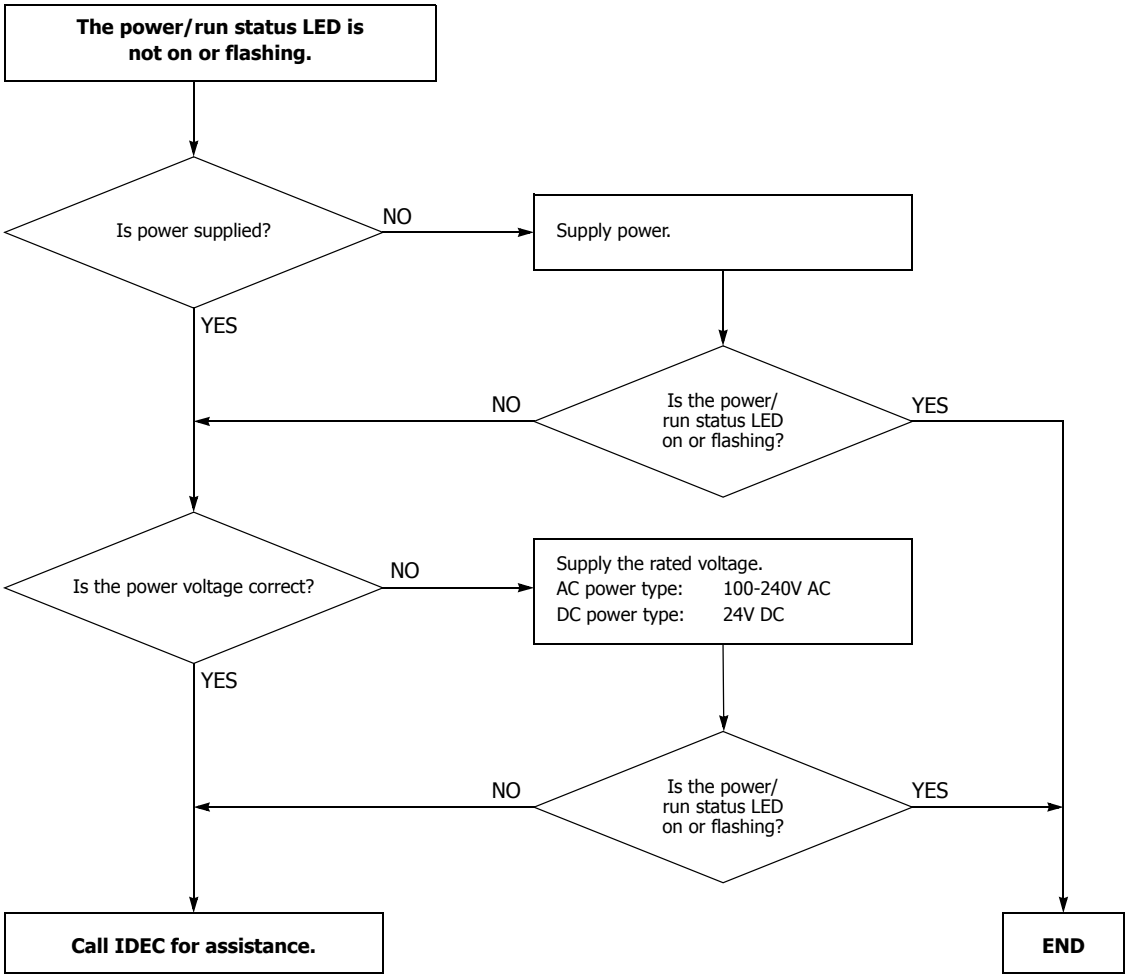
Troubleshooting Diagrams

When one of the following problems is encountered, see the trouble shooting diagrams on the following pages.

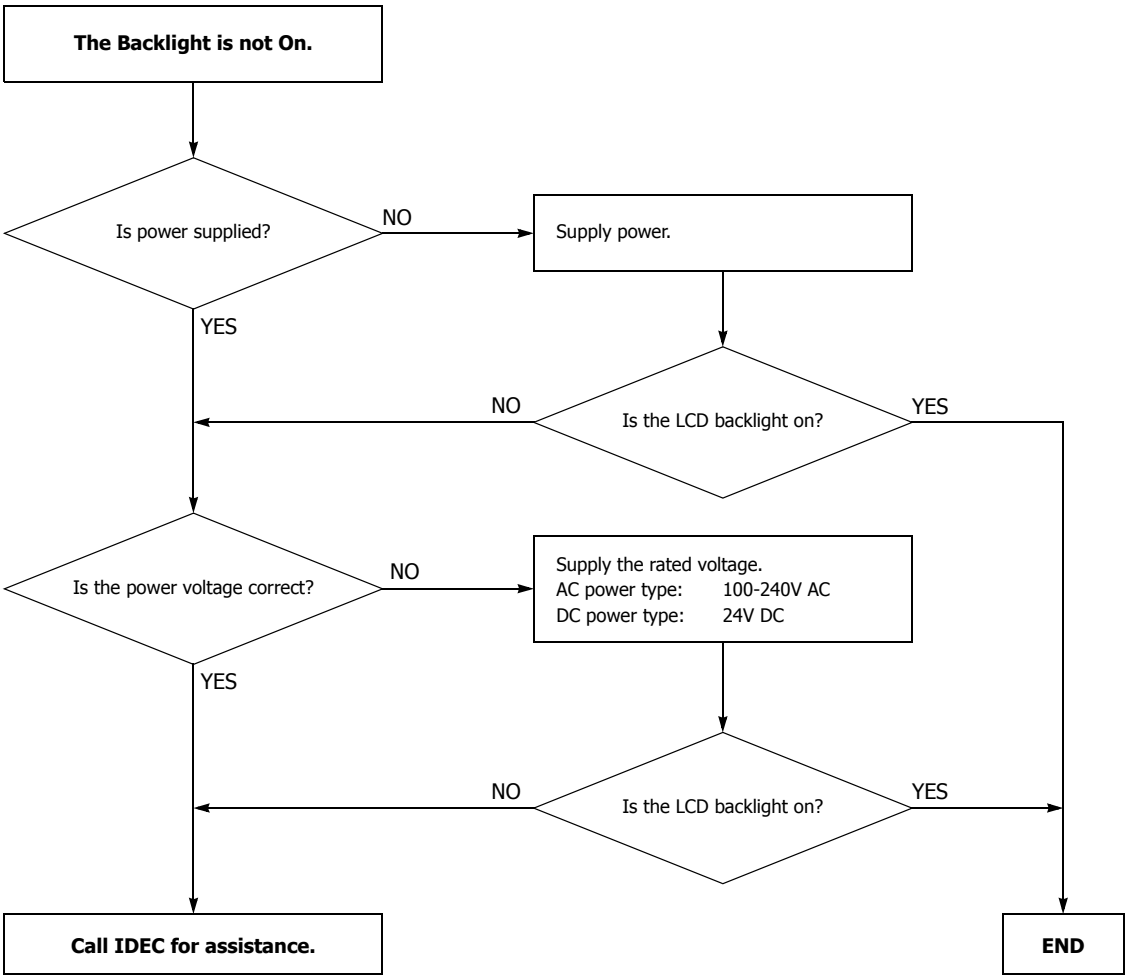
Problem	Troubleshooting Diagram
The power is not on.	Diagram 1
Operation has not started.	Diagram 2
An error has occurred.	Diagram 3
Input does not operate normally.	Diagram 4
Output does not operate normally.	Diagram 5
Communication between WindLDR on a computer and the SmartAxis is not possible.	Diagram 6
Cannot stop or reset operation.	Diagram 7
Watchdog timer error occurs and the CPU does not run.	Diagram 8
The interrupt/catch input cannot receive short pulses.	Diagram 9
Frequency measurement does not work.	Diagram 10
Data is not transmitted at all in the user communication mode. (24-, 40-, 48-I/O types only)	Diagram 11
Data is not transmitted correctly in the user communication mode. (24-, 40-, 48-I/O types only)	Diagram 12
Data is not received at all in the user communication mode. (24-, 40-, 48-I/O types only)	Diagram 13
Data is not received correctly in the user communication mode. (24-, 40-, 48-I/O types only)	Diagram 14
Modbus master communication does not work. (24-, 40-, 48-I/O types only)	Diagram 15
Long communication cycle for Modbus RTU master communication or Modbus TCP client communication. (24-, 40-, 48-I/O types only)	Diagram 16
WindLDR and the SmartAxis cannot communicate.	Diagram 17
WindLDR does not communicate with PLC via USB.	Diagram 18
Modbus master communication request is slow.	Diagram 19

Troubleshooting Diagram 1

- **SmartAxis Lite - The Power/Run Status LED (PWR/RUN) is not On or Flashing**
  The SmartAxis Lite power/run status LED (PWR/RUN) is on while running and flashes while stopped.

