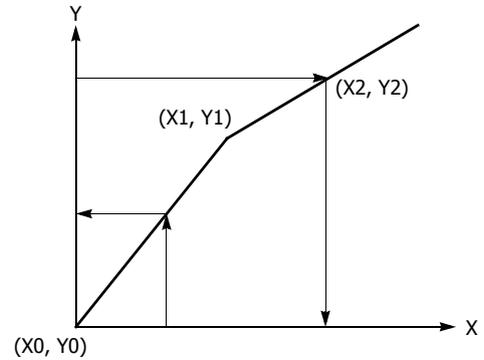


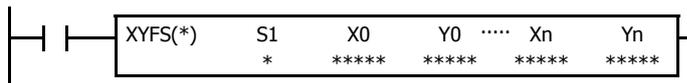
# 17: COORDINATE CONVERSION INSTRUCTIONS

## Introduction

The coordinate conversion instructions convert one data point to another value, using a linear relationship between values of X and Y.



## XYFS (XY Format Set)



When input is on, the format for XY conversion is set. The XY coordinates define the linear relationship between X and Y.

No. of XY Coordinates	n
2 to 32	$0 \leq n \leq 31$

## Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

## Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Format number	—	—	—	—	—	—	—	0 to 7	—
X0 through Xn	X value	X	X	X	X	X	X	X	0 to 65535	—
Y0 through Yn	Y value	X	X	X	X	X	X	X	0 to 65535 -32768 to 32767	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When T (timer) or C (counter) is used as X0 through Xn or Y0 through Yn, the timer/counter current value (TC or CC) is displayed.

### S1 (Format number)

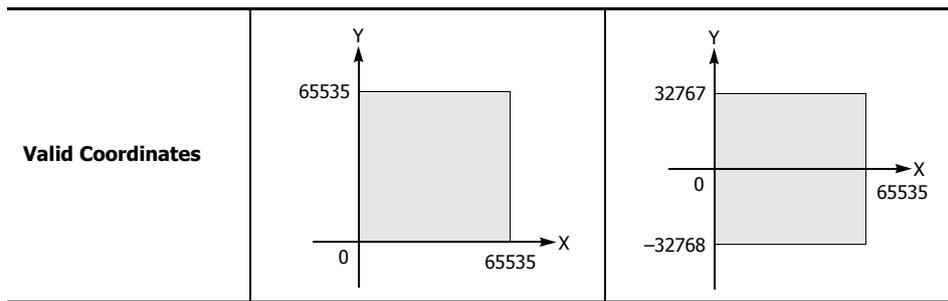
Select a format number 0 through 7. A maximum of 8 formats for XY conversion can be set.

### Xn (X value), Yn (Y value)

Enter values for the X and Y coordinates. Two different data ranges are available depending on the data type.

Data Type	Word	Integer
Xn (X value)	0 to 65535	0 to 65535
Yn (Y value)	0 to 65535	-32768 to 32767

## 17: COORDINATE CONVERSION INSTRUCTIONS



### Valid Data Types

<b>W (word)</b>	X	When a bit device such as I (input), Q (output), M (internal relay), or R (shift register) is assigned as Xn or Yn, 16 points are used.
<b>I (integer)</b>	X	
<b>D (double word)</b>	—	When a word device such as T (timer), C (counter), or D (data register) is assigned as Xn or Yn, 1 point is used.
<b>L (long)</b>	—	
<b>F (float)</b>	—	

**Note:** The XYFS instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### CVXTY (Convert X to Y)



When input is on, the X value assigned by device S2 is converted into the corresponding Y value according to the linear relationship defined in the XYFS instruction. Device S1 selects a format from a maximum of 8 XY conversion formats. The conversion result is set to the device assigned by D1.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Format number	—	—	—	—	—	—	—	0 to 7	—
S2 (Source 2)	X value	X	X	X	X	X	X	X	0 to 65535	—
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S2, the timer/counter current value (TC or CC) is displayed. When T (timer) or C (counter) is used as D1, the data is written in as a preset value (TP or CP) which can be 0 through 65535.

#### S1 (Format number)

Select a format number 0 through 7 which have been set using the XYFS instruction. When an XYFS instruction with the corresponding format number is not programmed, or when XYFS and CVXTY instructions of the same format number have different data type designations, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

#### S2 (X value)

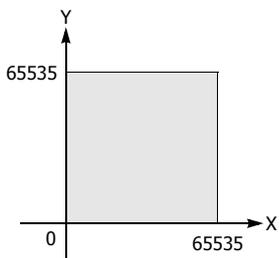
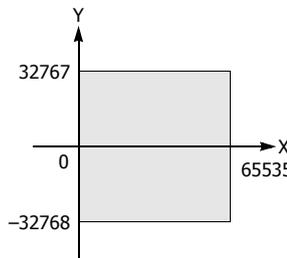
Enter a value for the X coordinate to convert, within the range specified in the XYFS instruction.

**D1 (Destination to store results)**

The conversion result of the Y value is stored to the destination.

Data Type	Word	Integer
S2 (X value)	0 to 65535	0 to 65535
D1 (Y value)	0 to 65535	-32768 to 32767

Valid Coordinates	Word	Integer
		

**Valid Data Types**

<b>W (word)</b>	X	When a bit device such as I (input), Q (output), M (internal relay), or R (shift register) is assigned as S2 or D1, 16 points are used.
<b>I (integer)</b>	X	
<b>D (double word)</b>	—	When a word device such as T (timer), C (counter), or D (data register) is assigned as S2 or D1, 1 point is used.
<b>L (long)</b>	—	
<b>F (float)</b>	—	

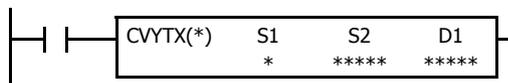
**Data Conversion Error**

The data conversion error is ±0.5.

**Note:** The CVXTY instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

**CVYTX (Convert Y to X)**



When input is on, the Y value assigned by device S2 is converted into the corresponding X value according to the linear relationship defined in the XYFS instruction. Device S1 selects a format from a maximum of 8 XY conversion formats. The conversion result is set to the device assigned by D1.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Format number	—	—	—	—	—	—	—	0 to 7	—
S2 (Source 2)	Y value	X	X	X	X	X	X	X	0 to 65535 -32768 to 32767	—
D1 (Destination 1)	Destination to store results	—	X	▲	X	X	X	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

When T (timer) or C (counter) is used as S2, the timer/counter current value (TC or CC) is displayed. When T (timer) or C (counter) is used as D1, the data is written in as a preset value (TP or CP) which can be 0 through 65535.

**S1 (Format number)**

Select a format number 0 through 7 which have been set using the XYFS instruction. When an XYFS instruction with the corresponding format number is not programmed, or when XYFS and CVYTX instructions of the same format number have different data type designations, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

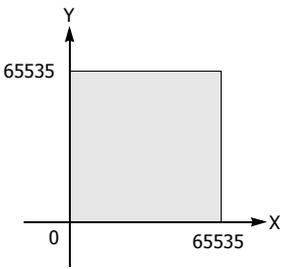
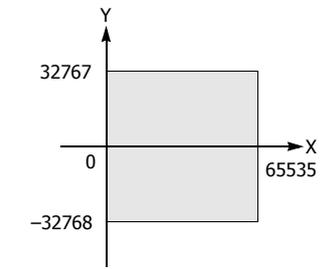
**S2 (Y value)**

Enter a value for the Y coordinate to convert, within the range specified in the XYFS instruction. Two different data ranges are available depending on the data type.

## 17: COORDINATE CONVERSION INSTRUCTIONS

### D1 (Destination to store results)

The conversion result of the X value is stored to the destination.

Data Type	Word	Integer
<b>S2 (Y value)</b>	0 to 65535	-32768 to 32767
<b>D1 (X value)</b>	0 to 65535	0 to 65535
<b>Valid Coordinates</b>		

### Valid Data Types

<b>W (word)</b>	X	When a bit device such as I (input), Q (output), M (internal relay), or R (shift register) is assigned as S2 or D1, 16 points are used.
<b>I (integer)</b>	X	
<b>D (double word)</b>	—	When a word device such as T (timer), C (counter), or D (data register) is assigned as S2 or D1, 1 point (integer data) is used.
<b>L (long)</b>	—	
<b>F (float)</b>	—	

### Data Conversion Error

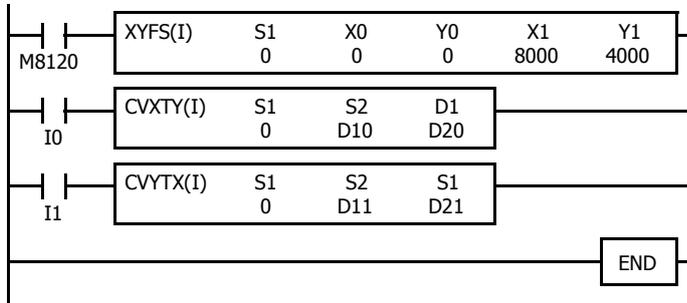
The data conversion error is  $\pm 0.5$ .

**Note:** The CVYTX instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

**Example: Linear Conversion**

The following example demonstrates setting up two coordinate points to define the linear relationship between X and Y. The two points are  $(X_0, Y_0) = (0, 0)$  and  $(X_1, Y_1) = (8000, 4000)$ . Once these are set, there is an X to Y conversion, as well as a Y to X conversion.

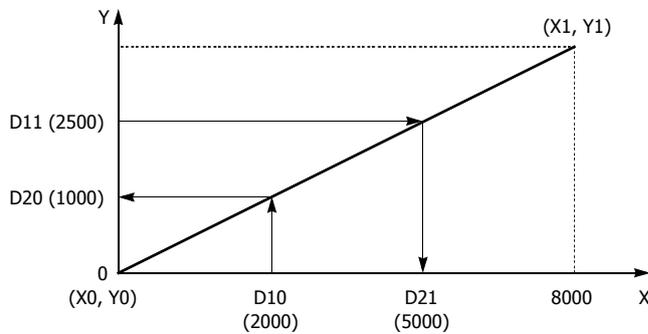


M8120 is the initialize pulse special internal relay.

At startup, XYFS specifies two points.

When input I0 is on, CVXTY converts the value in D10 and stores the result in D20.

When input I1 is on, CVYTX converts the value in D11 and stores the result in D21.



The graph shows the linear relationship that is defined by the two points:

$$Y = \frac{1}{2}X$$

If the value in data register D10 is 2000, the value assigned to D20 is 1000.

For Y to X conversion, the following equation is used:

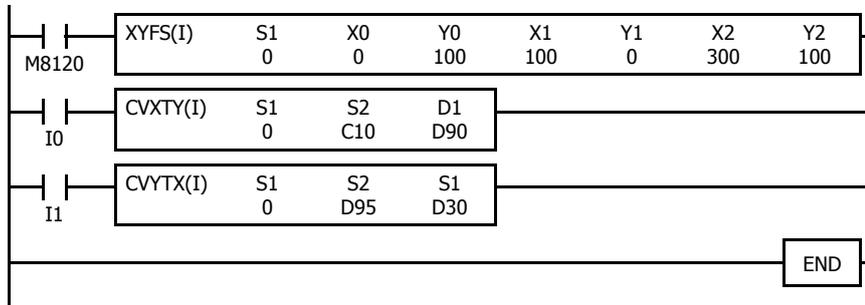
$$X = 2Y$$

If the value in data register D11 is 2500, the value assigned to D21 is 5000.

## 17: COORDINATE CONVERSION INSTRUCTIONS

### Example: Overlapping Coordinates

In this example, the XYFS instruction sets up three coordinate points, which define two different linear relationships between X and Y. The three points are:  $(X_0, Y_0) = (0, 100)$ ,  $(X_1, Y_1) = (100, 0)$ , and  $(X_2, Y_2) = (300, 100)$ . The two line segments define overlapping coordinates for X. That is, for each value of Y within the designated range, there would be two X values assigned.

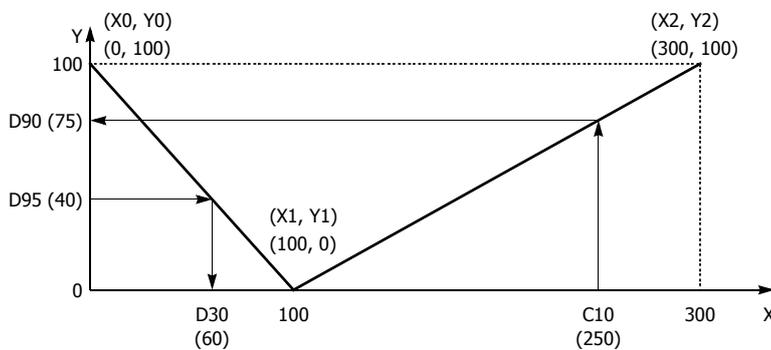


M8120 is the initialize pulse special internal relay.

At startup, XYFS specifies three points.

CVXTY converts the current value in C10 and stores the result in D90.

CVYTX converts the value in D95 and stores the result in D30.



The first line segment defines the following relationship for X to Y conversion:

$$Y = -X + 100$$

The second line segment defines another relationship for X to Y conversion:

$$Y = \frac{1}{2}X - 50$$

For X to Y conversion, each value of X has only one corresponding value for Y. If the current value of counter C10 is 250, the value assigned to D90 is 75.

For Y to X conversion, the XYFS instruction assigns two possible values of X for each value of Y. The relationship defined by the first two points has priority in these cases. The line between points  $(X_0, Y_0)$  and  $(X_1, Y_1)$ , that is, the line between  $(0, 100)$  and  $(100, 0)$ , has priority in defining the relationship for Y to X conversion ( $X = -Y + 100$ ).

Therefore, if the value in data register D95 is 40, the value assigned to D30 is 60, not 180.

Exactly the same two line segments might also be defined by the XYFS instruction, except that the point  $(300, 100)$  could be assigned first, as  $(X_0, Y_0)$ , and the point  $(100, 0)$  could be defined next, as  $(X_1, Y_1)$ . In this case, this linear relationship would have priority.

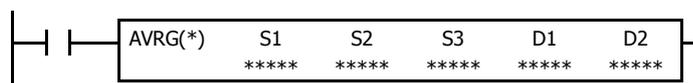
In this case, if the value in data register D95 is 40, the value assigned to D30 is 180, not 60.

# 18: AVERAGE INSTRUCTIONS

## Introduction

Average instructions average the specified data.

## AVRG (Average)



When input is on, sampling data assigned by device S1 is processed according to sampling conditions assigned by devices S2 and S3.

When sampling is complete, average, maximum, and minimum values are stored to 3 consecutive devices starting with device assigned by D1, then sampling completion output assigned by device D2 is turned on.

Data Type	W, I	D, L, F
Average	D1	D1·D1+1
Maximum value	D1+1	D1+2·D1+3
Minimum value	D1+2	D1+4·D1+5

The AVRG instruction is effective for data processing of analog input values. A maximum of eight AVRG instructions can be programmed in a user program.

## Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

## Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Sampling data	X	X	X	X	X	X	X	—	—
S2 (Source 2)	Sampling end input	X	X	X	X	—	—	—	—	—
S3 (Source 3)	Sampling cycles (scan times)	X	X	X	X	X	X	X	0-65535	—
D1 (Destination 1)	First device address to store results	—	—	—	—	—	—	X	—	—
D2 (Destination 2)	Sampling completion output	—	X	▲	—	—	—	—	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

▲ Internal relays M0 through M1277 can be designated as D2. Special internal relays cannot be designated as D2.

When T (timer) or C (counter) is used as S1 or S3, the timer/counter current value (TC or CC) is displayed.

When F (float) data is selected, only data registers can be designated as S1 and D1.

While input is on, the AVRG instruction is executed in each scan. When the quantity of sampling cycles (scan times) designated by device S3 is 1 through 65535, sampling data designated by device S1 is processed in each scan. When the designated sampling cycles have been completed, the average value of the sampling data is set to the device designated by D1 (data type W or I) or D1·D1+1 (data type D, L, or F). The maximum value of the sampling data is set to the next device, D1+1 (data type W or I) or D1+2·D1+3 (data type D, L, or F). The minimum value of the sampling data is set to the next device, D1+2 (data type W or I) or D1+4·D1+5 (data type D, L, or F). The sampling completion output designated by device D2 is turned on.

When the quantity of sampling cycles designated by device S3 is 0, sampling is started when the input to the AVRG instruction is turned on, and stopped when the sampling end input designated by device S2 is turned on. Then, the average, maximum, and minimum values are set to 3 devices starting with device designated by D1.

When the sampling exceeds 65535 cycles, the average, maximum, and minimum values at this point are set to 3 devices starting with device designated by D1, and sampling continues.

When the sampling end input is turned on before the sampling cycles designated by device S3 have been completed, sampling is stopped and the results at this point are set to 3 devices starting with device designated by D1.

The average value is calculated to units, rounding the fractions of one decimal place.

When the sampling end input is not used, designate an internal relay or another valid device as a dummy for source device S2.

When F (float) data is selected and S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. When an error occurs, incorrect S1 data are skipped. Average, maximum, and minimum values are calculated from correct S1 data, and set to 3 devices starting with the device designated by D1. For details about user program execution errors, see "User Program Execution Errors" on page 4-13.

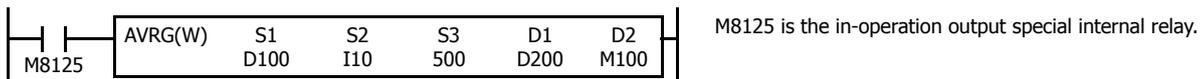
## 18: AVERAGE INSTRUCTIONS

### Valid Data Types

<b>W (word)</b>	X	When a bit device such as I (input), Q (output), M (internal relay), or R (shift register) is assigned as the source, 16 points (word or integer data) or 32 points (double-word or long data) are used.
<b>I (integer)</b>	X	
<b>D (double word)</b>	X	
<b>L (long)</b>	X	When a word device such as T (timer), C (counter), or D (data register) is assigned as the source, 1 point (word or integer data) or 2 points (double-word, long, or float data) are used.
<b>F (float)</b>	X	

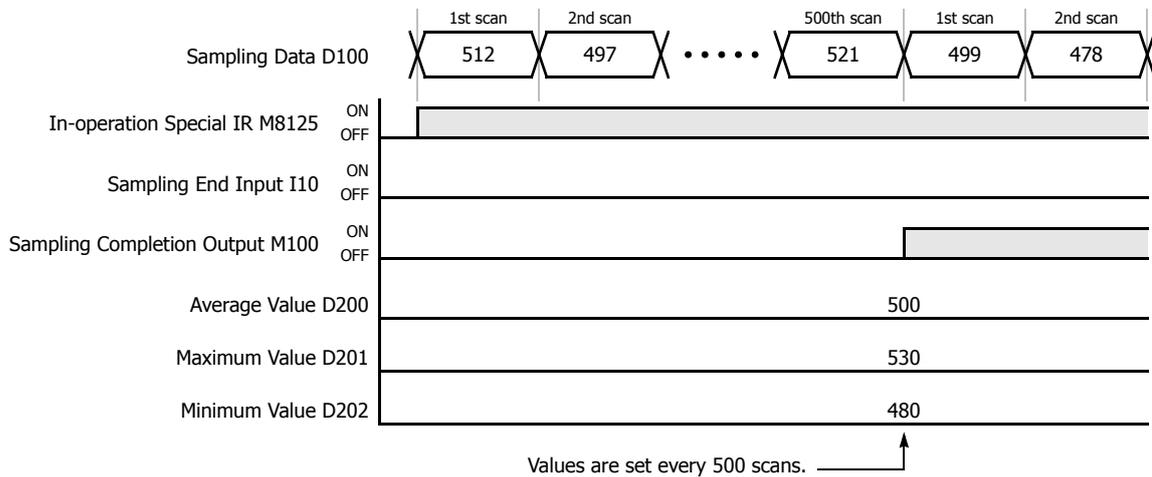
### Example: AVRG

The following example demonstrates a program that calculates the average values of data register D100 and store the result to data register D200 every 500 scans.



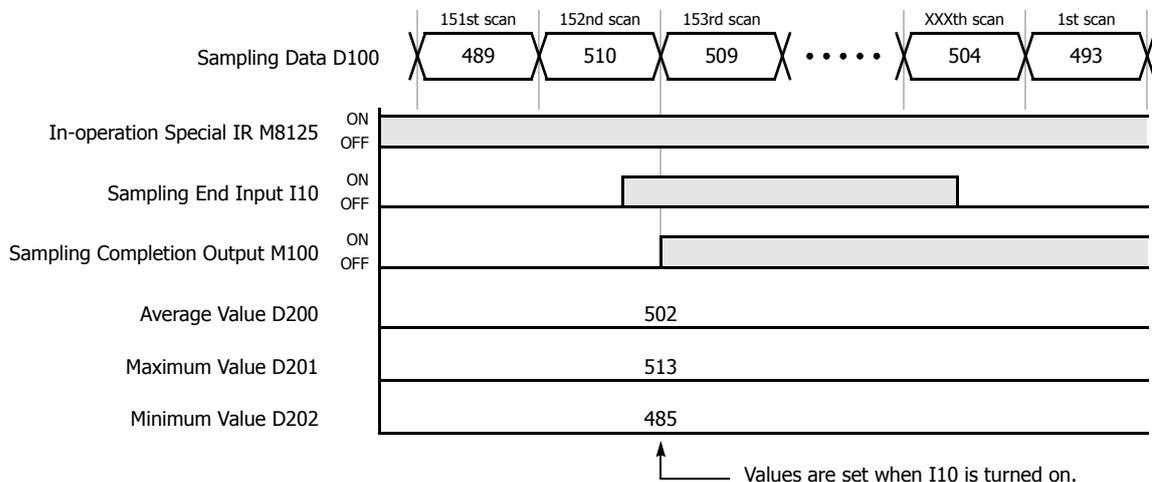
#### When the sampling end input does not turn on

While sampling end input I10 is off, the average, maximum, and minimum values are calculated every 500 scans and stored to data registers D200, D201, and D202, respectively. Sampling completion output M100 is set every 500 scans.



#### When the sampling end input turns on

When sampling end input I10 turns on, the average, maximum, and minimum values at this point are stored to data registers D200, D201, and D202, respectively. Sampling completion output M100 is also set. When sampling end input I10 turns off, sampling resumes starting at the first scan.

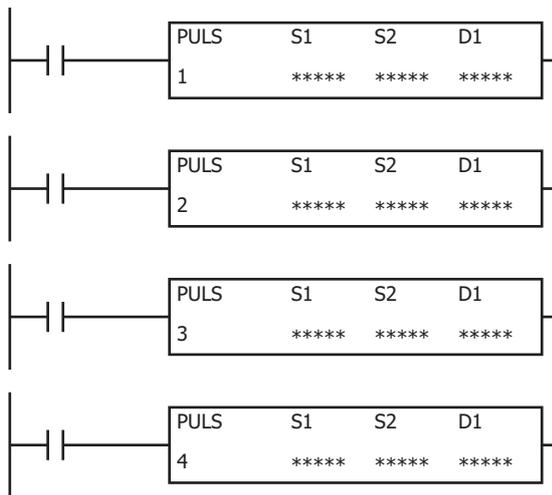


# 19: PULSE OUTPUT INSTRUCTIONS

## Introduction

The pulse output instructions output pulses of a specified frequency. These pulses will be generated from the pulse output ports.

## PULS (Pulse Output)



The PULS instructions output pulses of a specified frequency from the specified pulse output ports.

When input is on, pulses are output according to the control register settings specified by S1.

The pulse control information (output on/output complete/error) is stored in the internal relays specified by D1 as the operation status.

When the initialization input specified by S2 is turned on, the initial values configured in the WinLDR PULS instruction dialog box, on the **Setting** tab, are stored in the control registers.

**Note:** Configure multiple PULS (pulse output), PWM (pulse width modulation), RAMP (trapezoidal control), and ARAMP (RAMP with table) instructions so that they do not share the same pulse output port.

However, the ZRN (zero return) instruction can be configured with the same pulse output port as the PULS (pulse output), PWM (pulse width modulation), RAMP (trapezoidal control), and ARAMP (RAMP with table) instructions.

**Note:** The PULS instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

## Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X (Note)	X	—

**Note:** These instructions cannot be used with FT1A-H40RC and FT1A-B40RC.

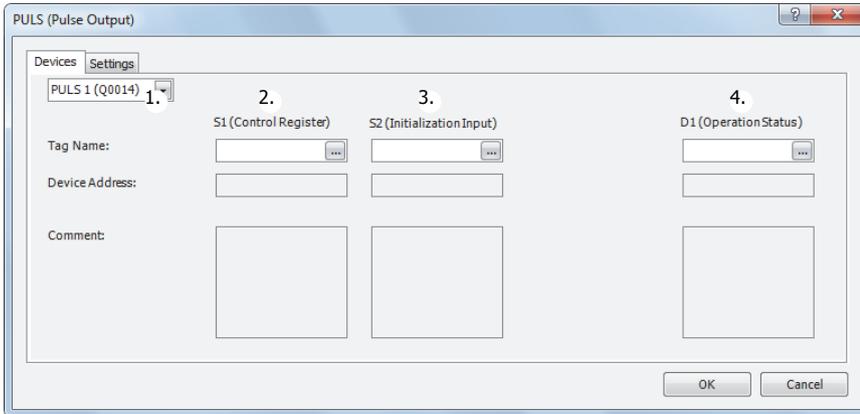
## Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Control register	—	—	—	—	—	—	▲	—	—
S2 (Source 2)	Initialization input	X	—	X	—	—	—	—	—	—
D1 (Destination 1)	Operation status	—	—	▲	—	—	—	—	—	—

▲ Special data registers cannot be designated as S1. Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1. The first digit of the internal relay number must be 0 (not 1 to 7).

Settings

• Device tab



1. Select instruction

This item selects which PULS instruction to use (PULS1, PULS2, PULS3, or PULS4).

The pulse output, configurable operation modes, and enabling/disabling pulse counting varies based on the instruction.

Instruction	Pulse output	Configurable operation mode	Enable/disable pulse counting
PULS1	Q14	Operation mode 0: 1 Hz to 10 kHz	Pulse counting can be enabled or disabled (Pulse counting range: 1 to 100,000,000)
PULS2	Q15	Operation mode 1: 200 Hz to 100 kHz	
PULS3	Q16	Operation mode 0: 1 Hz to 5 kHz	Disable pulse counting
PULS4	Q17		

2. S1 (source 1): Control register

S1 specifies the starting number for the data registers to use with PULS1, PULS2, PULS3, or PULS4 instructions.

Starting from the specified number, 7 consecutive 16-bit data registers are used.

The range of available data register numbers is D0 to D993 and D1000 to D1993.

Storage destination	Function	Setting	Reference				
Starting number+0	Output pulse frequency	<table border="1"> <tr> <td>PULS1, PULS2</td> <td>Mode 0: 1 to 10,000 (increments of 1 Hz) Mode 1: 20 to 10,000 (increments of 10 Hz)</td> </tr> <tr> <td>PULS3, PULS4</td> <td>Mode 0: 1 to 5,000 (increments of 1 Hz) Mode 1: Cannot be specified</td> </tr> </table>	PULS1, PULS2	Mode 0: 1 to 10,000 (increments of 1 Hz) Mode 1: 20 to 10,000 (increments of 10 Hz)	PULS3, PULS4	Mode 0: 1 to 5,000 (increments of 1 Hz) Mode 1: Cannot be specified	"6. Output pulse frequency" on page 19-3
PULS1, PULS2	Mode 0: 1 to 10,000 (increments of 1 Hz) Mode 1: 20 to 10,000 (increments of 10 Hz)						
PULS3, PULS4	Mode 0: 1 to 5,000 (increments of 1 Hz) Mode 1: Cannot be specified						
Starting number+1	Reserved	—	—				
Starting number+2	Preset value (high word) (Note)	1 to 100,000,000 pulses	"8. Preset value" on page 19-4				
Starting number+3	Preset value (low word) (Note)						
Starting number+4	Current value (high word) (Note)	1 to 100,000,000 pulses	"9. Current value" on page 19-4				
Starting number+5	Current value (low word) (Note)						
Starting number+6	Error status	0 to 4	"10. Error status" on page 19-4				

**Note:** The upper and lower data registers change according to the 32-bit data storage method specified.

For details, see Chapter 5 "Special Functions" – "32-bit Data Storage Setting" in the SmartAXIS Pro/Lite User's Manual.

**3. S2 (source 2): Initialization input**

S2 specifies the initialization input. When the initialization input is turned on, the initial values configured in the WindLDR PULS instruction dialog box, on the **Setting** tab, are stored in the control registers. An external input (I0 to I35) (Note) or an internal relay (M0 to M1277) can be specified.

When the initialization input is on, the initial values are written to the data registers with each scan. To only initialize the values one time, use the initialization input in combination with the SOTU (single output up) instruction or the SOTD (single output down) instruction.

**Note:** For the 40-I/O type, external inputs (I0 to I27) can be used.

**4. D1 (destination 1): Operation status**

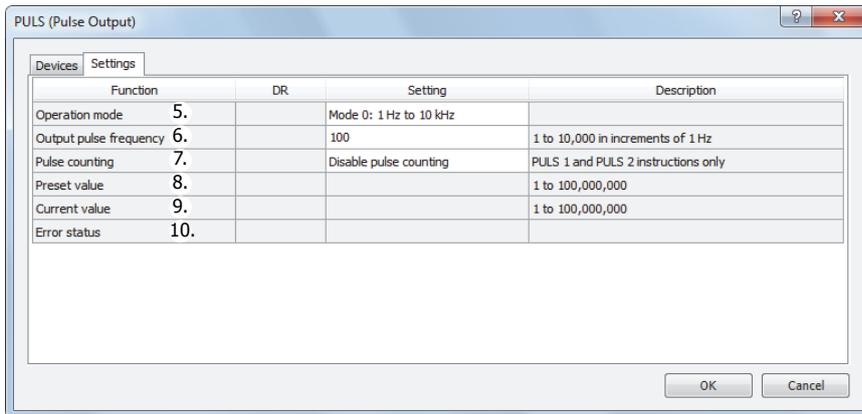
D1 specifies the starting number of the internal relays to use with PULS instructions.

Starting from the specified internal relay, 3 sequential internal relays are used.

The range of available internal relays is M0 to M1270. The first digit of the internal relay number must be set to 0.

Storage destination	Function	Setting	
Starting number+0	Pulse output ON	0: Pulse output OFF 1: Pulse output ON	This relay turns on during pulse output. This relay turns off when pulse output stops. This relay turns off when the specified number of pulses are output and output ends.
Starting number+1	Pulse output complete	0: Pulse output not complete 1: Pulse output complete	This relay turns on when pulse output is complete. This relay turns off when pulse output starts.
Starting number+2	Overflow	0: None 1: An overflow has occurred	When pulse counting is enabled, this relay turns on when a pulse is output that exceeds the configured preset value.

• **Setting tab**



**5. Operation mode**

This setting selects the frequency range to output from two operation modes. Only PULS3 and PULS4 support operation mode 0.

Operation mode	Supported instruction			
	PULS1	PULS2	PULS3	PULS4
0: 1 Hz to 10 kHz (increments of 1 Hz) (Note) (PULS1, PULS2) 1 Hz to 5 kHz (increments of 1 Hz) (Note) (PULS3, PULS4)	X	X	X	X
1: 200 Hz to 100 kHz (increments of 10 Hz) (Note)	X	X	—	—

**Note:** The output frequency error is within ±5%.

**6. Output pulse frequency**

PULS1, PULS2: Mode 0: Set between 1 Hz and 10 kHz in increments of 1 Hz. The output frequency error is ±5%.

Mode 1: Set between 200 Hz and 100 kHz in increments of 10 Hz. The output frequency error is ±5%.

PULS3, PULS4: Set between 1 Hz and 5 kHz in increments of 1 Hz. The output frequency error is ±5%.

## 19: PULSE OUTPUT INSTRUCTIONS

### 7. Pulse counting

This setting enables or disables pulse counting.

Pulse counting		Supported instruction			
		PULS1	PULS2	PULS3	PULS4
0: Disable pulse counting	Pulses are continuously output while the input is on.	X	X	X	X
1: Enable pulse counting	The number of pulses specified by the preset value are output.	X	X	—	—

### 8. Preset value

When counting pulses, this setting specifies the number of pulses to output.

### 9. Current value

The number of pulses that were output is stored in this data register. The current value is updated when the PULS instruction is executed at each scan.

### 10. Error status

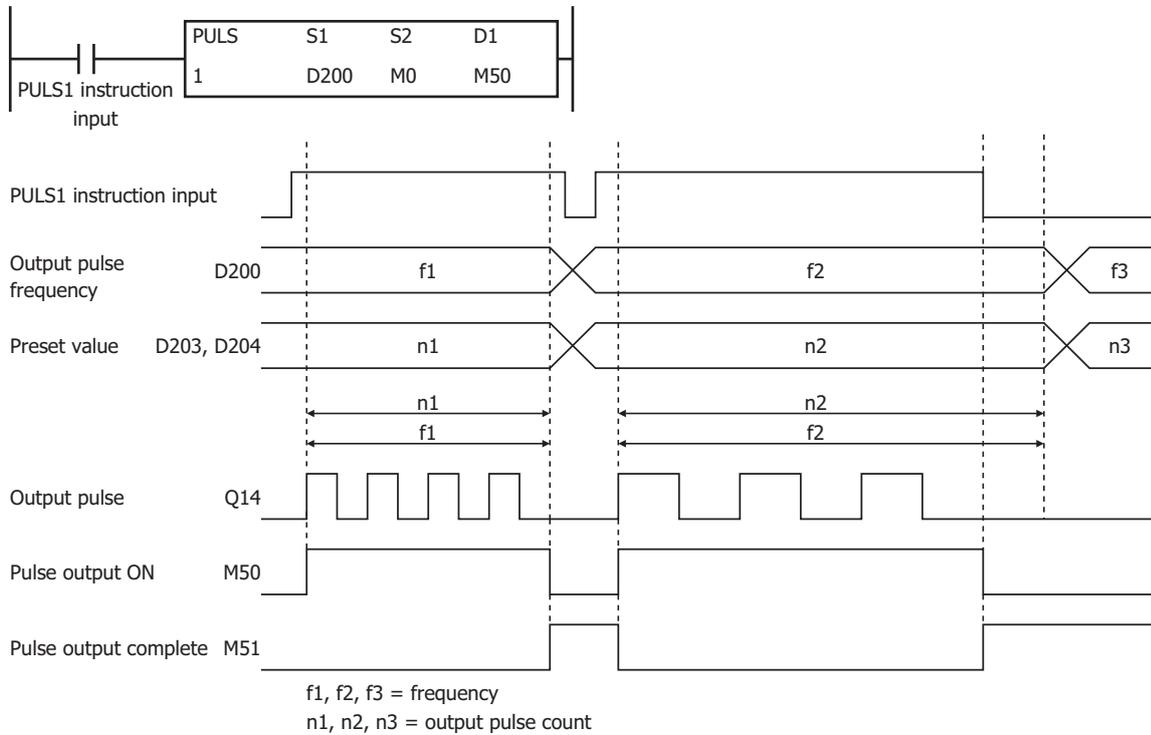
If a configuration error occurs when the PULS instruction input changes from off to on, M8004 (user program execution error) is turned on and this register is set to the error code.

Error code	Status	Description	
0	Normal	—	
2	Pulse frequency designation error	PULS1, PULS2	The pulse frequency was not set between 1 and 10,000 in operation mode 0. The pulse frequency was not set between 20 and 10,000 in operation mode 1.
		PULS3, PULS4	The pulse frequency was not set between 1 and 5,000 in operation mode 0.
4	Preset value designation error	The preset value was not set between 1 and 100,000,000.	

**Examples: PULS**

**PULS1 instruction (pulse counting enabled) timing chart**

[PULS1 instruction, S1 is specified as D200, D1 is specified as internal relay M50]



When the PULS1 instruction input changes from off to on, M50 turns on and pulses with the frequency configured by D200 are output. When the number of pulses configured by D202 and D203 are output, pulse output stops. If the value of D200 changes during pulse output, pulses are output with the frequency based on that value.

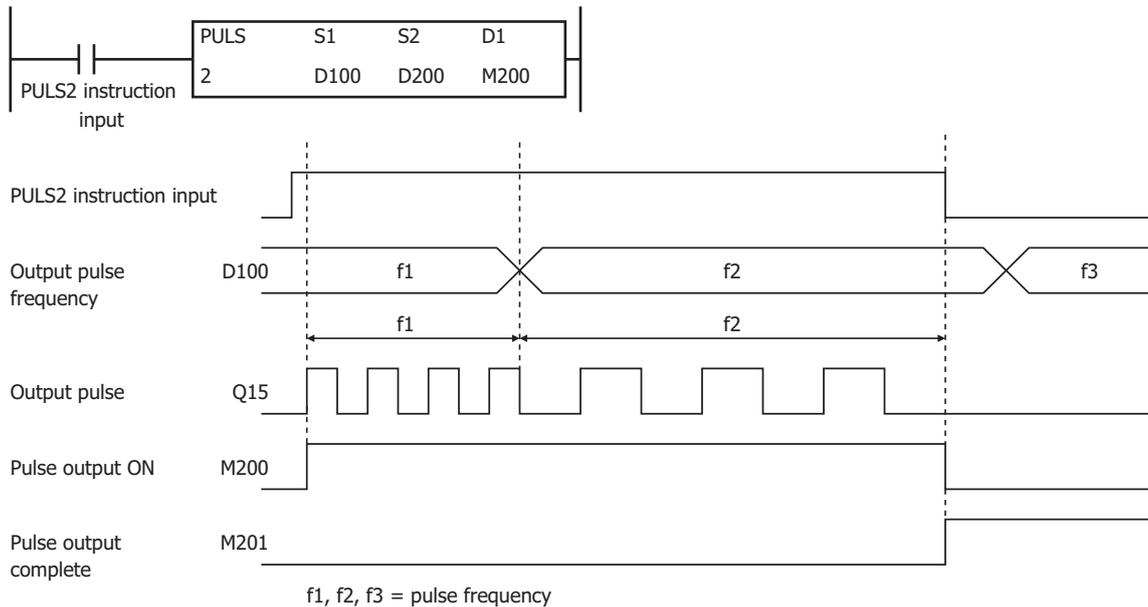
When the PULS1 instruction input changes from on to off, M50 turns off and M51 turns on at the same time.