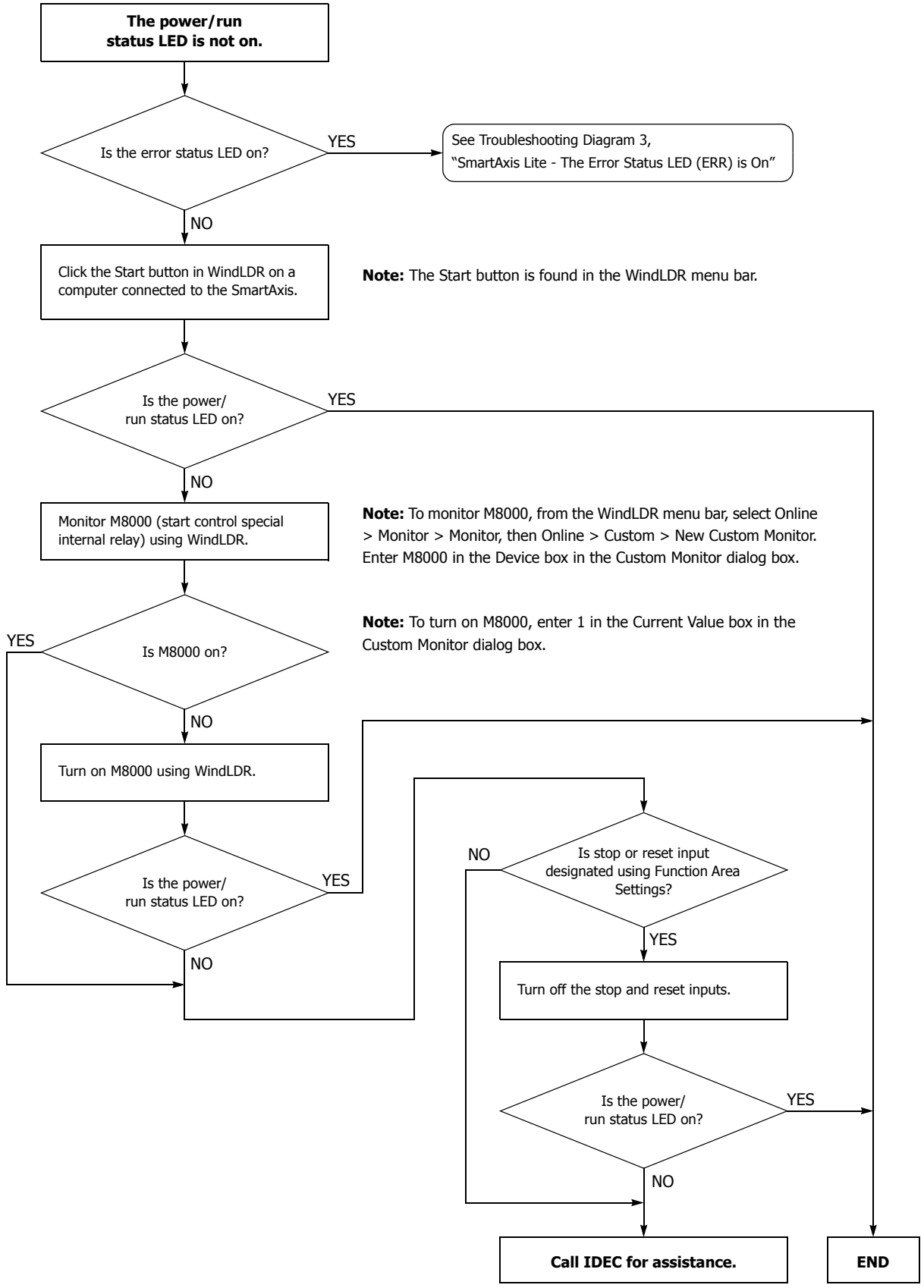


- **SmartAxis Pro - The Backlight is not On**



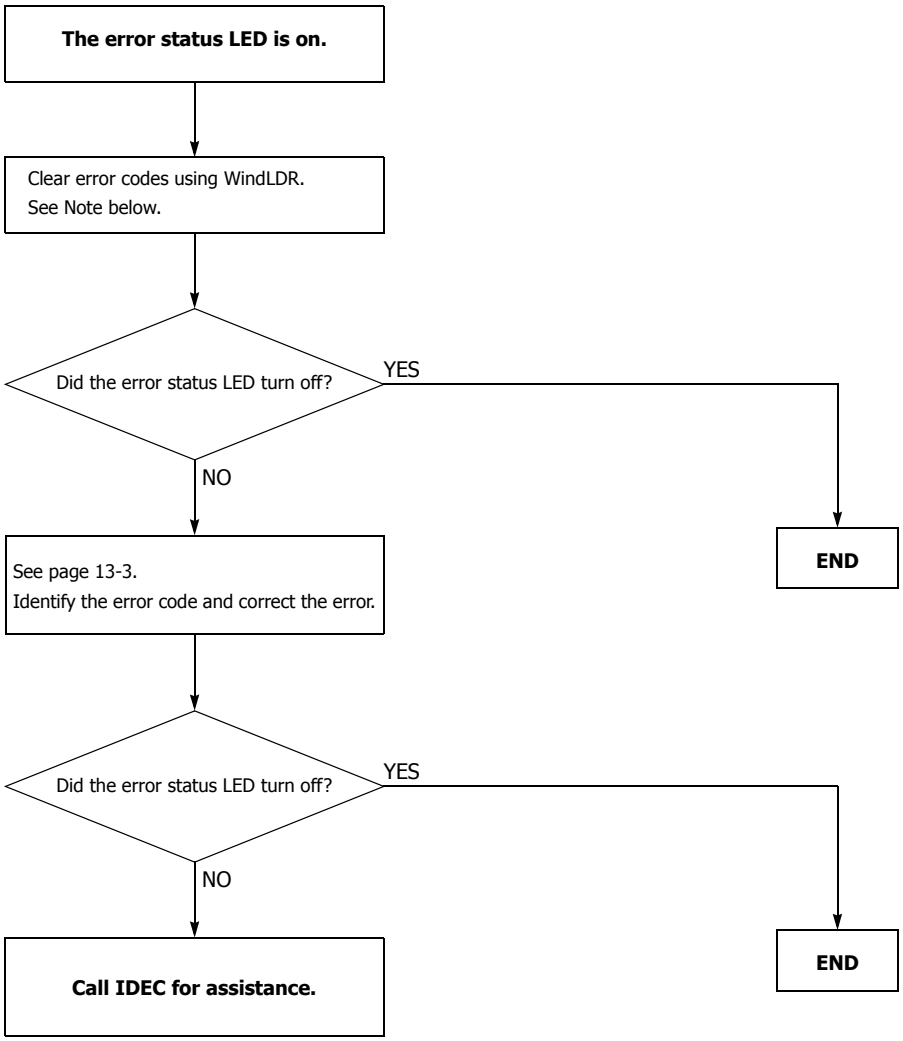
Troubleshooting Diagram 2

- **SmartAxis Lite - The Power/Run Status LED (PWR/RUN) is not On**
  The SmartAxis Lite power/run status LED (PWR/RUN) is on while running and flashes while stopped.



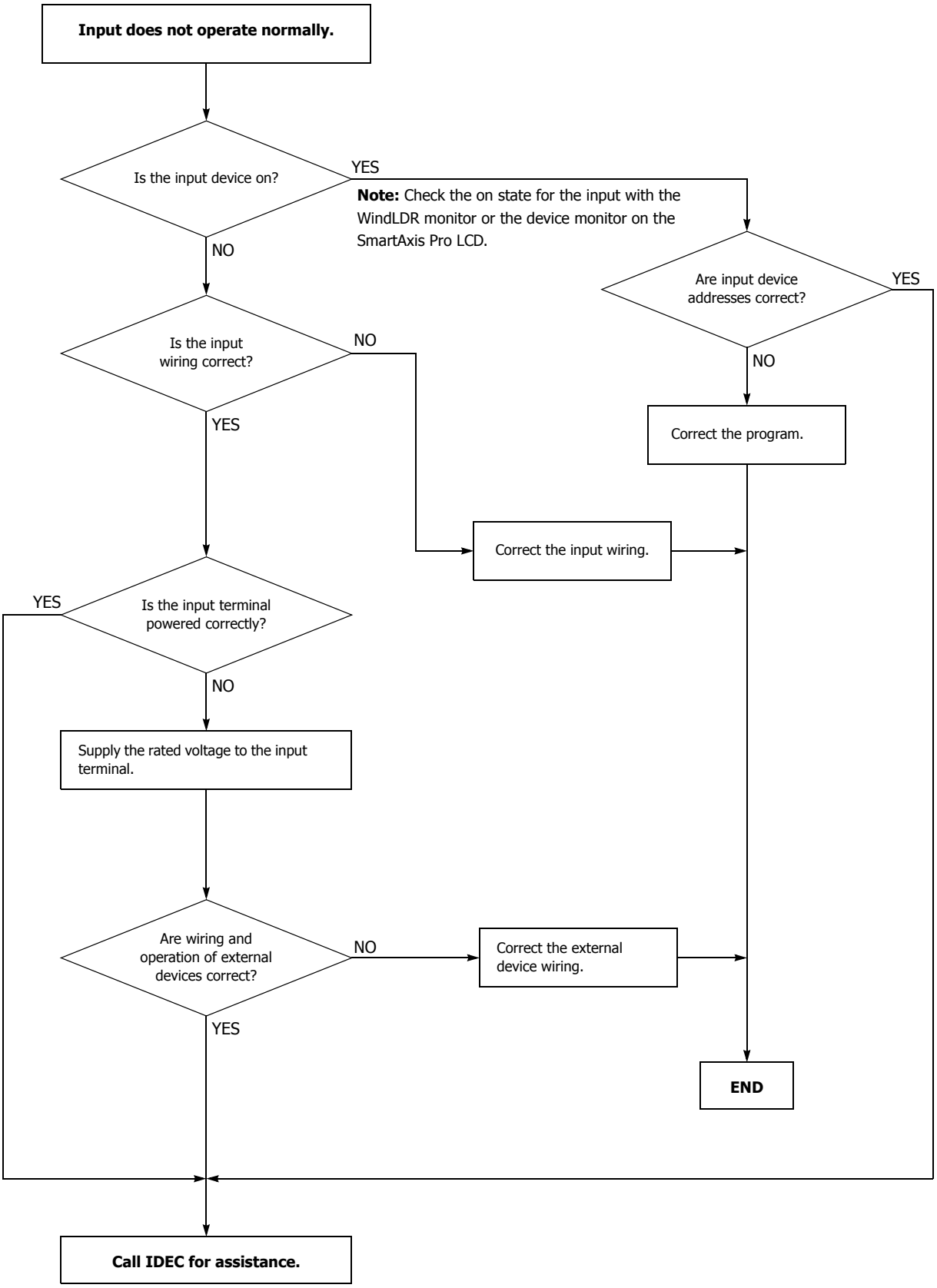
Troubleshooting Diagram 3

- **SmartAxis Lite - The Error Status LED (ERR) is On**

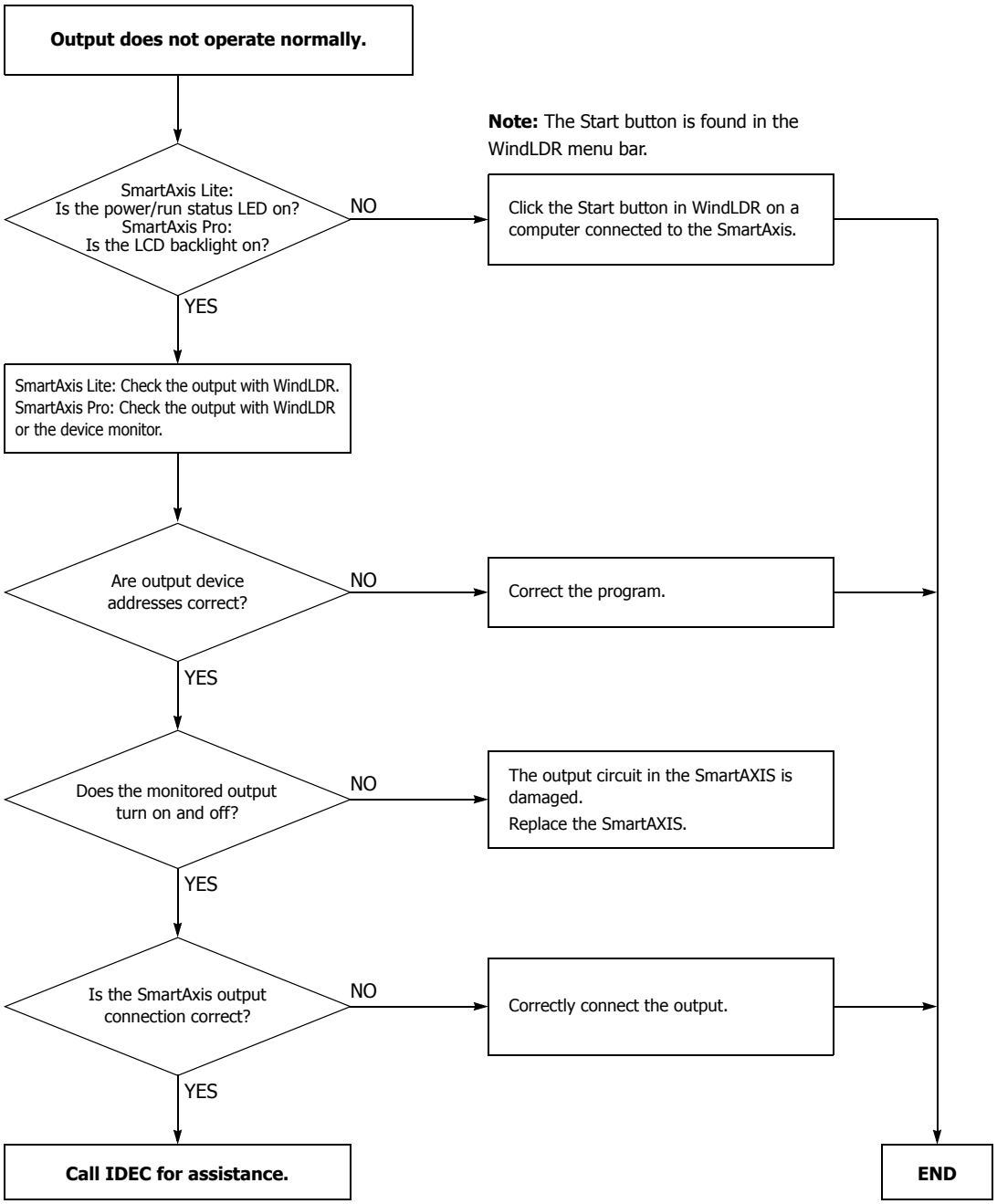


Note: Temporary errors can be cleared to restore normal operation by clearing error codes from WindLDR. See page 13-2.

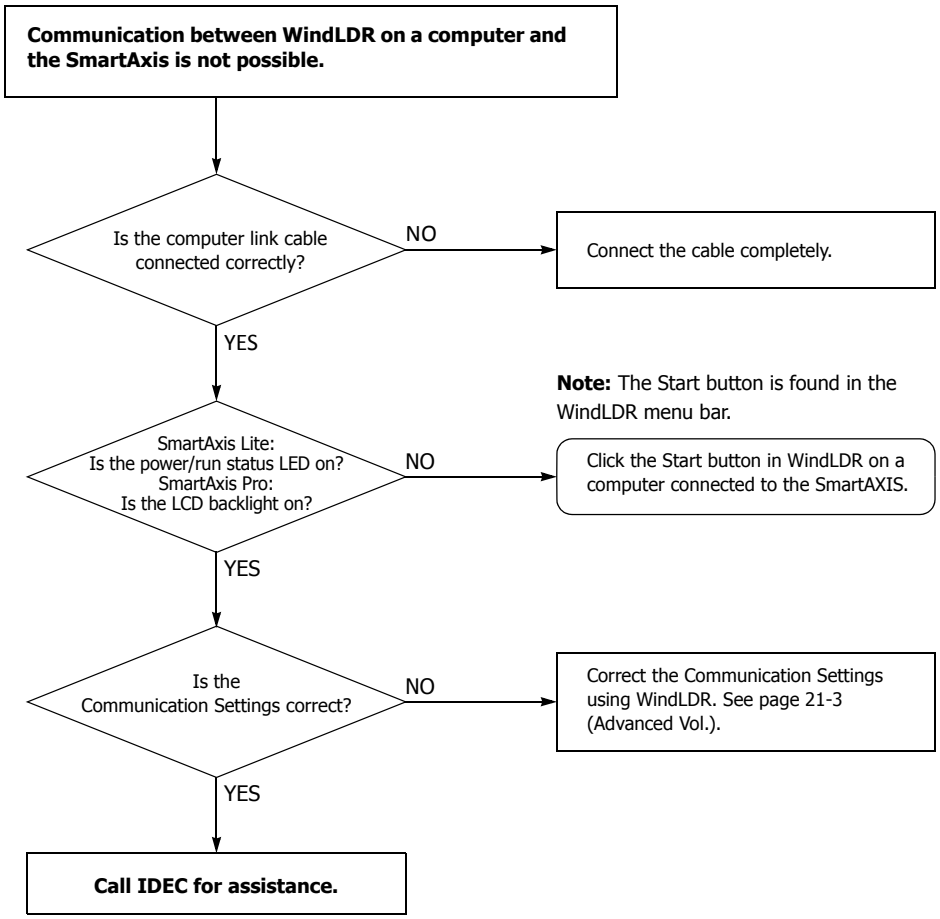
Troubleshooting Diagram 4



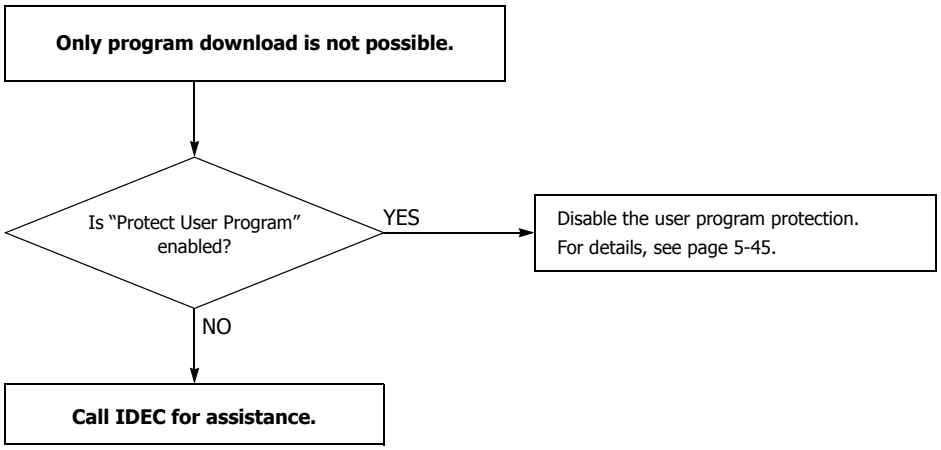
Troubleshooting Diagram 5



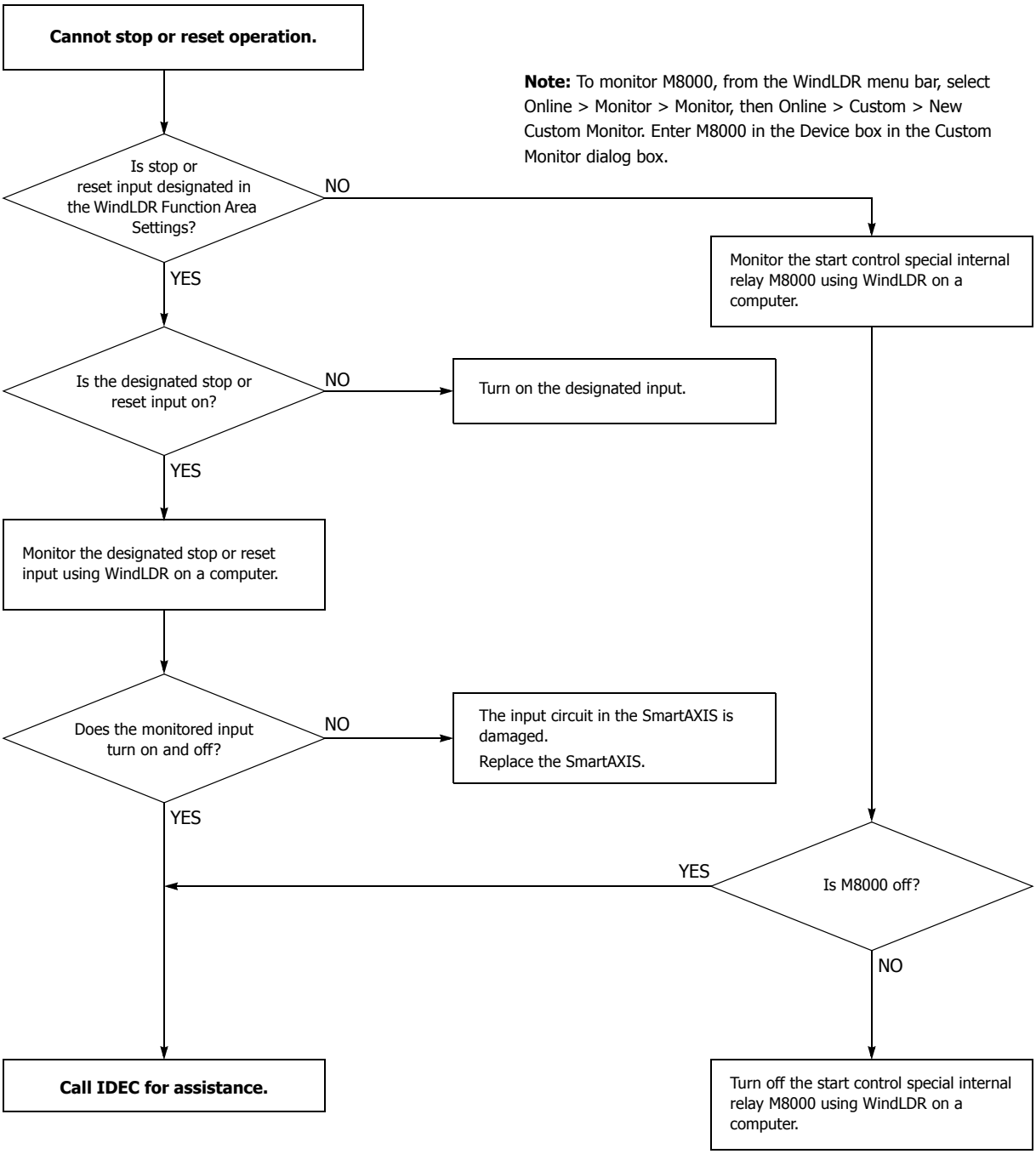
Troubleshooting Diagram 6



When only program download is not possible:



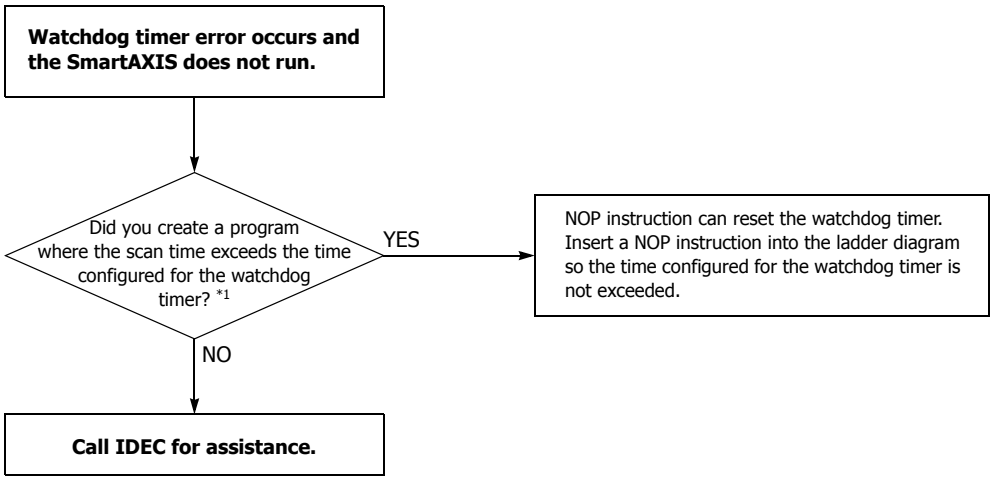
Troubleshooting Diagram 7



Note: To monitor M8000, from the WindLDR menu bar, select Online > Monitor > Monitor, then Online > Custom > New Custom Monitor. Enter M8000 in the Device box in the Custom Monitor dialog box.

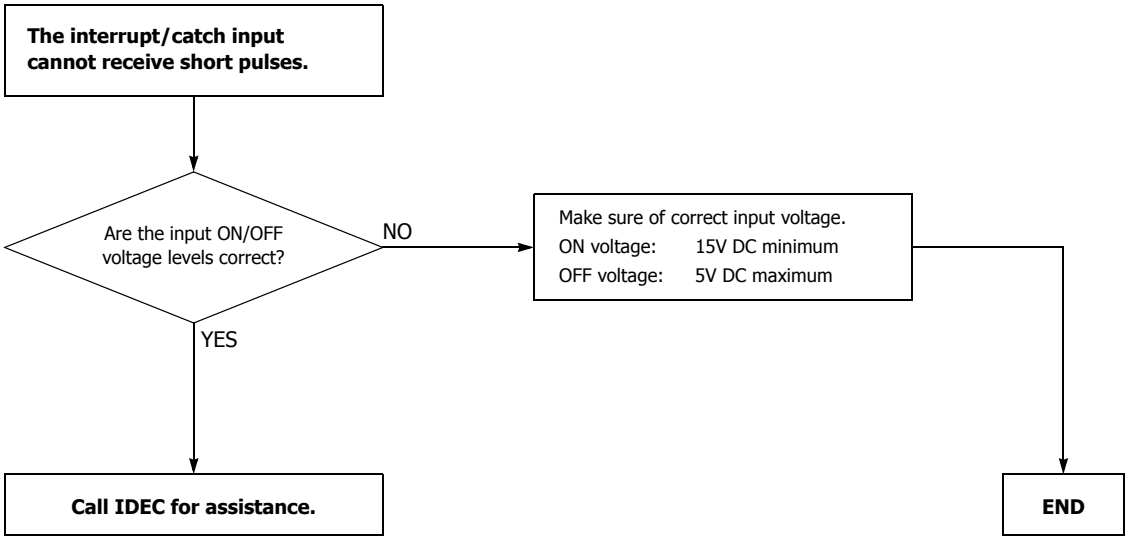
Note: To turn off M8000, enter 0 in the Current Value box in the Custom Monitor dialog box.

Troubleshooting Diagram 8

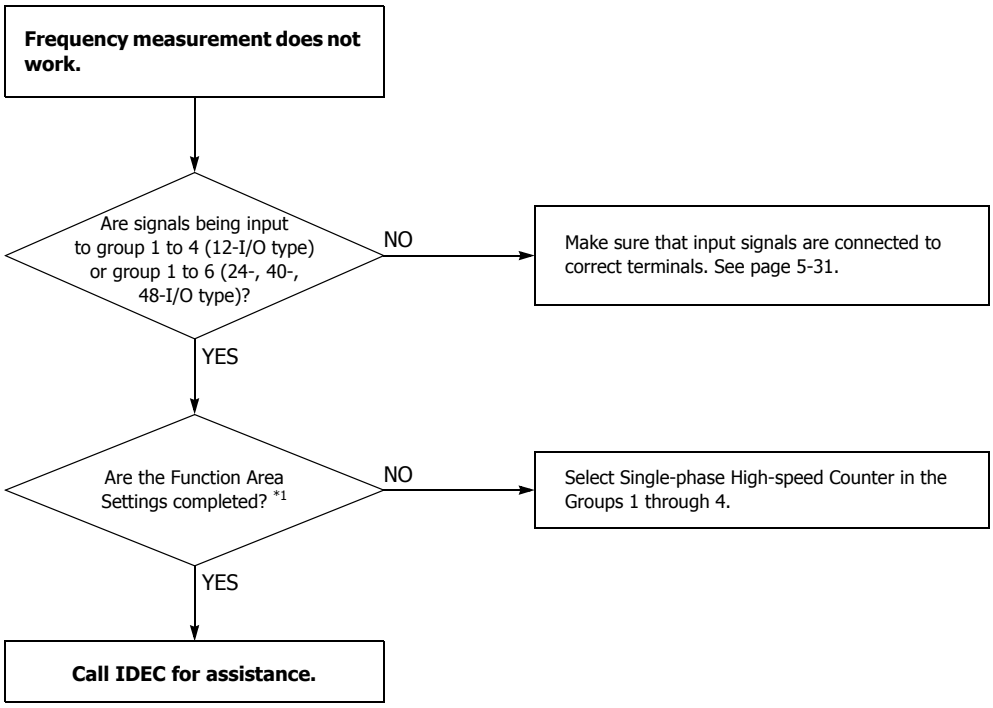


*1 See Chapter 5 "Special Functions" – "Watchdog Timer" on page 5-59.