The changes from the initialization input are not reflected while the PULS1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

## 19: PULSE OUTPUT INSTRUCTIONS

### PULS2 instruction (pulse counting disabled) timing chart

[PULS2 instruction, S1 is specified as D100, D1 is specified as internal relay M200]



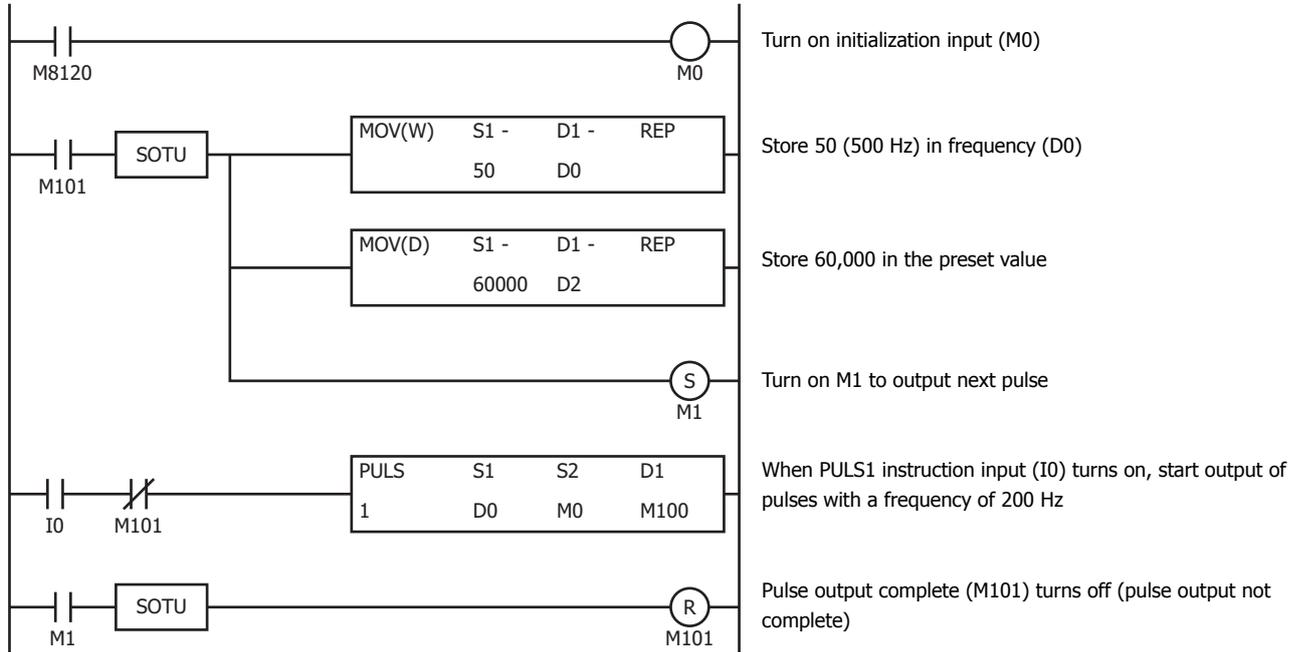
When the PULS2 instruction input changes from off to on, M200 turns on and pulses with the frequency configured by D100 are output. If the value of D100 changes during pulse output, pulses are output with the frequency based on that value.

When the PULS2 instruction input changes from on to off, M200 turns off and M201 turns on at the same time.

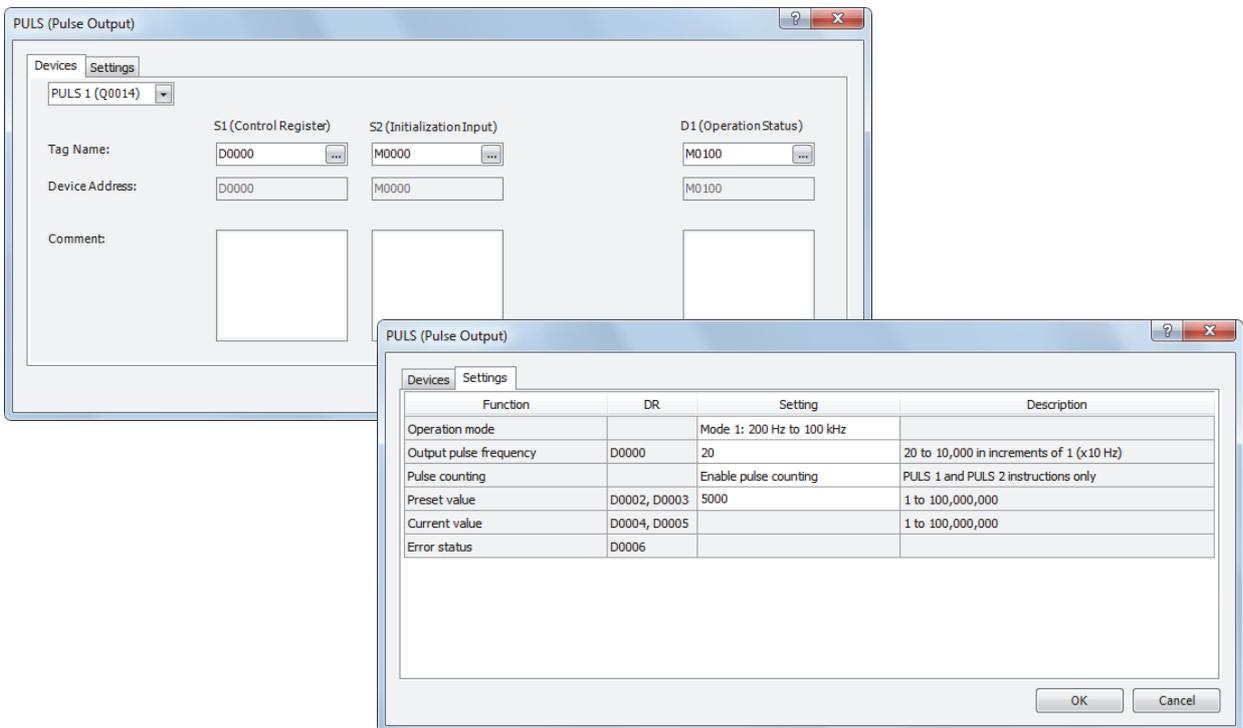
The changes from the initialization input are not reflected while the PULS2 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

**Sample program**

This section describes an example program that outputs 5,000 pulses (each at 200 Hz) and then 60,000 pulses (each at 500 Hz) from output Q14

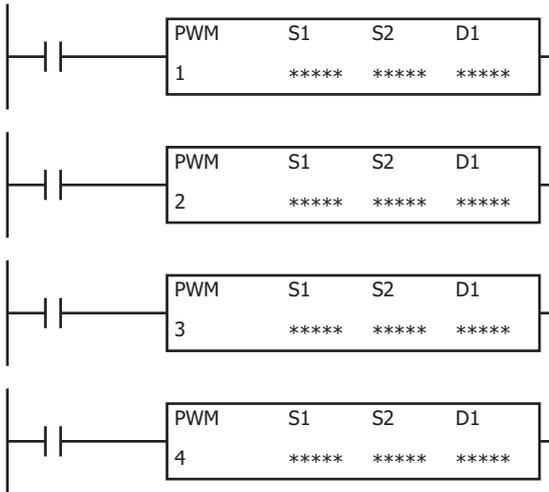


**Settings**



Function	Device address	Setting value	Details
Operation mode	—	Mode 1	200 Hz to 100 kHz
Output pulse frequency	D0	20	200 Hz
Pulse counting	—	Enable pulse counting	—
Preset value	D2, D3	5000	Preset value=5,000

**PWM (Variable Duty Cycle Pulse Output)**



The PWM instructions output pulses at the specified frequency and duty cycle from the output port.

When the input is on, pulses are output according to the control register settings specified by S1.

The pulse control information (output on/output complete/error) is stored in the internal relays specified by D1 as the operation status.

When the initialization input specified by S2 is turned on, the initial values configured in the WindLDR PWM instruction dialog box, on the **Setting** tab, are stored in the control registers.

**Note:** Configure multiple PULS (pulse output), PWM (pulse width modulation), RAMP (trapezoidal control), and ARAMP (RAMP with table) instructions so that they do not share the same pulse output port.

However, the ZRN (zero return) instruction can be configured with the same pulse output port as the PULS (pulse output), PWM (pulse width modulation), RAMP (trapezoidal control), and ARAMP (RAMP with table) instructions.

**Note:** The PWM instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X (Note)	X	—

**Note:** These instructions cannot be used with FT1A-H40RC and FT1A-B40RC.

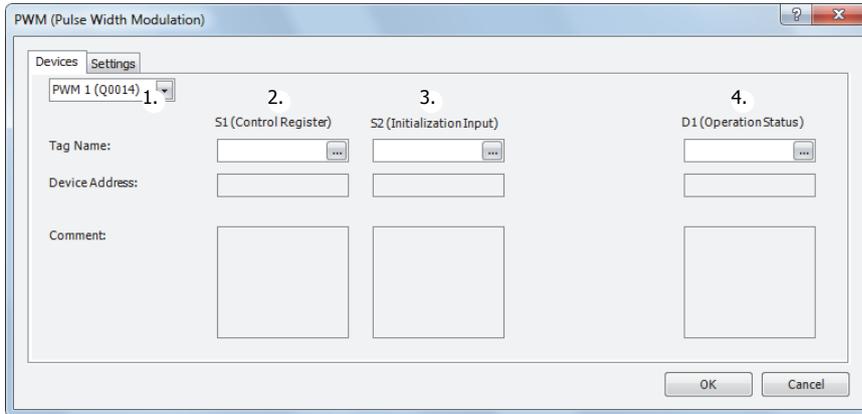
**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Control register	—	—	—	—	—	—	▲	—	—
S2 (Source 2)	Initialization input	X	—	X	—	—	—	—	—	—
D1 (Destination 1)	Operation status	—	—	▲	—	—	—	—	—	—

▲ Special data registers cannot be designated as S1. Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1. The first digit of the internal relay number must be set to 0.

**Settings**

• **Device tab**



**1. Select instruction**

This item selects which PWM instruction to use (PWM1, PWM2, PWM3, or PWM4).

The pulse output, pulse duty cycle (ON ratio), and enabling/disabling pulse counting varies based on the instruction.

Instruction	Pulse output	Pulse duty cycle (ON ratio)	Enable/disable pulse counting
PWM1	Q14	1 to 100% (increments of 1%)	Pulse counting can be enabled or disabled (Pulse counting range: 1 to 100,000,000)
PWM2	Q15		
PWM3	Q16	1 to 100% (1 to 50 Hz: increments of 1%, 51 to 1,000 Hz: increments of (pulse frequency ÷ 50)%)	Disable pulse counting
PWM4	Q17		

**2. S1 (source 1): Control register**

S1 specifies the starting number for the data registers to use with PWM1, PWM2, PWM3, or PWM4 instructions.

Starting from the specified number, 7 consecutive 16-bit data registers are used.

The range of available data register numbers is D0 to D993 and D1000 to D1993.

Storage destination	Function	Setting	Reference
Starting number+0	Output pulse frequency	1 to 1,000 (increments of 1 Hz)	"5. Output pulse frequency" on page 19-10
Starting number+1	Pulse duty cycle (ON ratio)	1 to 100%	"6. Pulse width ratio" on page 19-10
Starting number+2	Preset value (high word) (Note)	1 to 100,000,000 pulses	"8. Preset value" on page 19-11
Starting number+3	Preset value (low word) (Note)		
Starting number+4	Current value (high word) (Note)	1 to 100,000,000 pulses	"9. Current value" on page 19-11
Starting number+5	Current value (low word) (Note)		
Starting number+6	Error status	0 to 4	"10. Error status" on page 19-11

**Note:** The upper and lower data registers change according to the 32-bit data storage method specified.

For details, see Chapter 5 "Special Functions" – "32-bit Data Storage Setting" in the SmartAXIS Pro/Lite User's Manual.

**3. S2 (source 2): Initialization input**

S2 specifies the initialization input. When the initialization input S2 is turned on, the initial values configured in the WindLDR PWM instruction dialog box, on the **Setting** tab, are stored in the control registers. An external input (I0 to I35) (Note) or an internal relay (M0 to M1277) can be specified.

When the initialization input is on, the initial values are written to the data registers with each scan. To only initialize the values one time, use the initialization input in combination with the SOTU (single output up) instruction or the SOTD (single output down) instruction.

**Note:** For the 40-I/O type, external inputs (I0 to I27) can be used.

## 19: PULSE OUTPUT INSTRUCTIONS

### 4. D1 (destination 1): Operation status

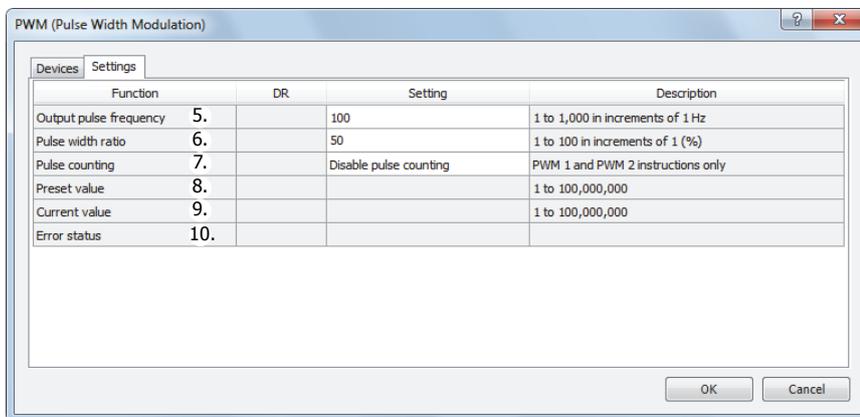
D1 specifies the starting number of the internal relays to use with PWM instructions.

Starting from the specified internal relay, 3 sequential internal relays are used.

The range of available internal relay numbers is M0 to M1270. The first digit of the internal relay number must be set to 0.

Storage destination	Function	Setting	
Starting number+0	Pulse output ON	0: Pulse output OFF 1: Pulse output ON	This relay turns on during pulse output. This relay turns off when the PWM instruction output stops. This relay turns off when the specified number of pulses are output and output ends.
Starting number+1	Pulse output complete	0: Pulse output not complete 1: Pulse output complete	This relay turns on when pulse output is complete. This relay turns off when the PWM instruction output starts.
Starting number+2	Overflow	0: None 1: An overflow has occurred	When pulse counting is enabled, this relay turns on when a pulse is output that exceeds the configured preset value.

### • Setting tab



### 5. Output pulse frequency

This setting configures the frequency for the pulses to output from 1 Hz to 1,000 Hz in increments of 1 Hz.

The output frequency error is within  $\pm 5\%$ .

### 6. Pulse width ratio

This setting specifies the ON ratio (duty cycle) for the pulse frequency to output. The duty cycle can be set for output frequency in increments of 1%. The pulse duty cycle can be set for output frequency in increments of 1% from 1 Hz to 50 Hz, but from 51 Hz to 1,000 Hz, the increments for the pulse duty cycle that can be specified to change according to the output frequency. The increment becomes (pulse frequency  $\div$  50)%. For example, when 51 Hz is specified for the pulse frequency,  $51 \div 50 = 2$  (rounded up), so the increment is 2%. When 1,000 Hz is specified for the pulse frequency,  $1000 \div 50 = 20$ , so the increment is 20%. For increments of 2%, a value from 1 to 2 entered in **Pulse width ratio** is rounded up and handled as 2%, 3 to 4 is rounded up and handled as 4%. For increments of 20%, 1 to 20 is handled as 20%, 21 to 40 is handled as 40%.

### 7. Pulse counting

This setting enables or disables pulse counting.

Pulse counting		Supported instruction			
		PWM1	PWM2	PWM3	PWM4
0: Disable pulse counting	Pulses are continuously output while the input is on.	X	X	X	X
1: Enable pulse counting	The number of pulses specified by the preset value are output.	X	X	—	—

**8. Preset value**

When counting pulses, this setting specifies the number of pulses to output.

**9. Current value**

The number of pulses that were output is stored in this data register. The current value is updated when the PWM instruction is executed at each scan.

**10. Error status**

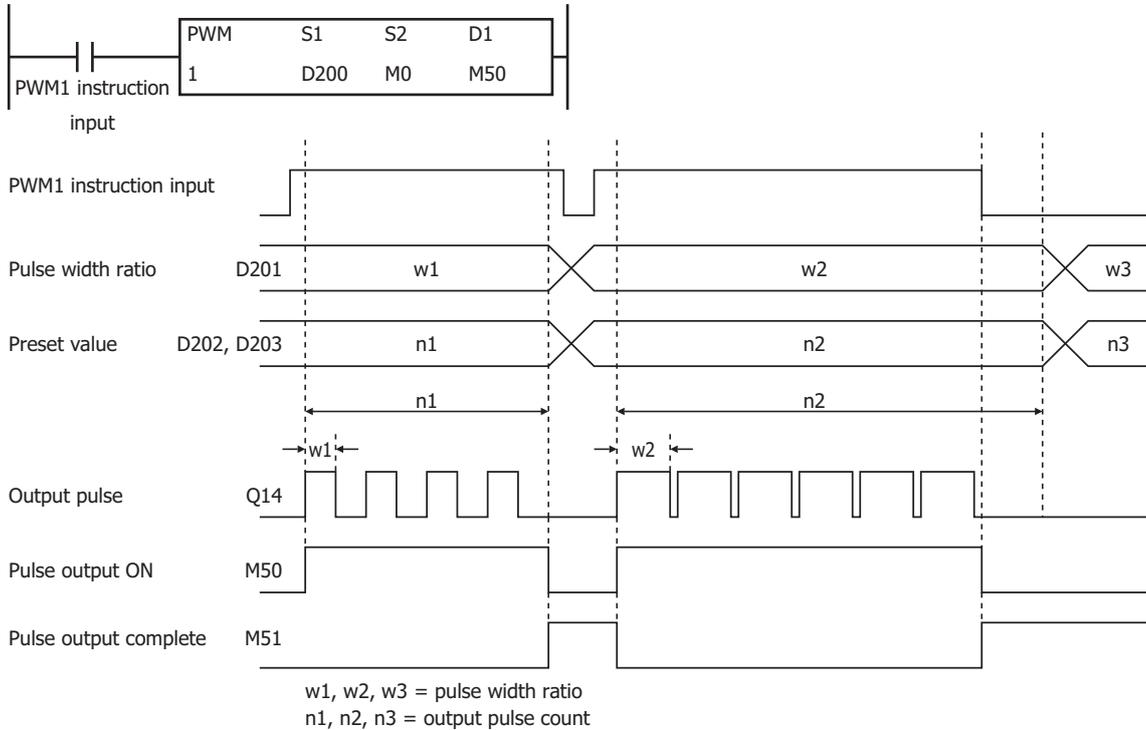
If a configuration error occurs when the PWM instruction input changes from off to on, M8004 (user program execution error) is turned on and this register is set to the error code.

<b>Error code</b>	<b>Status</b>	<b>Description</b>
0	Normal	—
1	Pulse frequency designation error	The pulse frequency was not set between 1 and 1,000.
2	Pulse width ratio designation error	The pulse width ratio was not set between 1 and 100.
4	Preset value designation error	The preset value was not set between 1 and 100,000,000.

Examples: PWM

PWM1 instruction (pulse counting enabled) timing chart

[PWM1 instruction, S1 is specified as D200, D1 is specified as internal relay M50]



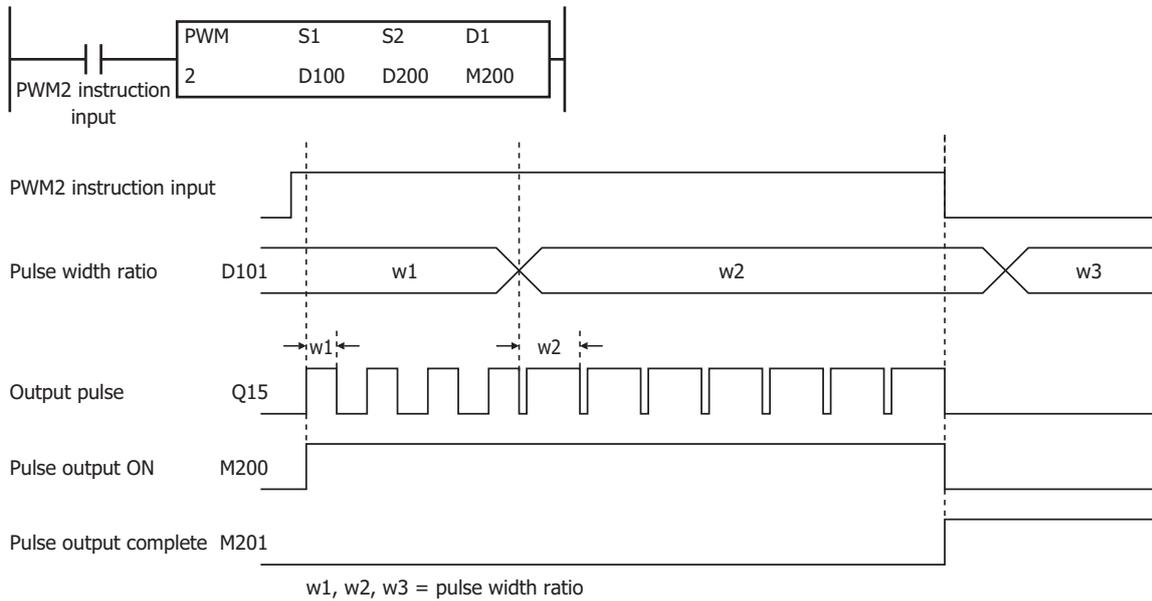
When the PWM1 instruction input changes from off to on, M50 turns on and pulses with the width ratio configured by D201 are output. When the number of pulses configured by D202 and D203 are output, pulse output stops. If the value of D201 changes during pulse output, pulses are output with the width ratio based on that value.

When the PWM1 instruction input changes from on to off, M50 turns off and M51 turns on at the same time.

The changes from the initialization input are not reflected while the PWM1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

**PWM2 instruction (pulse counting disabled) timing chart**

[PWM2 instruction, S1 is specified as D100, D1 is specified as internal relay M200]



When the PWM2 instruction input changes from off to on, M200 turns on and pulses with the width ratio configured by D101 are output. If the value of D101 changes during pulse output, pulses are output with the width ratio based on that value.

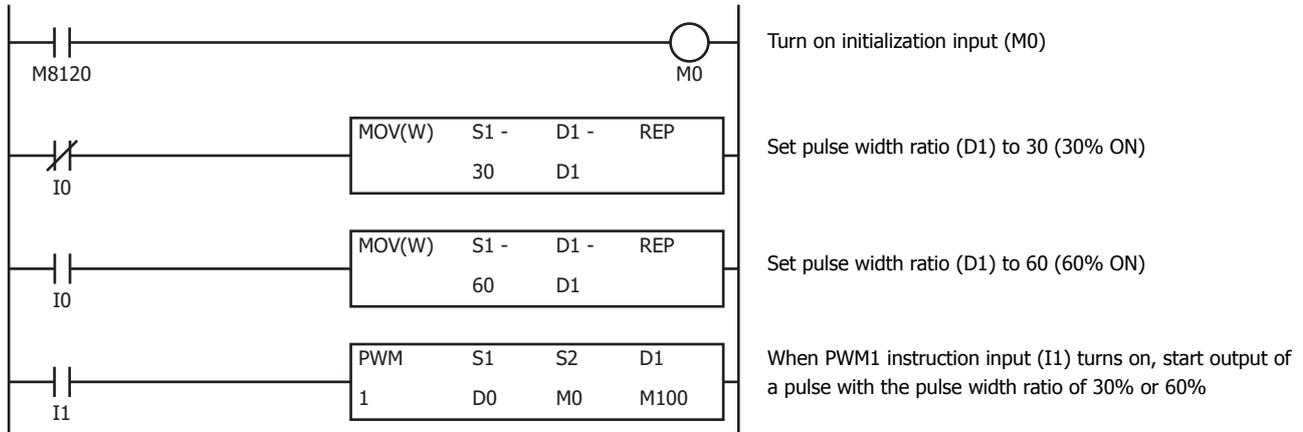
When the PWM2 instruction input changes from on to off, M200 turns off and M201 turns on at the same time.

The changes from the initialization input are not reflected while the PWM2 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

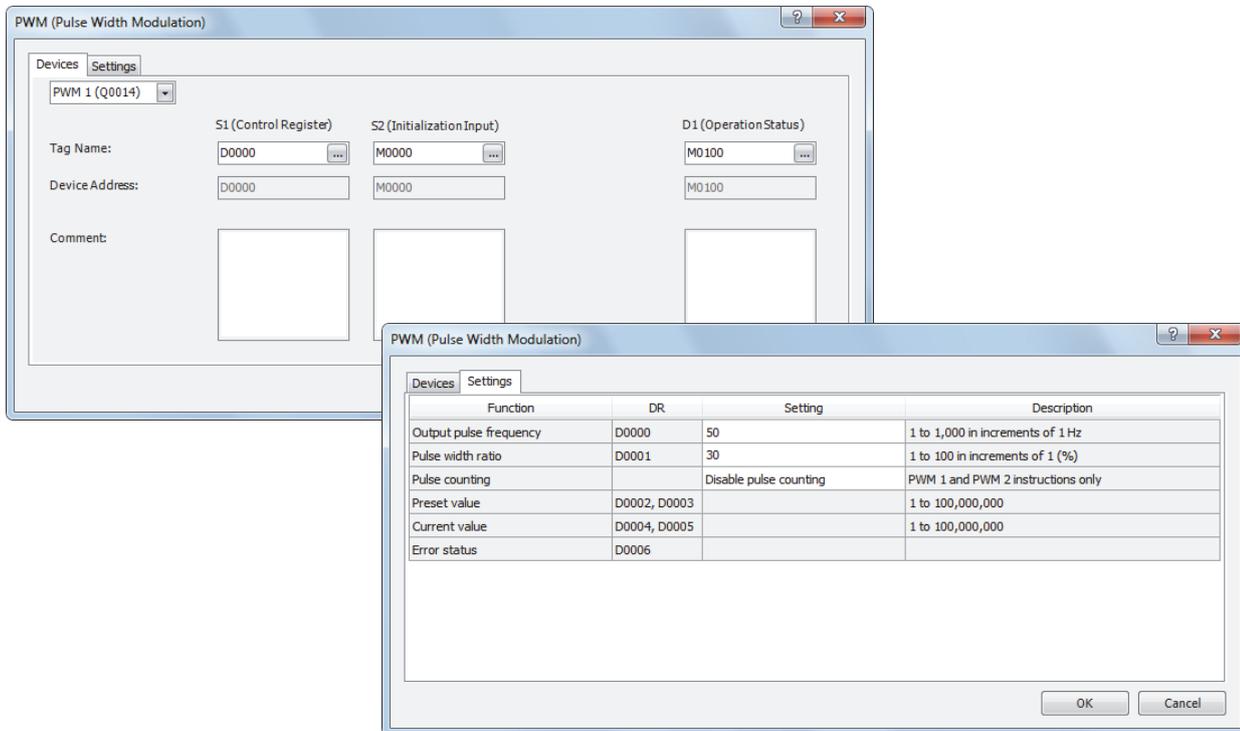
## 19: PULSE OUTPUT INSTRUCTIONS

### Sample program

This section describes an example program that outputs a pulse with the pulse width ratio of 30% when I0 is off, and a pulse with the pulse width ratio of 60% when I0 is on.

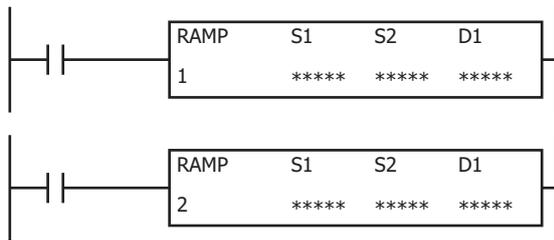


### Settings



Function	Device address	Setting value	Details
Output pulse frequency	D0	50	50 Hz
Pulse width ratio	D1	30	30%
Pulse counting	—	Disable pulse counting	—
Preset value	D2, D3	—	—

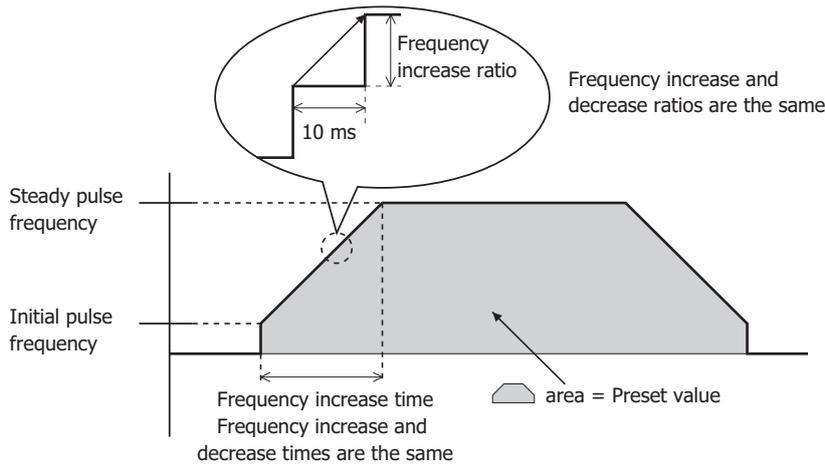
### RAMP (Trapezoidal Control)



The RAMP instruction outputs pulses with a frequency change function.

When the input is on, pulses of the initial pulse frequency specified by S1 are output, and then the pulse frequency is increased by a fixed ratio until it reaches the steady pulse frequency.

After steady pulse output at the steady pulse frequency, the pulse frequency is decreased before the pulse count reaches the preset value specified by S1, and then pulse output stops when the preset value is reached.



**Note:** Configure multiple PULS (pulse output), PWM (pulse width modulation), RAMP (trapezoidal control), and ARAMP (RAMP with table) instructions so that they do not share the same pulse output port.

However, the ZRN (zero return) instruction can be configured with the same pulse output port as the PULS (pulse output), PWM (pulse width modulation), RAMP (trapezoidal control), and ARAMP (RAMP with table) instructions.

**Note:** The RAMP instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X (Note)	X	—

**Note:** These instructions cannot be used with FT1A-H40RC and FT1A-B40RC.

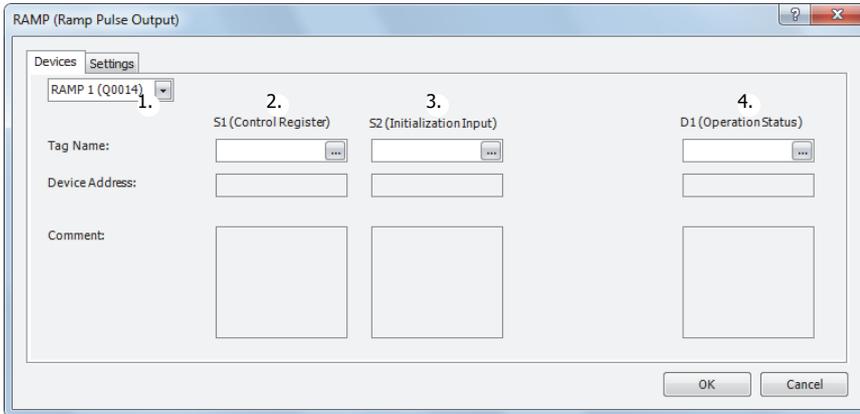
#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Control register	—	—	—	—	—	—	—	▲	—
S2 (Source 2)	Initialization input	—	—	—	—	—	—	X	—	—
D1 (Destination 1)	Operation status	—	—	▲	—	—	—	—	—	—

▲ Special data registers cannot be designated as S1. Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1. The first digit of the internal relay number must be set to 0.

Settings

• Device tab



1. Select instruction

This item selects which RAMP instruction to use (RAMP1 or RAMP2).

The reversible control mode that can be selected varies based on the instruction.

For limitations based on the combination of instruction, reversible control mode, and the pulse output mode, see "9. Reversible control enable" on page 19-18.

2. S1 (source 1): Control register

S1 specifies the starting number of the data registers to use with RAMP1 or RAMP2 instructions.

Starting from the specified number, 9 consecutive 16-bit data registers are used.

The range of available data register numbers is D0 to D991 and D1000 to D1991.

Storage destination	Function	Setting	Reference
Starting number+0	Steady pulse frequency	Operation mode 0: 1 to 10,000 (increments of 1 Hz) Operation mode 1: 20 to 10,000 (increments of 10 Hz)	"6. Steady pulse frequency" on page 19-18
Starting number+1	Initial pulse frequency	Operation mode 0: 1 to 10,000 (increments of 1 Hz) Operation mode 1: 20 to 10,000 (increments of 10 Hz)	"7. Initial pulse frequency" on page 19-18
Starting number+2	Frequency change time	10 to 10,000 ms	"8. Frequency change time" on page 19-18
Starting number+3	Control direction	0: Forward 1: Reverse	"10. Control direction" on page 19-18
Starting number+4	Preset value (high word) (Note)	1 to 100,000,000 pulses	"11. Preset value" on page 19-18
Starting number+5	Preset value (low word) (Note)		
Starting number+6	Current value (high word) (Note)	1 to 100,000,000 pulses	"12. Current value" on page 19-19
Starting number+7	Current value (low word) (Note)		
Starting number+8	Error status	0 to 9	"13. Error status" on page 19-19

**Note:** The upper and lower data registers change according to the 32-bit data storage method specified.

For details, see Chapter 5 "Special Functions" – "32-bit Data Storage Setting" in the SmartAXIS Pro/Lite User's Manual.

**3. S2 (source 2): Initialization input**

S2 specifies the initialization input.

When the initialization input S2 is turned on, the initial values configured in the WindLDR RAMP instruction dialog box, on the **Setting** tab, are stored in the control registers.

An external input (I0 to I35) (Note) or an internal relay (M0 to M1277) can be specified.

When the initialization input is on, the initial values are written to the data registers with each scan. To only initialize the values one time, use the initialization input in combination with the SOTU (single output up) instruction or the SOTD (single output down) instruction.

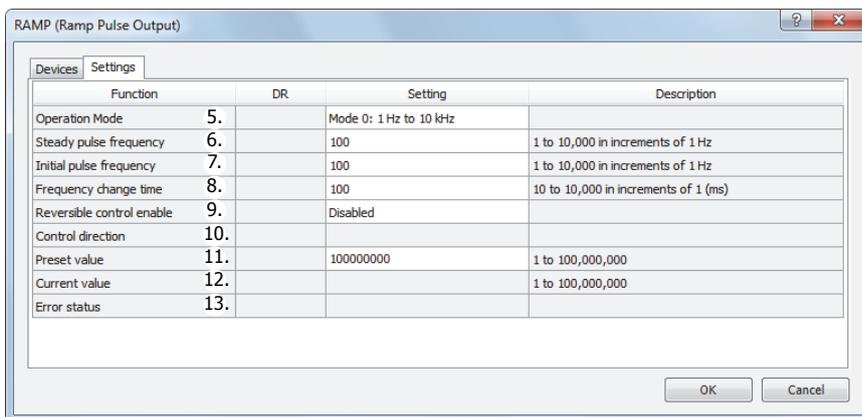
**Note:** For the 40-I/O type, external inputs (I0 to I27) can be used.

**4. D1 (destination 1): Operation status**

D1 specifies the starting number of the internal relays to use with the RAMP instructions. Starting from the specified internal relay, 4 sequential internal relays are used. The range of available internal relay numbers is M0 to M1270. The first digit of the internal relay number must be set to 0.

Storage destination	Function	Setting	
Starting number+0	Pulse output ON	0: Pulse output OFF 1: Pulse output ON	This relay turns on during pulse output. This relay turns off when the RAMP instruction output stops. This relay turns off when the specified number of pulses are output and output ends.
Starting number+1	Pulse output complete	0: Pulse output not complete 1: Pulse output complete	This relay turns on when pulse output is complete. This relay turns off when the RAMP instruction output starts.
Starting number+2	Pulse output status	0: Steady pulse output 1: Changing output pulse frequency	This relay turns off when the pulse output status is steady. This relay turns on when the pulse output is changing.
Starting number+3	Overflow	0: None 1: An overflow has occurred	This internal relay turns on when the pulses output exceed the configured preset value. Pulse output continues even if an overflow occurs during steady output or while the pulse frequency is changing. However, pulse counting is suspended at the point when the overflow occurred.

**• Setting tab**



**5. Operation mode**

This setting selects the frequency range to output from the following operation modes. Select the operation mode according to the steady pulse frequency and the initial pulse frequency used.

Operation mode
0: 1 Hz to 10 kHz (increments of 1 Hz) (Note)
1: 200 Hz to 100 kHz (increments of 10 Hz) (Note)

**Note:** The output frequency error is within ±5%.

## 19: PULSE OUTPUT INSTRUCTIONS

### 6. Steady pulse frequency

This setting specifies the steady pulse frequency after the pulse frequency increases.

For operation mode 0, set the frequency in the range of 1 to 10,000 (increments of 1 Hz).

For operation mode 1, set the frequency in the range of 20 to 10,000 (increments of 10 Hz).

### 7. Initial pulse frequency

This setting specifies the frequency when pulse output starts.

For operation mode 0, set the frequency in the range of 1 to 10,000 (increments of 1 Hz).

For operation mode 1, set the frequency in the range of 20 to 10,000 (increments of 10 Hz).

### 8. Frequency change time

This setting specifies the time to increase and decrease the pulse frequency.

Set the time between 10 and 10,000 ms in increments of 10 ms. The first digit of the setting is ignored.

### 9. Reversible control enable

This setting enables or disables reversible control and selects the reversible control method from the following reversible control modes.

Reversible control enable	
0:	Reversible control disabled
1:	Reversible control (single-pulse output)
2:	Reversible control (dual-pulse output)

There are two modes for the pulse output mode: single-pulse and dual-pulse. They can be combined with reversible control as follows.

Reversible control disabled	Select this option when using pulse output in a single direction. Pulse A and pulse B can be used independently.	
Reversible control Single-pulse output mode	Pulse A is used as pulse output. Pulse B on/off is used as reversible control.	
Reversible control Dual-pulse output mode	Pulse A is used as forward pulse (CW) output. Pulse B is used as reverse pulse (CCW) output.	

The ports used on the SmartAXIS vary based on the instruction used, the combination of the pulse output mode and reversible control, and the model used.