Troubleshooting Diagram 9

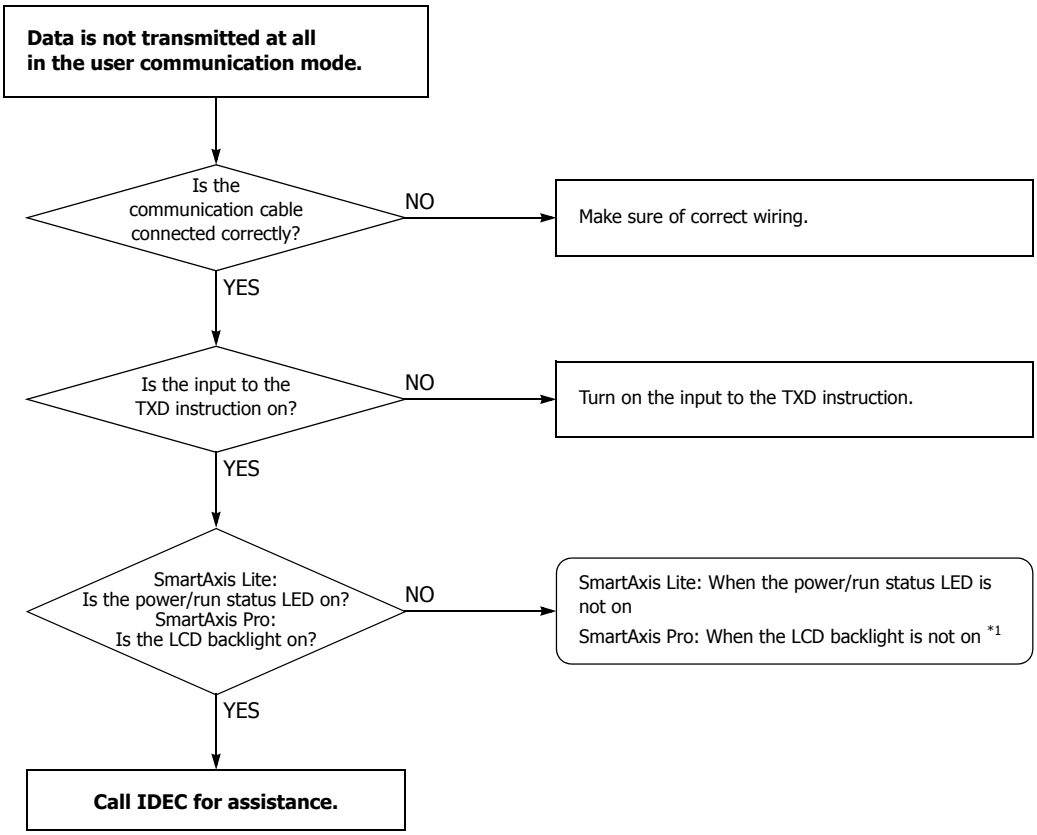


Troubleshooting Diagram 10



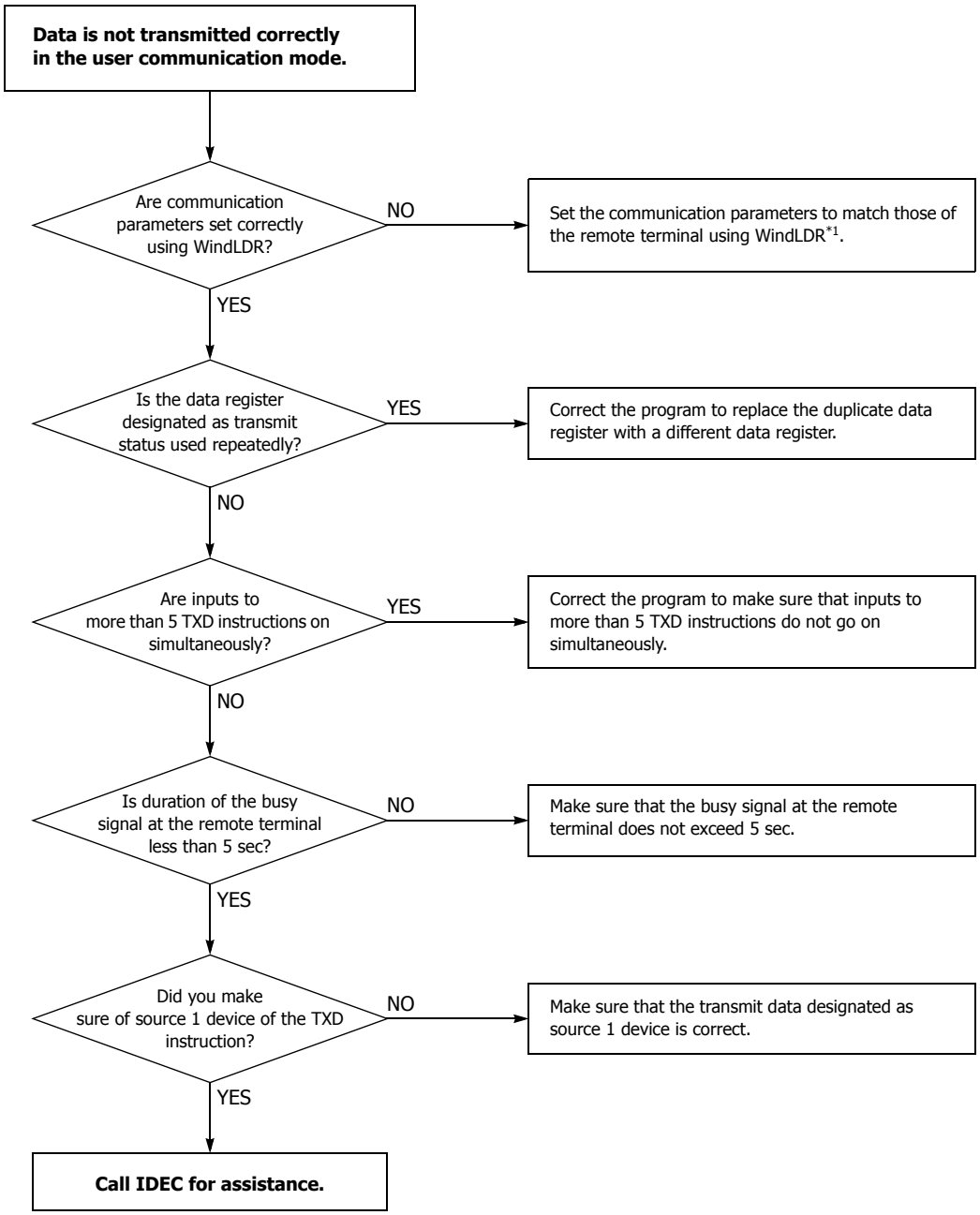
*1 See Chapter 5 "Special Functions" – "Frequency Measurement" on page 5-29.

Troubleshooting Diagram 11



*1 See ""SmartAxis Pro - The Backlight is not On" on page 13-9 or "SmartAxis Lite - The Power/Run Status LED (PWR/RUN) is not On" on page 13-10.

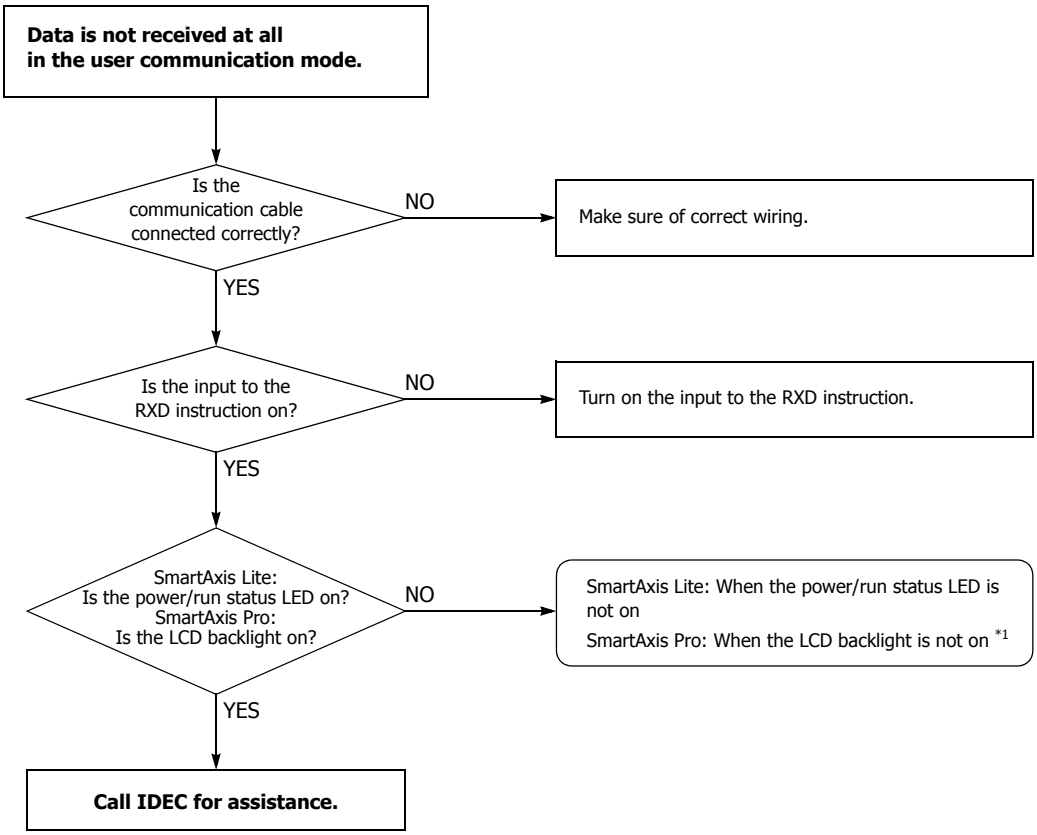
Troubleshooting Diagram 12



*1 See Chapter 10 "User Communication" - "Communication Port and Communication Format Settings" on page 10-2.

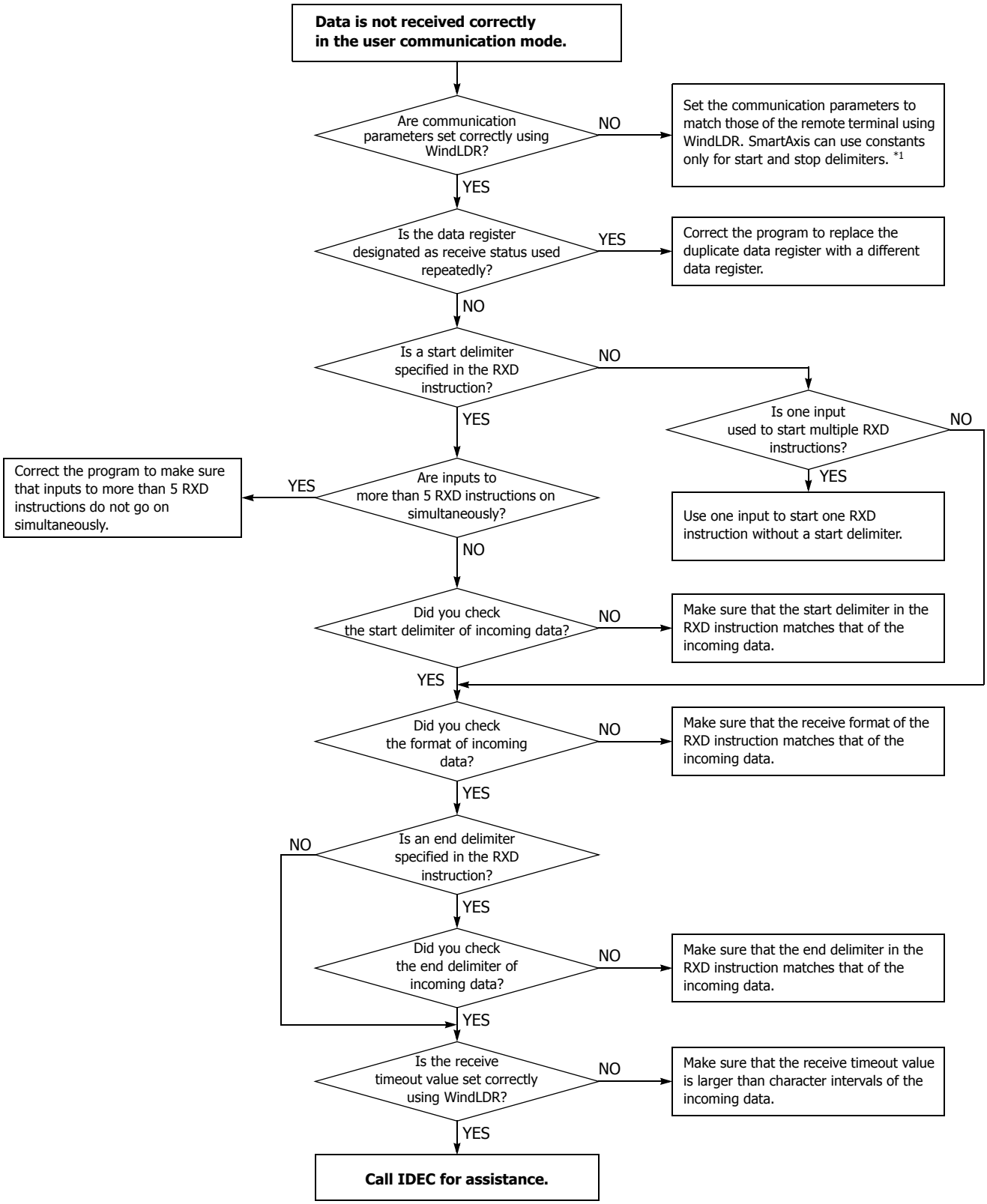
When the user communication still has a problem after completing the above procedure, also perform the procedure of Diagram 11 described on the preceding page.

Troubleshooting Diagram 13



*1 See "SmartAxis Pro - The Backlight is not On" on page 13-9 or "SmartAxis Lite - The Power/Run Status LED (PWR/RUN) is not On" on page 13-10.

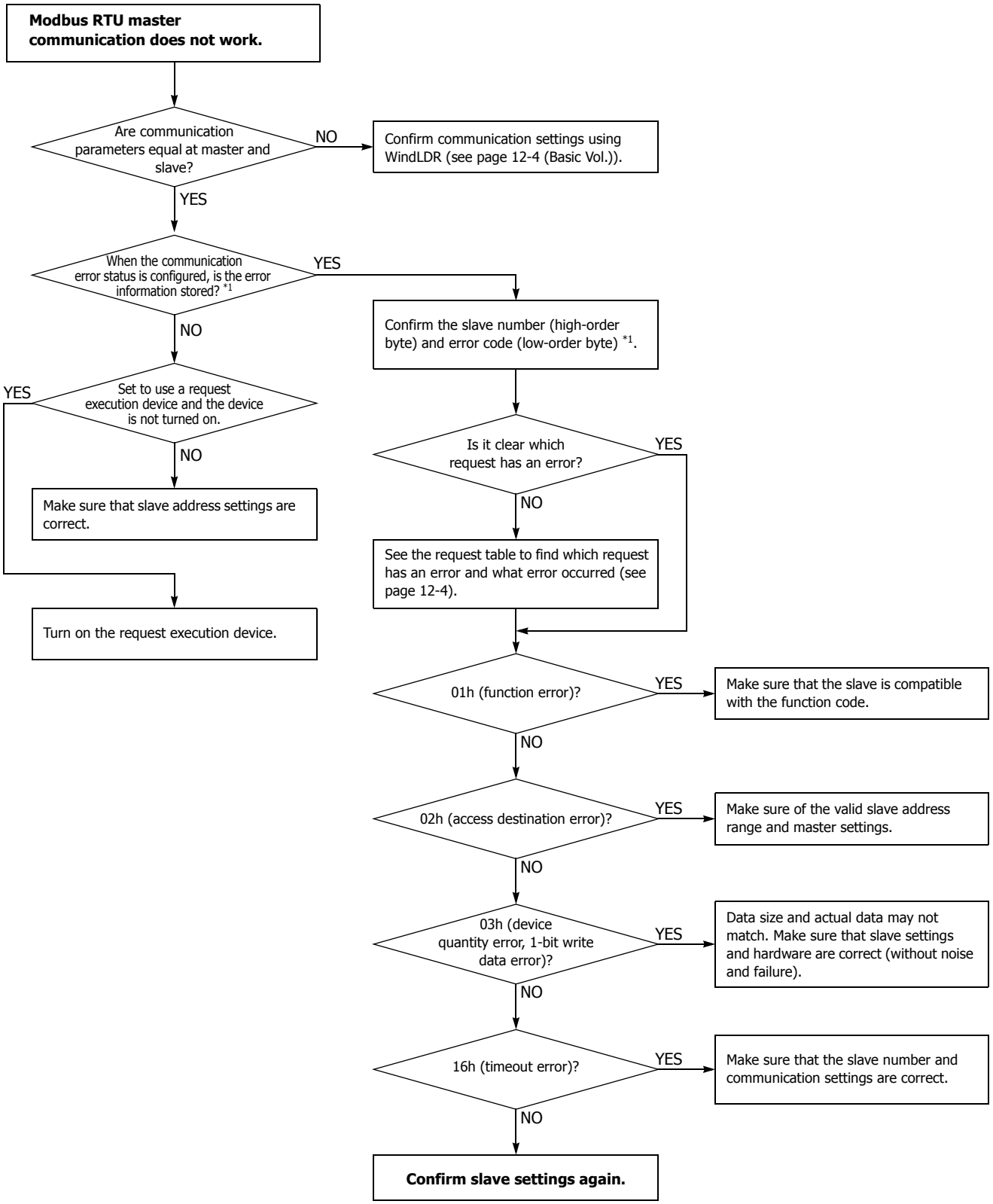
Troubleshooting Diagram 14



*1 See Chapter 10 "User Communication" - "Communication Port and Communication Format Settings" on page 10-2.

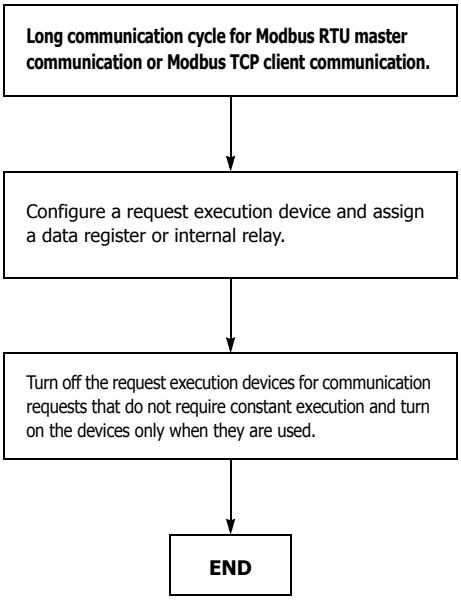
When the user communication still has a problem after completing the above procedure, also perform the procedure of Diagram 11 described on the preceding page.

Troubleshooting Diagram 15

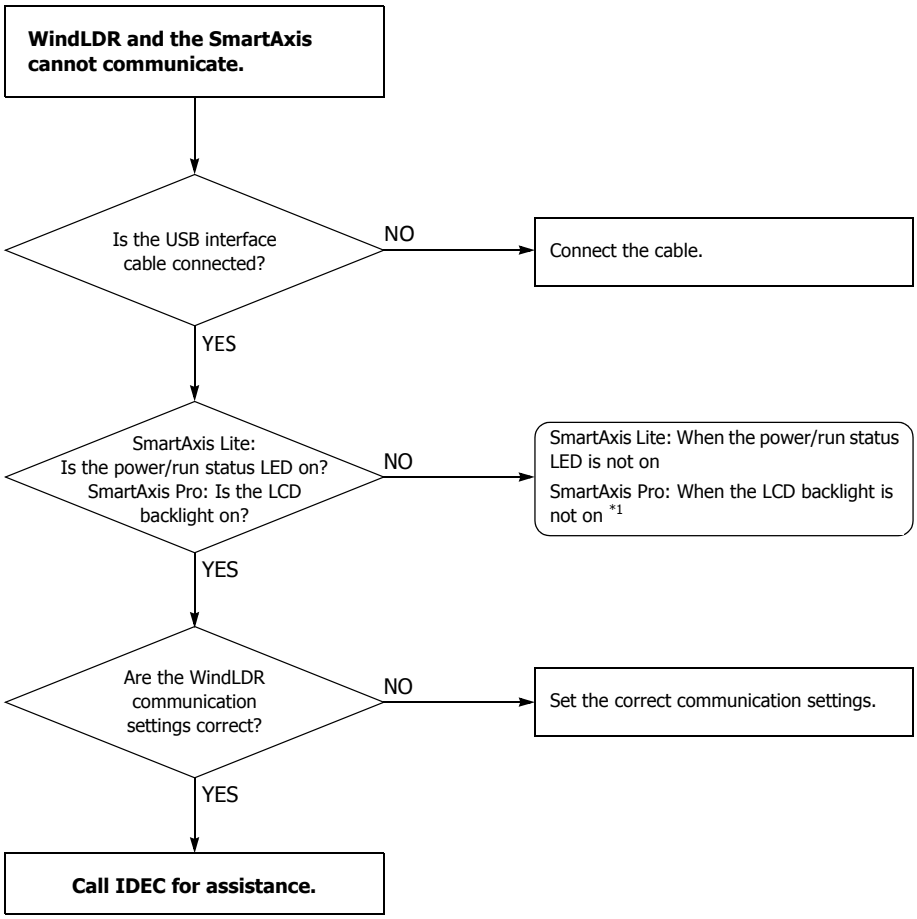


*1 See Chapter 11 "Modbus Communication" - "Modbus RTU Master" - "Error Status" on page 11-4.