Instruction	Operating condition	Port used			
		40-I/O type		48-I/O type	
		Pulse output port	Reversible control port	Pulse output port	Reversible control port
RAMP1	Reversible control disabled	Q14	—	Q14	—
	Reversible control (single-pulse output)	Q14	Q16 (Note)	Q14	Q12
	Reversible control (dual-pulse output)	Q14	Q15	Q14	Q15
RAMP2	Reversible control disabled	Q15	—	Q15	—
	Reversible control (single-pulse output)	Q15	Q17 (Note)	Q15	Q13
	Dual-pulse output mode cannot be used.	—	—	—	—

**Note:** When using single-pulse mode on the 40-I/O type, Q16 or Q17 are used. Therefore, PULS3, PWM3, or PULS4, PWM4 cannot be used.

### 10. Control direction

When reversible control is enabled, store 0 in this data register for forward operation and store 1 in this data register for reverse operation.

### 11. Preset value

This setting configures the total number of output pulses from 1 to 100,000,000.

**12. Current value**

The number of pulses output from the pulse output port is stored in this data register.  
The current value is updated when the RAMP instruction is executed at each scan.

**13. Error status**

If a configuration error occurs when the RAMP instruction input changes from off to on, M8004 (user program execution error) is turned on and this register is set to the error code.

Error code	Description	
0	Normal	—
2	Initial pulse frequency designation error	The initial pulse frequency was not set between 1 and 10,000 in operation mode 0. The initial pulse frequency was not set between 20 and 10,000 in operation mode 1.
3	Preset value designation error	The preset value was not set between 1 to 100,000,000.
4	Steady pulse frequency designation error	The steady pulse frequency was not set between 1 and 10,000 in operation mode 0. The steady pulse frequency was not set between 20 and 10,000 in operation mode 1.
5	Frequency change time designation error	The frequency change time was not set between 10 and 10,000.
7	Control direction designation error	The control direction was not set to 0 or 1.
8	Exceeded pulse count error	The number of frequency change pulses exceed the total number of output pulses (Note 1).
9	The initial pulse frequency was set to the same frequency as the steady pulse frequency or it was set to a value larger than the steady pulse frequency (Note 2).	

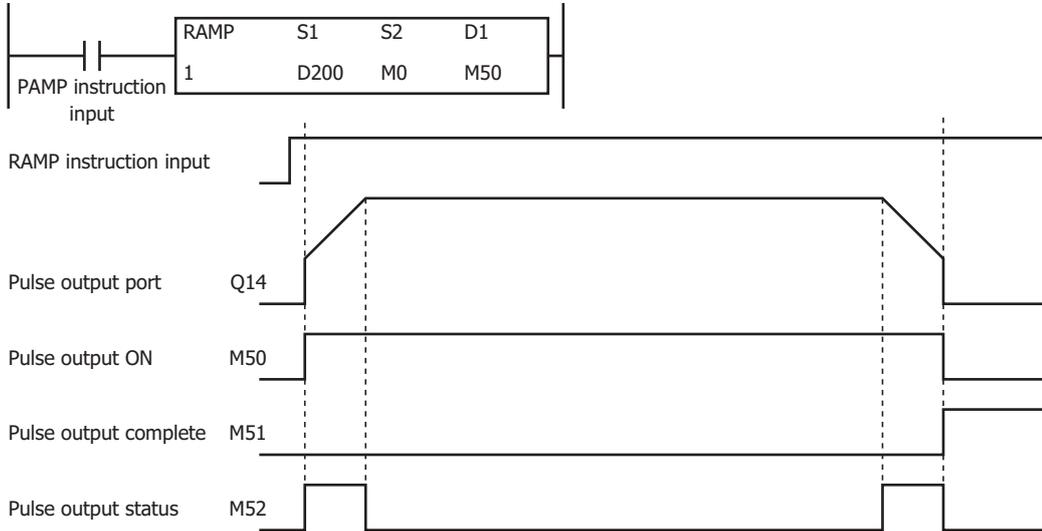
**Notes 1:** The number of pulses in the frequency change region calculated by the initial pulse frequency, steady pulse frequency, and frequency change time has exceeded the total number of output pulses. Adjust the settings by decreasing the steady or initial pulse frequency or by shortening the frequency change time.

**Notes 2:** Set the initial pulse frequency so that it is lower than the steady pulse frequency.

**Examples: RAMP**

**RAMP1 instruction (reversible control disabled) timing chart**

**[RAMP1 instruction, S1 is specified as D200, D1 is specified as internal relay M50]**



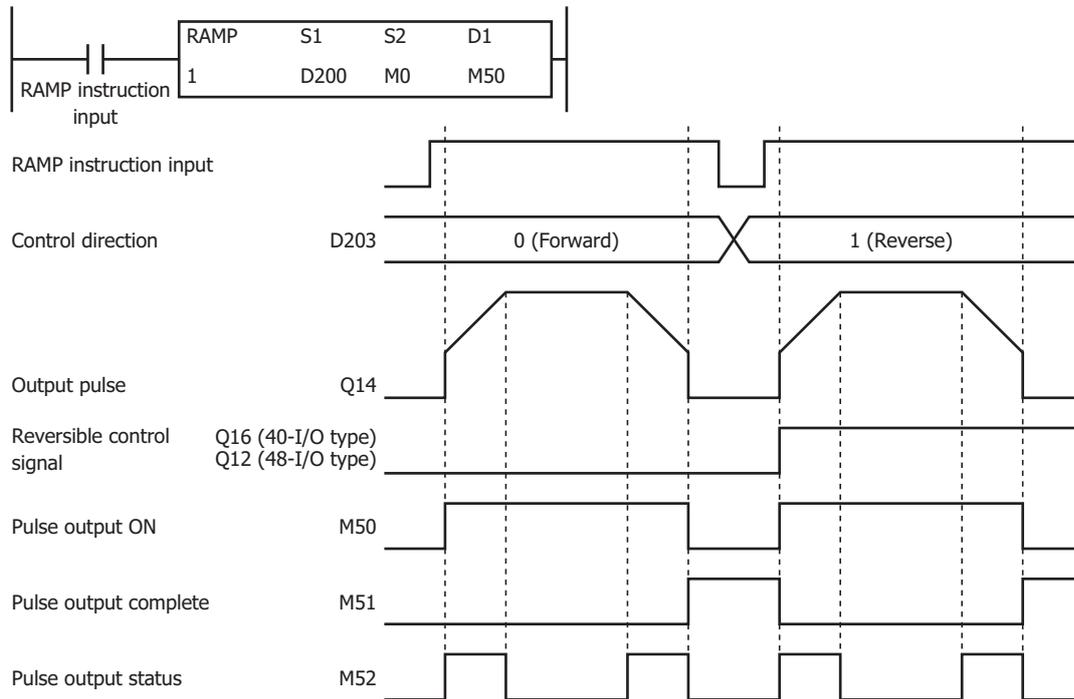
When the RAMP instruction input is on, pulses are output according to the settings configured by the control registers. M50 turns on during pulse output. M52 turns on or off while increasing or decreasing the pulse frequency. Pulses are output according to the frequency change time, until they reach the steady pulse frequency (from the initial pulse frequency). The frequency increases or decreases every 10 ms. Pulse output stops when the pulses configured by the preset value are output. At this time, M50 turns off and M51 turns on.

If the RAMP instruction input turns off during pulse output, pulse output is canceled. If the RAMP instruction input turns on again, the pulse count is reset and pulse counting starts. Even if the contents of the control registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the RAMP instruction is executed.

The changes from the initialization input are not reflected while the RAMP1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

**RAMP1 instruction (reversible control enabled, single-pulse output mode) timing chart**

[RAMP1 instruction, S1 is specified as D200, D1 is specified as internal relay M50]



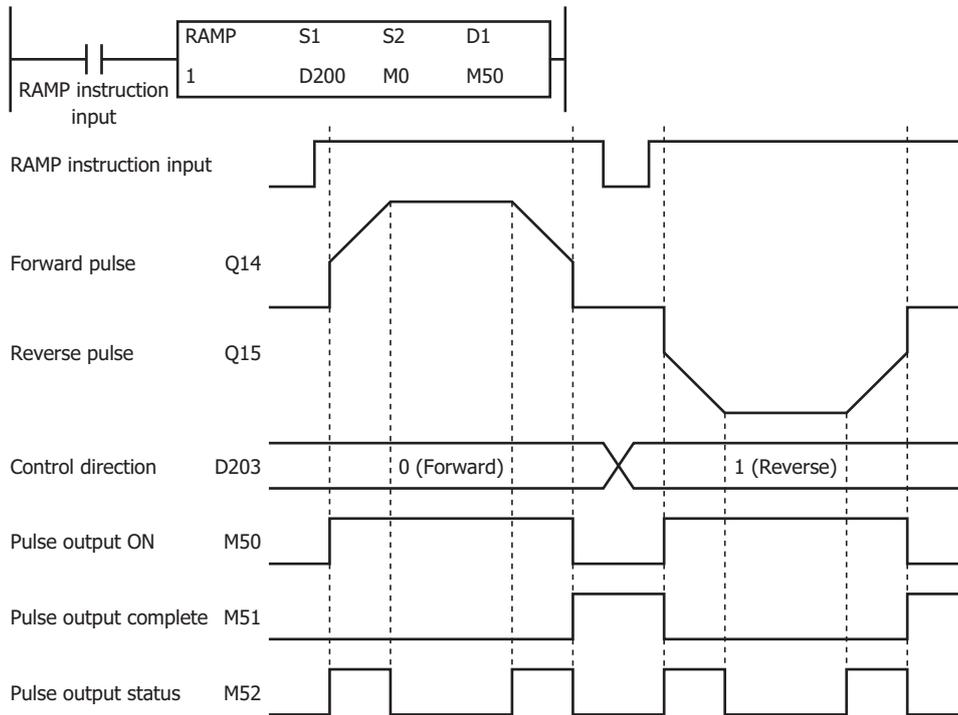
When the RAMP instruction input is on, pulses are output according to the settings configured by the control registers. The reversible control signal is output from Q16 or Q12. When pulse output starts, M50 turns on. M52 turns on while the pulse frequency is increasing or decreasing. The pulses increase according to the frequency change time every 10 ms until they reach the steady pulse frequency (from the initial pulse frequency). When the configured number of pulses are output, the pulses stop. In this situation, M50 turns off and M51 turns on.

If the RAMP instruction input turns off during pulse output, pulse output is canceled. If this input turns on again, the operation starts from the beginning. Even if the contents of the data registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the RAMP instruction is started.

The changes from the initialization input are not reflected while the RAMP1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

**RAMP1 instruction (reversible control enabled, dual-pulse output mode) timing chart**

[RAMP1 instruction, S1 is specified as D200, D1 is specified as internal relay M50]



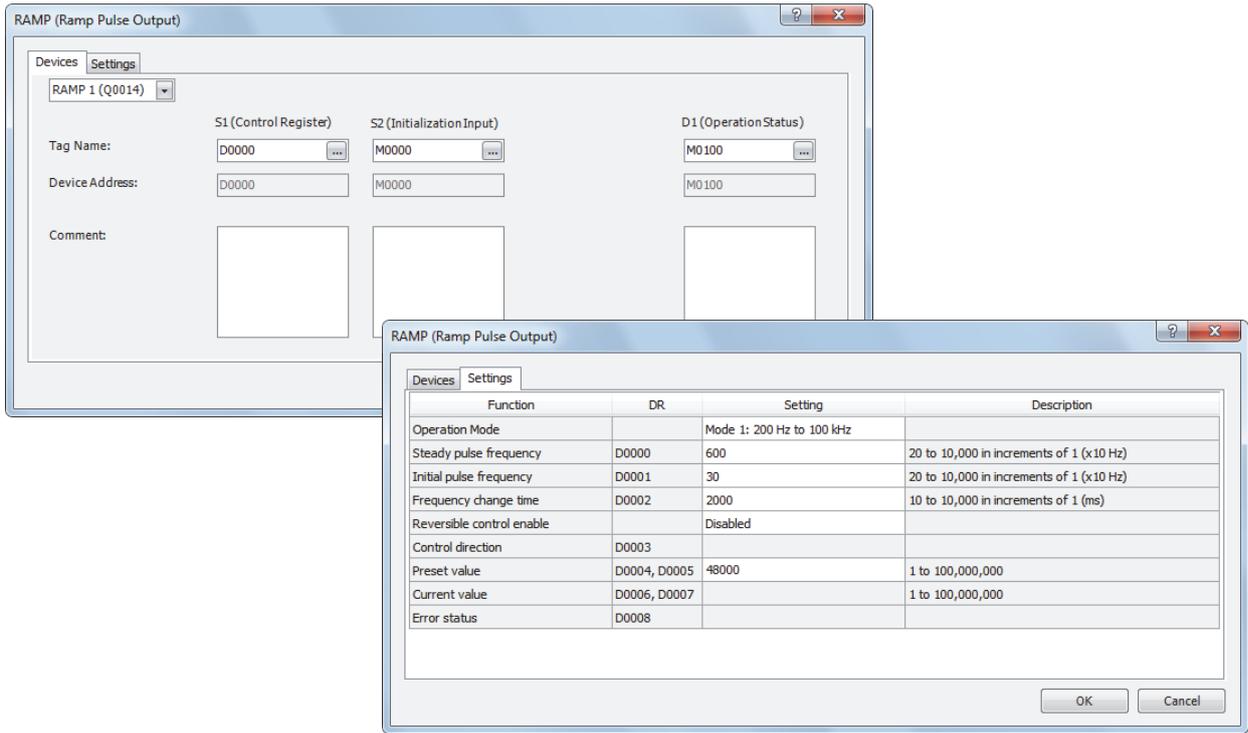
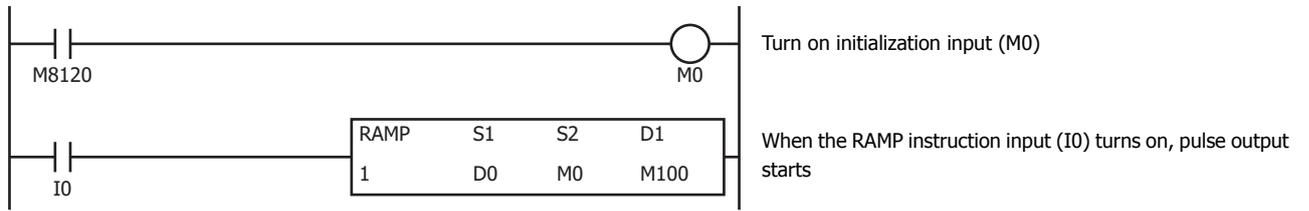
When the RAMP instruction input changes from off to on, pulses are output from Q14 or Q15 according to the settings configured by the data registers. When pulse output starts, M50 turns on. M52 turns on while the pulse frequency is increasing or decreasing. The pulses increase according to the frequency change time every 10 ms until they reach the steady pulse frequency (from the initial pulse frequency). When the configured number of pulses are output, the pulses stop. In this situation, M50 turns off and M51 turns on.

If the RAMP instruction input turns off during pulse output, pulse output is canceled. If this input turns on again, the operation starts from the beginning. Even if the contents of the data registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the RAMP instruction is started.

The changes from the initialization input are not reflected while the RAMP1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

Sample program

[To output 48,000 pulses with the frequency change function (reversible control disabled) from Q14]



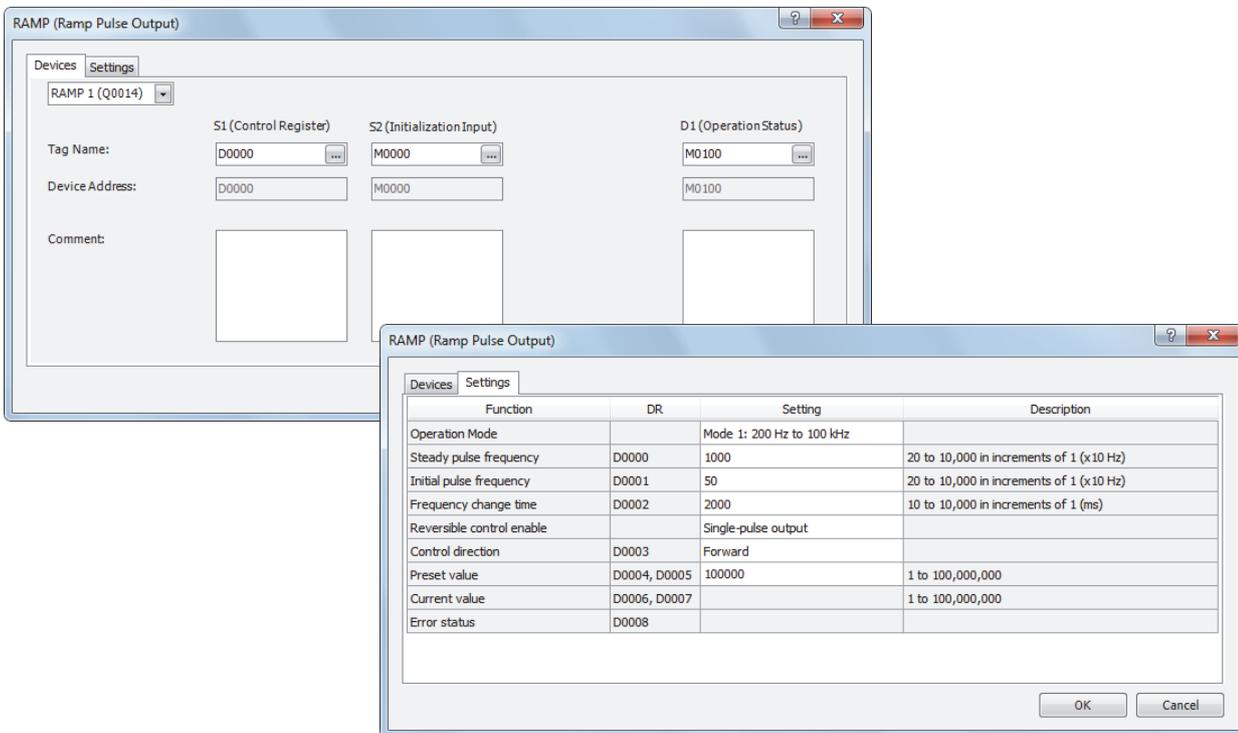
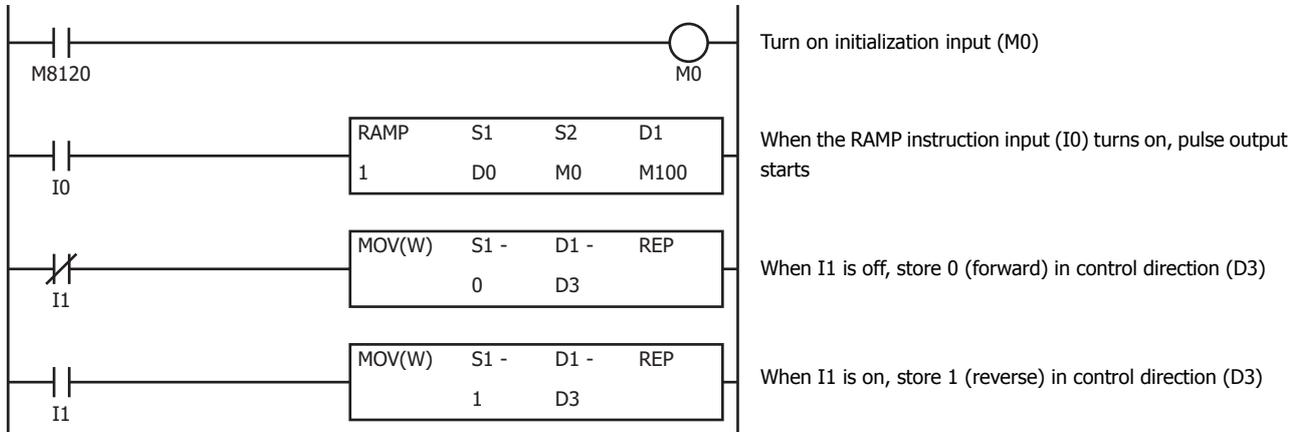
Function	Device address	Setting value	Details
Operation mode	—	Mode 1	200 Hz to 100 kHz
Steady pulse frequency	D0	600	6000 Hz
Initial pulse frequency	D1	30	300 Hz
Frequency change time	D2	2000	2,000 ms
Reversible control enable	—	Disable	—
Control direction	D3	—	—
Preset value	D4, D5	48000	Preset value=48,000

## 19: PULSE OUTPUT INSTRUCTIONS

### [To output 100,000 pulses with the frequency change function (reversible control by single-pulse output) from Q14]

When the RAMP instruction input (I0) changes from off to on, pulse output starts. When I1 is off, the reversible control signal (Q15) turns off (forward).

When I1 is on, the reversible control signal (Q15) turns on (reverse).

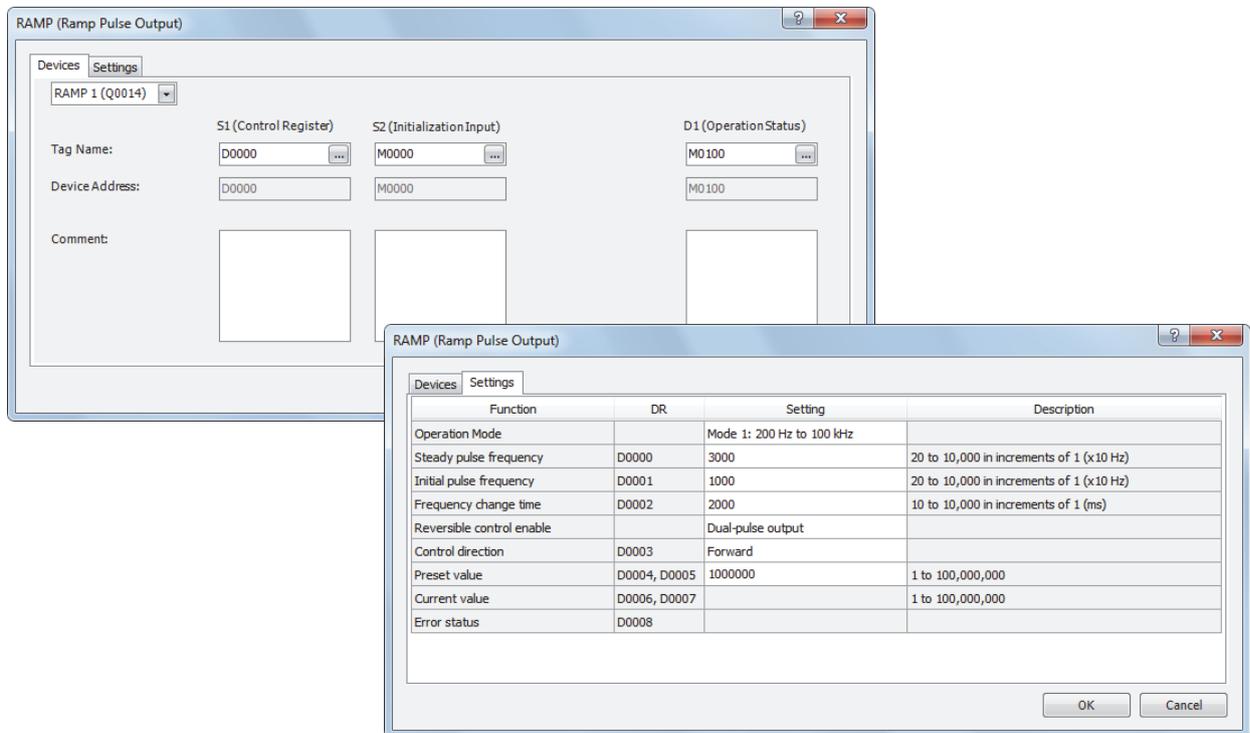
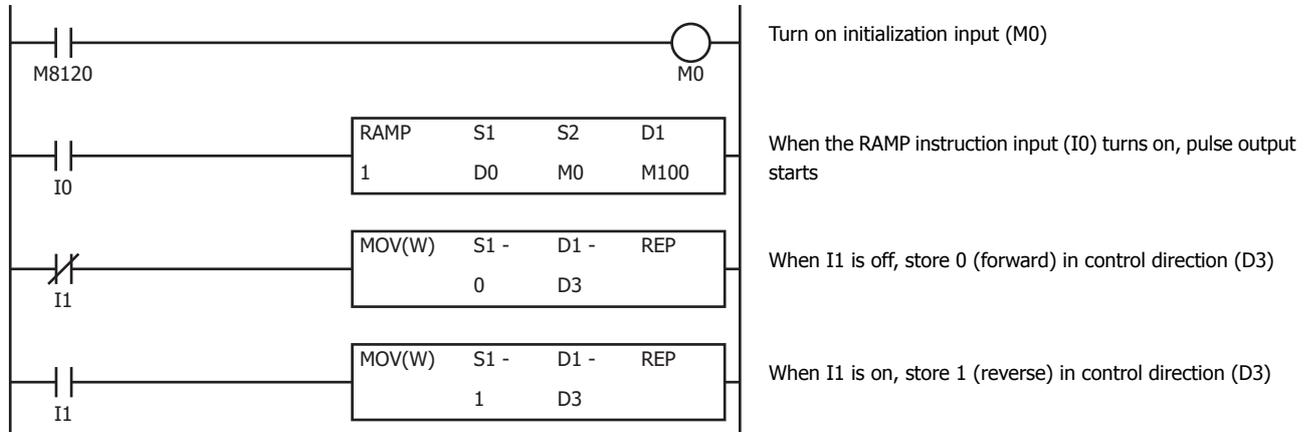


Function	Device address	Setting value	Details
Operation mode	—	Mode 1	200 Hz to 100 kHz
Steady pulse frequency	D0	1000	10 kHz
Initial pulse frequency	D1	50	500 Hz
Frequency change time	D2	2000	2,000 ms
Reversible control enable	—	Single-pulse output	—
Control direction	D3	Forward	Forward=0
Preset value	D4, D5	100000	Preset value=100,000

**[To output 1,000,000 pulses with the frequency change function (reversible control by dual-pulse output)]**

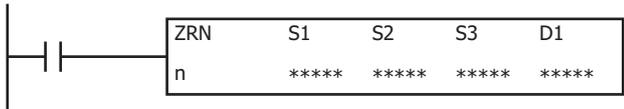
When the RAMP instruction input (I0) changes from off to on, pulse output starts. For forward when I1 is off, pulses (CW) are output from Q14.

For reverse when I1 is on, pulses (CCW) are output from Q15.



Function	Device address	Setting value	Details
Operation mode	—	Mode 1	200 Hz to 100 kHz
Steady pulse frequency	D0	3000	30 Hz
Initial pulse frequency	D1	1000	10 kHz
Frequency change time	D2	2000	2,000 ms
Reversible control enable	—	Dual-pulse output	—
Control direction	D3	Forward	Forward=0
Preset value	D4, D5	1000000	Preset value=1,000,000

**ZRN (Zero Return)**



The ZRN instruction outputs pulses while the proximity signal is off.

When the input is on, pulses of the initial pulse frequency specified by S1 and S1+1 are output until the proximity signal specified by S3 turns on.

When the proximity signal turns on, pulses of the creep pulse frequency specified by S1+2 and S1+3 are output until the proximity signal turns off.

When the proximity signal turns off, pulse output stops.

**Note:** The ZRN instruction cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X (Note)	X	—

**Note:** These instructions cannot be used with FT1A-H40RC and FT1A-B40RC.

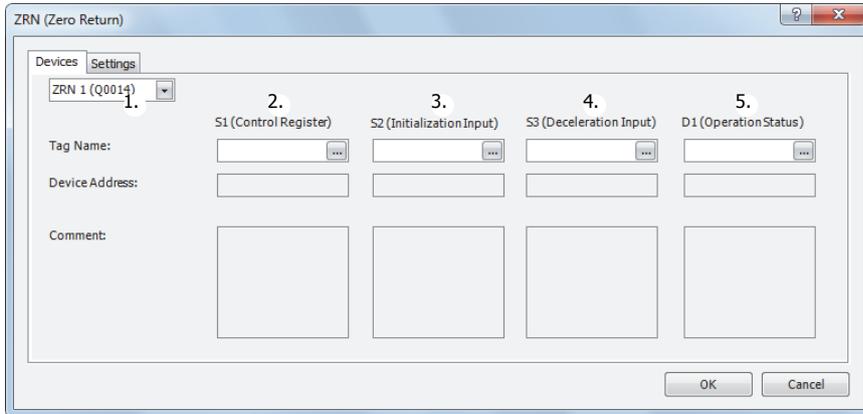
**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Control register	—	—	—	—	—	—	▲	—	—
S2 (Source 2)	Initialization input	X	—	X	—	—	—	—	—	—
S2 (Source 3)	Proximity signal	X	—	X	—	—	—	—	—	—
D1 (Destination 1)	Operation status	—	—	▲	—	—	—	—	—	—

▲ Special data registers cannot be designated as S1. Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1. Caution: The first digit of the internal relay number must be 0 (not 1 to 7). Otherwise, the ZRN instruction will not operate correctly.

**Settings**

• **Device tab**



**1. Select instruction**

This item selects which ZRN instruction to use (ZRN1 or ZRN2).

The output differs by the instruction.

Instruction	Pulse output
ZRN1	Q14
ZRN2	Q15

**2. S1 (source 1): Control register**

S1 specifies the starting number of the data registers to use with ZRN1 or ZRN2 instructions.

Starting from the specified number, 3 consecutive 16-bit data registers are used.

The range of available data register numbers is D0 to D997 and D1000 to D1997.

Storage destination	Function	Setting	Reference
Starting number+0	Initial pulse frequency	0: 1 to 10,000 (increments of 1 Hz) 1: 20 to 10,000 (increments of 10 Hz)	"7. Initial pulse frequency" on page 19-28
Starting number+1	Creep pulse frequency	0: 1 to 10,000 (increments of 1 Hz) 1: 20 to 10,000 (increments of 10 Hz)	"9. Creep pulse frequency" on page 19-29
Starting number+2	Error status	0/2	"10. Error status" on page 19-29

**3. S2 (source 2): Initialization input**

S2 specifies the initialization input. When the initialization input S2 is turned on, the initial values configured in the WindLDR ZRN instruction dialog box, on the **Setting** tab, are stored in the control registers. An external input (I0 to I35) (Note) or an internal relay (M0 to M1277) can be specified.

When the initialization input is on, the initial values are written to the data registers with each scan. To only initialize the values one time, use the initialization input in combination with the SOTU (single output up) instruction or the SOTD (single output down) instruction.

**Note:** For the 40-I/O type, external inputs (I0 to I27) can be used.

## 19: PULSE OUTPUT INSTRUCTIONS

### 4. S3 (source 3): Proximity signal

S3 specifies the proximity signal. Specify either an external input or an internal relay.

The external input can be specified as (I0 to I35) or the internal relay can be specified as (M0 to M1277).

High-speed	I0, I2, I3, I5, I6, I7	An interrupt is used to read the proximity signal. The proximity signal can be read without being affected by the user program scan.
Normal	I1, I4, I10 to I35 M0 to M1277	The information updated in the END processing is read as the proximity signal. It is affected by the user program scan.

#### Notes:

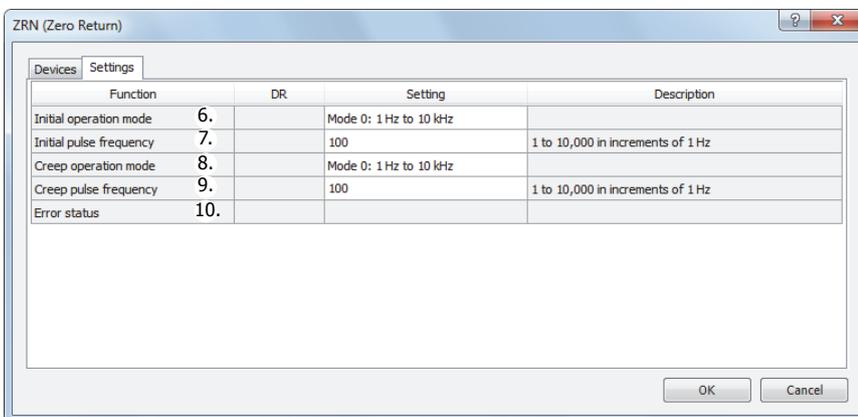
- Do not use the same input or internal relay as the proximity signal for the ZRN1 and ZRN2 instructions. If they operate simultaneously, pulse output may not stop even if the proximity signal changes from on to off.
- To use the high-speed proximity signal, set the relevant input to **Normal Input** under **Special Input** on **Function Area Settings**. Do not use the input as interrupt input, catch input, high-speed counter, or frequency measurement.
- When using the high-speed proximity signal, ensure that no chatter noise occurs in the proximity signal.

### 5. D1 (destination 1): Operation status

D1 specifies the starting number of the internal relays to use with the ZRN1 and ZRN2 instructions. Starting from the specified internal relay, this instruction uses 2 sequential internal relays. The range of available internal relays is M0 to M1270. Caution: The first digit of the internal relay number must be 0 (not 1 to 7). Otherwise, the ZRN instruction will not operate correctly.

Storage destination	Function	Setting	
Starting number+0	Pulse output ON relay	0: Pulse output OFF 1: Pulse output ON	This relay turns on during pulse output. This relay turns off when ZRN instruction output stops or when the proximity signal turns off and pulse output ends.
Starting number+1	Pulse output complete relay	0: Pulse output not complete 1: Pulse output complete	This relay turns on when the proximity signal turns off and pulse output end. This relay turns off when ZRN instruction output starts.

#### • Setting tab



### 6. Initial operation mode

This setting selects the range of frequencies to output from the two modes.

Initial operation mode
0: 1 Hz to 10 kHz (increments of 1 Hz)
1: 200 Hz to 100 kHz (increments of 10 Hz)

### 7. Initial pulse frequency

This setting specifies the initial pulse frequency to output.

Initial operation mode 0: Set between 1 Hz and 10 kHz in increments of 1 Hz.

Initial operation mode 1: Set between 200 Hz and 100 kHz in increments of 10 Hz.

**8. Creep operation mode**

This setting selects the range of frequencies to output from the two modes.

Creep operation mode
0: 1 Hz to 10 kHz (increments of 1 Hz)
1: 200 Hz to 100 kHz (increments of 10 Hz)

**9. Creep pulse frequency**

This setting specifies the creep pulse frequency to output.

Creep operation mode 0: Set between 1 Hz and 10 kHz in increments of 1 Hz.

Creep operation mode 1: Set between 200 Hz and 100 kHz in increments of 10 Hz.

**10. Error status**

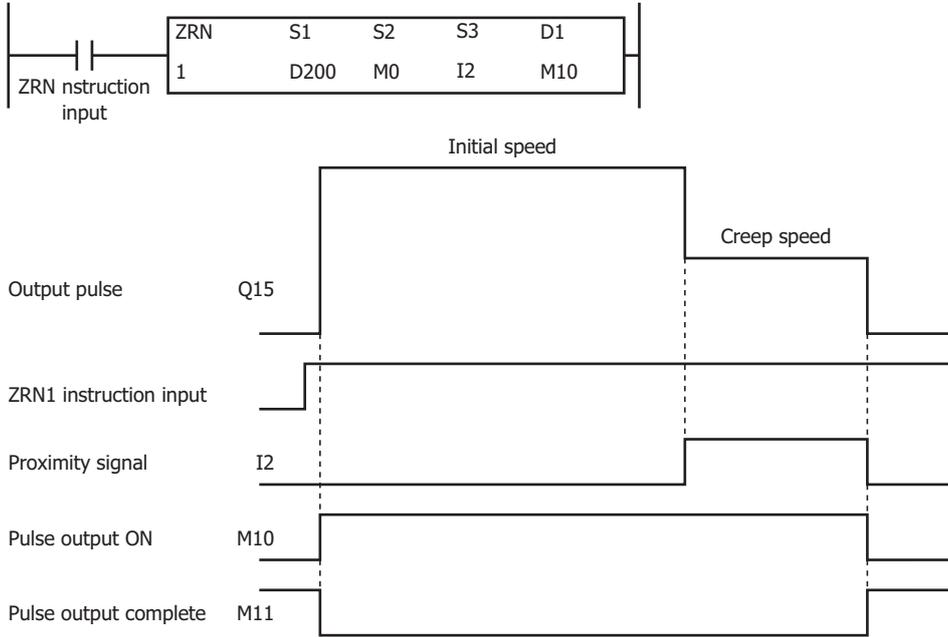
If a configuration error occurs when the ZRN instruction is being executed, M8004 (user program execution error) is turned on and this relay is set to the error code.

Error code	Status	Description
0	Normal	—
2	Pulse frequency designation error	The pulse frequency was not set between 1 and 10,000 in initial pulse operation mode 0/creep operation mode 0. The pulse frequency was not set between 20 and 10,000 in initial pulse operation mode 1/creep operation mode 1.