Troubleshooting Diagram 16

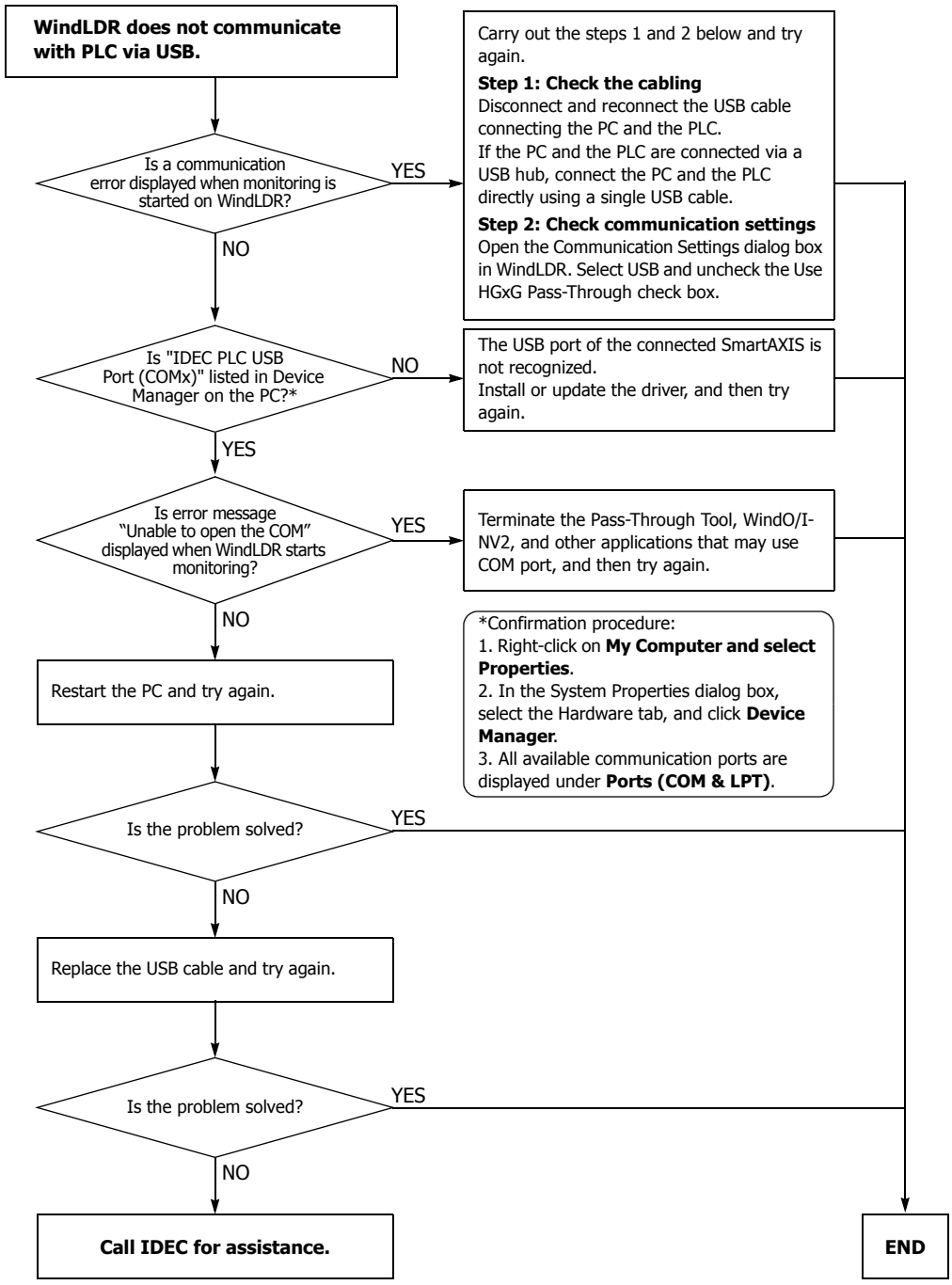


Troubleshooting Diagram 17

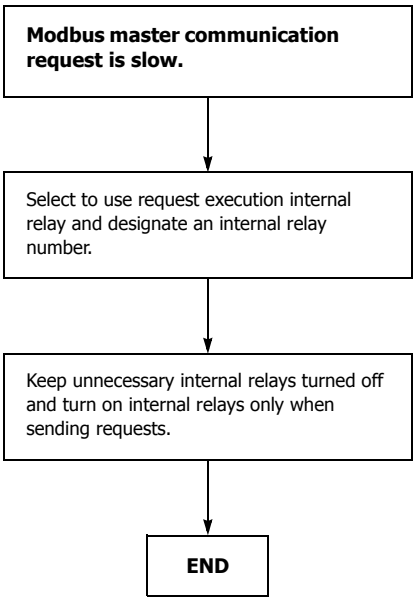


*1 See "SmartAxis Pro - The Backlight is not On" on page 13-9 or "SmartAxis Lite - The Power/Run Status LED (PWR/RUN) is not On" on page 13-10.

Troubleshooting Diagram 18



Troubleshooting Diagram 19



APPENDIX

System Software

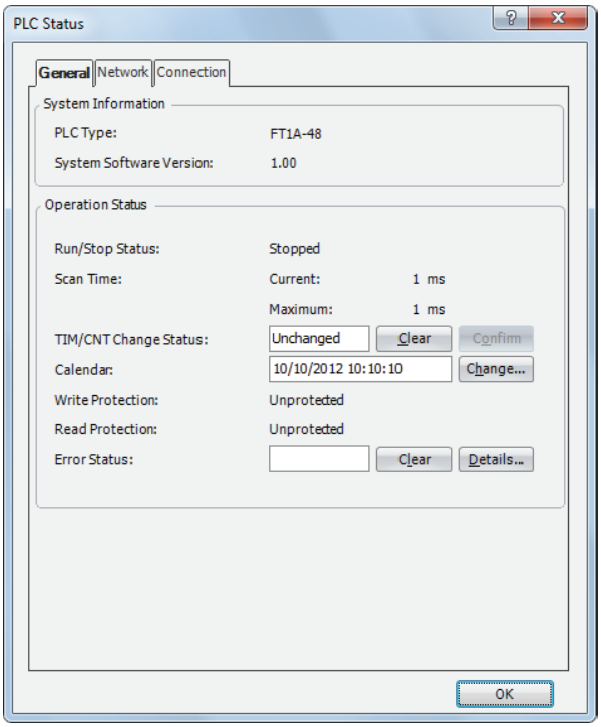
Getting the Latest Version of the System Software

When you install or upgrade to the latest version of Automation Organizer, the latest system software is also installed along with the software.

Checking the Version

You can check the SmartAxis system software version with the following steps.

1. Connect the PC to the SmartAxis USB port with the USB maintenance cable (HG9Z-XCM42).
2. From the WindLDR menu bar, select **Online** > **Monitor** > **Start Monitor**.
   WindLDR enters monitor mode.
3. Select **Online** > **PLC** > **Status**.
   The PLC Status dialog box is displayed.



You can check the SmartAxis system software version with **System Software Version**.

Note: SmartAxis system software downloads can be executed from WindLDR.
For how to download the system software, see "Upgrade SmartAxis System Software" on page A-2.

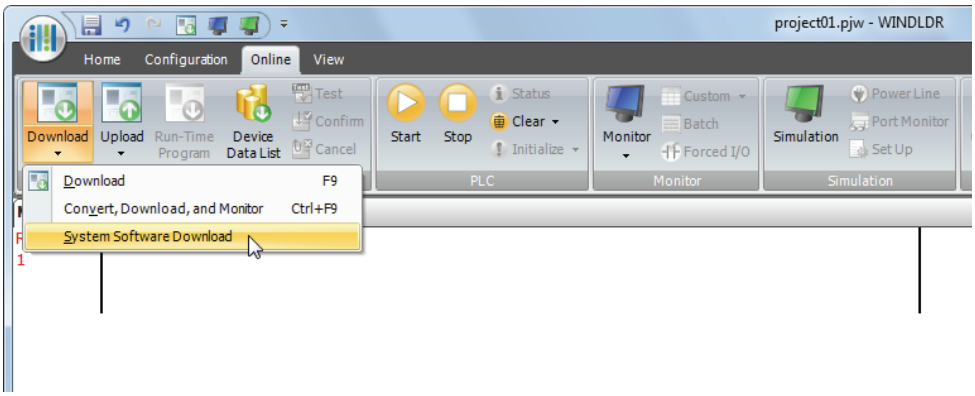
Upgrade SmartAxis System Software

The system software of SmartAxis can be upgraded using WindLDR. If the system software of your SmartAxis is old, upgrade the system software with the following procedure:

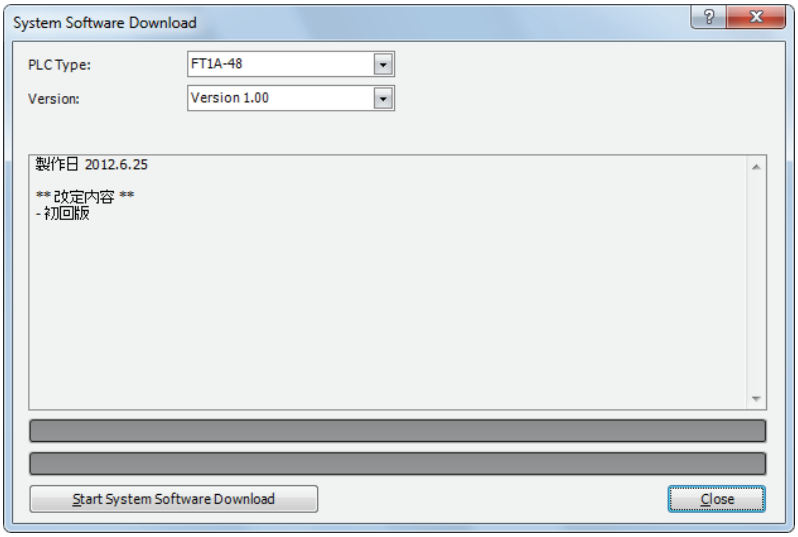
1. Connect the SmartAxis to the PC where WindLDR is installed using the USB maintenance cable (recommended cable: HG9Z-XCM42).

Note: System software cannot be downloaded via the expansion communication ports or the Ethernet port.

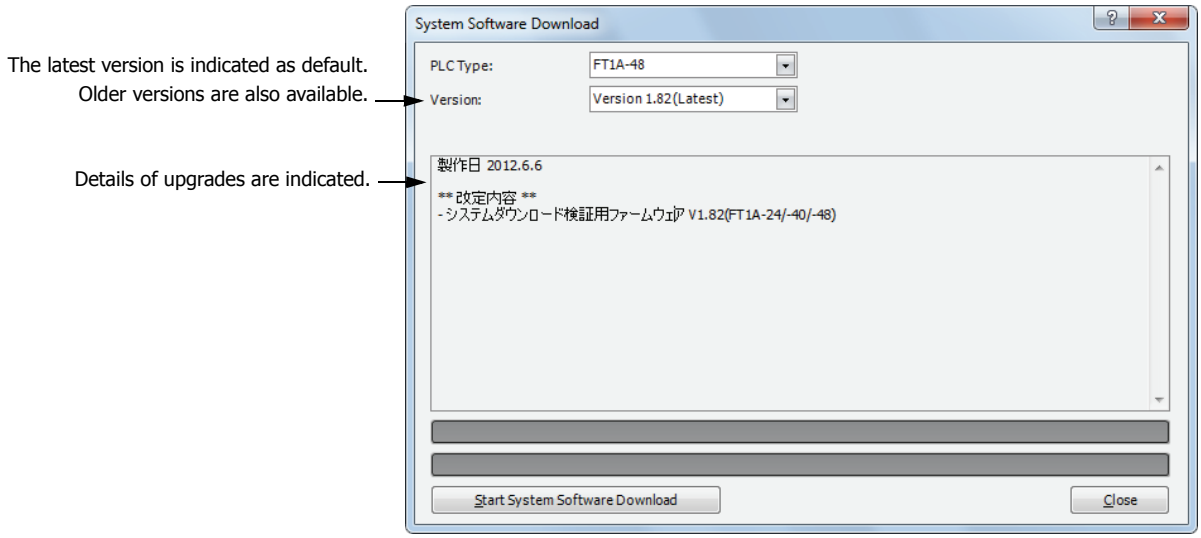
2. From the WindLDR menu bar, select **Online** > **Download** > **System Software Download**.



The System Software Download dialog box appears.



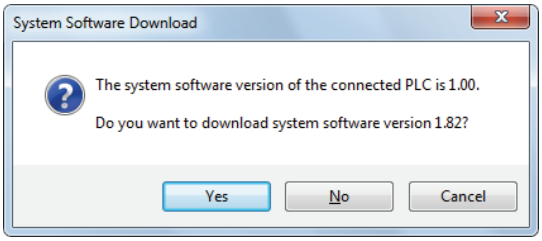
3. Select the PLC type and the system software version to download, and then click **Start System Software Download**.



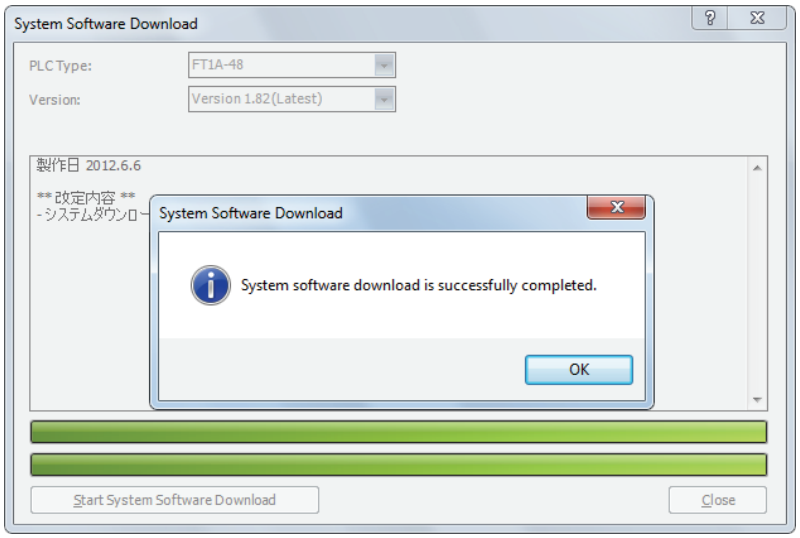
Notes:

- If the SmartAxis is running, it is stopped automatically before the system software download starts.
- Older system software can also be downloaded to the SmartAxis if required.
- The system software download takes about one minute.

4. A confirmation message is displayed. Click **OK** to start downloading the system software.



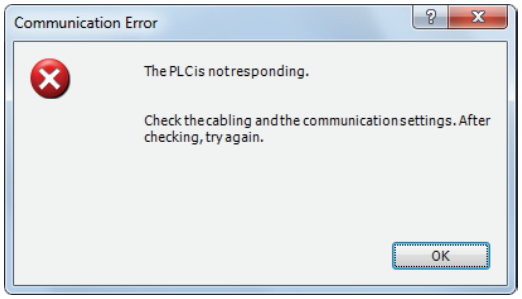
5. System software download status is shown by a progress bar. A completion message appears when the system software has been downloaded successfully. Click **OK** to close the System Software Download dialog box.



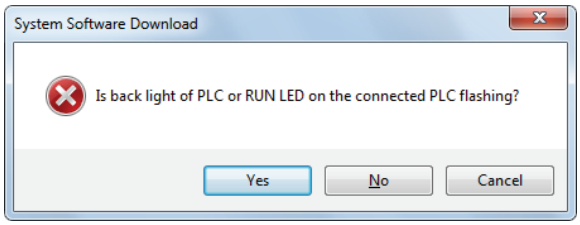
Notes:

- For the SmartAxis Pro, its backlight will flash while the system software is downloading. For the SmartAxis Lite, its error status LED will flash.
- After the system software has downloaded, the SmartAxis will be in the STOP state. Start the SmartAxis with WindLDR or the SmartAxis Pro LCD/operation switches.
- The user program stored in the SmartAxis before downloading the system software remains and is executed when the SmartAxis is restarted. A user program execution error may occur if an older system software is downloaded to the SmartAxis.
- If the system software download fails, the backlight on the SmartAxis Pro will remain flashing or the error status LED on the SmartAxis Lite will remain flashing. In this situation, turn on the SmartAxis power again and redo the download from step 1. If the SmartAxis Pro backlight is still flashing or the SmartAxis Lite error status LED is still flashing even after turning on the power again, the communication error dialog box is displayed before step 4.

1. A communication error dialog box is displayed. Click **Cancel**.



2. A dialog box prompting you to check the status of the SmartAxis is displayed. Click **Yes**.

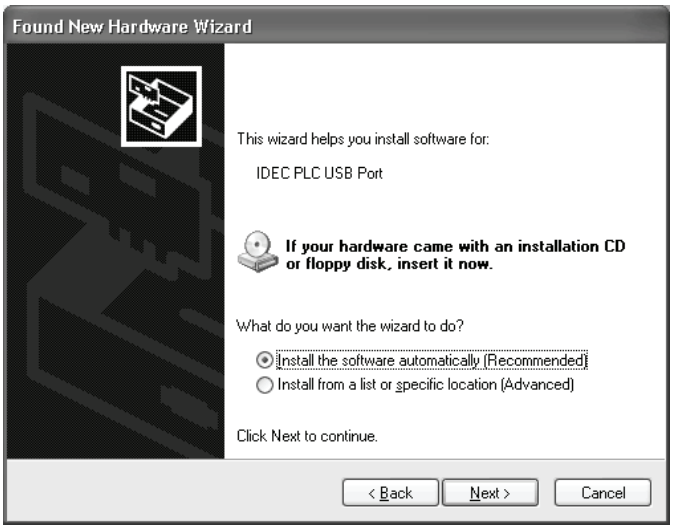


USB Driver Installation Procedure

Installing on Windows XP

1. Connect a USB cable to the USB port on the SmartAXIS (with power supplied) and the PC running.
2. After the message "Found New Hardware" appears on the PC, the driver installation wizard appears. Select **No**, **not this time** and click **Next**.

3. Select **Install the software automatically (Recommended)** and click **Next**.



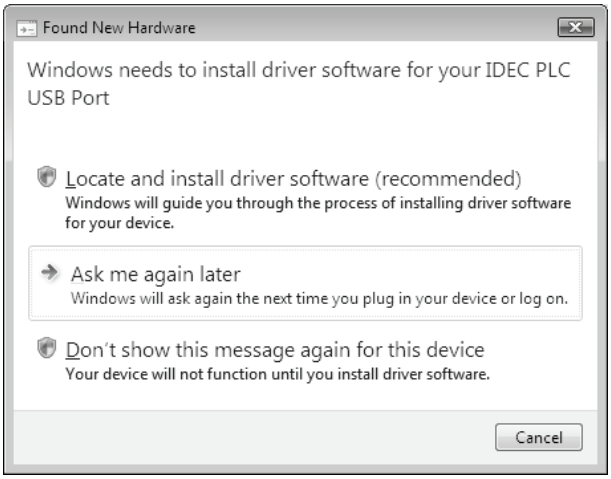
4. Click **Continue Anyway** button.

If the installation is aborted without showing the dialog box above, **Block** is selected in the Driver Signing Options in **Driver Signing** in the **System Properties** dialog box. If the installation is aborted, this option should be changed to **Warn**. After changing the option to **Warn**, reconnect the SmartAXIS and retry the installation procedure from the step 1.

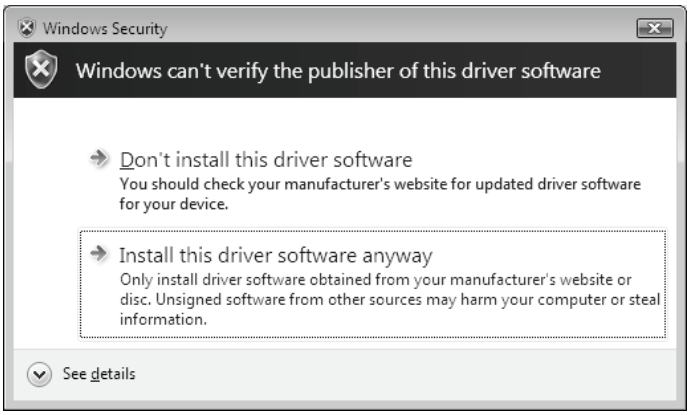
5. Installation is now complete. Click **Finish**.

Installing on Windows Vista

1. Connect a USB cable to the USB port on the SmartAXIS (with power supplied) and the PC running.
2. The dialog box below appears. Select **Locate and install driver software (recommended)**.



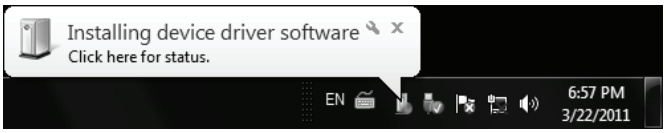
3. The User Account Control dialog box appears. Click **Continue** button.
4. The dialog box below appears. Select **Install this driver software anyway**.



5. Installation is complete once the message "Your devices are ready to use" appears in the bottom right corner of the desktop.

Installing on Windows 7 32-bit or 64-bit Edition

1. Connect a USB cable to the USB port on the SmartAXIS (with power supplied) and the PC running.
2. The following message appears in the bottom right corner of the desktop.



3. Installation is complete once the message "Your device is ready to use" appears in the bottom right corner of the desktop.

Cables

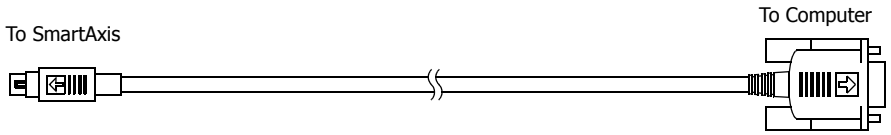
Communication cables and their connector pinouts are described in this section.

Communication Port and Applicable Cables

Communication Port	Communication Cartridge	Applicable Cable
Expansion Communication Port 2 **Expansion Communication Port 3**	RS232C communication cartridge FT1A-PC1 (Mini-DIN type)	FC2A-KC4C FC2A-KP1C HG9Z-XC295 FC4A-KC1C FC4A-KC2C
	RS485 communication cartridge FT1A-PC2 (Mini-DIN type)	FC2A-KP1C
	RS485 communication cartridge FT1A-PC3 (Terminal block type)	Twisted-pair shielded cable with a minimum core wire of 0.3 mm^2 (Conductor resistance 85 Ω/km maximum, shield resistance 20 Ω/km maximum)

Computer Link Cable 4C (FC2A-KC4C)

Cable Length: 3m (9.84 feet)



Mini DIN Connector Pinouts

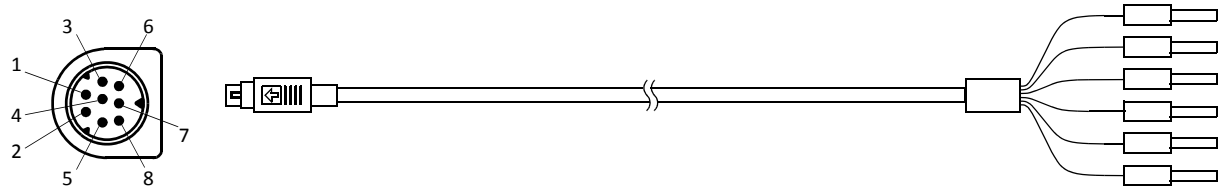
Description		Pin
Shield		**Cover**
TXD	Transmit Data	**3**
RXD	Receive Data	**4**
RTS	Request to Send	**1**
NC	No Connection	**8**
DSR	Data Set Ready	**5**
DTR	Data Terminal Ready	**2**
SG	Signal Ground	**7**
SG	Signal Ground	**6**

D-sub 9-pin Female Connector Pinouts

Pin	Description	
Cover	FG	Frame Ground
3	TXD	Transmit Data
2	RXD	Receive Data
6	DSR	Data Set Ready
8	CTS	Clear to Send
1	DCD	Data Carrier Detect
4	DTR	Data Terminal Ready
5	SG	Signal Ground
7	NC	No Connection
9	NC	No Connection

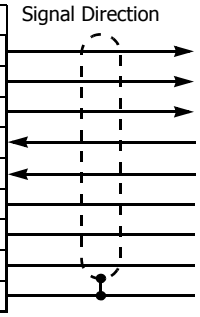
User Communication Cable 1C (FC2A-KP1C)

Cable Length: 2.5m (8.2 feet)



Mini DIN Connector Pinouts

Pin	Signal line (RS232C)		Signal line (RS485)		AWG#		Color
1	RTS	Request to Send	B		28	Twisted	Black
2	DTR	Data Terminal Ready	A		28		Yellow
3	TXD	Transmit Data	NC	No Connection	28		Blue
4	RXD	Receive Data	NC	No Connection	28		Green
5	DSR	Data Set Ready	NC	No Connection	28		Brown
6	SG	Signal Ground	NC	No Connection	28		Gray
7	SG	Signal Ground	SG	Signal Ground	26	Twisted	Red
8	NC	No Connection	NC	No Connection	26		White
Cover	—		—		—		Shield

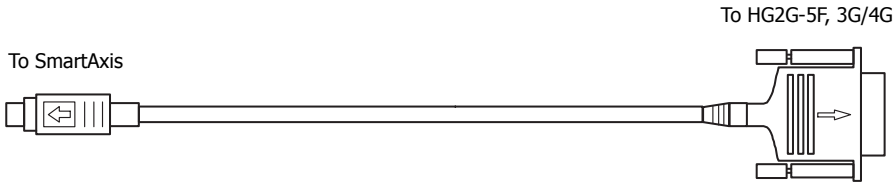


Caution

- Do not connect any wiring to NC terminals, otherwise operation failure or device damage may be caused.