**Examples: ZRN**

**ZRN1 instruction timing chart**

[ZRN1 instruction, S1 is specified as data register D200, S3 is specified as external input I2, D1 is specified as internal relay M10]



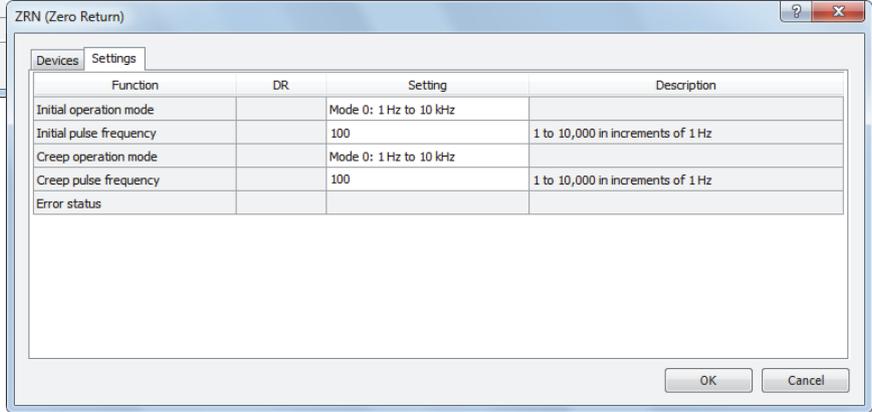
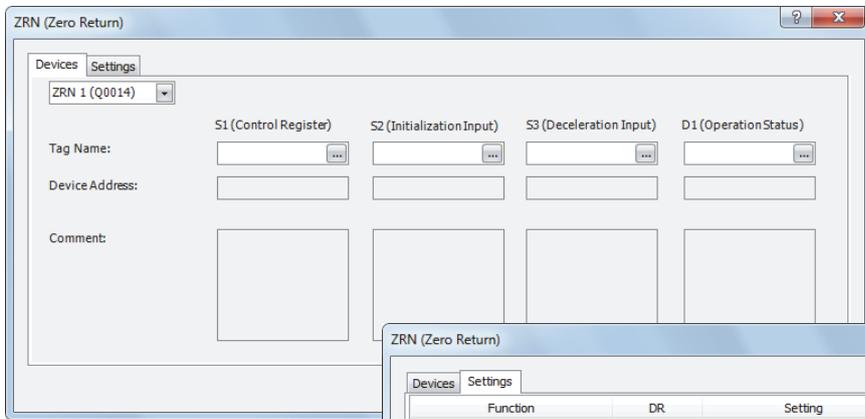
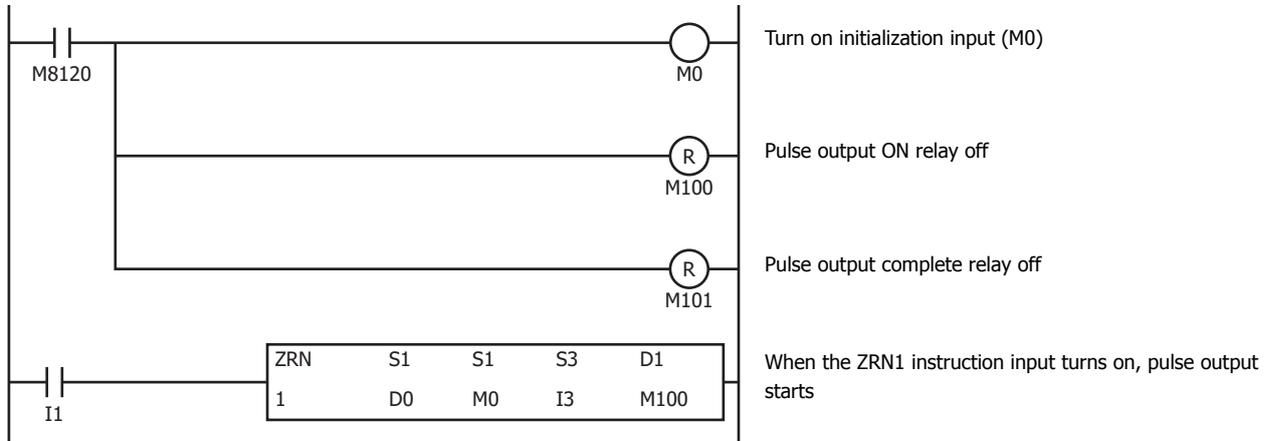
When the ZRN1 instruction changes from off to on, pulses are output at the initial pulse frequency. When pulse output starts, M10 turns on and M11 turns off. When I2 changes from off to on, pulses are output at the creep pulse frequency. When I2 changes from on to off, pulse output stops. When pulse output stops, M10 turns off and M11 turns on.

If the ZRN1 instruction input turns off during pulse output, pulse output stops. If the input turns on again, the operation starts from the beginning. Even if the contents of the data registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the ZRN1 instruction starts.

The changes from the initialization input are not reflected while the ZRN1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

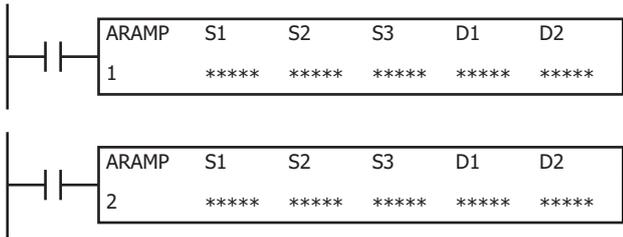
Sample program

[To perform a zero return operation with proximity signal I3, initial pulse frequency 3 kHz, and creep pulse frequency 800 Hz]



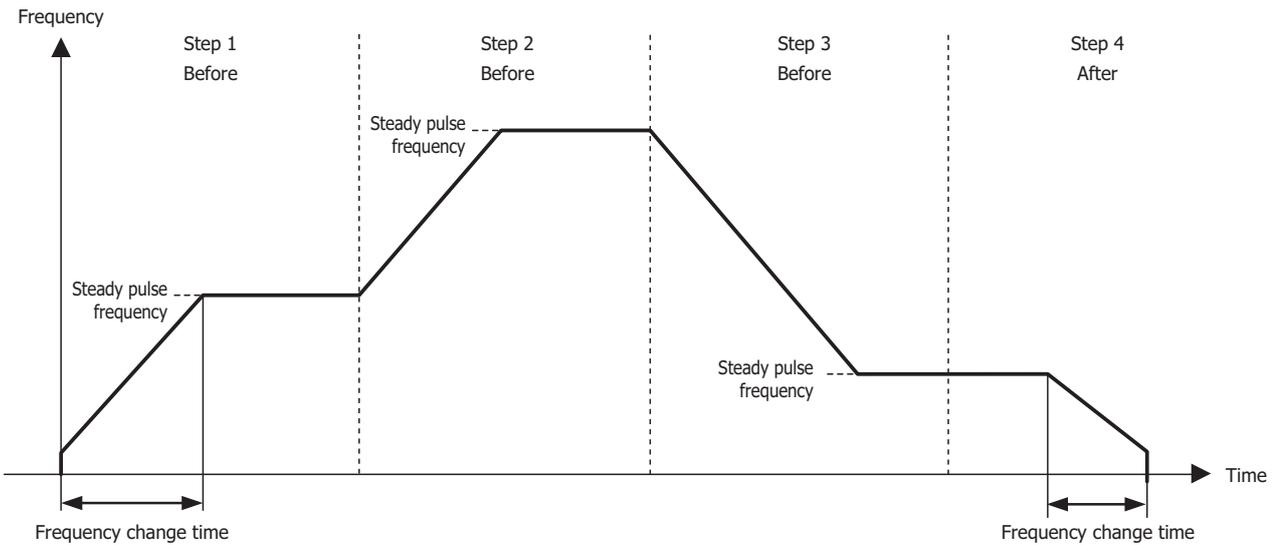
Function	Device address	Setting value	Details
Initial operation mode	—	Mode 0	1 Hz to 10 kHz
Initial pulse frequency	D0	3000	3 kHz
Creep operation mode	—	Mode 0	1 Hz to 10 kHz
Creep pulse frequency	D1	800	800 Hz

ARAMP (RAMP with Table)



The ARAMP instructions output pulses with the frequency change function according to the information in the frequency table.

When the input is on, pulses are output according to the frequency change settings stored in the control register settings specified by S1. The pulse frequency is controlled by combining multiple steps that define the change time and steady pulse speed. The pulses change frequency at a constant rate until they reach the steady pulse frequency in the step option settings. You can select to output pulses at the steady pulse frequency or to change the frequency at a constant rate until the steady pulse frequency is reached, after pulses that maintain the frequency in the previous step are output. The next step is executed when the number of pulses output reaches the preset value. You can configure a maximum of 18 steps.



When the initialization input specified by S2 is turned on, the initial values configured in the WindLDR ARAMP instruction are stored in the control registers.

When the interrupt input configured by S3 is turned on, the step being executed is aborted and the interrupt step is executed. The settings for the step being executed, including the preset value and the steady pulse frequency, are stored in the data registers specified by D1.

The control status, including the pulse output status (output on, output direction, output complete), is set as the operation status in the internal relays specified by D2.

**Note:** Configure multiple PULS (pulse output), PWM (pulse width modulation), RAMP (ramp control), and ARAMP (RAMP with table) instructions so that they do not share the same pulse output port.

However, the ZRN (zero return) instruction can be configured with the same pulse output port as the PULS (pulse output), PWM (pulse width modulation), RAMP (ramp control), and ARAMP (RAMP with table) instructions.

**Note:** The ARAMP instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X (Note)	X	—

**Note:** These instructions cannot be used with FT1A-H40RC and FT1A-B40RC.

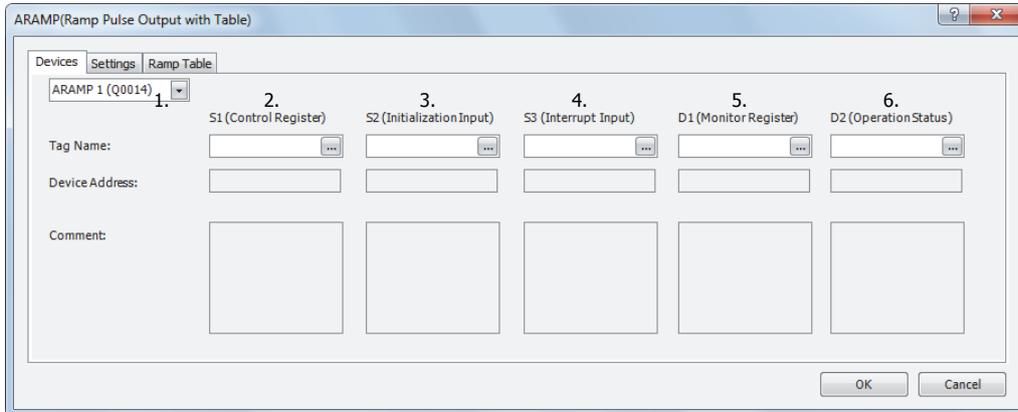
Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Control register	—	—	—	—	—	—	▲	—	—
S2 (Source 2)	Initialization input	X	—	X	—	—	—	—	—	—
S3 (Source 3)	Interrupt input	X	—	X	—	—	—	—	—	—
D1 (Destination 1)	Monitor register	—	—	—	—	—	—	▲	—	—
D2 (Destination 2)	Operation status	—	—	▲	—	—	—	—	—	—

▲ Special data registers cannot be designated as S1. Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1. The first digit of the internal relay number must be set to 0.

Settings

• Device tab



1. Select instruction

This item selects which ARAMP instruction to use (ARAMP1 or ARAMP2).

The reversible control mode that can be selected varies based on the instruction.

For limitations based on the combination of instruction, reversible control mode, and the pulse output mode, see "8. Reversible control enable" on page 19-37.

2. S1 (source 1): Control register

S1 specifies the starting number of the data registers to use with the ARAMP1 or ARAMP2 instruction.

Starting from the specified data register, "2+6 x N (N: number of steps)" consecutive 16-bit data registers are used.

The range of available data register numbers is D0 to D992 (dependent on the number of steps).

The steps operate with the settings that are configured when the steps start. If the settings for a step are changed after it starts running, those changes are not reflected while the step is running.

Storage destination	Function	Setting	Reference
Starting number+0	Interrupt number	1 to 18	"11. Interrupt number" on page 19-37
Starting number+1	Reserved		
<b>Step 1 (6 words)</b>			
Starting number+2	Steady pulse frequency	Mode 0: 1 to 10,000 (increments of 1 Hz) Mode 1: 20 to 10,000 (increments of 10 Hz)	"13. Steady pulse frequency" on page 19-38
Starting number+3	Frequency change time	10 to 10,000 ms	"14. Frequency change time" on page 19-38
Starting number+4	Preset value (high word) (Note)	1 to 100,000,000 pulses	"15. Preset value" on page 19-38
Starting number+5	Preset value (low word) (Note)		
Starting number+6	Step options	0 to 3	"16. Step options" on page 19-38
Starting number+7	Next step number	1 to 18	"17. Next step number" on page 19-38

**Note:** The upper and lower data registers change according to the 32-bit data storage method specified.

For details, see Chapter 5 "Special Functions" – "32-bit Data Storage Setting" in the SmartAXIS Pro/Lite User's Manual.

## 19: PULSE OUTPUT INSTRUCTIONS

### Step 2 (6 words)

Storage destination	Function	Setting	Reference
Starting number+8	Steady pulse frequency	Mode 0: 1 to 10,000 (increments of 1 Hz) Mode 1: 20 to 10,000 (increments of 10 Hz)	"13. Steady pulse frequency" on page 19-38
:	:	:	:
Starting number+13	Next step number	1 to 18	"17. Next step number" on page 19-38

### Step N (6 words)

Starting number+2+N x 6-6	Steady pulse frequency	Mode 0: 1 to 10,000 (increments of 1 Hz) Mode 1: 20 to 10,000 (increments of 10 Hz)	"13. Steady pulse frequency" on page 19-38
:	:	:	:
Starting number+7+N x 6-6	Next step number	1 to 18	"17. Next step number" on page 19-38

### 3. S2 (source 2): Initialization input

S2 specifies the initialization input.

When the initialization input S2 is turned on, the initial values configured in the WindLDR ARAMP instruction dialog box, on the **Setting** tab, are stored in the control registers.

An external input (I0 to I35) (Note) or an internal relay (M0 to M1277) can be specified.

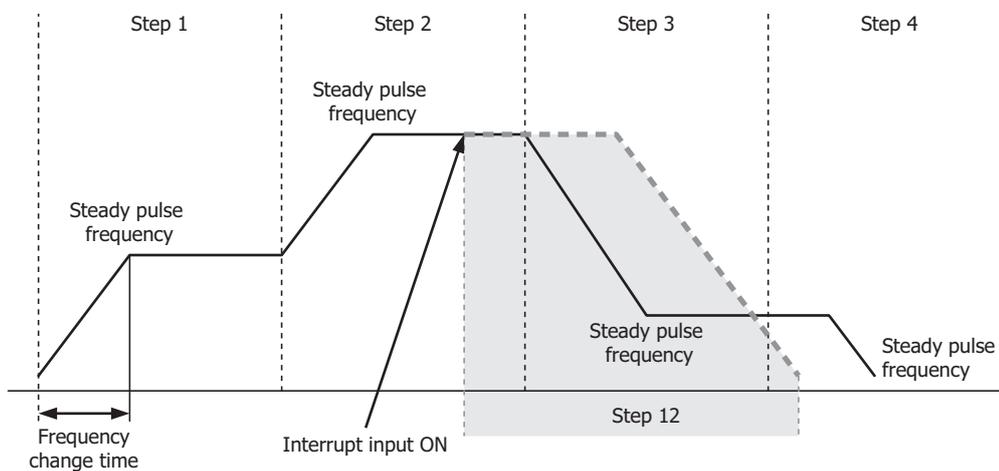
When the initialization input is on, the initial values are written to the data registers with each scan. To only initialize the values one time, use the initialization input in combination with the SOTU (single output up) instruction or the SOTD (single output down) instruction.

**Note:** For the 40-I/O type, external inputs (I0 to I27) can be used.

### 4. S3 (source 3): Interrupt input

When the interrupt input changes from off to on, the pulse output process for the running step is aborted, and pulse output restarts with the settings for the step configured by the interrupt number.

In the following example, the interrupt input turns on while step 2 is running. Pulse output processing for step 2 aborts and the operation transitions to step 12.



An external input (I0 to I35) or internal relay (M0 to M1277) can be specified as the interrupt input.

High-speed	I0, I2, I3, I5, I6, I7	An interrupt is used to read the interrupt input. The interrupt input can be read without being affected by the user program scan.
Normal	I1, I4, I10 to I35 M0 to M1277	The information updated in the END processing is read as the interrupt input. It is affected by the user program scan.

#### Notes:

- Do not use the same input or internal relay as the interrupt input signal for the ARAMP1 and ARAMP2 instructions.
- To use the high-speed interrupt input signal, set the relevant input to **Normal Input** under **Special Input** on **Function Area Settings**. Do not use the input as interrupt input, catch input, high-speed counter, or frequency measurement.
- When using the high-speed interrupt input, ensure that no chatter noise occurs in the interrupt input.

**5. D1 (destination 1): Monitor register**

D1 specifies the starting number of the data registers to use with ARAMP1 or ARAMP2. Starting from the specified number, 9 consecutive 16-bit data registers are used. The range of available data register numbers is D0 to D991 and D1000 to D1991. The contents of the monitor registers are read-only.

Address	Description		Value range (unit)
Starting number+0	Next step number		0 to 18
Starting number+1	Running step number		1 to 18
Starting number+2	Steady pulse frequency monitor		Mode 0: 1 to 10,000 (increments of 1 Hz), mode 1: 20 to 10,000 (increments of 10 Hz)
Starting number+3	Frequency change time monitor		10 to 10,000 ms
Starting number+4	Preset value monitor	(High word) (Note)	1 to 100,000,000 pulses
Starting number+5		(Low word) (Note)	
Starting number+6	Current value	(High word) (Note)	1 to 100,000,000 pulses
Starting number+7		(Low word) (Note)	
Starting number+8	Error status		0 to 9

**Note:** The upper and lower data registers change according to the 32-bit data storage method specified. For details, see Chapter 5 "Special Functions" – "32-bit Data Storage Setting" in the SmartAXIS Pro/Lite User's Manual.

**Next step**

This register stores the number of the step to execute next.  
If the next step is 0, pulse output ends after the currently executed step is complete.

**Running step**

This register stores the number of the step that is currently being executed.

**Steady pulse frequency monitor**

This register stores the steady pulse frequency for the step that is currently being executed.

**Frequency change time monitor**

This register stores the frequency change time for the step that is currently being executed.  
Set the time between 10 and 10,000 ms in increments of 10 ms. The first digit of the setting is discarded.

**Preset value monitor**

This register stores the preset value for the step that is currently being executed.

**Current value**

This register stores the number of pulses that have been output for the step that is currently being executed. The current value is updated when the ARAMP instruction is executed at each scan.

**Error status**

If a configuration error occurs when a step starts executing, M8004 (user program execution error) is turned on and this register is set to the error code.

Error code	Status	Description
0	Normal	—
3	Preset value designation error	The preset value was not set between 1 to 100,000,000.
4	Steady pulse frequency designation error	The frequency was not set between 1 to 10,000 in operation mode 0. The frequency was not set between 20 to 10,000 in operation mode 1.
5	Frequency change time designation error	The frequency change time was not set between 10 and 10,000.
7	Step options designation error	The step options were not set to a valid value.
8	Next step number destination error	The next step number was not set between 0 and 18.
9	Interrupt number destination error	The interrupt number was not set between 1 and 18.

## 19: PULSE OUTPUT INSTRUCTIONS

### 6. D2 (destination 2): Operation status

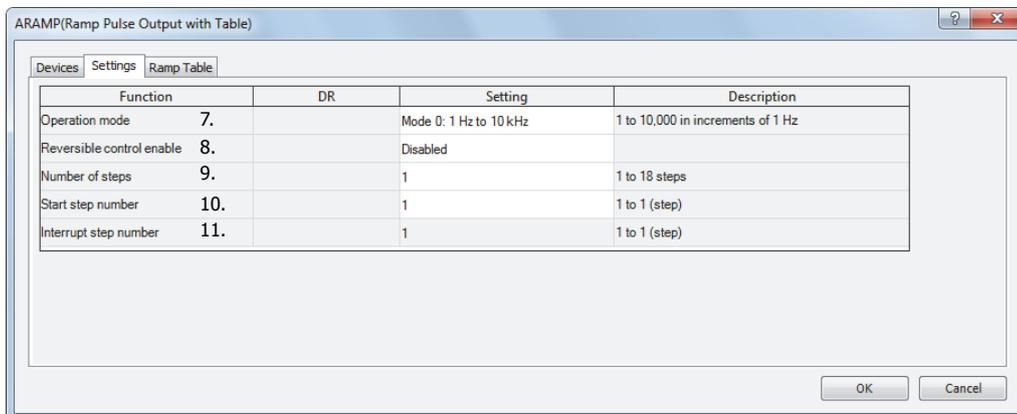
D2 specifies the starting number of the internal relays to use with ARAMP1 and ARAMP2 instructions.

Starting from the specified internal relay, 5 sequential internal relays are used.

The range of available internal relay numbers is M0 to M1270. The first digit of the internal relay number must be set to 0.

Address	Description		
Starting number+0	Pulse output ON	0: Pulse output OFF 1: Pulse output ON	This relay turns on during pulse output. This relay turns off when the ARAMP instruction output stops. This relay turns off when the specified number of pulses are output and output ends
Starting number+1	Pulse output complete	0: Pulse output not complete 1: Pulse output complete	This relay turns on when pulse output completes. This relay turns on when the step number currently being executed is 0. This relay turns off when the ARAMP instruction output starts.
Starting number+2	Pulse output status	0: Steady pulse output 1: Changing output pulse frequency	This relay turns off when the pulse output status is steady. This relay turns on when the pulse output is changing.
Starting number+3	Overflow	0: None 1: An overflow has occurred	This relay turns on when the pulses output exceed the configured preset value. Pulse output continues even if an the overflow occurs during steady output or while the pulse frequency is changing. However, pulse counting (current value data register) is suspended at the point when the overflow occurred.
Starting number+4	Pulse output direction	0: Forward 1: Reverse	This relay turns off when the output direction of the pulses being output is forward. This relay turns on when the output direction of the pulses being output is reverse.

### • Setting tab



### 7. Operation mode

This setting selects the frequency range to output from following operation modes.

Operation mode
0: 1 Hz to 10 kHz (increments of 1 Hz) (Note)
1: 200 Hz to 100 kHz (increments of 10 Hz) (Note)

**Note:** The output frequency error is within  $\pm 5\%$ .

**8. Reversible control enable**

This setting enables or disables reversible control and selects the reversible control method from the following modes.

Reversible control enable	
0:	Reversible control disabled
1:	Reversible control (single-pulse output)
2:	Reversible control (dual-pulse output)

There are two modes for the pulse output mode: single-pulse and dual-pulse. They can be combined with reversible control as follows.

Reversible control disabled	Select this option when using pulse output in a single direction. Pulse A and pulse B can be used independently.	
Reversible control Single-pulse output mode	Pulse A is used as pulse output. Pulse B on/off is used as reversible control.	
Reversible control Dual-pulse output mode	Pulse A is used as forward pulse (CW) output. Pulse B is used as reverse pulse (CCW) output.	

The ports used on the SmartAXIS varies based on the instruction used, the combination of the pulse output mode and reversible control, and the model used.

Instruction	Operating condition	Port used			
		40-I/O type		48-I/O type	
		Pulse output port	Reversible control port	Pulse output port	Reversible control port
ARAMP1	Reversible control disabled	Q14	—	Q14	—
	Reversible control (single-pulse output)	Q14	Q16 (Note)	Q14	Q12
	Reversible control (dual-pulse output)	Q14	Q15	Q14	Q15
ARAMP2	Reversible control disabled	Q15	—	Q15	—
	Reversible control (single-pulse output)	Q15	Q17 (Note)	Q15	Q13
	Dual-pulse mode cannot be used.	—	—	—	—

**Note:** When using single-pulse mode on the 40-I/O type, Q16 or Q17 are used. Therefore, PULS3, PWM3, or PULS4, PWM4 cannot be used.

**9. The number of steps**

This setting specifies the number of steps. The maximum is 18.

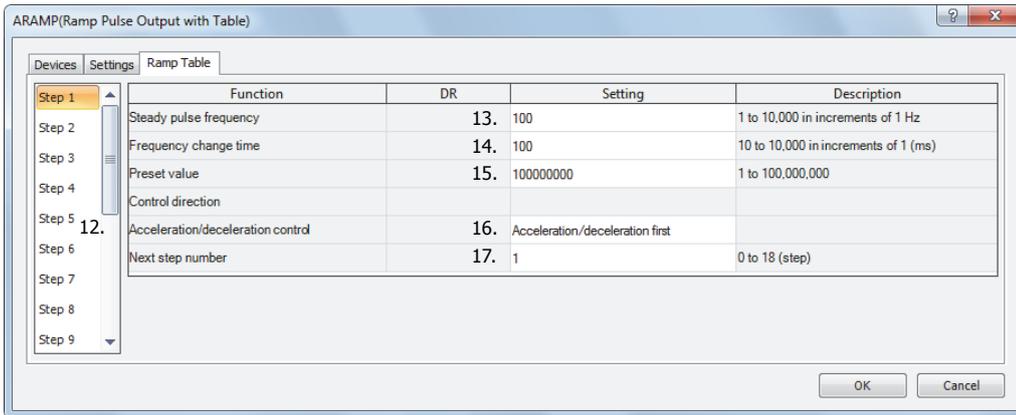
**10. Start number**

When the input changes from off to on, pulse output starts with the settings for the step configured as the start number.

**11. Interrupt number**

When the interrupt input changes from off to on, the pulse output process for the running step is aborted, and pulse output restarts with the settings for the step configured by the interrupt number.

• ARAMP step settings



**12. Step numbers**

This option selects the step number to configure.

**13. Steady pulse frequency**

This setting specifies the frequency at the steady output state before or after changing the frequency.

For mode 0, set this value in the range of 1 to 10,000 (increments of 1 Hz).

For mode 1, set this value in the range of 20 to 10,000 (increments of 10 Hz).

**14. Frequency change time**

This setting specifies the time to change the pulses.

Set this value in the range of 10 to 10,000 (increments of 10 ms).

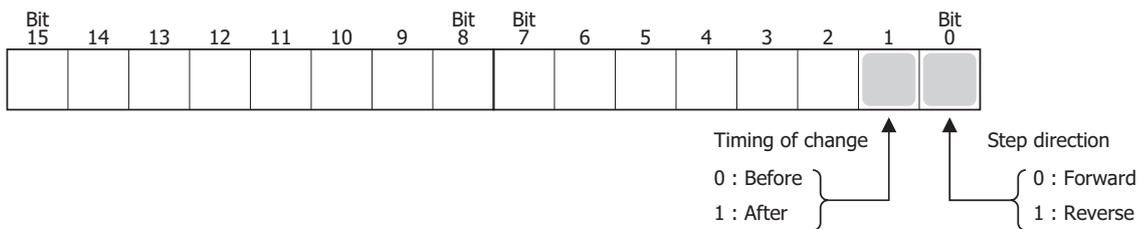
The first digit of the setting is discarded.

**15. Preset value**

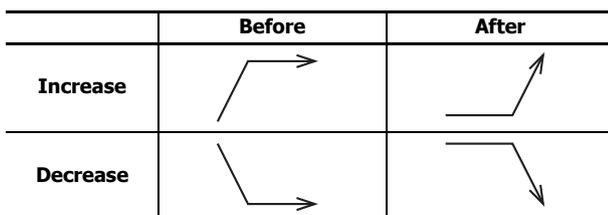
This setting configures the number of pulses to output from 1 to 100,000,000.

**16. Step options**

This setting configures the step direction and the execution timing of the change in the pulses.



The frequency changes as shown in the following diagram according to the setting for the execution timing of the change. In the Before column, the frequency changes and then becomes steady. When the number of pulses in the preset value is output, the instruction transitions to the next step. In the After column, the steady pulse frequency is maintained, then the frequency changes, and the instruction transitions to the next step.

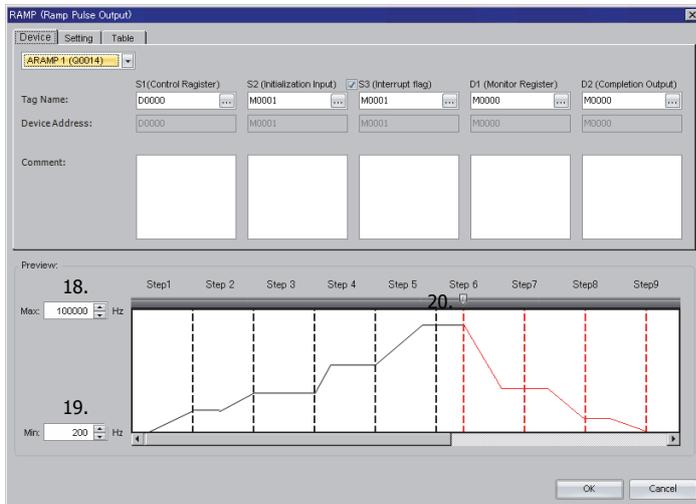


**17. Next step number**

This setting specifies the number of the next step to be executed after the output for the currently executed step is completed.

• **Preview**

The preview shows the operation with the content configured on the **Table** tab.



**18. Max**

This setting configures the maximum value for the graph. The range of values that can be entered depends on the selected mode.

**19. Min**

This setting configures the minimum value for the graph. The range of values that can be entered depends on the selected mode.

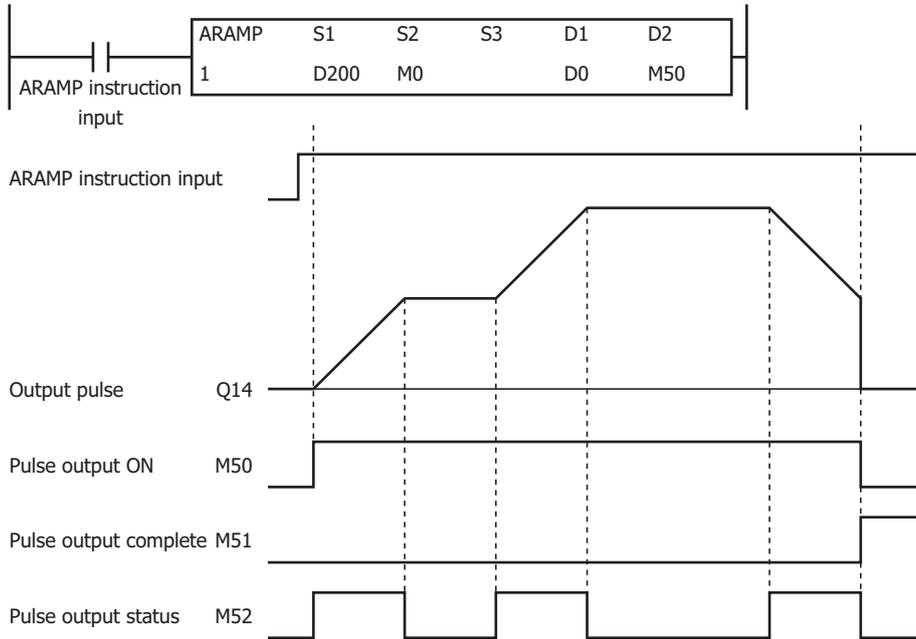
**20. Slide bar**

Move the slide bar to preview the operation when the interrupt input is executed.

**Examples: ARAMP**

**ARAMP1 instruction (reversible control disabled) timing chart**

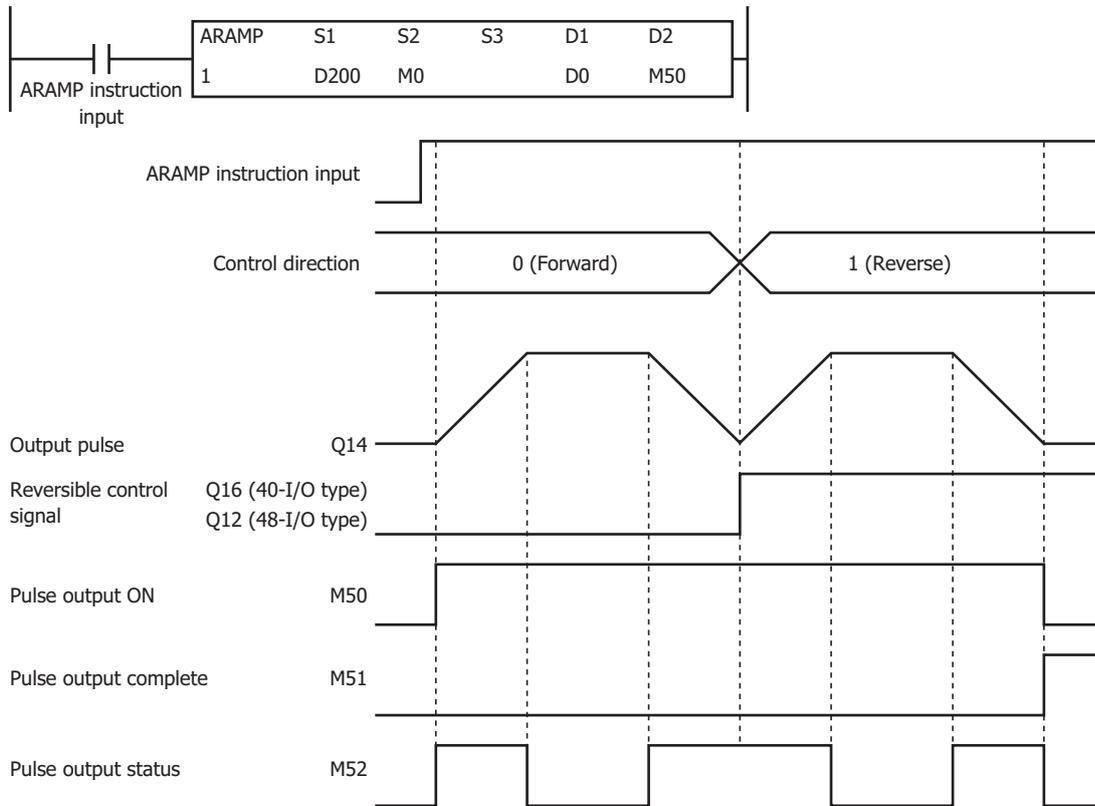
[ARAMP1 instruction, S1 is specified as data register D200, S2 is specified as internal relay M0, S3 is disabled, D1 is specified as data register D0, D2 is specified as internal relay M50]



When the ARAMP instruction input changes from off to on, pulses are output from Q14 according to the settings configured by the data registers. When pulse output starts, M50 turns on. M52 turns on while the pulse frequency is increasing or decreasing. The pulses increase according to the frequency change time until they reach the steady pulse frequency (from the initial pulse frequency). When the configured number of pulses are output, the pulses stop. In this situation, M50 turns off and M51 turns on. If the ARAMP instruction input turns off during pulse output, pulse output ends. If the ARAMP instruction input turns on again, the operation starts from the beginning. Even if the contents of the data registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the ARAMP instruction is started. The changes from the initialization input are not reflected while the ARAMP instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the ARAMP instruction input.

**ARAMP1 instruction (single-pulse output reversible control enabled) timing chart**

[ARAMP1 instruction, S1 is specified as data register D200, S2 is specified as internal relay M0, S3 is disabled, D1 is specified as data register D0, D2 is specified as internal relay M50]



When the ARAMP instruction input changes from off to on, pulses are output from Q14 according to the settings configured by the data registers. The reversible control signal is output from Q16 or Q12. When pulse output starts, M50 turns on. M52 turns on while the pulse frequency is increasing or decreasing. The pulses increase and decrease according to the frequency change time until they reach the steady pulse frequency from the current pulse frequency. When the configured number of pulses are output, the pulses stop. In this situation, M50 turns off and M51 turns on.

If the ARAMP instruction input turns off during pulse output, pulse output ends. If this input turns on again, the operation starts from the beginning. Even if the contents of the data registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the ARAMP instruction is started.

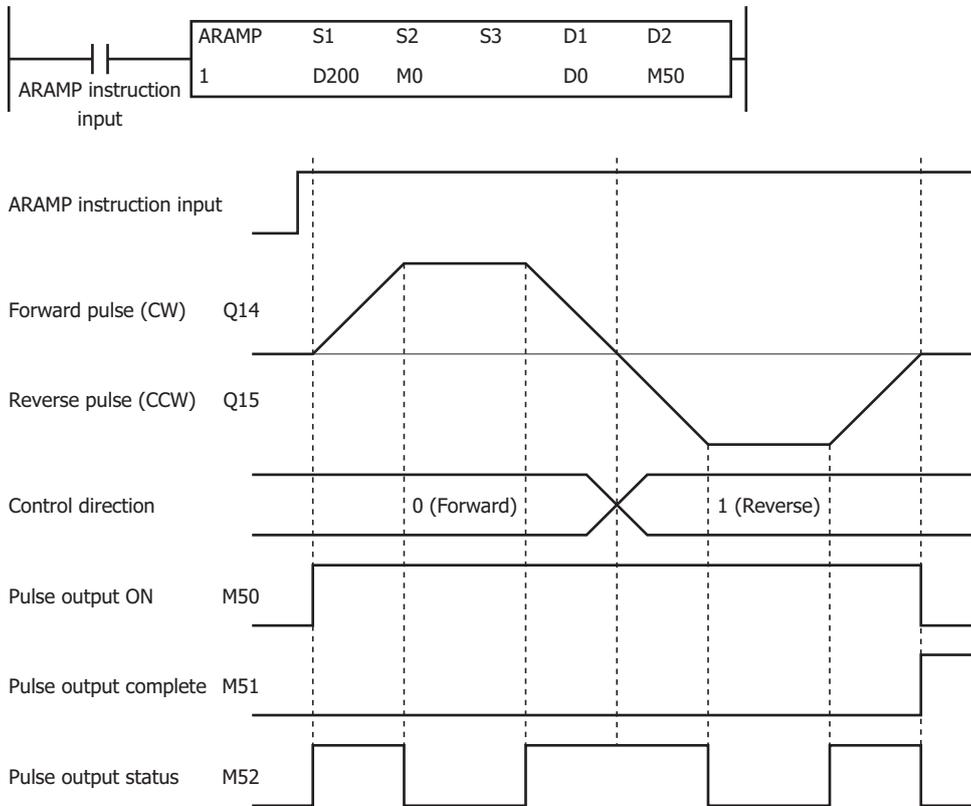
Forward and reverse cannot be changed until the pulse output pulse frequency is set to its minimum. In mode 1 for example, forward and reverse cannot be changed until the pulse frequency is set to 200 Hz.

The changes from the initialization input are not reflected while the ARAMP1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the input.

## 19: PULSE OUTPUT INSTRUCTIONS

### ARAMP1 instruction (dual-pulse output reversible control enabled) timing chart

[40-I/O type, ARAMP1 instruction, S1 is specified as data register D200, S2 is specified as internal relay M0, S3 is disabled, D1 is specified as data register D0, D2 is specified as internal relay M50]



When the ARAMP instruction input changes from off to on, pulses are output from Q14 according to the settings configured by the data registers. The reversible control signal is output from Q14 or Q15. When pulse output starts, M50 turns on. M52 turns on while the pulse frequency is increasing or decreasing. The pulses increase and decrease according to the frequency change time until they reach the steady pulse frequency from the current pulse frequency. When the configured number of pulses are output, the pulses stop. In this situation, M50 turns off and M51 turns on.

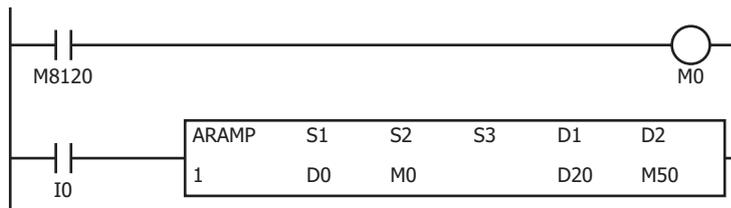
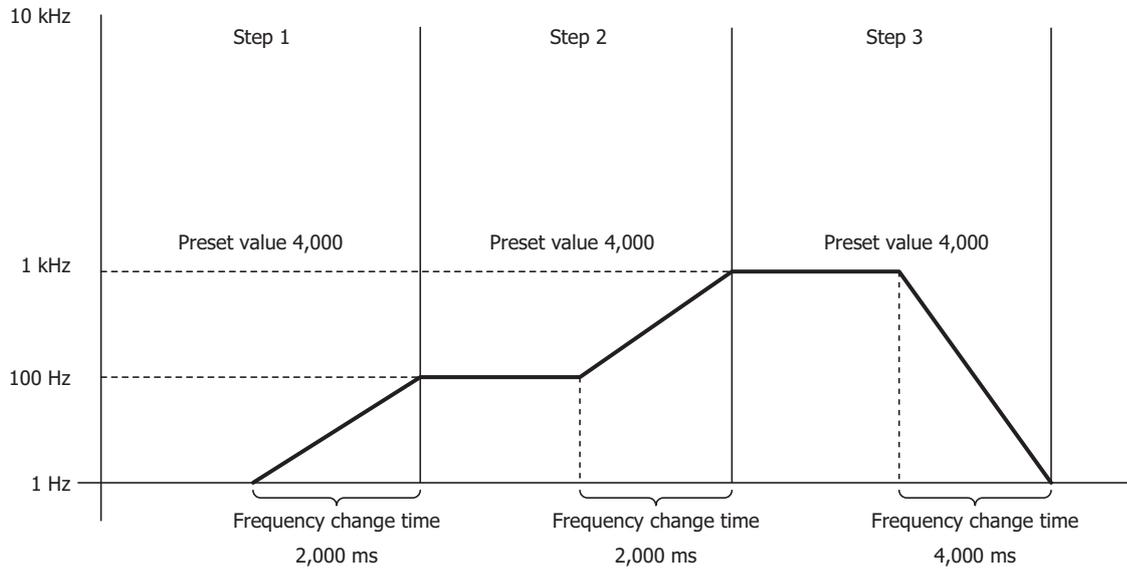
If the ARAMP instruction input turns off during pulse output, pulse output ends. If the ARAMP instruction input turns on again, the operation starts from the beginning. Even if the contents of the data registers are changed during pulse output, the change is not reflected in the pulse output operation. The changed content is reflected the next time the ARAMP instruction is started.

Forward and reverse cannot be changed until the pulse output pulse frequency is set to its minimum.

The changes from the initialization input are not reflected while the ARAMP1 instruction input is on. If you wish to initialize the data registers with the initialization input, turn the initialization input on after turning off the ARAMP instruction input.

**Sample program**

This section describes an example program that outputs pulses as shown below with the frequency change function (reversible control disabled) using the following settings. The pulses are output from Q14.



Initialize the data registers when the PLC starts

When the ARAMP instruction input (I0) turns on, pulse output starts

**Basic settings**

Function	DR	Setting	Description
Operation mode		Mode 0: 1 Hz to 10 kHz	1 to 10,000 in increments of 1 Hz
Reversible control enable		Disabled	
Number of steps		3	1 to 18 steps
Start step number		1	1 to 3 (step)
Interrupt step number	D0000	1	1 to 3 (step)

Function	Device address	Setting value	Details
Operation mode	—	Mode 0	1 Hz to 10 kHz
Reversible control enable	—	Disable	—
The number of steps	—	3	—
Start number	—	1	Step 1
Interrupt number	D0	—	—

## 19: PULSE OUTPUT INSTRUCTIONS

### Step 1 settings

Function	DR	Setting	Description
Steady pulse frequency	D0002	100	1 to 10,000 in increments of 1 Hz
Frequency change time	D0003	2000	10 to 10,000 in increments of 1 (ms)
Preset value	D0004, D0005	4000	1 to 100,000,000
Control direction	D0006		
Acceleration/deceleration control	D0006	Acceleration/deceleration later	
Next step number	D0007	2	0 to 3 (step)

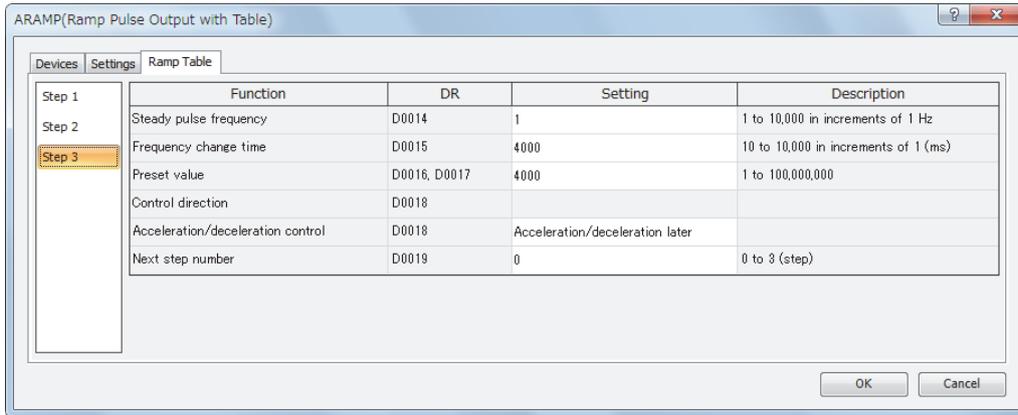
Function	Device address	Setting value	Details
Steady pulse frequency	D2	100	100 Hz
Frequency change time	D3	2000	2,000 ms
Preset value	D4, D5	4000	Preset value=4,000
Control direction	D6	—	—
Timing of change	D6	Acceleration/deceleration later	After
Next step number	D7	2	Step 2

### Step 2 settings

Function	DR	Setting	Description
Steady pulse frequency	D0008	1000	1 to 10,000 in increments of 1 Hz
Frequency change time	D0009	2000	10 to 10,000 in increments of 1 (ms)
Preset value	D0010, D0011	4000	1 to 100,000,000
Control direction	D0012		
Acceleration/deceleration control	D0012	Acceleration/deceleration later	
Next step number	D0013	3	0 to 3 (step)

Function	Device address	Setting value	Details
Steady pulse frequency	D8	1000	1,000 Hz
Frequency change time	D9	2000	2,000 ms
Preset value	D10, D11	4000	Preset value=4,000
Control direction	D12	—	—
Timing of change	D12	Acceleration/deceleration later	After
Next step number	D13	3	Step 3

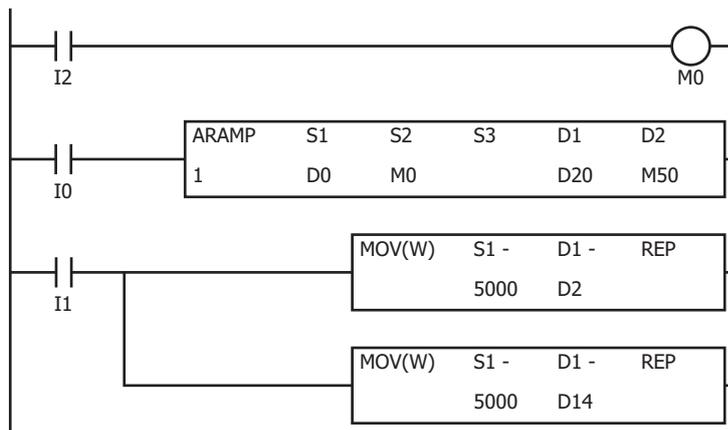
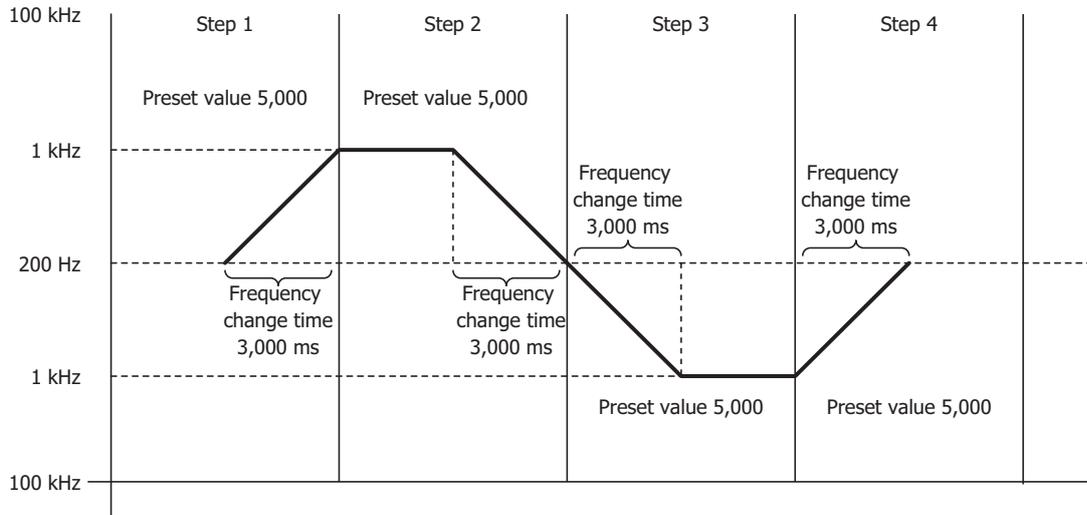
Step 3 settings



Function	Device address	Setting value	Details
Steady pulse frequency	D14	1	1 Hz
Frequency change time	D15	4000	4,000 ms
Preset value	D16, D17	4000	Preset value=4,000
Control direction	D18	—	—
Timing of change	D18	Acceleration/deceleration later	After
Next step number	D19	0	0=End output

This section describes an example program that outputs pulses as shown below with the frequency change function (single-pulse output reversible control enabled) using the following settings.

The pulses are output from Q14.



When I2 turns on, the initialization input (M0) is turned on and the ARAMP instruction control register values are initialized

When the ARAMP instruction input (I0) turns on, pulse output starts

When the MOV instruction input (I1) turns on, the steady pulse frequencies for step 2 and step 4 (D2 and D15) are changed to 5 kHz.

## 19: PULSE OUTPUT INSTRUCTIONS

### Basic settings

ARAMP(Ramp Pulse Output with Table)

Devices Settings Ramp Table

ARAMP 1 (Q0014)

S1 (Control Register) S2 (Initialization Input) S3 (Interrupt Input) D1 (Monitor Register) D2 (Operation Status)

Tag Name: D0000 M0000 D0020 M0050

Device Address: D0000 M0000 D0020 M0050

Comment:

ARAMP(Ramp Pulse Output with Table)

Devices Settings Ramp Table

Function	DR	Setting	Description
Operation mode		Mode 1: 200 Hz to 100 kHz	20 to 10,000 in increments of 1 (x10 Hz)
Reversible control enable		Single-pulse output	
Number of steps		4	1 to 18 steps
Start step number		1	1 to 4 (step)
Interrupt step number	D0000	1	1 to 4 (step)

OK Cancel

Function	Device address	Setting value	Details
Operation mode	—	Mode 1	200 Hz to 100 kHz
Reversible control enable	—	Single-pulse output	—
The number of steps	—	4	—
Start number	—	1	Step 1
Interrupt number	D0	—	—

### Step 1 settings

ARAMP(Ramp Pulse Output with Table)

Devices Settings Ramp Table

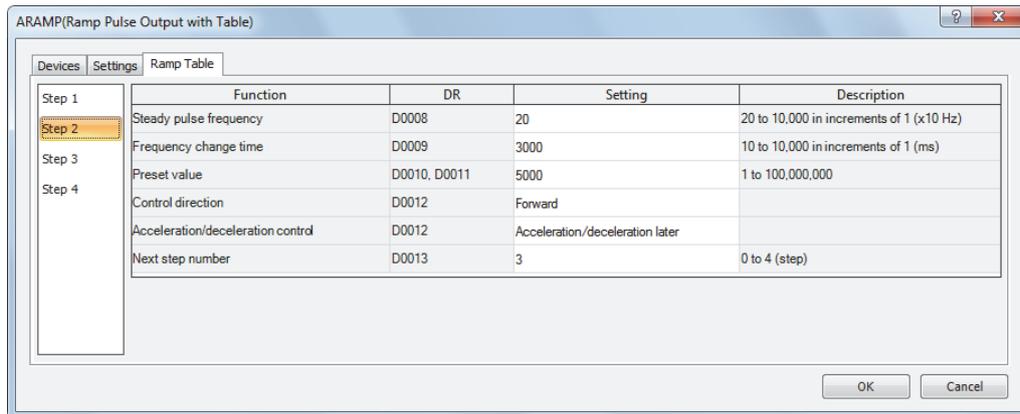
Step 1

Function	DR	Setting	Description
Steady pulse frequency	D0002	100	20 to 10,000 in increments of 1 (x10 Hz)
Frequency change time	D0003	3000	10 to 10,000 in increments of 1 (ms)
Preset value	D0004, D0005	5000	1 to 100,000,000
Control direction	D0006	Forward	
Acceleration/deceleration control	D0006	Acceleration/deceleration later	
Next step number	D0007	2	0 to 4 (step)

OK Cancel

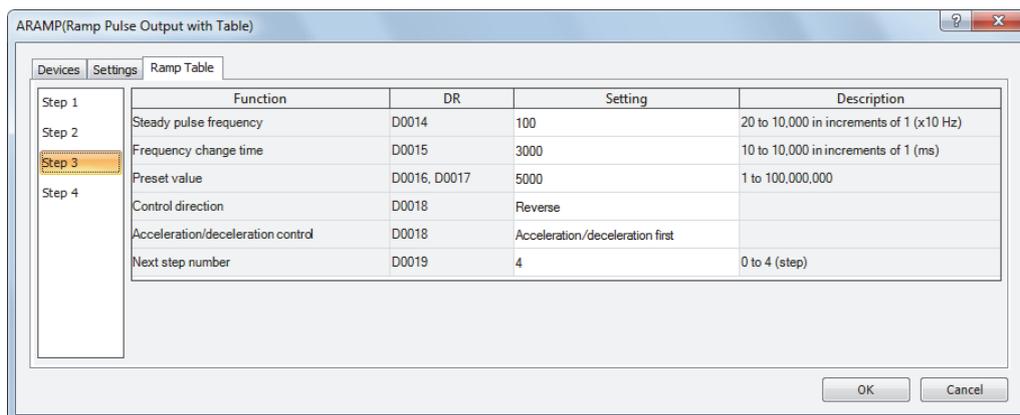
Function	Device address	Setting value	Details
Steady pulse frequency	D2	100	1 kHz
Frequency change time	D3	3000	3,000 ms
Preset value	D4, D5	5000	Preset value=5,000
Control direction	D6	Forward	Forward=0
Timing of change	D6	Acceleration/deceleration later	After=2
Next step number	D7	2	Step 2

**Step 2 settings**



Function	Device address	Setting value	Details
Steady pulse frequency	D8	20	200 Hz
Frequency change time	D9	3000	3,000 ms
Preset value	D10, D11	5000	Preset value=5,000
Control direction	D12	Forward	Forward=0
Timing of change	D12	Acceleration/deceleration later	After=2
Next step number	D13	3	Step 3

**Step 3 settings**



Function	Device address	Setting value	Details
Steady pulse frequency	D14	100	1 kHz
Frequency change time	D15	3000	3,000 ms
Preset value	D16, D17	5000	Preset value=5,000
Control direction	D18	Reverse	Reverse=1
Timing of change	D18	Acceleration/deceleration first	Before=0
Next step number	D19	4	Step 4

## 19: PULSE OUTPUT INSTRUCTIONS

### Step 4 settings

ARAMP(Ramp Pulse Output with Table)

Devices Settings Ramp Table

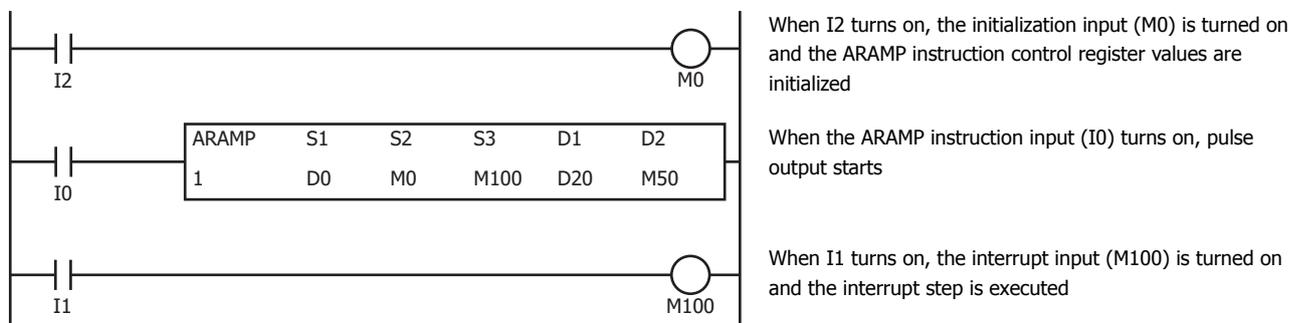
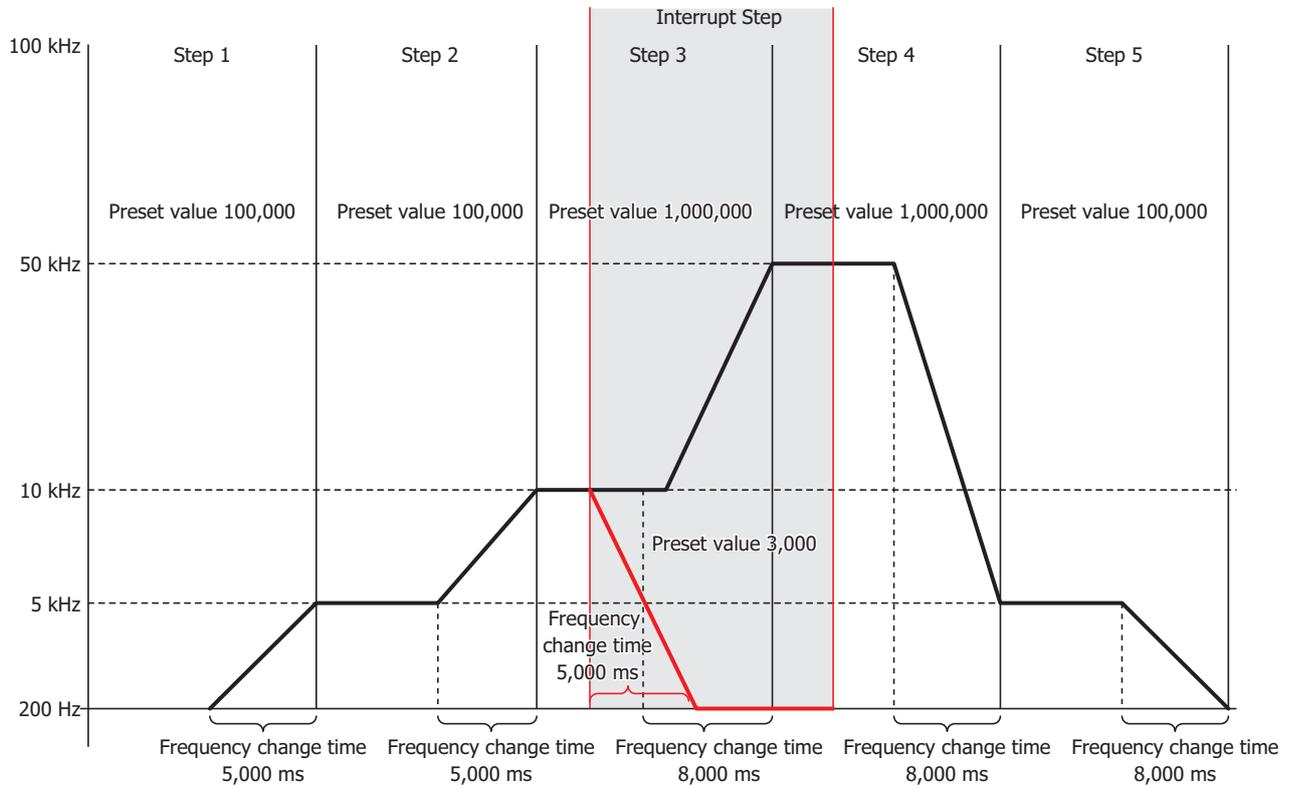
Step	Function	DR	Setting	Description
Step 1	Steady pulse frequency	D0020	20	20 to 10,000 in increments of 1 (x10 Hz)
Step 2	Frequency change time	D0021	3000	10 to 10,000 in increments of 1 (ms)
Step 3	Preset value	D0022, D0023	5000	1 to 100,000,000
Step 4	Control direction	D0024	Reverse	
	Acceleration/deceleration control	D0024	Acceleration/deceleration first	
	Next step number	D0025	0	0 to 4 (step)

OK Cancel

Function	Device address	Setting value	Details
Steady pulse frequency	D20	20	200 Hz
Frequency change time	D21	3000	3,000 ms
Preset value	D22, D23	5000	Preset value=5,000
Control direction	D24	Reverse	Reverse=1
Timing of change	D24	Acceleration/deceleration first	Before=0
Next step number	D25	0	Step 0 (end)

This section describes an example program that outputs pulses as shown below with the frequency change function (single-pulse output reversible control disabled) using the following settings.

The pulses are output from Q14.



## 19: PULSE OUTPUT INSTRUCTIONS

### Basic settings

ARAMP(Ramp Pulse Output with Table)

Devices Settings Ramp Table

ARAMP 1 (Q0014)

S1 (Control Register) S2 (Initialization Input) S3 (Interrupt Input) D1 (Monitor Register) D2 (Operation Status)

Tag Name: D0000 M0000 M0100 D0020 M0050

Device Address: D0000 M0000 M0100 D0020 M0050

Comment:

ARAMP(Ramp Pulse Output with Table)

Function	DR	Setting	Description
Operation mode		Mode 1: 200 Hz to 100 kHz	20 to 10,000 in increments of 1 (x10 Hz)
Reversible control enable		Disabled	
Number of steps		6	1 to 18 steps
Start step number		1	1 to 6 (step)
Interrupt step number	D0000	6	1 to 6 (step)

OK Cancel

Function	Device address	Setting value	Details
Operation mode	—	Mode 1	200 Hz to 100 kHz
Reversible control enable	—	Disable	—
The number of steps	—	6	—
Start number	—	1	Step 1
Interrupt number	D0	6	Step 6

### Step 1 settings

ARAMP(Ramp Pulse Output with Table)

Devices Settings Ramp Table

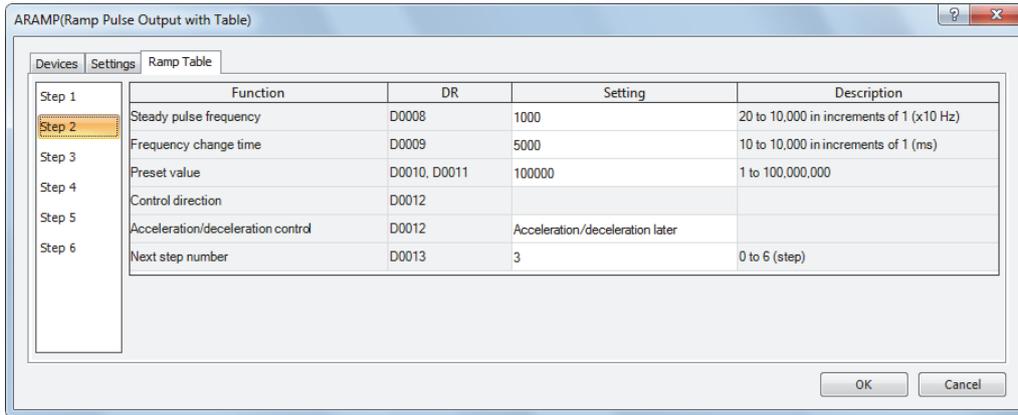
Step 1

Function	DR	Setting	Description
Steady pulse frequency	D0002	500	20 to 10,000 in increments of 1 (x10 Hz)
Frequency change time	D0003	5000	10 to 10,000 in increments of 1 (ms)
Preset value	D0004, D0005	100000	1 to 100,000,000
Control direction	D0006		
Acceleration/deceleration control	D0006	Acceleration/deceleration later	
Next step number	D0007	2	0 to 6 (step)

OK Cancel

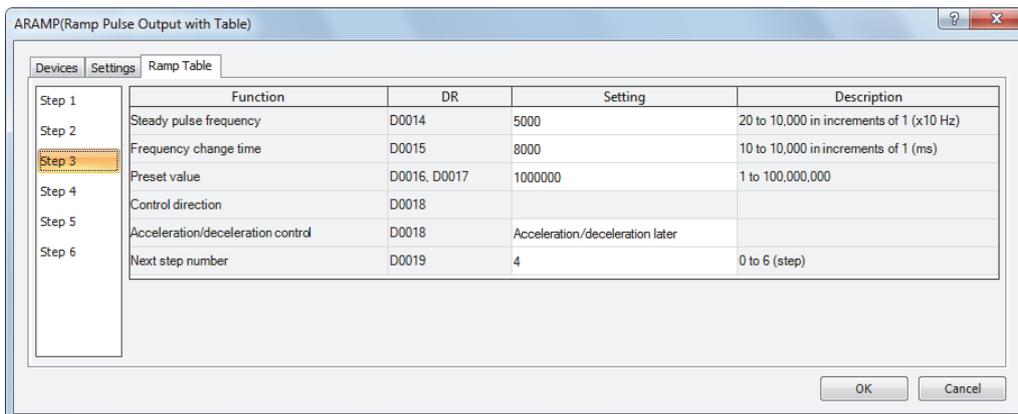
Function	Device address	Setting value	Details
Steady pulse frequency	D2	500	5 kHz
Frequency change time	D3	5000	5,000 ms
Preset value	D4, D5	100000	Preset value=100,000
Control direction	D6	—	—
Timing of change	D6	Acceleration/deceleration later	—
Next step number	D7	2	Step 2

**Step 2 settings**



Function	Device address	Setting value	Details
Steady pulse frequency	D8	1000	10 kHz
Frequency change time	D9	5000	5,000 ms
Preset value	D10, D11	100000	Preset value=100,000
Control direction	D12	—	—
Timing of change	D12	Acceleration/deceleration later	—
Next step number	D13	3	Step 3

**Step 3 settings**



Function	Device address	Setting value	Details
Steady pulse frequency	D14	5000	50 kHz
Frequency change time	D15	8000	8,000 ms
Preset value	D16, D17	1000000	Preset value=1,000,000
Control direction	D18	—	—
Timing of change	D18	Acceleration/deceleration later	—
Next step number	D19	4	Step 4

## 19: PULSE OUTPUT INSTRUCTIONS

### Step 4 settings

Step	Function	DR	Setting	Description
Step 1	Steady pulse frequency	D0020	500	20 to 10,000 in increments of 1 (x10 Hz)
Step 2	Frequency change time	D0021	8000	10 to 10,000 in increments of 1 (ms)
Step 3	Preset value	D0022, D0023	1000000	1 to 100,000,000
Step 4	Control direction	D0024		
Step 5	Acceleration/deceleration control	D0024	Acceleration/deceleration later	
Step 6	Next step number	D0025	5	0 to 6 (step)

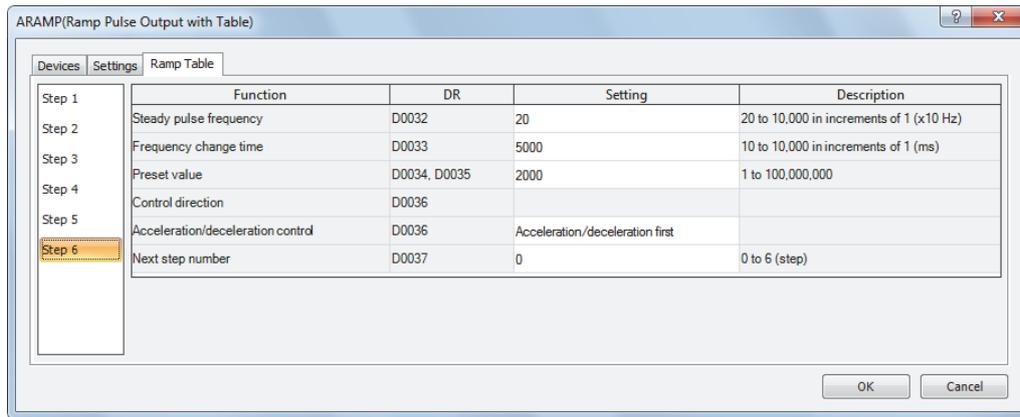
Function	Device address	Setting value	Details
Steady pulse frequency	D20	500	5 kHz
Frequency change time	D21	8000	8,000 ms
Preset value	D22, D23	1000000	Preset value=1,000,000
Control direction	D24	—	—
Timing of change	D24	Acceleration/deceleration later	—
Next step number	D25	5	Step 5

### Step 5 settings

Step	Function	DR	Setting	Description
Step 1	Steady pulse frequency	D0026	20	20 to 10,000 in increments of 1 (x10 Hz)
Step 2	Frequency change time	D0027	8000	10 to 10,000 in increments of 1 (ms)
Step 3	Preset value	D0028, D0029	100000	1 to 100,000,000
Step 4	Control direction	D0030		
Step 5	Acceleration/deceleration control	D0030	Acceleration/deceleration later	
Step 6	Next step number	D0031	0	0 to 6 (step)

Function	Device address	Setting value	Details
Steady pulse frequency	D26	20	200 Hz
Frequency change time	D27	8000	8,000 ms
Preset value	D28, D29	100000	Preset value=100,000
Control direction	D30	—	—
Timing of change	D30	Acceleration/deceleration later	—
Next step number	D31	0	0=End output

**Step 6 settings**



Function	Device address	Setting value	Details
Steady pulse frequency	D32	20	200 Hz
Frequency change time	D33	5000	5000 ms
Preset value	D34, D35	2000	Preset value=2,000
Control direction	D36	—	—
Timing of change	D36	Acceleration/deceleration first	Before=0
Next step number	D37	0	0=End output



# 20: DUAL / TEACHING TIMER INSTRUCTIONS

## Introduction

Dual timer instructions generate ON/OFF pulses of required durations from a designated output, internal relay, or shift register bit. Four dual timers are available and the ON/OFF duration can be selected from 1 ms up to 65535 sec.

Teaching timer instruction measures the ON duration of the start input for the teaching timer instruction and stores the measured data to a designated data register, which can be used as a preset value for a timer instruction.

### DTML (1-sec Dual Timer)

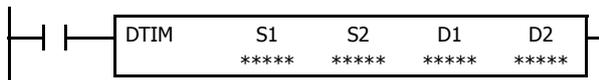


While input is on, destination device D1 repeats to turn on and off for a duration assigned by devices S1 and S2, respectively.

When the input is off, D1 turns off.

The time range is 0 through 65535 sec.

### DTIM (100-ms Dual Timer)

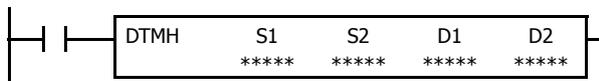


While input is on, destination device D1 repeats to turn on and off for a duration assigned by devices S1 and S2, respectively.

When the input is off, D1 turns off.

The time range is 0 through 6553.5 sec.

### DTMH (10-ms Dual Timer)

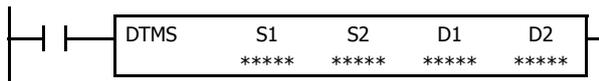


While input is on, destination device D1 repeats to turn on and off for a duration assigned by devices S1 and S2, respectively.

When the input is off, D1 turns off.

The time range is 0 through 655.35 sec.

### DTMS (1-ms Dual Timer)



While input is on, destination device D1 repeats to turn on and off for a duration assigned by devices S1 and S2, respectively.

When the input is off, D1 turns off.

The time range is 0 through 65.535 sec.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

## 20: DUAL / TEACHING TIMER INSTRUCTIONS

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant
S1 (Source 1)	ON duration	—	—	—	—	—	—	X	0-65535
S2 (Source 2)	OFF duration	—	—	—	—	—	—	X	0-65535
D1 (Destination 1)	Dual timer output	—	X	▲	X	—	—	—	—
D2 (Destination 2)	System work area	—	—	—	—	—	—	X	—

For valid device address ranges, see "Device Addresses" on page 3-1.

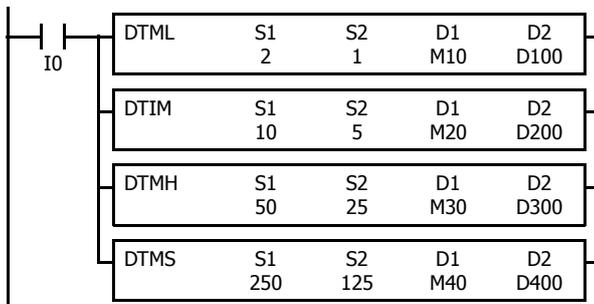
▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

Destination device D2 (system work area) uses 2 data registers starting with the device designated as D2. Data registers D0-D998 and D1000-D1998 can be designated as D2. The two data registers are used for a system work area. Do not use these data registers for destinations of other advanced instructions, and do not change values of these data registers using the monitor function on WindLDR. If the data in these data registers are changed, the dual timer does not operate correctly.

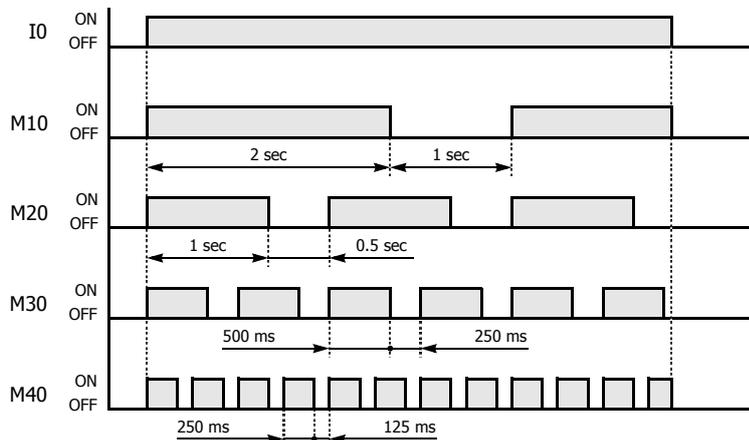
The dual timer instructions cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. The data in D1 (destination 1) is unchanged. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### Examples: DTML, DTIM, DTMH, DTMS



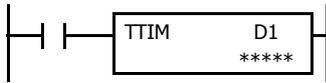
While input I0 is on, four dual timer instructions turn on and off the destination devices according to the on and off durations assigned by source devices S1 and S2.



Instruction	Increments	S1	ON duration	S2	OFF duration
DTML	1 sec	2	1 sec × 2 = 2 sec	1	1 sec × 1 = 1 sec
DTIM	100 ms	10	100 ms × 10 = 1 sec	5	100 ms × 5 = 0.5 sec
DTMH	10 ms	50	10 ms × 50 = 500 ms	25	10 ms × 25 = 250 ms
DTMS	1 ms	250	1 ms × 250 = 250 ms	125	1 ms × 125 = 125 ms

For the timer accuracy of timer instructions, see "TML, TIM, TMH, and TMS (Timer)" on page 5-7.

### TTIM (Teaching Timer)



While input is on, the ON duration is measured in units of 100 ms and the measured value is stored to a data register assigned by destination device D1.

When the input is off, D1 turns off.

The measured time range is 0 through 6553.5 sec.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant
D1 (Destination 1)	Measured value	—	—	—	—	—	—	X	—

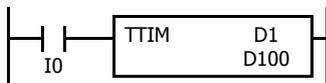
For valid device address ranges, see "Device Addresses" on page 3-1.

Destination device D1 (measured value) uses 3 data registers starting with the device designated as D1. Data registers D0-D997 and D1000-D1997 can be designated as D1. Subsequent two data registers starting with destination device D1+1 are used for a system work area. Do not use these two data registers for destinations of other advanced instructions, and do not change values of these data registers using the monitor function on WindLDR. If the data in these data registers are changed, the teaching timer does not operate correctly.

The teaching timer instruction cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

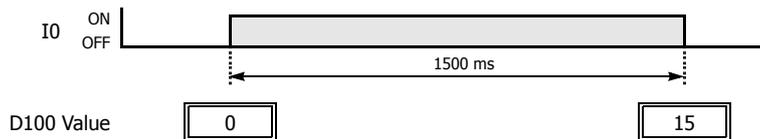
When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. The data in D1 (destination 1) is unchanged. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### Examples: TTIM

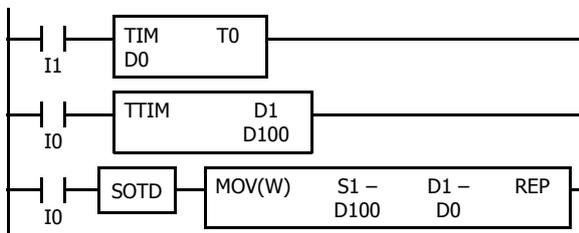


When input I0 is turned on, TTIM resets data register D100 to zero and starts to store the ON duration of input I0 to data register D100, measured in units of 100 ms.

When input I0 is turned off, TTIM stops the measurement, and data register D100 maintains the measured value of the ON duration.



The following example demonstrates a program to measure the ON duration of input I0 and to use the ON duration as a preset value for 100-ms timer instruction TIM.



When input I1 is turned on, 100-ms timer T0 starts to operate with a preset value stored in data register D0.

While input I0 is on, TTIM measures the ON duration of input I0 and stores the measured value in units of 100 ms to data register D100.

When input I0 is turned off, MOV(W) stores the D100 value to data register D0 as a preset value for timer T0.

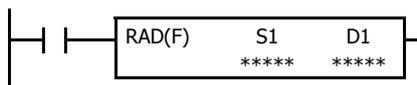


# 21: TRIGONOMETRIC FUNCTION INSTRUCTIONS

## Introduction

Trigonometric function instructions are used for conversion between radian and degree values, conversion from radian value to sine, cosine, and tangent, and also calculation of arc sine, arc cosine, and arc tangent values.

## RAD (Degree to Radian)



$$S1 \cdot S1 + 1^\circ \times \pi / 180 \rightarrow D1 \cdot D1 + 1 \text{ rad}$$

When input is on, the degree value assigned by source device S1 is converted into a radian value and stored to the destination assigned by device D1.