O/I Communication Cable (HG9Z-XC295)

Cable Length: 5m (16.4 feet)



D-sub 9-pin Female Connector Pinouts

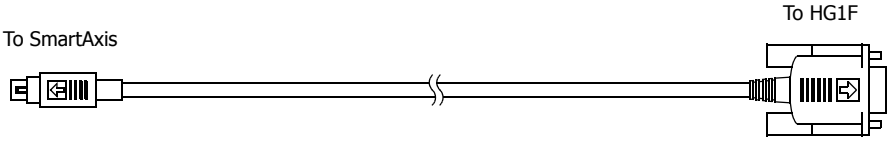
Description	Pin
RS	**1**
ER	**2**
SD	**3**
RD	**4**
DR	**5**
SG	**6**
SG	**7**
NC	**8**
Shield	**Cover**

Mini DIN Connector Pinouts

Pin	Description
2	RD
3	SD
5	SG
7	RS
8	CS
Cover	Shield

O/I Communication Cable 1C (FC4A-KC1C)

Cable Length: 5m (16.4 feet)



Mini DIN Connector Pinouts

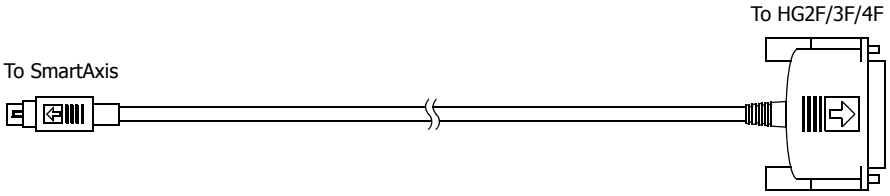
Description		Pin
NC	No Connection	1
NC	No Connection	2
TXD	Transmit Data	3
RXD	Receive Data	4
NC	No Connection	5
SG	Signal Ground	6
SG	Signal Ground	7
NC	No Connection	8
Shield		Cover

D-sub 9-pin Male Connector Pinouts

Pin	Description	
1	FG	Frame Ground
2	TXD1	Transmit Data 1
3	RXD1	Receive Data 1
4	TXD2	Transmit Data 2
5	RXD2	Receive Data 2
6	DSR	Data Set Ready
7	SG	Signal Ground
8	NC	No Connection
9	DTR	Data Terminal Ready

O/I Communication Cable 2C (FC4A-KC2C)

Cable Length: 5m (16.4 feet)



Mini DIN Connector Pinouts

Description		Pin
NC	No Connection	1
NC	No Connection	2
TXD	Transmit Data	3
RXD	Receive Data	4
NC	No Connection	5
CMSW	Communication Switch	6
SG	Signal Ground	7
NC	No Connection	8
Shield		Cover

D-sub 25-pin Male Connector Pinouts

Pin	Description	
1	FG	Frame Ground
2	TXD	Transmit Data
3	RXD	Receive Data
4	RTS	Request to Send
5	CTS	Clear to Send
6	DSR	Data Set Ready
7	SG	Signal Ground
8	DCD	Data Carrier Detect
20	DTR	Data Terminal Ready

Type List

SmartAxis Pro / Lite

Type	Power Voltage	I/O Points (Input Points/ Output Points)	Input Type		Output Type			Type No.
			Digital Input	Analog Input (Note)	Relay Output (10A)	Relay Output (2A)	Transistor Output	
Pro	24V DC	12 points (8/4)	6	2	4	—	—	FT1A-H12RA
		24 points (16/8)	12	4		4		FT1A-H24RA
		40 points (24/16)	18	6		8	4 (Sink)	FT1A-H40RKA
							4 (Source)	FT1A-H40RSA
		48 points (30/18)	22	8	—	—	18 (Sink)	FT1A-H48KA
							18 (Source)	FT1A-H48SA
	100-240V AC 50/60 Hz	12 points (8/4)	8	—	4	—	—	FT1A-H12RC
		24 points (16/8)	16			4		FT1A-H24RC
		40 points (24/16)	24			12		FT1A-H40RC
		48 points (30/18)	30			—	18 (Sink)	FT1A-H48KC
							18 (Source)	FT1A-H48SC
Lite	24V DC	12 points (8/4)	6	2	4	—	—	FT1A-B12RA
		24 points (16/8)	12	4		4		FT1A-B24RA
		40 points (24/16)	18	6		8	4 (Sink)	FT1A-B40RKA
							4 (Source)	FT1A-B40RSA
		48 points (30/18)	22	8	—	—	18 (Sink)	FT1A-B48KA
							18 (Source)	FT1A-B48SA
	100-240V AC 50/60 Hz	12 points (8/4)	8	—	4	—	—	FT1A-B12RC
		24 points (16/8)	16			4		FT1A-B24RC
		40 points (24/16)	24			12		FT1A-B40RC
		48 points (30/18)	30		—	—	18 (Sink)	FT1A-B48KC
							18 (Source)	FT1A-B48SC

Note: Shared with digital inputs

Options

Name	Description/specification		Type No.
FT1A Series Pro/Lite User's Manual	Japanese	Describes product specifications, installation and wiring instructions, instructions for basic programming operations and special functions, device and instruction lists, communication functions, and troubleshooting procedures for the SmartAxis Pro/Lite series.	FT9Y-B1377
	English		FT9Y-B1378
	Chinese (simplified)		FT9Y-B1379
	German		FT9Y-B1380
FT1A Series Ladder Programming Manual	Japanese	Describes basic operations for ladder programming, instructions for editing and monitoring ladders on the SmartAxis, available devices and instruction lists, and details of each instruction.	FT9Y-B1381
	English		FT9Y-B1382
	Chinese (simplified)		FT9Y-B1383
	German		FT9Y-B1384
Application Software	Automation Organizer		SW1A-W1C
Communication Cartridge	Connection Specifications	Mini DIN	FT1A-PC1
	Standards	EIA RS232C	
	Maximum Baud Rate	115,200 bps	
	Communication Functions	Maintenance communication, User communication, Modbus RTU master/slave	
	Isolation between Internal Circuit and Communication Port	Not isolated	
	Connection Specifications	Mini DIN	FT1A-PC2
	Standards	EIA RS485	
	Maximum Baud Rate	115,200 bps	
	Communication Functions	Maintenance communication, User communication, Modbus RTU master/slave	
	Isolation between Internal Circuit and Communication Port	Not isolated	
	Connection Specifications	Terminal block	FT1A-PC3
	Standards	EIA RS485	
	Maximum Baud Rate	115,200 bps	
	Communication Functions	Maintenance communication, User communication, Modbus RTU master/slave	
	Isolation between Internal Circuit and Communication Port	Not isolated	
End Clips	Used on DIN rail to fasten SmartAxis modules (package quantity 10)		BNL6PN10
Direct Mounting Hook	Direct mounting hook for 12- and 24-I/O types for maintenance, 5 pcs.		FT9Z-PSP1PN05
SD Memory Card	Capacity: 2GB		HG9Z-XMS2
Memory Cartridge	Dedicated user program save memory		FT1A-PM1
Maintenance Cable	USB maintenance cable USB A male to USB mini-B male, 2 m		HG9Z-XCM42
	USB extension cable (for panel attachment) USB mini-B female to USB mini-B male, 1m		HG9Z-XCM21

Fonts

This section describes the fonts that can be displayed on the SmartAxis Pro LCD.

Supported Languages

The SmartAxis Pro is equipped with the fonts for multiple languages as standard. Messages in the language selected with the MSG instruction can be displayed on the LCD.

The menu can be displayed in English, Chinese, or Japanese, and messages can be displayed in the desired two languages out of these languages: German, English, Italian, Spanish, Dutch, French, Cyrillic, Chinese, and Japanese.

Installed Fonts List

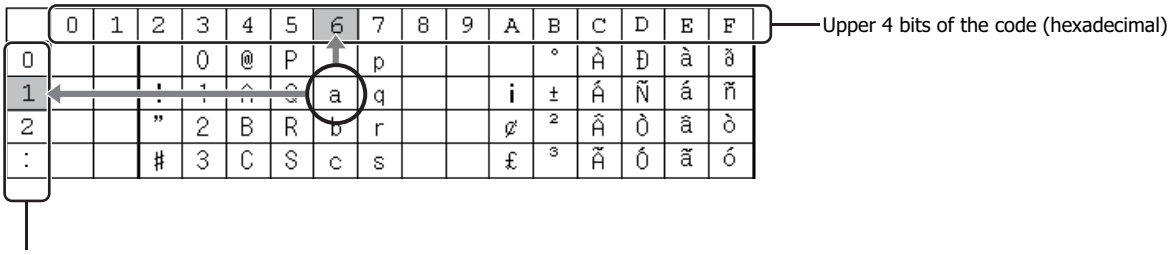
Setting name	Character code system	Supported languages
European	ISO8859-1 (Latin-1)	English, German, Italian, Spanish, Dutch (Note), French (Note)
Japanese	Shift-JIS	Japanese (level 1)
Chinese	GB2312	Chinese (simplified)
Cyrillic	ANSI1251	Russian

Note: Some of the characters cannot be input.

Character Code Table

Using the Character Code Table

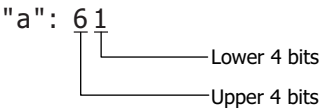
Example: Finding the character code for the character "a" in the table.



The upper 4 bits of the code are hexadecimal 6.

The lower 4 bits of the code are hexadecimal 1.

Therefore, the character code for "a" is as follows.



Note: For other fonts and two-byte characters, refer to the table of the relevant code system.

European Font (ISO 8859-1)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0				0	@	P	`	p				°	À	Đ	à	ð
1			!	1	A	Q	a	q			¡	±	Á	Ñ	á	ñ
2			"	2	B	R	b	r			¢	²	Â	Ò	â	ò
3			#	3	C	S	c	s			£	³	Ã	Ó	ã	ó
4			$	4	D	T	d	t			¤	´	Ä	Ô	ä	ô
5			%	5	E	U	e	u			¥	µ	Å	Õ	å	õ
6			&	6	F	V	f	v			¦	¶	Æ	Ö	æ	ö
7			'	7	G	W	g	w			§	·	Ç	×	ç	÷
8			(	8	H	X	h	x			¨	¸	È	Ø	è	ø
9			)	9	I	Y	i	y			©	¹	É	Ù	é	ù
A			*	:	J	Z	j	z			ª	º	Ê	Ú	ê	ú
B			+	;	K	[	k	{			«	»	Ë	Û	ë	û
C			,	<	L	\	l	|			¬	¼	Ì	Ü	ì	ü
D			-	=	M	]	m	}				½	Í	Ý	í	ý
E			.	>	N	^	n	~			®	¾	Î	Þ	î	þ
F			/	?	O	_	o				¯	¿	Ï	ß	ï	ÿ

Cyrillic Font (ANSI 1251)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0				0	@	P	`	p	Ђ	ђ		°	А	Р	а	р
1			!	1	A	Q	a	q	Ґ	`	ў	±	Б	С	б	с
2			"	2	B	R	b	r	‚	’	Ў	І	В	Т	в	т
3			#	3	C	S	c	s	ґ	“	Ј	і	Г	У	г	у
4			$	4	D	T	d	t	„	”	¤	ґ	Д	Ф	д	ф
5			%	5	E	U	e	u	…	•	Ґ	µ	Е	Х	е	х
6			&	6	F	V	f	v	†	-	¦	¶	Ж	Ц	ж	ц
7			'	7	G	W	g	w	‡	–	§	·	З	Ч	з	ч
8			(	8	H	X	h	x	€		Ё	ё	И	Ш	и	ш
9			)	9	I	Y	i	y	‰	™	©	№	Й	Щ	й	щ
A			*	:	J	Z	j	z	Љ	љ	Є	є	К	Ъ	к	ъ
B			+	;	K	[	k	{	‹	›	«	»	Л	Ы	л	ы
C			,	<	L	\	l	|	Њ	њ	¬	j	М	Ь	м	ь
D			-	=	M	]	m	}	Ќ	ќ	-	S	Н	Э	н	э
E			.	>	N	^	n	~	Ћ	ћ	®	s	О	Ю	о	ю
F			/	?	O	_	o		Џ	џ	Ї	ї	П	Я	п	я

Japanese Font (JIS X0201)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0				0	@	P	`	p				-	タ	ミ		
1			!	1	A	Q	a	q			。	ア	チ	ム		
2			"	2	B	R	b	r			「	イ	ツ	メ		
3			#	3	C	S	c	s			」	ウ	テ	モ		
4			$	4	D	T	d	t			、	エ	ト	ヤ		
5			%	5	E	U	e	u			・	オ	ナ	ユ		
6			&	6	F	V	f	v			ヲ	カ	ニ	ヨ		
7			'	7	G	W	g	w			ァ	キ	ヌ	ラ		
8			(	8	H	X	h	x			ィ	ク	ネ	リ		
9			)	9	I	Y	i	y			ゥ	ケ	ノ	ル		
A			*	:	J	Z	j	z			ェ	コ	ハ	レ		
B			+	;	K	[	k	{			ォ	サ	ヒ	ロ		
C			,	<	L	¥	l	|			ャ	シ	フ	ワ		
D			-	=	M	]	m	}			ュ	ス	ヘ	ン		
E			.	>	N	^	n	~			ョ	セ	ホ	゛		
F			/	?	O	_	o				ッ	ソ	マ	°		

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