### Applicable SmartAXIS

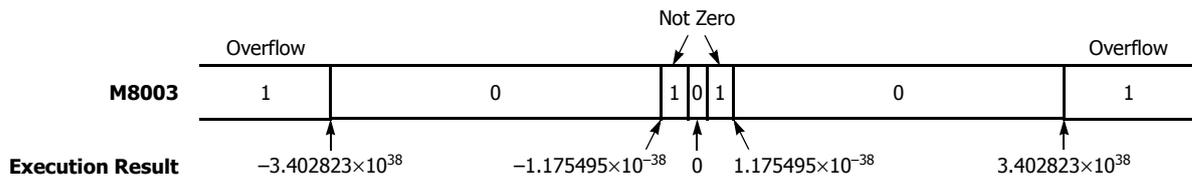
FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Degree value to convert into radian	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For the valid device address range, see "Device Addresses" on page 3-1.

When the conversion result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  and  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on except when the conversion result is 0. When the conversion result is between  $-1.175495 \times 10^{-38}$  and  $1.175495 \times 10^{-38}$ , the destination device designated by D1 stores 0.



When the data designated by S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

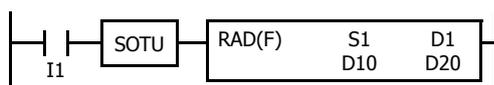
Since the RAD instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

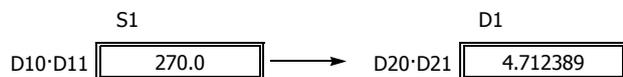
Since floating point data is used, the source and destination devices use two consecutive data registers.

## Example: RAD



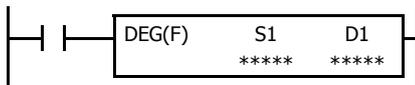
When input I1 is turned on, the degree value of data registers D10 and D11 assigned by source device S1 is converted into a radian value and stored to data registers D20 and D21 assigned by destination device D1.

$$270^\circ \times \pi / 180 \rightarrow 4.712389 \text{ rad}$$



## 21: TRIGONOMETRIC FUNCTION INSTRUCTIONS

### DEG (Radian to Degree)



$$S1 \cdot S1+1 \text{ rad} \times 180/\pi \rightarrow D1 \cdot D1+1^\circ$$

When input is on, the radian value assigned by source device S1 is converted into a degree value and stored to the destination assigned by device D1.

#### Applicable SmartAXIS

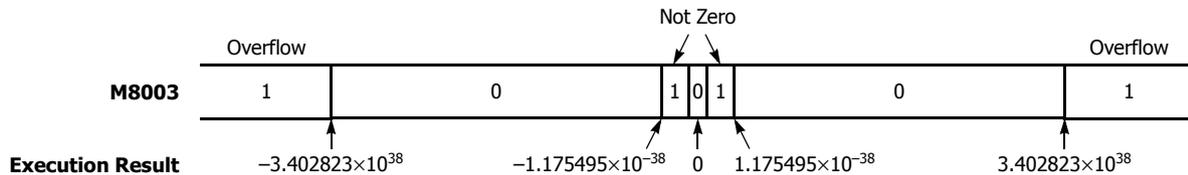
FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Radian value to convert into degree	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the conversion result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  and  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on except when the conversion result is 0. When the conversion result is below  $-3.402823 \times 10^{38}$  or over  $3.402823 \times 10^{38}$ , causing an overflow, the destination device designated by D1 stores a value of minus or plus infinity.



When the data designated by S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the DEG instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

#### Example: DEG



When input I1 is turned on, the radian value of data registers D10 and D11 assigned by source device S1 is converted into a degree value and stored to data registers D20 and D21 assigned by destination device D1.

$$4.712389 \text{ rad} \times 180/\pi \rightarrow 270.0^\circ$$



### SIN (Sine)



$$\sin S1 \cdot S1+1 \rightarrow D1 \cdot D1+1$$

When input is on, the sine of the radian value assigned by source device S1 is stored to the destination assigned by device D1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Radian value to convert into sine value	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the data designated by S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

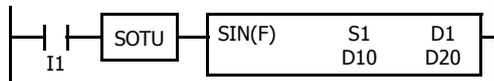
Since the SIN instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

Since the floating point data type is used, the source and destination devices use two consecutive data registers.

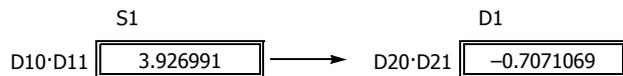
#### Example: SIN



When input I1 is turned on, the sine of the radian value of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$3.926991 \text{ rad} = 5\pi/4 \text{ rad}$$

$$\sin 5\pi/4 \rightarrow -0.7071069$$



## 21: TRIGONOMETRIC FUNCTION INSTRUCTIONS

### COS (Cosine)



$\cos S1 \cdot S1+1 \rightarrow D1 \cdot D1+1$

When input is on, the cosine of the radian value assigned by source device S1 is stored to the destination assigned by device D1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Radian value to convert into cosine value	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the data designated by S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

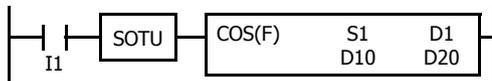
Since the COS instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

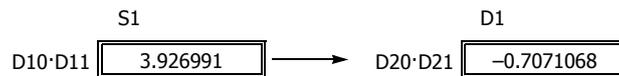
#### Example: COS



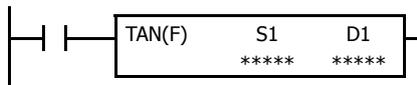
When input I1 is turned on, the cosine of the radian value of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$3.926991 \text{ rad} = 5\pi/4 \text{ rad}$$

$$\cos 5\pi/4 \rightarrow -0.7071068$$



**TAN (Tangent)**



tan S1·S1+1 → D1·D1+1

When input is on, the tangent of the radian value assigned by source device S1 is stored to the destination assigned by device D1.

**Applicable SmartAXIS**

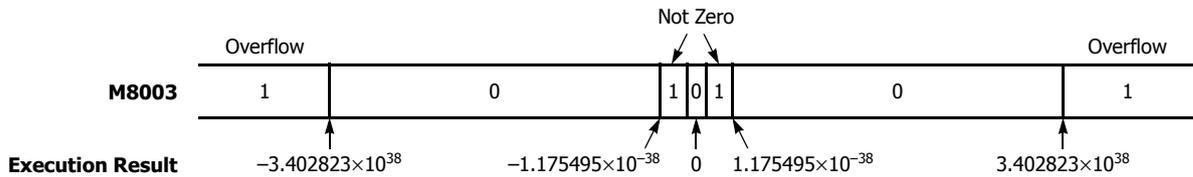
FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Radian value to convert into tangent value	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the conversion result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  and  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on except when the conversion result is 0. When the conversion result is below  $-3.402823 \times 10^{38}$  or over  $3.402823 \times 10^{38}$ , causing an overflow, the destination device designated by D1 stores a value of minus or plus infinity.



When the data designated by S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

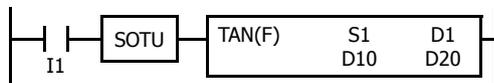
Since the TAN instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

**Valid Data Types**

<b>W (word)</b>	—
<b>I (integer)</b>	—
<b>D (double word)</b>	—
<b>L (long)</b>	—
<b>F (float)</b>	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

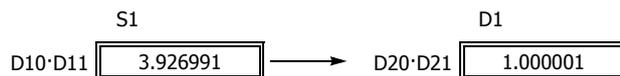
**Example: TAN**



When input I1 is turned on, the tangent of the radian value of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$3.926991 \text{ rad} = 5\pi/4 \text{ rad}$$

$$\tan 5\pi/4 \rightarrow 1.000001$$



## 21: TRIGONOMETRIC FUNCTION INSTRUCTIONS

### ASIN (Arc Sine)



asin S1·S1+1 → D1·D1+1 rad

When input is on, the arc sine of the value assigned by source device S1 is stored in radians to the destination assigned by device D1.

The S1·S1+1 value must be within the following range:

$$-1.0 \leq S1 \cdot S1+1 \leq 1.0$$

If the S1·S1+1 value is not within this range, 0 is stored to D1·D1+1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Arc sine value to convert into radian	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the data designated by source device S1 is not within the range between  $-1.0$  and  $1.0$  or does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

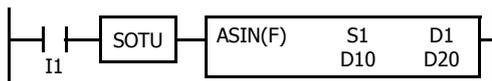
Since the ASIN instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

#### Example: ASIN



When input I1 is turned on, the arc sine of the value of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$\text{asin } -0.7071069 \rightarrow -0.7853982 \text{ rad}$$

$$-0.7853982 \text{ rad} = -\pi/4 \text{ rad}$$



### ACOS (Arc Cosine)



$\text{acos } S1 \cdot S1+1 \rightarrow D1 \cdot D1+1 \text{ rad}$

When input is on, the arc cosine of the value assigned by source device S1 is stored in radians to the destination assigned by device D1.

The S1·S1+1 value must be within the following range:

$$-1.0 \leq S1 \cdot S1+1 \leq 1.0$$

If the S1·S1+1 value is not within this range, 0 is stored to D1·D1+1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Arc cosine value to convert into radian	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the data designated by source device S1 is not within the range between -1.0 and 1.0 or does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the ACOS instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

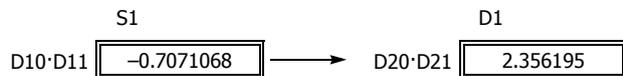
#### Example: ACOS



When input I1 is turned on, the arc cosine of the value of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$\text{acos } -0.7071068 \rightarrow 2.356195 \text{ rad}$$

$$2.356195 \text{ rad} = 3\pi/4 \text{ rad}$$



## 21: TRIGONOMETRIC FUNCTION INSTRUCTIONS

### ATAN (Arc Tangent)



atan S1·S1+1 → D1·D1+1 rad

When input is on, the arc tangent of the value assigned by source device S1 is stored in radians to the destination assigned by device D1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Arc tangent value to convert into radian	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the data designated by source device S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the ATAN instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

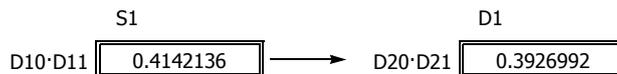
#### Example: ATAN



When input I1 is turned on, the arc tangent of the value of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

atan 0.4142136 → 0.3926992 rad

0.3926992 rad =  $\pi/8$  rad

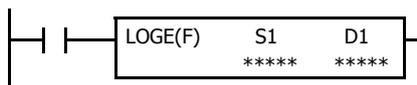


# 22: LOGARITHM / POWER INSTRUCTIONS

## Introduction

This chapter describes logarithm and power instructions which are used to calculate logarithm or powered values of source devices.

## LOGE (Natural Logarithm)



$$\log_e S1 \cdot S1+1 \rightarrow D1 \cdot D1+1$$

When input is on, the natural logarithm of the binary data assigned by source device S1 is stored to the destination assigned by device D1.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Binary data to convert into natural logarithm	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the operation result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  and  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on except when the result is 0. For details, see "Carry and Borrow in Floating-Point Data Processing" on page 4-11.

When the value of S1 (source 1) is 0, a user program execution error occurs and an infinity is stored in D1.

When the value of S1 (source 1) is less than 0, a user program execution error occurs and a non-numeric value is stored in D1.

When the data designated by source device S1 does not comply with the normal floating-point format, a user program execution error occurs, and the execution of the instruction is canceled. The value of D1 is left unchanged and the next instruction is executed.

When a user program execution error occurs, special internal relay M8004 and ERR LED on the SmartAXIS are turned on. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the LOGE instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

### Valid Data Types

<b>W (word)</b>	—
<b>I (integer)</b>	—
<b>D (double word)</b>	—
<b>L (long)</b>	—
<b>F (float)</b>	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

### Example: LOGE

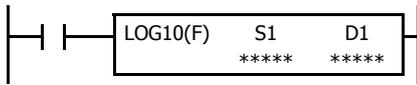


When input I1 is on, the natural logarithm of the binary data of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$\log_e 86.0 \rightarrow 4.454347$$



**LOG10 (Common Logarithm)**



$$\log_{10} S1 \cdot S1+1 \rightarrow D1 \cdot D1+1$$

When input is on, the common logarithm of the binary data assigned by source device S1 is stored to the destination assigned by device D1.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Binary data to convert into common logarithm	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store conversion results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the operation result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  and  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on except when the result is 0. For details, see "Carry and Borrow in Floating-Point Data Processing" on page 4-11

When the value of S1 (source 1) is 0, a user program execution error occurs and an infinity is stored in D1.

When the value of S1 (source 1) is less than 0, a user program execution error occurs and a non-numeric value is stored in D1.

When the data designated by source device S1 does not comply with the normal floating-point format, a user program execution error occurs, and the execution of the instruction is canceled. The value of D1 is left unchanged and the next instruction is executed.

When a user program execution error occurs, special internal relay M8004 and ERR LED on the SmartAXIS are turned on. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

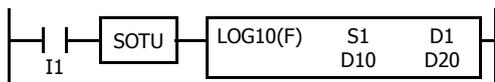
Since the LOG10 instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

**Valid Data Types**

W (word)	—
I (integer)	—
D (double word)	—
L (long)	—
F (float)	X

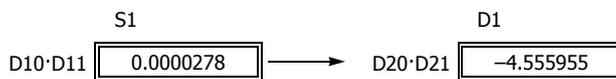
Since floating point data is used, the source and destination devices use two consecutive data registers.

**Example: LOG10**



When input I1 is on, the common logarithm of the binary data of data registers D10 and D11 assigned by source device S1 is stored to data registers D20 and D21 assigned by destination device D1.

$$\log_{10} 0.0000278 \rightarrow -4.555955$$



**EXP (Exponent)**



$$e^{S1 \cdot S1 + 1} \rightarrow D1 \cdot D1 + 1$$

When input is on, e is raised to the power S1·S1+1 assigned by source device S1 and is stored to the destination assigned by device D1.

e (base of natural logarithm) = 2.7182818

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Binary data of exponent	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the operation result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  and  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on except when the result is 0. For details, see "Carry and Borrow in Floating-Point Data Processing" on page 4-11.

When the operation result is between  $-1.175495 \times 10^{-38}$  and  $1.175495 \times 10^{-38}$ , the destination device designated by D1 stores 0. When the operation result is less than  $-3.402823 \times 10^{38}$  or larger than  $3.402823 \times 10^{38}$ , causing an overflow, the destination device designated by D1 stores a value of minus or plus infinity.

When the data designated by source device S1 does not comply with the normal floating-point format, a user program execution error occurs, and the execution of the instruction is canceled. The value of D1 is left unchanged and the next instruction is executed.

When a user program execution error occurs, special internal relay M8004 and ERR LED on the SmartAXIS are turned on. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

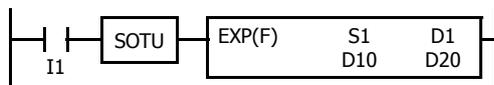
Since the EXP instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

**Valid Data Types**

<b>W (word)</b>	—
<b>I (integer)</b>	—
<b>D (double word)</b>	—
<b>L (long)</b>	—
<b>F (float)</b>	X

Since floating point data is used, the source and destination devices use two consecutive data registers.

**Example: EXP**



When input I1 is on, e is raised to the data of data registers D10 and D11 assigned by source device S1 and the operation result is stored to data registers D20 and D21 assigned by destination device D1.

$$e^2 = 2.7182818^2 \rightarrow 7.389056$$



**POW (Power)**



$$S1 \cdot S1+1^{S2 \cdot S2+1} \rightarrow D1 \cdot D1+1$$

When input is on, data assigned by source device S1 is raised to the power  $S2 \cdot S2+1$  assigned by source device S2 and the operation result is stored to the destination assigned by device D1.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Binary data of base	—	—	—	—	—	—	X	X	—
S2 (Source 2)	Binary data of exponent	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When the operation result is not within the range between  $-3.402823 \times 10^{38}$  and  $-1.175495 \times 10^{-38}$  or between  $1.175495 \times 10^{-38}$  to  $3.402823 \times 10^{38}$ , special internal relay M8003 (carry or borrow) is turned on, except when the result is 0. For details, see "Carry and Borrow in Floating-Point Data Processing" on page 4-11.

When the operation result is between  $-1.175495 \times 10^{-38}$  and  $1.175495 \times 10^{-38}$ , the destination device designated by D1 stores 0. When the operation result is less than  $-3.402823 \times 10^{38}$  or greater than  $3.402823 \times 10^{38}$ , causing an overflow, the destination device designated by D1 stores a value of minus or plus infinity.

When one of the following conditions occurs, a user program execution error occurs and 0 is stored in D1.

- The data designated by source device S1 is less than 0 and the data designated by source device S2 is not an integer.
- The data designated by source device S1 is 0 and the data designated by source device S2 is less than or equal to 0.

When the data designated by source device S1 or S2 does not comply with the normal floating-point format, a user program execution error occurs, and the execution of the instruction is canceled. The value of D1 is left unchanged and the next instruction is executed.

When a user program execution error occurs, special internal relay M8004 and ERR LED on the SmartAXIS are turned on. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

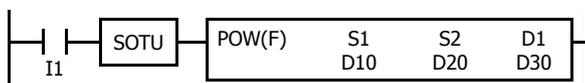
Since the POW instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

**Valid Data Types**

<b>W (word)</b>	—
<b>I (integer)</b>	—
<b>D (double word)</b>	—
<b>L (long)</b>	—
<b>F (float)</b>	X

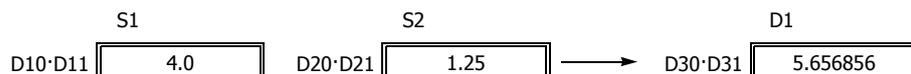
Since floating point data is used, the source and destination devices use two consecutive data registers.

**Example: POW**



When input I1 is on, the data of data registers D10 and D11 assigned by source device S1 is raised to the power  $D20 \cdot D20+1$  assigned by source device S2 and the operation result is stored to data registers D30 and D31 assigned by destination device D1.

$$4^{1.25} \rightarrow 5.656856$$



# 23: FILE DATA PROCESSING INSTRUCTIONS

## Introduction

File data processing instructions implement the first-in first-out (FIFO) data structure. FIFOF (FIFO Format) instructions initialize the FIFO data files storing the data. FIEX (First-In Execute) instructions store new data to the FIFO data files, and FOEX (First-Out Execute) instructions retrieve the stored data from the FIFO data files. The first data to be stored to the FIFO data files by FIEX instructions will be the first data to be retrieved by FOEX instructions.

NDSRC (N Data Search) instructions search a designated value through a specified range.

## FIFOF (FIFO Format)



When input is on, FIFOF instruction initializes an FIFO data file. Each data file has unique number 0 through 9. A maximum of 10 data files can be used in a user program.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
N (File Number)	File Number	—	—	—	—	—	—	—	0-9	—
S1 (Source 1)	Quantity of data registers per record	—	—	—	—	—	—	—	1-255	—
S2 (Source 2)	Quantity of records	—	—	—	—	—	—	—	2-255	—
D1 (Destination 1)	First data register to store FIFO data file	—	—	—	—	—	—	X	—	—
D2 (Destination 2)	FIFO status output	—	—	▲	—	—	—	—	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

▲ Special internal relays cannot be designated as D2.

Since the FIFOF instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

### Valid Data Types

<b>W (word)</b>	X	When an M (internal relay) is assigned as the D2, three internal relays starting with the device assigned by D2 are used.
<b>I (integer)</b>	—	
<b>D (double word)</b>	—	When a D (data register) is assigned as the D1, S1×S2+2 data registers starting with the device assigned by D1 are used.
<b>L (long)</b>	—	
<b>F (float)</b>	—	

## 23: FILE DATA PROCESSING INSTRUCTIONS

### Destination Device D1 (FIFO Data File)

FIFO data files are initialized when corresponding FIFOF instructions are executed. FIFO data file is placed in the area starting with the device designated by D1 and occupies as many as  $S1 \times S2 + 2$  data registers. The size of each record is equal to S1. S1-1 records of data can be stored in an FIFO data file using FIEX instructions. The stored data can be retrieved from the FIFO data file using FOEX instructions.

Device	Function	Description
D1+0	FI pointer	The FI pointer indicates the position to store new data into the FIFO data file. When an FIEX instruction is executed, the new data in data registers starting with the device designated by S1 of the FIEX instruction is stored at the position indicated by the FI pointer, and the FI pointer is incremented by 1 to indicate the position to store the next data. When the FI pointer indicates the last record of the FIFO data file, and an FIEX instruction is executed, the FI pointer will return to 0.
D1+1	FO pointer	The FO pointer indicates the position to retrieve the stored data from the FIFO data file. When an FOEX instruction is executed, the data at the position indicated by the FIFO pointer is retrieved and stored to the data registers starting with the device designated by D1 of the FOEX instruction, and the FO pointer is incremented by 1 to indicate the position to retrieve the next data. When the FO pointer indicates the last record of the FIFO data file, and an FOEX instruction is executed, the FO pointer will return to 0.
D1+2	Record 0	The first record to store the data.
...		
D1+(S1+1)		
D1+(S1+2)	Record 1	The second record to store the data.
...		
D1+(S1×2+1)		
~~~~~		
D1+(S1×(S2-1)+2)	Record S2-1	The last record to store the data.
...		
D1+(S1×S2+1)		

### Destination Device D2 (FIFO Status Output)

When FIEX or FOEX instructions are executed, the following internal relays are turned on or off according to the execution status.

Device	Function	Description
D2+0	Data file full output	When the value stored in the FI pointer (D1+0) is equal to the value stored in the FO pointer (D1+1) - 1, the FIFO data file is full, and no more data can be stored. If an FIEX instruction is executed when the FIFO data file is full, no operation is executed, and the data file full output (D2+0) will be turned on.
D2+1	Data file empty output	When the value stored in the FI pointer (D1+0) is equal to the value stored in the FO pointer (D1+1), the FIFO data file is empty. If an FOEX instruction is executed when the FIFO data file is empty, no operation is executed, and the data file empty output (D2+1) will be turned on.
D2+2	Pointer out of range output	The value stored in the FI or FO pointer can be 0 through S2-1. When an FIEX or FOEX instruction is executed while the FI or FO pointer value exceeds the valid range, no operation is executed, and the pointer out of range output (D2+2) will be turned on.

**Note:** The FIFOF instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### FIEX (First-In Execute)



When input is on, the data stored in data registers starting with the device assigned by S1 is stored to the corresponding FIFO data file.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
N (File Number)	File number	—	—	—	—	—	—	—	0-9	—
S1 (Source 1)	First data register to store data to FIFO data file	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

Make sure that FIEX instructions are executed after the corresponding FIFOF instruction has initialized the FIFO data file. If FIEX instructions are executed without executing the corresponding FIFOF instruction, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the FIEX instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Valid Data Types

<b>W (word)</b>	X
<b>I (integer)</b>	—
<b>D (double word)</b>	—
<b>L (long)</b>	—
<b>F (float)</b>	—

When a D (data register) is assigned as the source, as many data registers as the value stored in device S1 of the corresponding FIFOF instruction are used.

### FOEX (First-Out Execute)



When input is on, the data is retrieved from the corresponding FIFO data file and stored to the data registers starting with the device assigned by D1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
N (File Number)	File number	—	—	—	—	—	—	—	0-9	—
D1 (Destination 1)	First data register number to store data	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

Make sure that FOEX instructions are executed after the corresponding FIFOF instruction has initialized the FIFO data file. If FOEX instructions are executed without executing the corresponding FIFOF instruction, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the FOEX instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

## 23: FILE DATA PROCESSING INSTRUCTIONS

### Valid Data Types

<b>W (word)</b>	X
<b>I (integer)</b>	—
<b>D (double word)</b>	—
<b>L (long)</b>	—
<b>F (float)</b>	—

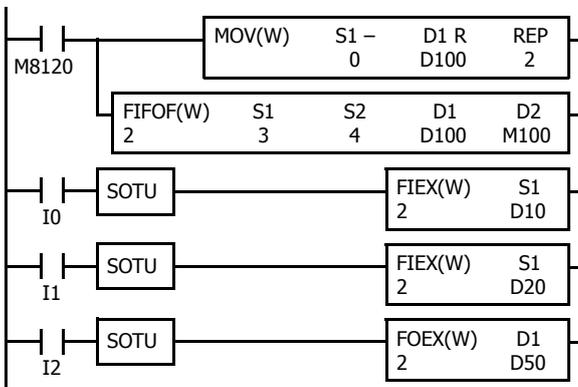
When a D (data register) is assigned as the destination, as many data registers as the value stored in device S1 of the corresponding FIFOF instruction are used.

### Example: FIFOF, FIEX, and FOEX

This program demonstrates a user program of the FIFOF, FIEX, and FOEX instructions to use an FIFO data file.

File number: 2  
 Quantity of data registers per record: 3  
 Quantity of records: 4  
 FIFO Data file: D100 through D113 (3×4+2 data registers)  
 FIFO status outputs: M100 through M102

### Ladder Diagram



M8120 is the initialize pulse special internal relay.

When the CPU starts, MOV sets 0 to FI and FO pointers, and FIFOF initializes FIFO data file 2.

When input I0 is turned on, the data in D10 through D12 are stored to the FIFO data file 2.

When input I1 is turned on, the data in D20 through D22 are stored to the FIFO data file 2.

When input I2 is turned on, the first data is retrieved from the FIFO data file 2 and stored to D50 through D52.

### FIFO Data File

The table below shows the data stored in FIFO data file 2 when inputs I0, I1, and I2 are turned on in this order. Only valid data managed by the FIFOF, FIEX, and FOEX instructions are shown in the table.

Function	Device Address	Input I0	Input I1	Input I2
FI Pointer	D100	1	2	2
FO Pointer	D101	0	0	1
Record 0	D102 through D104	D10, D11, D12	D10, D11, D12	—
Record 1	D105 through D107	—	D20, D21, D22	D20, D21, D22
Record 2	D108 through D110	—	—	—
Record 3	D111 through D113	—	—	—

**NDSRC (N Data Search)**



When input is on, a value specified by device S1 is searched for. Data registers are searched, starting with the data register assigned by device S2. Device S3 specifies the quantity of 1-word or 2-word blocks of data registers to search, depending on the data type.

The offset of the data register where a match first occurred is stored in data register assigned by device D1. The number of matches is stored in the next data register. When the search results in no match, 65535 is stored in device D1 and 0 is stored in device D+1.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Value to be sought	—	—	—	—	—	—	X	X	—
S2 (Source 2)	First data register number to search	—	—	—	—	—	—	X	—	—
S3 (Source 3)	Quantity of blocks to search	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Search result	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

Source S1 data specifies the value to be sought and the valid range depends on the data type.

The search range cannot straddle data registers and non-retentive data registers. Make sure that the sum of data register numbers designated by S1 and S2 does not result in a different data register range.

For source S3 and destination D1, 1 word is always used without regard to the data type.

Destination D1 occupies two consecutive data registers starting with the device designated by D1. Data registers D0-D998 and D1000-D1998 can be designated as destination D1.

When F (float) data is selected and S1 does not comply with the normal floating-point format, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed.

When data in S2 to S2+(S3) does not comply with floating-point format, the data is skipped to continue the search and the results are stored in D1 and D1+1.

The NDSRC instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When S3 is zero or the sum of S2 and S3 is not within the valid data register range, a user program execution error will result, turning on special internal relay M8004 and ERR LED on the SmartAXIS. When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed.

For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the NDSRC instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

**Valid Data Types**

<b>W (word)</b>	X	When a word device such as D (data register) is assigned as the source, 1 point (word or integer data) or 2 points (double-word, long, or float data) are used.
<b>I (integer)</b>	X	
<b>D (double word)</b>	X	
<b>L (long)</b>	X	
<b>F (float)</b>	X	

**Quantity of Source and Destination Devices**

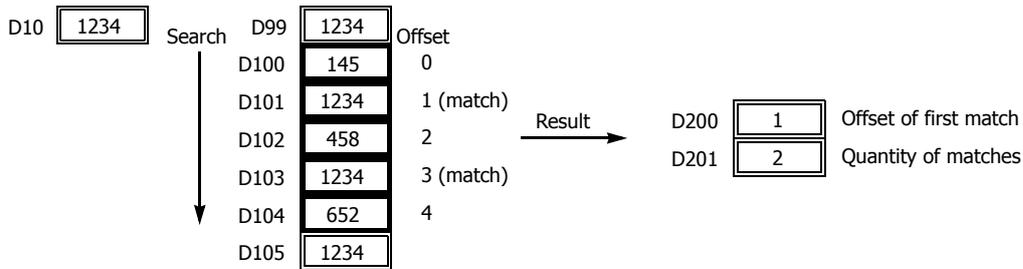
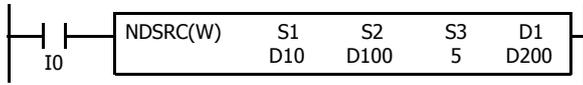
Depending on the data type, source devices S1 and S2 use a different quantity of devices. Source device S3 and destination device D1 always use 1 word without regards to the data type.

Device	W (word), I (integer)	D (double word), L (long), F (float)
S1, S2	1 word device	2 word devices
S3, D1	1 word device	1 word device

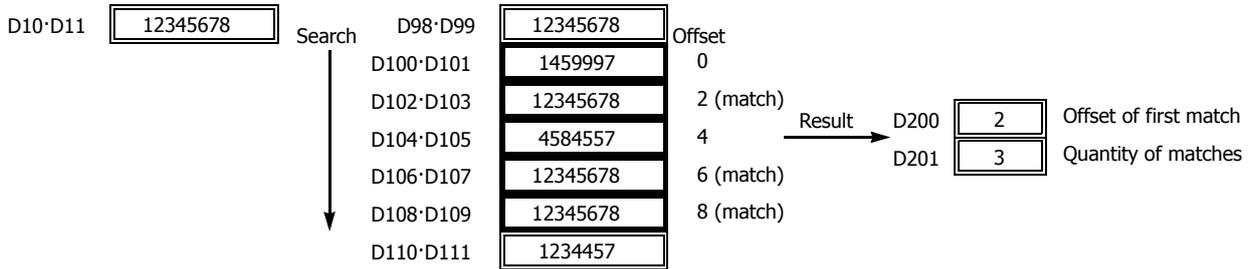
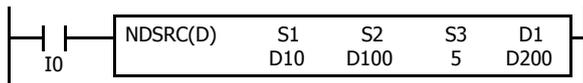
**Examples: NDSRC**

The following examples demonstrate the NDSRC instruction that searches the data of three different data types.

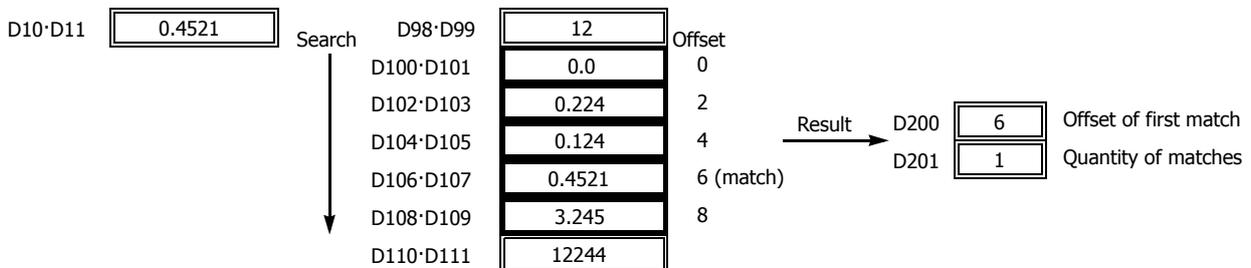
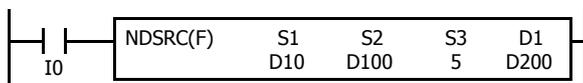
• **Data Type: Word**



• **Data Type: Double Word**



• **Data Type: Float**



# 24: CLOCK INSTRUCTIONS

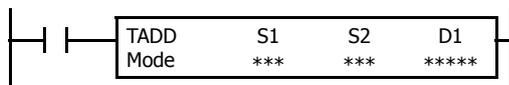
## Introduction

TADD (time addition) and TSUB (time subtraction) instructions add or subtract time data in two different modes. The data can be selected from time (hour, minute, and second) or date/time (year, month, day, day of week, hour, minute, and second).

HTOS (HMS to sec) and STOH (sec to HMS) instructions perform conversion of time data between hours, minutes, seconds and seconds.

HOUR (hour meter) instruction measures the on duration of the input and compares the total duration to a preset value. When the preset value is reached, an output or internal relay is turned on.

## TADD (Time Addition)



$S1 + S2 \rightarrow D1, CY$

When input is on, time data assigned by source device S2 are added to date/time data assigned by source device S1, depending on the selected mode. The result is stored to destination device D1 and carry (M8003).

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
Mode	Selection of S1 data range	—	—	—	—	—	—	—	0, 1	—
S1 (Source 1)	Date/time data to add to	—	—	—	—	—	—	X	—	—
S2 (Source 2)	Time data to add	—	—	—	—	—	—	X	—	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When Mode 0 is selected, source devices S1 and S2 and destination device D1 occupy 3 consecutive data registers starting with the designated device. Data registers D0-D997 and D1000-D1997 can be designated as these devices.

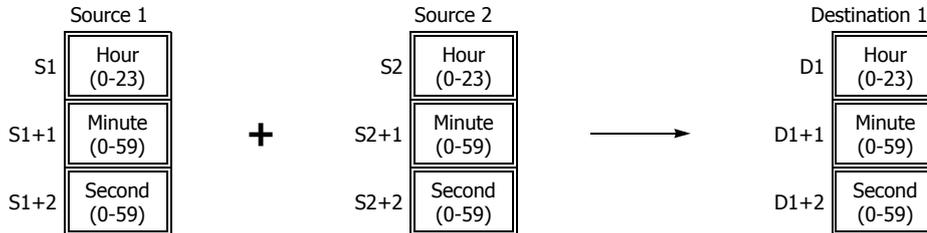
When Mode 1 is selected, source device S1 and destination device D1 occupy 7 consecutive data registers starting with the designated device. Data registers D0-D993 and D1000-D1993 can be designated as these devices. Source device S2 occupies 3 consecutive data registers starting with the designated device. Data registers D0-D997 and D1000-D1997 can be designated as source device S2.

Since the TADD instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

## 24: CLOCK INSTRUCTIONS

### Mode 0

When mode 0 is selected, time data (hour, minute, and second) stored in 3 data registers starting with source device S2 are added to the time data (hour, minute, and second) stored in 3 data registers starting with source device S1. The results are stored to 3 data registers starting with destination device D1.



Hour data can be 0 through 23. Minute and second data can be 0 through 59.

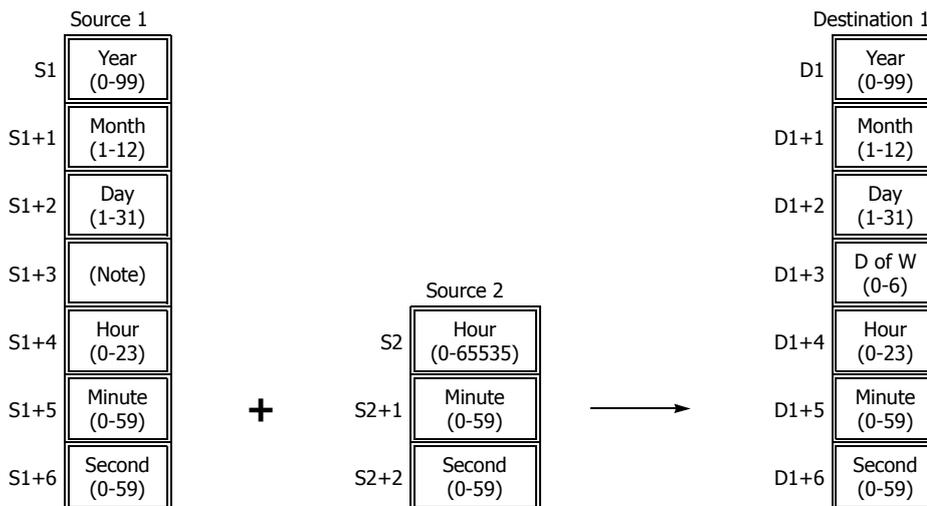
When the execution result exceeds 23:59:59, the result is subtracted by 24 hours and stored to the data register designated by destination device D1, turning on special internal relay M8003 (carry).

When any of the hour, minute, or second data exceeds the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### Mode 1

When mode 1 is selected, time data (hour, minute, and second) stored in 3 data registers starting with source device S2 are added to the date/time data (year, month, day, day of week, hour, minute, and second) stored in 7 data registers starting with source device S1. The results are stored to 7 data registers starting with destination device D1.



**Note:** Device S1+3 in source 1 is not used for execution and need not be designated.

TADD instruction supports leap years.

For source 1: Year data can be 0 through 99. Month data 1 through 12. Day data 1 through 31. Hour data 0 through 23. Minute and second data 0 through 59.

Year data 0 through 99 is processed as year 2000 through 2099.

For source 2: Hour data can be 0 through 65535. Minute and second data can be 0 through 59.

Destination 1: The day of week is calculated automatically from the resultant year, month, and day, and stored to device D1+3.

Day of week data represent: 0 (Sunday), 1 (Monday), 2 (Tuesday), 3 (Wednesday), 4 (Thursday), 5 (Friday), and 6 (Saturday).

When source 1 contains invalid day/time data, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

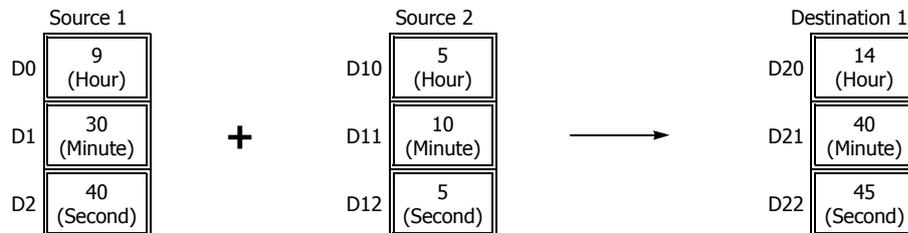
When the execution result exceeds 99 year 12 month 31 day 23:59:59, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

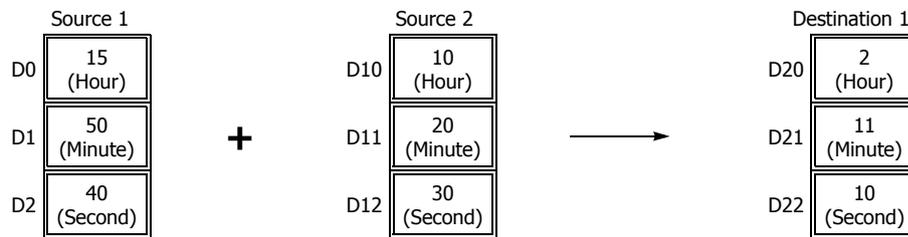
**Examples: TADD**

The following examples demonstrate the TADD instruction that will add time data in two different modes.

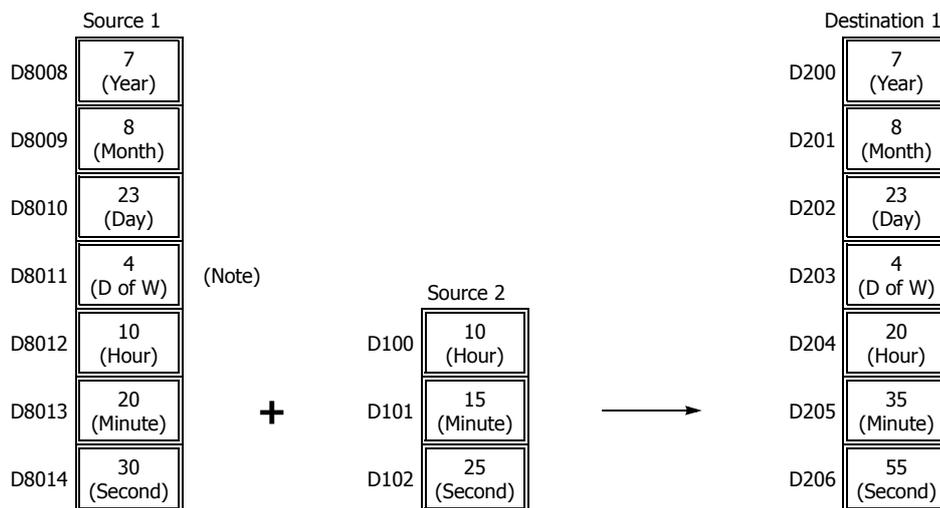
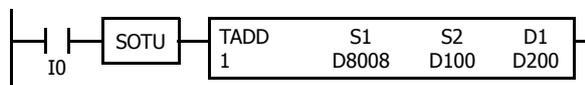
• **Mode 0**



When the result exceeds 23:59:59, the resultant hour data is subtracted by 24, turning on special internal relay M8003 (carry).



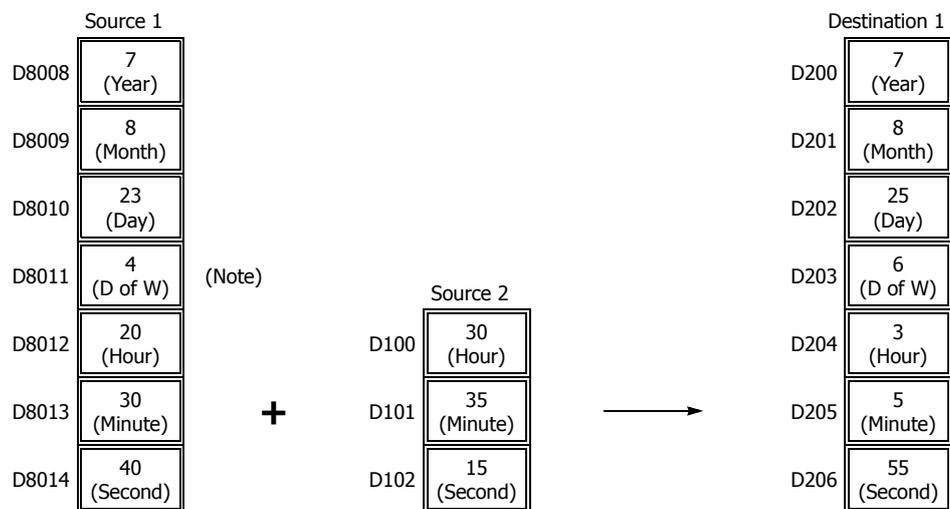
• **Mode 1**



**Note:** D8011 in source 1 is not used for execution and does not need to be designated. The day of week is calculated automatically from the resultant year, month, and day, and stored to D203 of destination 1.

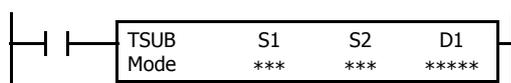
## 24: CLOCK INSTRUCTIONS

When the result exceeds 23:59:59, the resultant hour data is subtracted by a multiple of 24 and the day data is incremented.



**Note:** D8011 in source 1 is not used for execution and does not need to be designated. The day of week is calculated automatically from the resultant year, month, and day, and stored to D203 of destination 1.

## TSUB (Time Subtraction)



$S1 - S2 \rightarrow D1, CY$

When input is on, time data assigned by source device S2 is subtracted from date/time data assigned by source device S1, depending on the selected mode. The result is stored to destination device D1 and borrow (M8003).

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
Mode	Selection of S1 data range	—	—	—	—	—	—	—	0, 1	—
S1 (Source 1)	Date/time data to subtract from	—	—	—	—	—	—	X	—	—
S2 (Source 2)	Time data to subtract	—	—	—	—	—	—	X	—	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

When Mode 0 is selected, source devices S1 and S2 and destination device D1 occupy 3 consecutive data registers starting with the designated device. Data registers D0-D997 and D1000-D1997 can be designated as these devices.

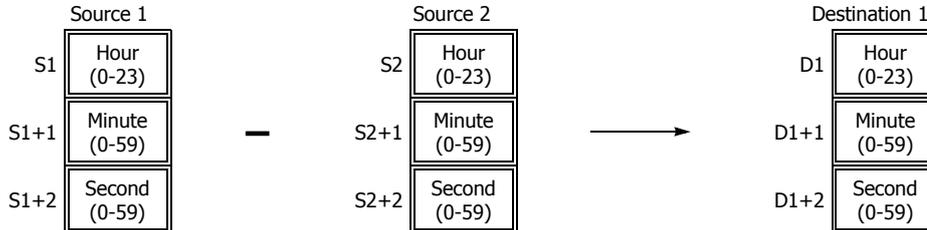
When Mode 1 is selected, source device S1 and destination device D1 occupy 7 consecutive data registers starting with the designated device. Data registers D0-D993 and D1000-D1993 can be designated as these devices. Source device S2 occupies 3 consecutive data registers starting with the designated device. Data registers D0-D997 and D1000-D1997 can be designated as source device S2.

Since the TSUB instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

## 24: CLOCK INSTRUCTIONS

### Mode 0

When mode 0 is selected, time data (hour, minute, and second) stored in 3 data registers starting with source device S2 is subtracted from the time data (hour, minute, and second) stored in 3 data registers starting with source device S1. The results are stored to 3 data registers starting with destination device D1.



Hour data can be 0 through 23. Minute and second data can be 0 through 59.

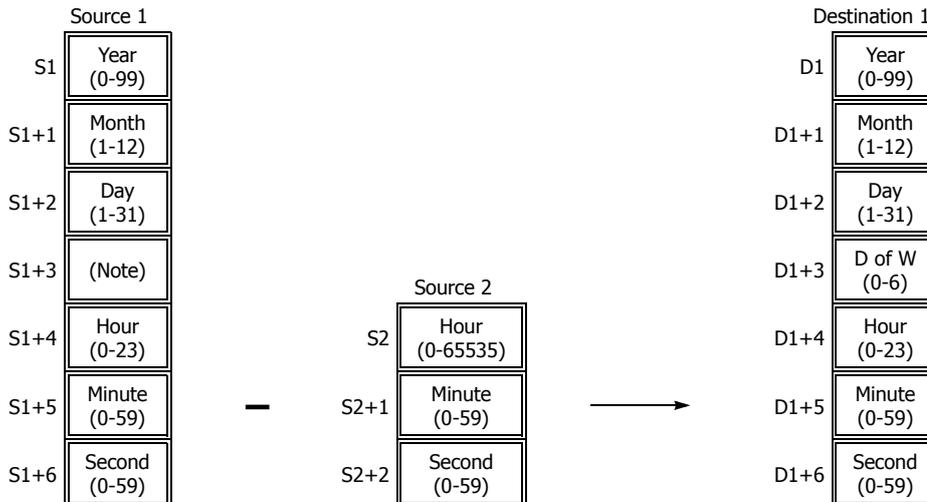
When the execution result is less than 00:00:00, 24 hour is added to the result and stored to the data register designated by destination device D1, turning on special internal relay M8003 (borrow).

When any of the hour, minute, or second data exceeds the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### Mode 1

When mode 1 is selected, time data (hour, minute, and second) stored in 3 data registers starting with source device S2 is subtracted from the date/time data (year, month, day, day of week, hour, minute, and second) stored in 7 data registers starting with source device S1. The results are stored to 7 data registers starting with destination device D1.



**Note:** Device S1+3 in source 1 is not used for execution and need not be designated.

TSUB instruction supports leap years.

For source 1: Year data can be 0 through 99. Month data 1 through 12. Day data 1 through 31. Hour data 0 through 23. Minute and second data 0 through 59.

Year data 0 through 99 is processed as year 2000 through 2099.

For source 2: Hour data can be 0 through 65535. Minute and second data can be 0 through 59.

Destination 1: The day of week is calculated automatically from the resultant year, month, and day, and stored to device D1+3.

Day of week data represent: 0 (Sunday), 1 (Monday), 2 (Tuesday), 3 (Wednesday), 4 (Thursday), 5 (Friday), and 6 (Saturday).

When source 1 contains invalid day/time data, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

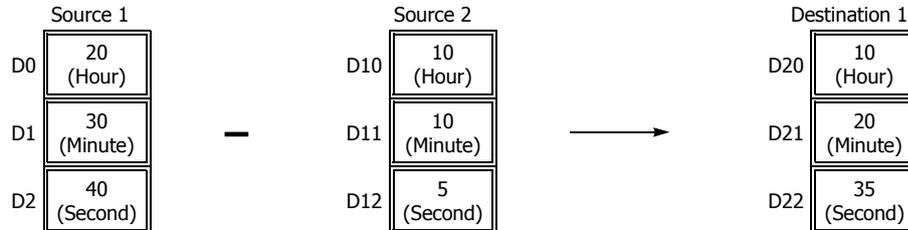
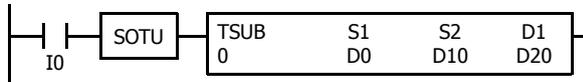
When the execution result is less than 00 year 1 month 1 day 00:00:00, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS.

When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

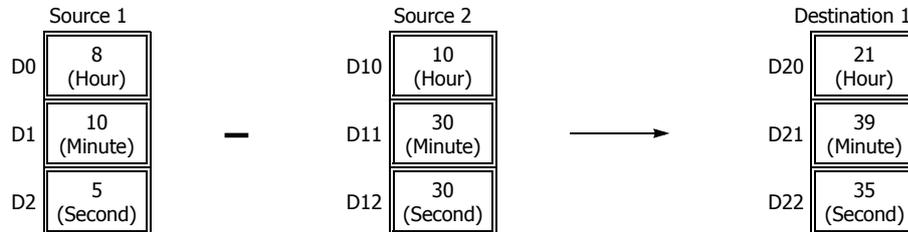
**Examples: TSUB**

The following examples demonstrate the TSUB instruction to that will subtract time data in two different modes.

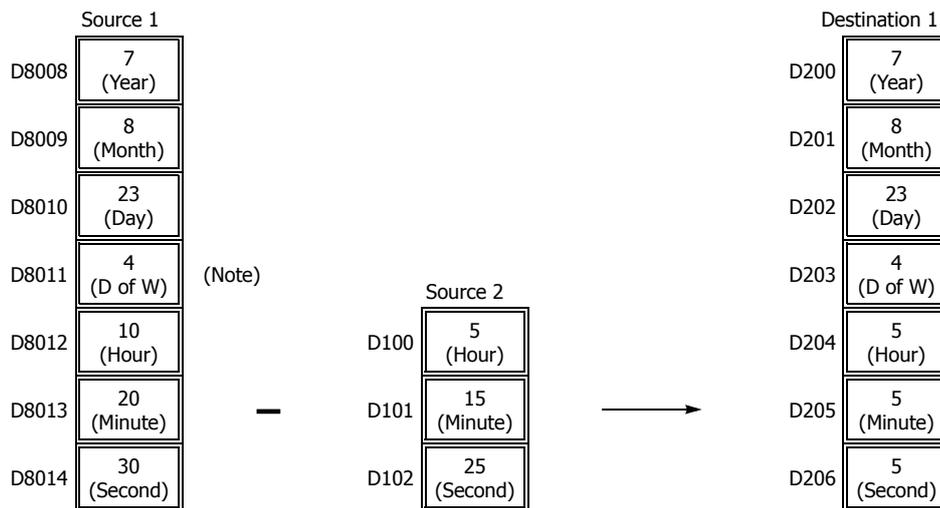
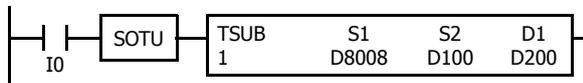
• **Mode 0**



When the result is less than 00:00:00, 24 is added to the result, turning on special internal relay M8003 (borrow).



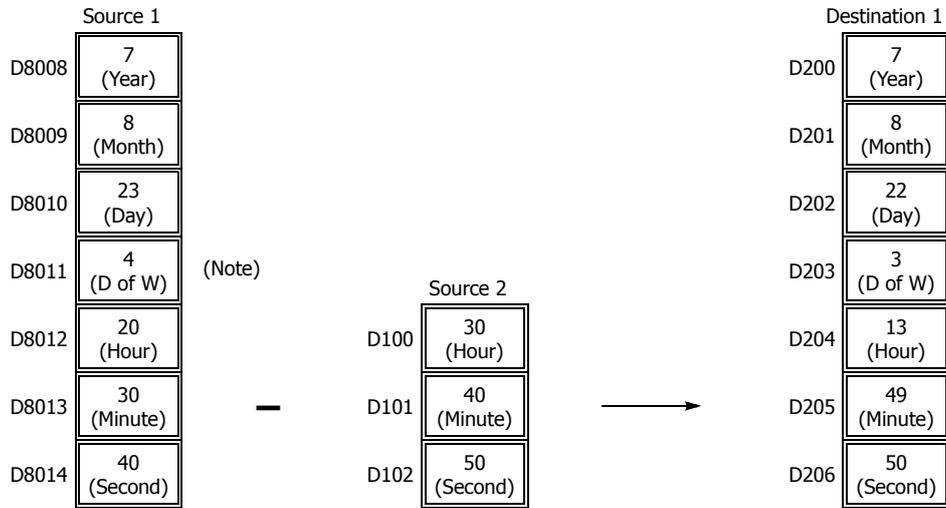
• **Mode 1**



**Note:** D8011 in source 1 is not used for execution and does not need to be designated. The day of week is calculated automatically from the resultant year, month, and day, and stored to D203 of destination 1.

## 24: CLOCK INSTRUCTIONS

When the result is less than 00:00:00, 24 is added to the result, and the day data is decremented.



**Note:** D8011 in source 1 is not used for execution and does not need to be designated. The day of week is calculated automatically from the resultant year, month, and day, and stored to D203 of destination 1.

### HTOS (HMS to Sec)



Hours, minutes, seconds → Seconds

When input is on, time data in hours, minutes, and seconds assigned by source device S1 is converted into seconds. The result is stored to destination device D1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Time data in hours, minutes, seconds	—	—	—	—	—	—	X	—	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

Source device S1 occupies 3 consecutive data registers starting with the designated device. Data registers D0-D997 and D1000-D1997 can be designated as source device S1.

Destination device D1 occupies 2 consecutive data registers to store double-word data, starting with the designated device. Data registers D0-D998 and D1000-D1998 can be designated as destination device D1.

Hour data can be 0 through 65535. Minute and second data can be 0 through 59.

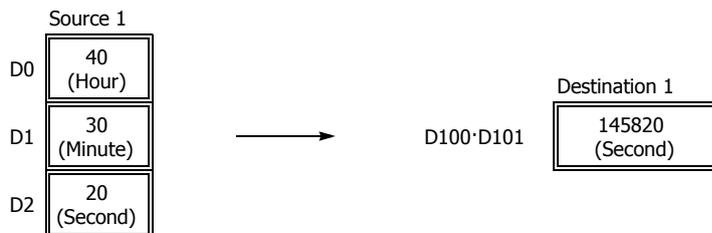
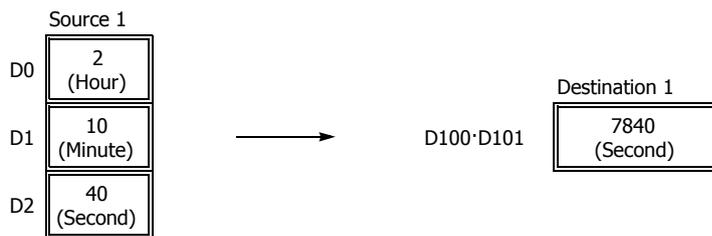
When any of the hour, minute, or second data exceeds the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. When a user program execution error occurs, the execution of the instruction is canceled and the next instruction is executed.

When the execution of the instruction is canceled, the data in D1 and D1+1 is left unchanged. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

Since the HTOS instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

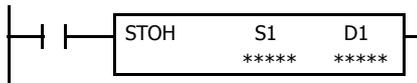
#### Examples: HTOS

The following examples demonstrate the HTOS instruction that will convert time data in hours, minutes, and seconds into seconds and store the results to two consecutive data registers.



## 24: CLOCK INSTRUCTIONS

### STOH (Sec to HMS)



Seconds → Hours, minutes, seconds

When input is on, time data in seconds assigned by source device S1 is converted into hours, minutes, and seconds. The result is stored to destination device D1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Time data in seconds	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Destination to store results	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

Source device S1 occupies 2 consecutive data registers to store double-word data, starting with the designated device. Data registers D0-D998 and D1000-D1998 can be designated as source device S1.

Destination device D1 occupies 3 consecutive data registers starting with the designated device. Data registers D0-D997 and D1000-D1997 can be designated as destination device D1.

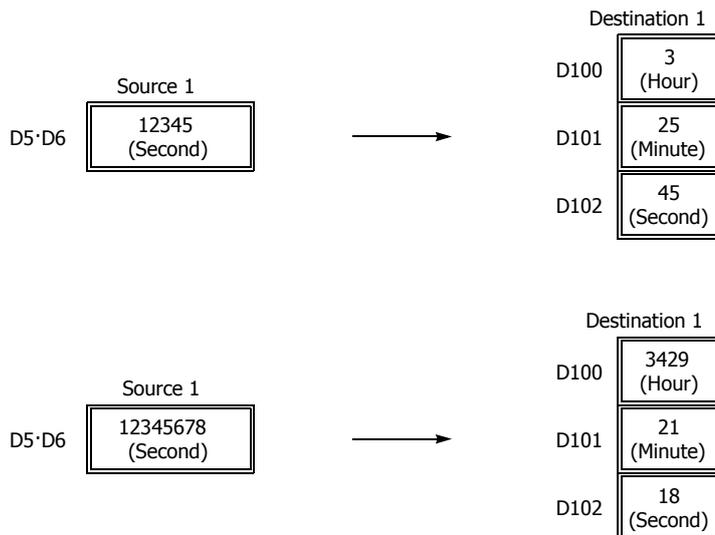
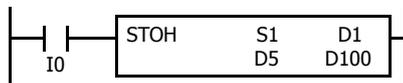
Second data for source device S1 can be 0 through 4,294,967,295.

When the conversion result exceeds 65535 hours 59 minutes 59 seconds, special internal relay M8003 (carry) is turned on. For example, when the conversion result is 65537 hours 0 minute 0 second, destination 1 stores 1 hour 0 minute 0 second, turning on special internal relay M8003 (carry).

Since the STOH instruction is executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

#### Examples: STOH

The following examples demonstrate the STOH instruction that will convert time data in seconds into hours, minutes, and seconds and store the results to three consecutive data registers.



## HOUR (Hour Meter)



S1 ↔ D1 → D2

While input is on, the ON duration of the input is measured. The measured time value (hour, minute, and second) is stored to 3 consecutive data registers assigned by destination device D1 and compared with the preset value assigned by source device S1.

When the D1 value reaches the S1 value, an output or internal relay assigned by destination device D2 is turned on.

Two data registers starting with destination device D3 are reserved for system work area.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
X	X	X	X	X

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Preset value	—	—	—	—	—	—	X	0-65535	—
D1 (Destination 1)	Measured input ON duration	—	—	—	—	—	—	X	—	—
D2 (Destination 2)	Comparison output	—	X	▲	—	—	—	—	—	—
D3 (Destination 3)	System work area	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

Source device S1 can be designated by a data register or constant.

Source device S1, when designated by a data register, and destination device D1 occupy 3 consecutive data registers starting with the designated device to store hour, minute, and second data. Data registers D0-D997 and D1000-D1997 can be designated as these devices.

When source device S1 is designated by a constant, the preset value can be 0 through 65535 in hours, then minutes and seconds are set to 0.

▲ Special internal relays cannot be designated as destination device D2.

Destination device D3 requires two data registers reserved for system work area.

Hour data can be 0 through 65535. Minute and second data can be 0 through 59.

When the measured input ON duration value in destination device D1 reaches the preset value designated by source device S1, the comparison output designated by destination device D2 turns on. As long as the input remains on, the measured input ON duration value continues to increase. When the measured input ON duration value exceeds 65535 hours 59 minutes 59 seconds, the value returns to 0 hours 0 minutes 0 seconds to repeat another measuring cycle, with the comparison output remaining on.

When any of the hour, minute, or second data of source device S1 exceeds the valid range, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS, but the input ON duration is measured.

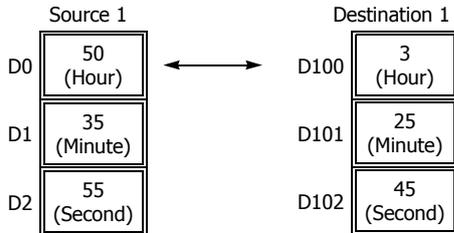
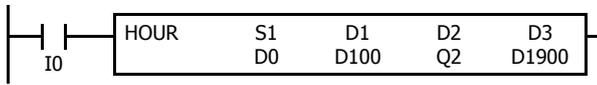
When any of the hour, minute, or second data of source device S1 is changed to an invalid value after the comparison output has turned on, the comparison output is turned off. Then a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS, but the input ON duration measurement is continued. For user program execution errors, see "User Program Execution Errors" on page 4-13.

## 24: CLOCK INSTRUCTIONS

### Examples: HOUR

The following examples demonstrate the HOUR instruction that will measure the input ON duration value in hours, minutes, and seconds and to compare the value in two different ways.

- **Source Device S1: Data Register**



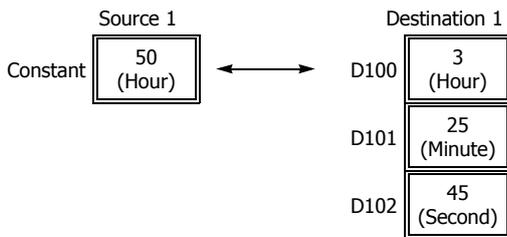
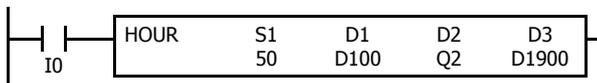
$D0 \cdot D1 \cdot D2 \ll D100 \cdot D101 \cdot D102 \rightarrow Q2$

While input I0 is on, the ON duration is measured. The measured time value (hour, minute, and second) is stored to data registers D100·D101·D102 assigned by destination device D1 and compared with the preset value stored in data registers D0·D1·D2 assigned by source device S1.

When the measured value reaches the preset value, output Q2 assigned by destination device D2 is turned on.

Data registers D1900 and D1901 assigned by destination device D3 are reserved for system work area.

- **Source Device S1: Constant**



$50 \ll D100 \cdot D101 \cdot D102 \rightarrow Q2$

While input I0 is on, the ON duration is measured. The measured time value (hour, minute, and second) is stored to data registers D100·D101·D102 assigned by destination device D1 and compared with 50 hours assigned by source device S1.

When the measured value reaches 50 hours, output Q2 assigned by destination device D2 is turned on.

Data registers D1900 and D1901 assigned by destination device D3 are reserved for system work area.

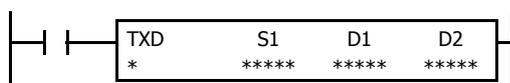
# 25: USER COMMUNICATION INSTRUCTIONS

## Introduction

User communication instructions convert data to the specified data type and transmit and receive that data.

The user communication instructions can be used on expansion communication ports or the Ethernet port. To perform user communication with external devices connected on the expansion communication ports, use the TXD (user communication transmit) and RXD (user communication receive) instructions. To perform user communication with external devices connected over the Ethernet, use the ETXD (User communication transmit over Ethernet) and ERXD (User communication receive over Ethernet) instructions.

## TXD (Transmit)



When input is on, data assigned by S1 is converted into a specified format and transmitted from port 2 through port 3 to a remote terminal with an RS232C/RS485 port.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	TXD2	TXD2-TXD3	TXD2-TXD3	—

### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Transmit data	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Transmit completion output	—	X	▲	—	—	—	—	—	—
D2 (Destination 2)	Transmit status register	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

Transmit data designated by device S1 can be a maximum of 200 bytes.

When transmission is complete, an output or internal relay, designated by device D1, is turned on.

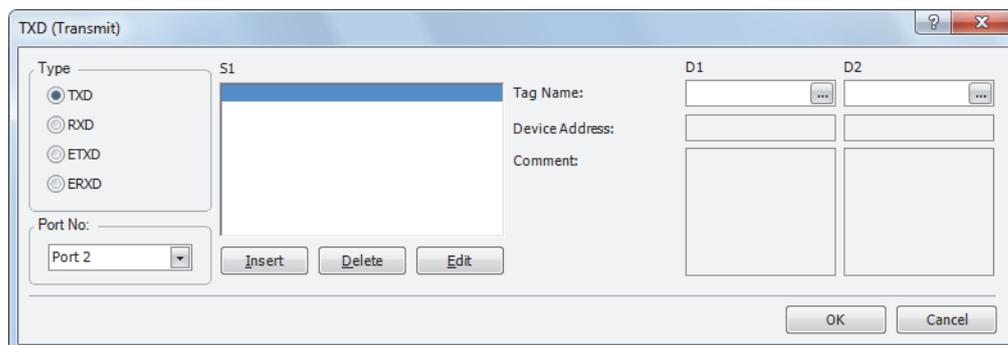
Destination 2 occupies two consecutive data registers starting with the device designated by D2. The transmit status data register, D0-D1998, stores the status of transmission and error code. The next data register stores the byte count of transmitted data. The same data registers cannot be used as transmit status registers for TXD2 through TXD3 instructions and receive status registers for RXD2 through RXD3 instructions.

The TXD instructions cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

### Precautions for Programming TXD Instruction

- The SmartAXIS has five formatting areas each for executing TXD2 through TXD3 instructions, so five instructions each of TXD2 through TXD3 can be processed at the same time. If inputs to more than five of the same TXD instructions are turned on at the same time, an error code is set to the transmit status data register, designated by device D2, in the excessive TXD instructions that cannot be executed.
- If the input for a TXD instruction turns on while another TXD instruction is executed, the subsequent TXD instruction is executed 2 scan times after the preceding TXD instruction is completed.
- Since TXD instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.

User Communication Transmit Instruction Dialog Box in WindLDR



Selections and Devices in Transmit Instruction Dialog Box

<b>Type</b>	<b>TXD</b>	Transmit instruction
	<b>RXD</b>	Receive instruction
<b>Port</b>	<b>Port 2 - Port 3</b>	Transmit user communication from port 2 (TXD2) through port 3 (TXD3)
<b>S1</b>	<b>Source 1</b>	Enter the data to transmit in this area. Transmit data can be constant values (character or hexadecimal), data registers, or BCC.
<b>D1</b>	<b>Destination 1</b>	Transmit completion output can be an output or internal relay.
<b>D2</b>	<b>Destination 2</b>	Transmit status register can be data register D0-D1998. The next data register stores the byte count of transmitted data.

Transmit Data

Transmit data is designated by source device S1 using constant values or data registers. BCC code can also be calculated automatically and appended to the transmit data. One TXD instruction can transmit a maximum of 200 bytes of data.

S1 (Source 1)

Transmit Data	Device	Conversion Type	Transmit Digits (Bytes)	Repeat	BCC Calculation	Calculation Start Position
<b>Constant</b>	00h-7Fh (FFh)	No conversion	1	—	—	—
<b>Data Register</b>	D0-D1999	A: Binary to ASCII	1-4	1-99	—	—
		B: BCD to ASCII	1-5			
		—: No conversion	1-2			
<b>BCC</b>	—	A: Binary to ASCII —: No conversion	1-2	—	X: XOR A: ADD C: Add-2comp M: Modbus ASCII M: Modbus RTU	1-15

**Note:** Total byte count of the transmit data is shown in S1 of TXD instruction on the ladder diagram of WindLDR.

Designating Constant as S1

When a constant value is designated as source device S1, one-byte data is transmitted without conversion. The valid transmit data value depends on the data bits selected in the Communication Parameters dialog box. These data bits are set in **Configuration > Comm. Ports**, followed by selecting **User Protocol** in Port 2 through Port 3 list box and clicking the **Configure** button. When 7 data bits are selected as default, 00h through 7Fh is transmitted. When 8 data bits are selected, 00h through FFh is transmitted. Constant values are entered in character or hexadecimal notation into the source data.

Constant (Character)

Any character available on the computer keyboard can be entered. One character is counted as one byte.

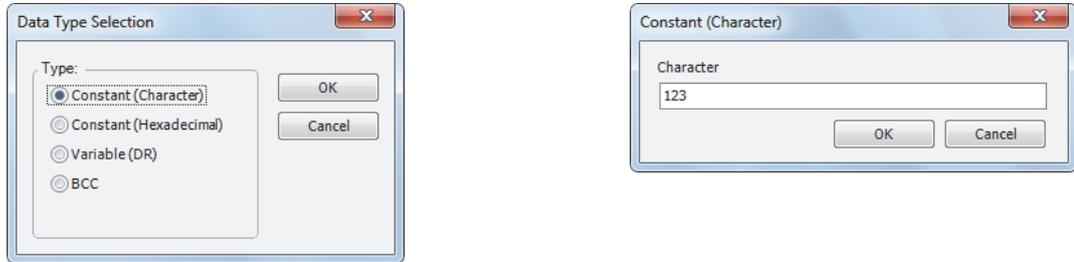
Constant (Hexadecimal)

Use this option to enter the hexadecimal code of any ASCII character. ASCII control codes NUL (00h) through US (1Fh) can also be entered using this option.

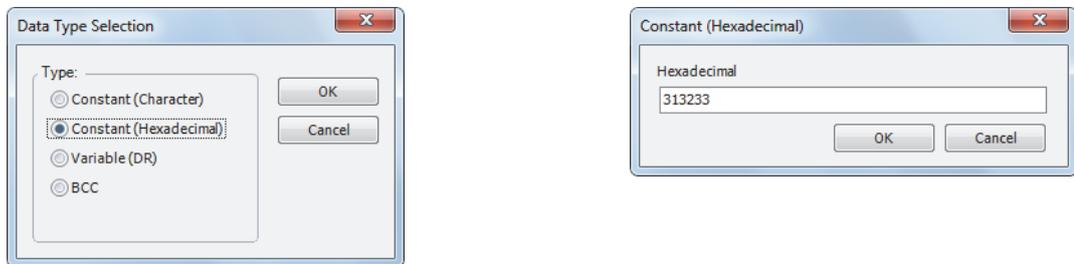
**Example:**

The following example shows two methods to enter 3-byte ASCII data "1" (31h), "2" (32h), "3" (33h).

(1) Constant (Character)



(2) Constant (Hexadecimal)



**Designating Data Register as S1**

When a data register is designated as source device S1, conversion type and transmit digits must also be assigned. The data stored in the designated data register is converted and the assigned quantity of digits of the resultant data is transmitted. The conversion types that are available are: Binary to ASCII, BCD to ASCII, and no conversion.

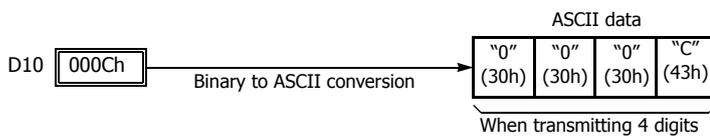
When repeat is designated, data of data registers as many as the repeat cycles are transmitted, starting with the designated data register. Repeat cycles can be up to 99.

**Conversion Type**

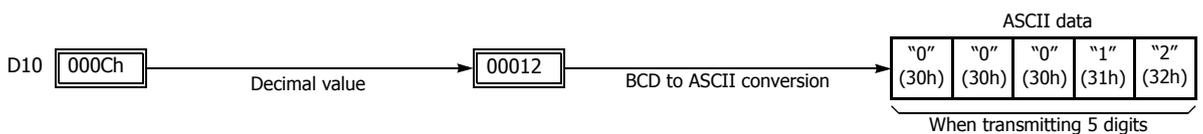
The transmit data is converted according to the designated conversion type as described below:

**Example:** D10 stores 000Ch (12)

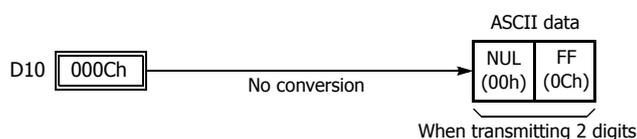
(1) Binary to ASCII conversion



(2) BCD to ASCII conversion



(3) No conversion



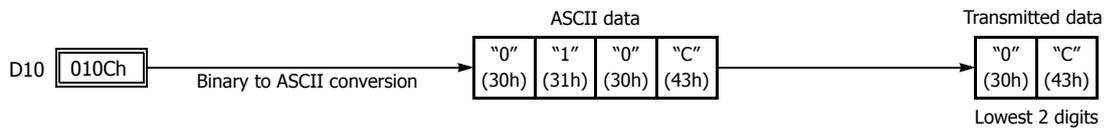
## 25: USER COMMUNICATION INSTRUCTIONS

### Transmit Digits (Bytes)

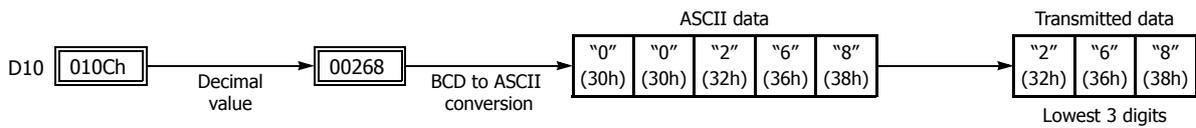
After conversion, the transmit data is taken out in specified digits. Possible digits depend on the selected conversion type.

Example: D10 stores 010Ch (268)

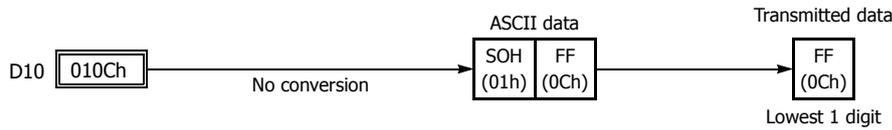
(1) Binary to ASCII conversion, Transmit digits = 2



(2) BCD to ASCII conversion, Transmit digits = 3



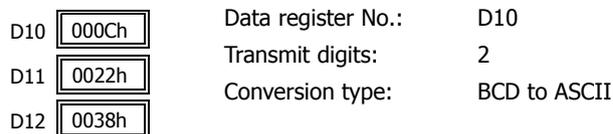
(3) No conversion, Transmit digits = 1



### Repeat Cycles

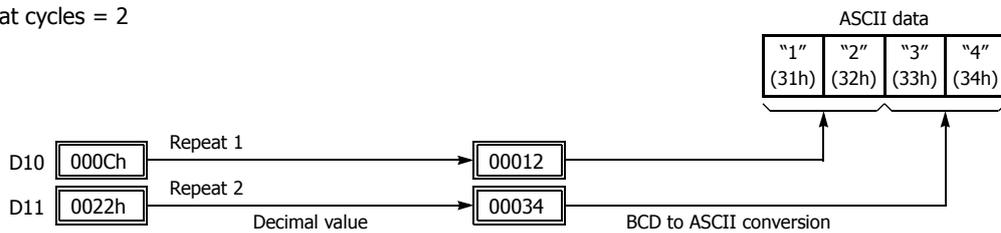
When a data register is assigned to repeat, as many consecutive data registers, as the repeat cycles, are used to transmit data in the same conversion type and transmit digits.

#### Example:

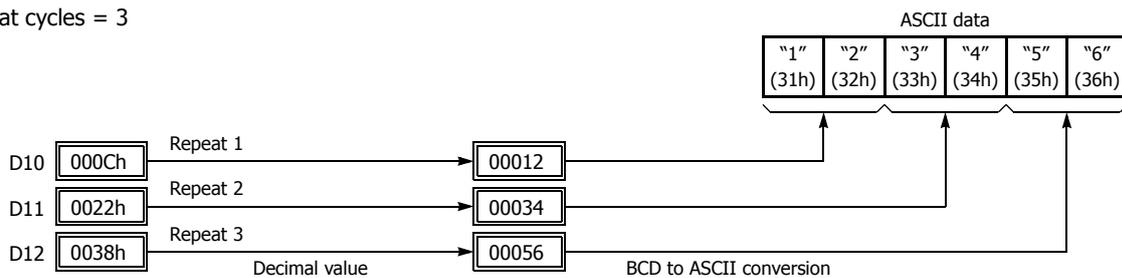


Data from data registers starting with D10 is converted in BCD to ASCII and is transmitted according to the designated repeat cycles.

(1) Repeat cycles = 2

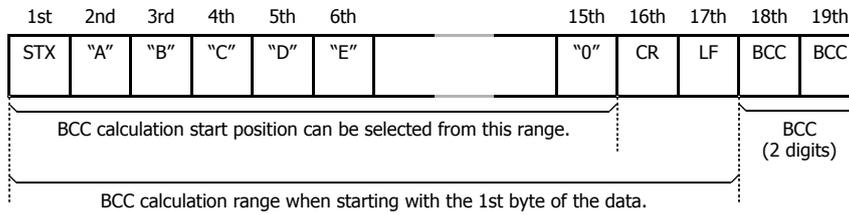


(2) Repeat cycles = 3



**BCC (Block Check Character)**

Block check characters can be appended to the transmit data. The start position for the BCC calculation can be selected from the first byte through the 15th byte. The BCC can be 1 or 2 digits.

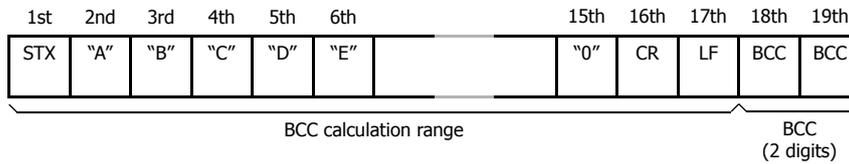


**BCC Calculation Start Position**

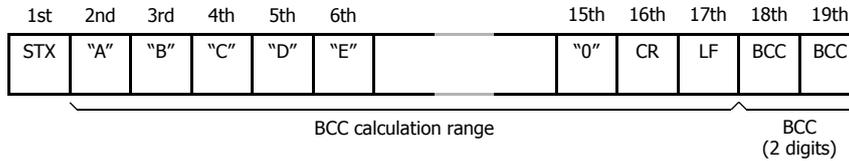
The start position for the BCC calculation can be specified from the first byte through the 15th byte. The BCC is calculated for the range starting at the designated position up to the byte immediately before the BCC of the transmit data.

**Example:** Transmit data consists of 17 bytes plus 2 BCC digits.

(1) Calculation start position = 1



(2) Calculation start position = 2



**BCC Calculation Formula**

BCC calculation formula can be selected from XOR (exclusive OR), ADD (addition), ADD-2comp, Modbus ASCII, or Modbus RTU.

**Example:** Conversion results of transmit data consist of 41h, 42h, 43h, and 44h.

ASCII data			
"A"	"B"	"C"	"D"
(41h)	(42h)	(43h)	(44h)

(1) BCC calculation formula = XOR

Calculation result =  $41h \oplus 42h \oplus 43h \oplus 44h = 04h$

(2) BCC calculation formula = ADD

Calculation result =  $41h + 42h + 43h + 44h = 10Ah \rightarrow 0Ah$  (Only the last 1 or 2 digits are used as BCC.)

(3) BCC calculation formula = ADD-2comp

Calculation result = FEh, F6h (2 digits without conversion)

(4) BCC calculation formula = Modbus ASCII

Calculation result = 88 (ASCII)

(5) BCC calculation formula = Modbus RTU

Calculation result = 85h 0Fh (binary)

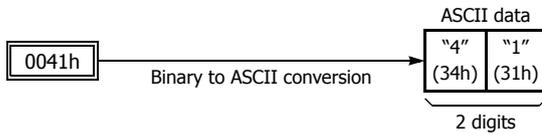
## 25: USER COMMUNICATION INSTRUCTIONS

### Conversion Type

The BCC calculation result is converted or not according to the designated conversion type as described below:

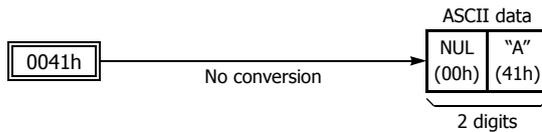
**Example:** BCC calculation result is 0041h.

(1) Binary to ASCII conversion



**Note:** On WindLDR, Modbus ASCII is defaulted to binary to ASCII conversion.

(2) No conversion

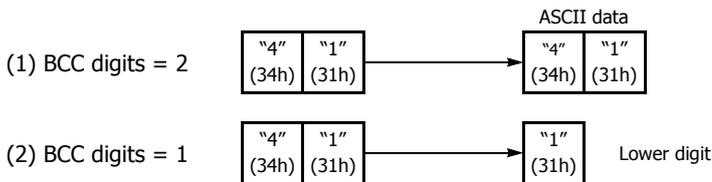


**Note:** On WindLDR, Modbus RTU is defaulted to no conversion.

### BCC Digits (Bytes)

The quantity of digits (bytes) of the BCC code can be selected from 1 or 2.

**Example:**



**Note:** On WindLDR, Modbus ASCII and Modbus RTU are defaulted to 2 digits.

### Transmit Completion Output

Designate an output, Q0 through Q21, or an internal relay, M0 through M1277, as a device for the transmit completion output. Special internal relays cannot be used.

When the start input for a TXD instruction is turned on, preparation for transmission is initiated, followed by data transmission. When a sequence of all transmission operations is complete, the designated output or internal relay is turned on.

### Transmit Status

Designate a data register, D0-D1998, as a device to store the transmit status information including a transmission status code and a user communication error code.

#### Transmit Status Code

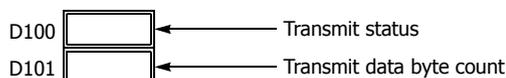
Transmit Status Code	Status	Description
16	Preparing transmission	From turning on the start input for a TXD instruction, until the transmit data is stored in the internal transmit buffer
32	Transmitting data	From enabling data transmission by an END processing, until all data transmission is completed
48	Data transmission complete	From completing all data transmission, until the END processing is completed for the TXD instruction
64	Transmit instruction complete	All transmission operation is completed and the next transmission is made possible

If the transmit status code is other than shown above, a transmit instruction error is suspected. See Chapter 10 "User Communication Instructions" - "User Communication Error" in the SmartAXIS Pro/Lite User's Manual.

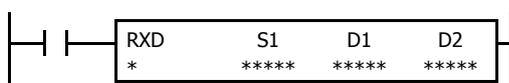
### Transmit Data Byte Count

The data register next to the device designated for transmit status stores the byte count of data transmitted by the TXD instruction. When BCC is included in the transmit data, the byte count of the BCC is also included in the transmit data byte count.

**Example:** Data register D100 is designated as a device for transmit status.



### RXD (Receive)



When input is on, data from an RS232C/RS485 remote terminal received by port 2 through port 3 is converted and stored in data registers according to the receive format assigned by S1.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	RXD2	RXD2-RXD3	RXD2-RXD3	—

#### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Receive format	—	—	—	—	—	—	X	X	—
D1 (Destination 1)	Receive completion output	—	X	▲	—	—	—	—	—	—
D2 (Destination 2)	Receive status	—	—	—	—	—	—	X	—	—

For valid device address ranges, see "Device Addresses" on page 3-1.

▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

Receive format designated by device S1 can be a maximum of 200 bytes.

When data receive is complete, an output or internal relay, designated by device D1, is turned on.

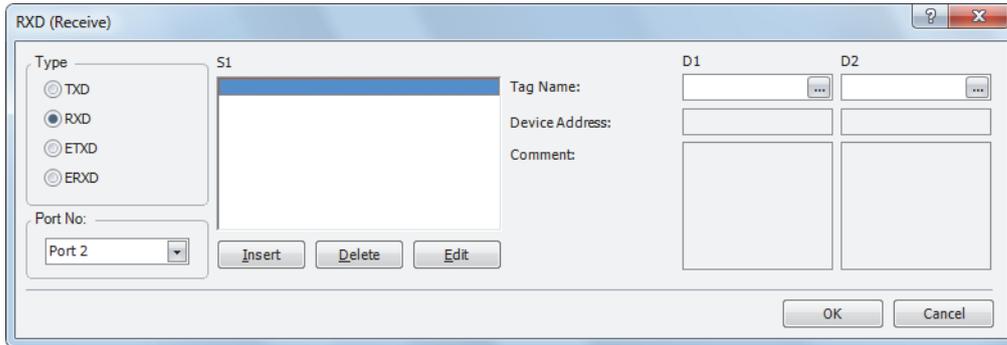
Destination 2 occupies two consecutive data registers starting with the device designated by D2. The receive status data register, D0-D1998, stores the status of data receive and error code. The next data register stores the byte count of received data. The same data registers can not be used as transmit status registers for TXD2 through TXD3 instructions and receive status registers for RXD2 through RXD3 instructions.

The RXD instructions cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

#### Precautions for Programming the RXD Instruction

- The SmartAXIS can execute a maximum of five instructions each of RXD2 through RXD3 that have a start delimiter at the same time. If a start delimiter is not programmed in RXD2 through RXD3 instructions, the SmartAXIS can execute only one instruction each of RXD2 through RXD3 at a time. If the start input for a RXD2 through RXD3 instruction is turned on while another RXD2 through RXD3 instruction, without a start delimiter is executed, a user communication error occurs.
- Since RXD instructions are executed in each scan while input is on, a pulse input from a SOTU or SOTD instruction should be used.
- Once the input to the RXD instruction is turned on, the RXD is activated and ready for receiving incoming communication even after the input is turned off. When the RXD completes data receiving, the RXD is deactivated if the input to the RXD is off. Or, if the input is on, the RXD is made ready for receiving another communication. Special internal relays are available to deactivate all RXD instructions waiting for incoming communication. For user communication receive instruction cancel flags, see "User Communication Receive Instruction Cancel Flag" on page 25-20.

User Communication Receive Instruction Dialog Box in WindLDR



Selections and Devices in Receive Instruction Dialog Box

<b>Type</b>	<b>TXD</b>	Transmit instruction
	<b>RXD</b>	Receive instruction
<b>Port</b>	<b>Port 2 - Port 3</b>	Receive user communication to port 2 (RXD2) through port 3 (RXD3)
<b>S1</b>	<b>Source 1</b>	Enter the receive format in this area. The receive format can include a start delimiter, data register to store incoming data, constants, end delimiter, BCC, and skip.
<b>D1</b>	<b>Destination 1</b>	Receive completion output can be an output or internal relay.
<b>D2</b>	<b>Destination 2</b>	Receive status register can be data register D0-D1998. The next data register stores the byte count of received data.

Receive Format

Receive format, designated by source device S1, specifies data registers to store received data, data digits for storing data, data conversion type, and repeat cycles. A start delimiter and an end delimiter can be included in the receive format to discriminate valid incoming communication. When some characters in the received data are not needed, "skip" can be used to ignore a specified number of characters. BCC code can also be appended to the receive format to verify the received data. One RXD instruction can receive 200 bytes of data at the maximum.

S1 (Source 1)

Receive Format	Device	Receive Digits (Bytes)	Conversion Type	Repeat	BCC Calculation	Calculation Start Position	Skip Bytes	Delimiter
<b>Data Register</b>	D0-D1999	1-4 1-5 1-2	A:ASCII to Binary B:ASCII to BCD -:No conversion	1-99	—	—	—	Hex ASCII
<b>Start Delimiter</b>	00h-FFh 1 to 5 bytes	—	No conversion	—	—	—	—	
<b>End Delimiter</b>	00h-FFh	—	No conversion	—	—	—	—	
<b>Constant for Verification</b>	00h-FFh	—	No conversion	—	—	—	—	
<b>BCC</b>	—	1-2	A:Binary to ASCII -:No conversion	—	X:XOR A:ADD C:Add-2comp M:Modbus ASCII M:Modbus RTU	1-15	—	
<b>Skip</b>	—	—	—	—	—	—	1-99	

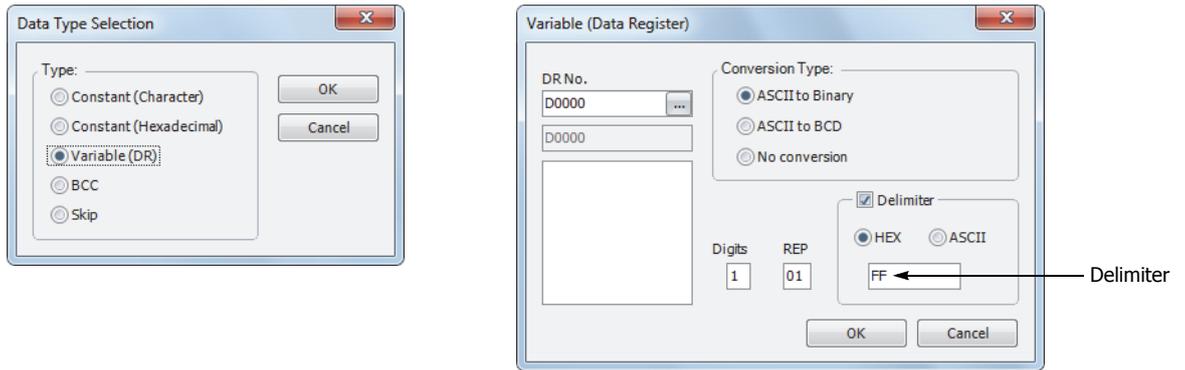
**Note:** Total byte count of the receive format is shown in S1 of RXD instruction on the ladder diagram of WindLDR.

**Designating Data Register as S1**

When a data register is designated as source device S1, receive digits and conversion type must also be assigned. The received data is divided into blocks of specified receive digits, converted in a specified conversion type, and stored to the designated data registers. Conversion types are available in ASCII to Binary, ASCII to BCD, and no conversion.

When repeat is designated, received data is divided, converted, and stored into as many data registers as the repeat cycles, starting with the designated data register. There can be up to 99 repeat cycles.

When a data register is designated as source device S1, a delimiter can be included in the data register designation to end receiving communication.



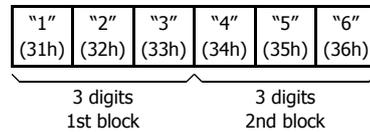
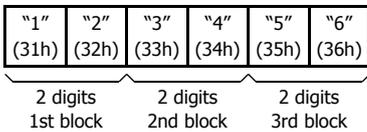
**Receive Digits**

The received data is divided into blocks of specified receive digits before conversion as described below:

**Example:** Received data of 6 bytes are divided in different receive digits. (Repeat is also designated.)

(1) Receive digits = 2

(2) Receive digits = 3

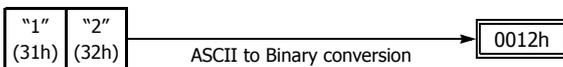


**Conversion Type**

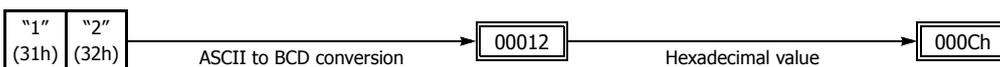
The data block of the specified receive digits is then converted according to the designated conversion type as described below:

**Example:** Received data has been divided into a 2-digit block.

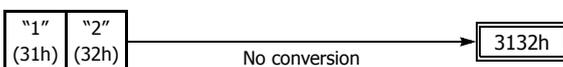
(1) ASCII to Binary conversion



(2) ASCII to BCD conversion



(3) No conversion



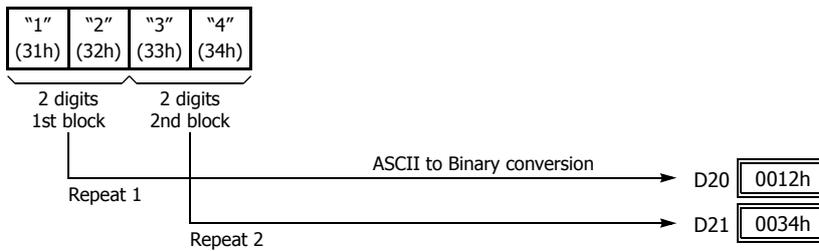
## 25: USER COMMUNICATION INSTRUCTIONS

### Repeat Cycles

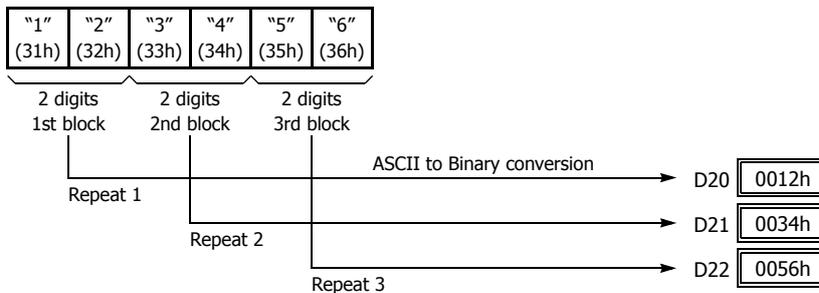
When a data register is assigned to repeat, the received data is divided and converted in the same way as specified, and the converted data is stored to as many consecutive data registers as repeat cycles.

**Example:** Received data of 6 bytes is divided into 2-digit blocks, converted in ASCII to Binary, and stored to data registers starting at D20.

(1) Repeat cycles = 2



(2) Repeat cycles = 3



### Delimiter

A delimiter for the data register in the receive format can be assigned. Using a delimiter, incoming data of variable length can be received and stored to data registers.

Delimiter	How the incoming data is stored to data registers
<b>Designated</b>	The incoming data is stored to data registers until all the data specified with receive digits, conversion type, and repeat is processed or the specified delimiter is received.
<b>No delimiter</b>	The incoming data is stored to data registers until all the data specified with receive digits, conversion type, and repeat is processed.

**Note:** Delimiters for data registers can be used in the receive format of RXD instructions only.

### Designating Constant as Start Delimiter

A start delimiter can be programmed at the first byte in the receive format of a RXD instruction; the SmartAXIS will recognize the beginning of valid communication, although a RXD instruction without a start delimiter can also be executed.

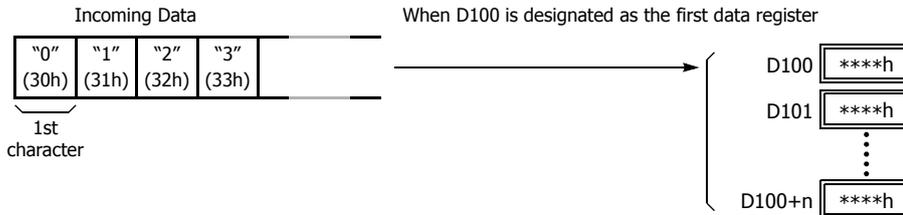
When a constant value is designated at the first byte of source device S1, the one-byte data serves as a start delimiter to start the processing of the received data.

A maximum of five instructions each of RXD2 through RXD3 with different start delimiters can be executed at the same time. When the first byte of the incoming data matches the start delimiter of a RXD instruction, the received data is processed and stored according to the receive format specified in the RXD instruction. If the first byte of the incoming data does not match the start delimiter of any RXD instruction that is executed, the SmartAXIS discards the incoming data and waits for the next communication.

When a RXD instruction without a start delimiter is executed, any incoming data is processed continuously according to the receive format. Only one instruction each of RXD2 through RXD3 without a start delimiter can be executed at a time. If start inputs to two or more RXD instructions without a start delimiter are turned on simultaneously, the one at the smallest address is executed and the corresponding completion output is turned on.

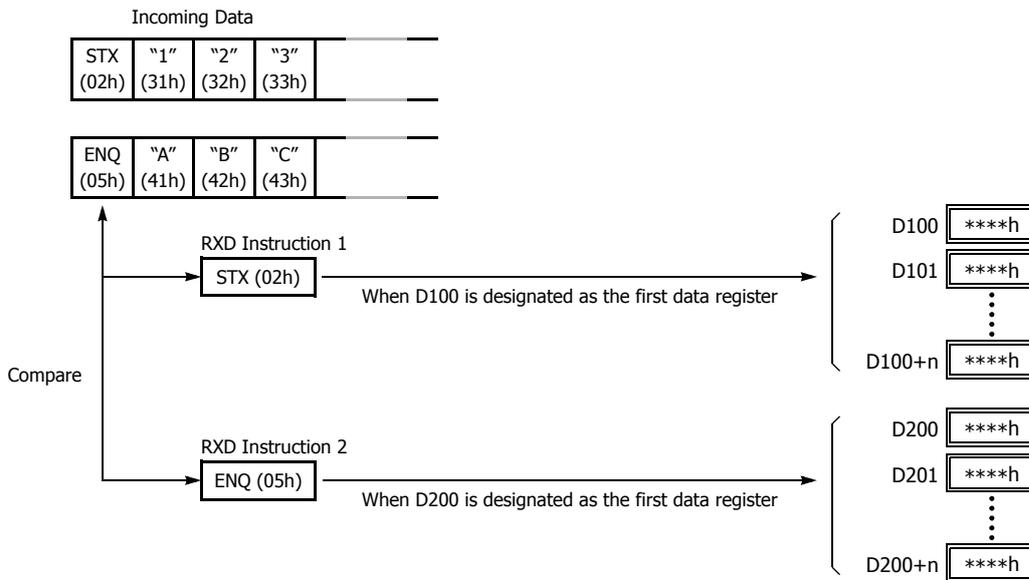
**Example:**

(1) When a RXD instruction without a start delimiter is executed



The incoming data is divided, converted, and stored to data registers according to the receive format.

(2) When RXD instructions with start delimiters STX (02h) and ENQ (05h) are executed



The incoming data is divided, converted, and stored to data registers according to the receive format. Start delimiters are not stored to data registers.

**Multi-byte Start Delimiter**

A start delimiter can be programmed at the first bytes in the receive format of a RXD instruction; the SmartAXIS will recognize the beginning of valid communication, although a RXD instruction without a start delimiter can also be executed. A maximum of 5 consecutive constants that are either character or hexadecimal from the first byte of the receive format are considered a multi-byte start delimiter.

If a RXD instruction with a start delimiter is executed and another RXD instruction with the same start delimiter is executed, user communication error code 5 is stored in the data register designated as the receive status of the second RXD instruction. When the error occurs, the second RXD instruction is canceled, and the first RXD instruction executed is kept.

If a multi-byte start delimiter is assigned, and the incoming data does not match the entire multi-byte start delimiter, the SmartAXIS discards the incoming data and waits for the next communication.

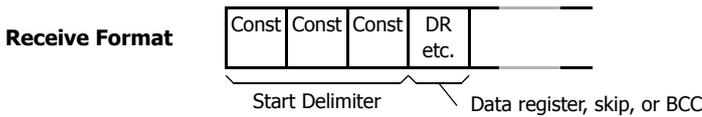
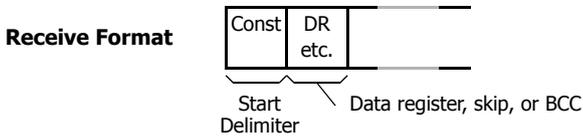
When the first one byte is received, a timer is started to monitor the interval between incoming data even when a multi-byte start delimiter is assigned. If data is not received in the period specified for the receive timeout value after receiving one byte of data, a receive timeout error occurs, and user communication error code 11 is stored in the status data register.

## 25: USER COMMUNICATION INSTRUCTIONS

### Examples: Multi-byte Start Delimiter

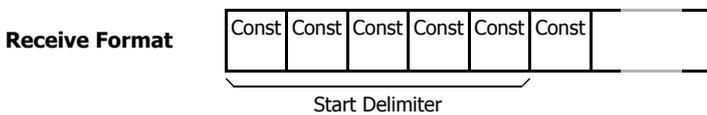
Multi-byte start delimiter is determined in the structure of the Receive Format. The following examples show how multi-byte start delimiter is determined.

- Constants are followed by data register, skip, or BCC



**Note:** Constants following data register, skip, or BCC are not considered start delimiter even if these are in the first five bytes of the receive format.

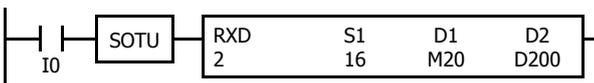
- More than 5 constants are specified from the first byte



**Note:** Constants that are neither start delimiters or end delimiters are considered constants for verification. See "Constant for Verification" on page 25-15.

### Example: Start Delimiter Duplication Error

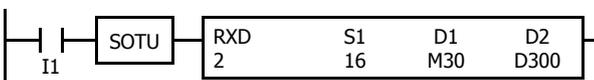
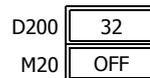
When input I0 is turned on, the first RXD instruction is executed and status code 32 is stored in the receive status D200, indicating the RXD instruction is waiting for the incoming data. When input I1 is turned on, another RXD instruction is executed, but since two RXD instructions have the same start delimiter, the second RXD instruction is not executed, and user communication error code 5 is stored in the receive status D300.



#### Receive Format S1



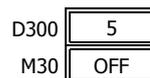
Communication port: Port 2  
Receive completion output: M20  
Receive status register: D200  
Receive data byte count: D201



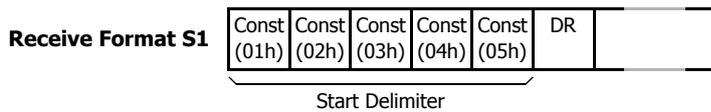
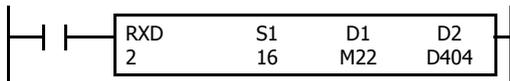
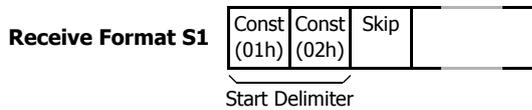
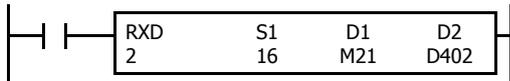
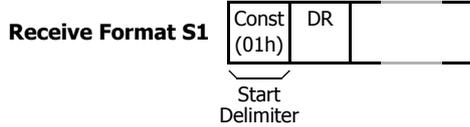
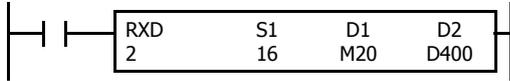
#### Receive Format S1



Communication port: Port 2  
Receive completion output: M30  
Receive status register: D300  
Receive data byte count: D301



**Note:** If you execute two or more RXD instructions with multi-byte start delimiters simultaneously, the start delimiters of those RXD instructions must be unique from the others. When the length of the multi-byte start delimiters of the RXD instructions is different, the length of the shortest one is applied to check the duplicated start delimiters. The start delimiter of any of two RXD instructions in the following RXD instructions are considered the same.

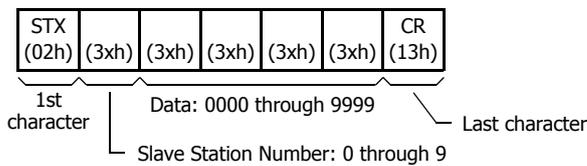


**Example: Using Multi-byte Start Delimiter**

The following example shows the advantages of using a multi-byte start delimiter rather than a single-byte start delimiter. A RXD instruction processes incoming data from the master station. The incoming data is sent to multiple slave stations 0 through 9, and the local slave station number is 1. Therefore, incoming data from the master station must be received only when the incoming data is sent for the slave station 1.

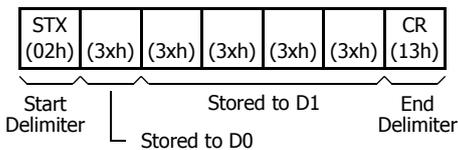
• **Incoming data**

Incoming data consists of start delimiter STX, a slave station number which can be 0 through 9, data 0000 through 9999, and end delimiter CR.



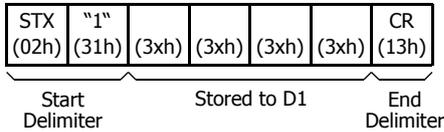
• **Single-byte start delimiter**

Only the first byte can be the start delimiter. The second byte of the incoming data, which is the slave station number, has to be stored to data register D0, and extra ladder programming is needed to see whether the slave station number of the incoming communication is 1 or not. Only when the slave station number is 1, received data stored in D1 is valid for the local PLC.



• Multi-byte start delimiter

First two bytes can be configured as a multi-byte start delimiter. The incoming data is processed according to the receive format only when the first two bytes of the incoming data match the start delimiter. Therefore, only the incoming data sent to slave station 1 is processed. No extra ladder programming is needed to check the slave station number.



**Designating Constant as End Delimiter**

An end delimiter can be programmed at the end of the receive format of a RXD instruction; the SmartAXIS will recognize the end of valid communication, although RXD instructions without an end delimiter can also be executed.

When a constant value is designated at the end of source device S1, the one-byte data serves as an end delimiter to end the processing of the received data. End delimiters can be 00h through FFh. Constant values are entered in character or hexadecimal notation into the source device. When using the same RXD instruction repeatedly in a user program, assign different end delimiters for each RXD instruction.

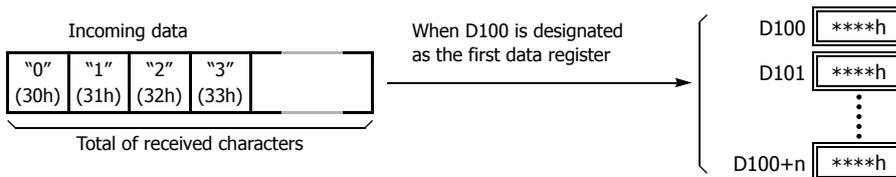
If a character in incoming data matches the end delimiter, the RXD instruction ends receiving data at this point and starts subsequent receive processing as specified. Even if a character matches the end delimiter at a position earlier than expected, the RXD instruction ends receiving data there.

If a BCC code is included in the receive format of a RXD instruction, an end delimiter can be positioned immediately before or after the BCC code. If a data register or skip is designated between the BCC and end delimiter, correct receiving is not ensured.

When a RXD instruction without an end delimiter is executed, data receiving ends when the specified bytes of data in the receive format, such as data registers and skips, have been received. In addition, data receiving also ends when the interval between incoming data characters exceeds the receive timeout value specified in the Communication Parameters dialog box whether the RXD has an end delimiter or not. The character interval timer is started when the first character of incoming communication is received and restarted each time the next character is received. When a character is not received within a predetermined period of time, timeout occurs and the RXD ends data receive operation.

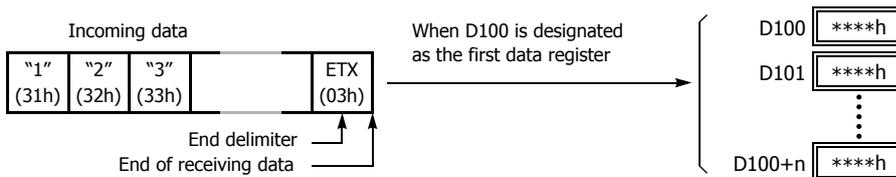
**Example:**

(1) When a RXD instruction without an end delimiter is executed



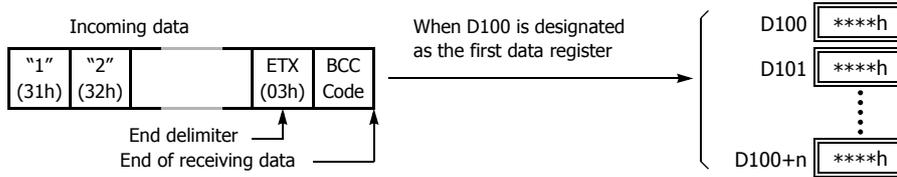
The incoming data is divided, converted, and stored to data registers according to the receive format. Receive operation is completed when the total characters programmed in RXD are received.

(2) When a RXD instruction with end delimiter ETX (03h) and without BCC is executed



The incoming data is divided, converted, and stored to data registers according to the receive format. The end delimiter is not stored to a data register. Any data arriving after the end delimiter is discarded.

(3) When a RXD instruction with end delimiter ETX (03h) and one-byte BCC is executed



The incoming data is divided, converted, and stored to data registers according to the receive format.  
 The end delimiter and BCC code are not stored to data registers.  
 After receiving the end delimiter, the SmartAXIS receives only the one-byte BCC code.

**Constant for Verification**

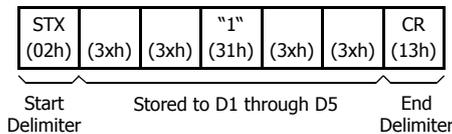
Constants excluding start and end delimiters can be configured in the receive format to verify the incoming data with the constants, which are either characters or hexadecimal values. As many constants can be configured for the verification as required. The verification result is stored in the receive status of the RXD instruction.

**Example: Programming Constant for Verification**

The following example shows the advantage of using constant for verification. The incoming data contains a constant value "1" in the middle, and that constant value needs to be verified to see whether the incoming data is valid.

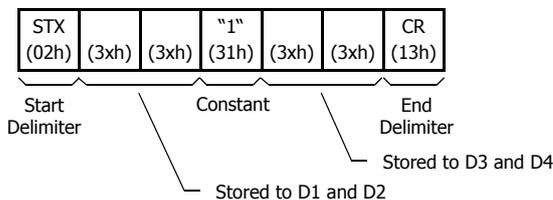
• **Using Data Register**

The incoming data including the constant value needs to be stored in data registers. When the RXD instruction completes receiving the incoming data, the receive status contains 64, meaning the RXD instruction has completed without errors, even if the constant value is not an expected value. Extra ladder programming is needed to see whether the constant value in the incoming data is correct or not.



• **Using Constant for Verification**

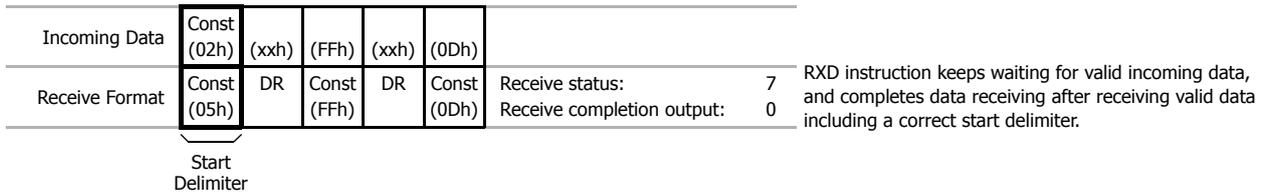
A constant to verify the constant value in the incoming data is designated in the receive format. If the constant value is not an expected value when the RXD instruction completes receiving the incoming data, the receive status contains 74, meaning the RXD instruction has completed but user communication error code 5 occurred. No extra ladder programming is needed to see whether the constant value in the received data is correct or not.



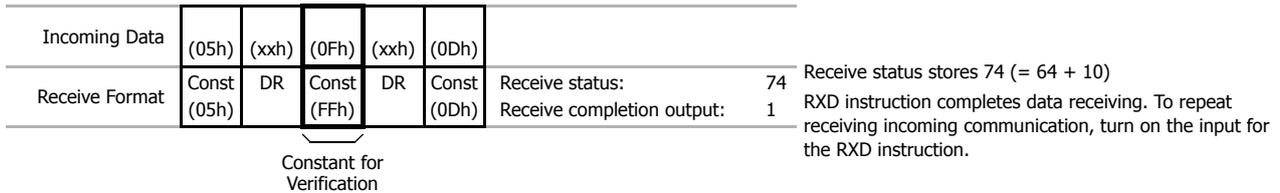
**Note:** When configuring constants, which are either characters or hexadecimal values, in the receive format, and the incoming data does not match the constants in the receive format, then a user communication error code is stored in the receive status. The error code contained in the receive status depends on whether the constants are used as a start delimiter or as constants for verification. If used as a start delimiter, user communication error code 7 is stored in the receive status, and the RXD instruction keeps waiting for valid incoming data. On the other hand, if used as constants for verification, the receive status contains 74, and the RXD instruction finishes the execution. To repeat receiving incoming communication, turn on the input for the RXD instruction.

## 25: USER COMMUNICATION INSTRUCTIONS

- Start delimiter of incoming data does not match the receive format

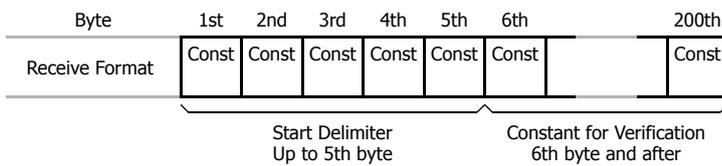


- Constant for verification of incoming data does not match the receive format

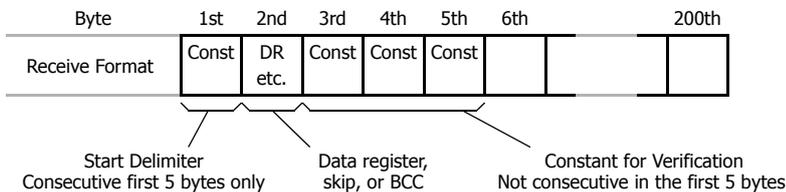


**Note:** Constants configured in the beginning of receive formats have different functions as shown below:

- More than five constants are configured in the beginning of the receive format



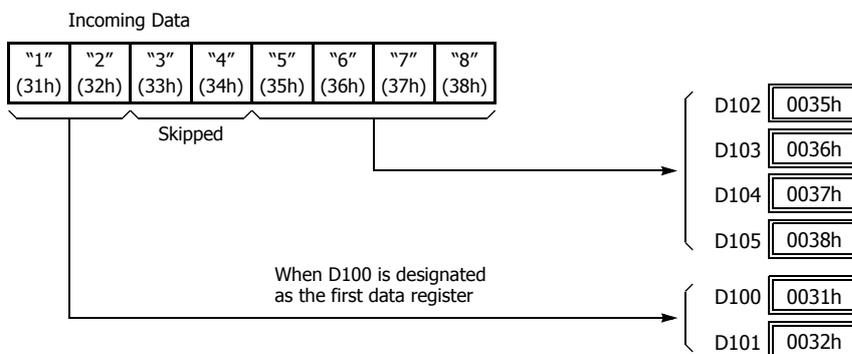
- Other than constants (data register, skip, or BCC) are included in the first five bytes of the receive format



### Skip

When "skip" is designated in the receive format, a specified quantity of digits in the incoming data are skipped and not stored to data registers. A maximum of 99 digits (bytes) of characters can be skipped continuously.

**Example:** When a RXD instruction with skip for 2 digits starting at the third byte is executed



**BCC (Block Check Character)**

The SmartAXIS has an automatic BCC calculation function to detect a communication error in incoming data. If a BCC code is designated in the receive format of a RXD instruction, the SmartAXIS calculates a BCC value for a specified starting position through the position immediately preceding the BCC. It then compares the calculation result with the BCC code in the received incoming data. The start position for the BCC calculation can be specified from the first byte through the 15th byte. The BCC can be 1 or 2 digits.

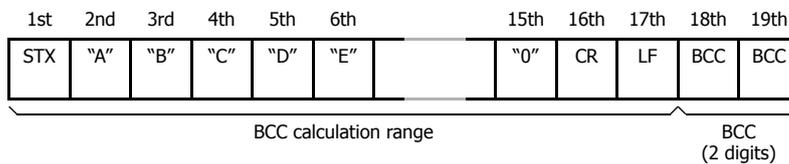
When an end delimiter is not used in the RXD instruction, the BCC code must be positioned at the end of the receive format designated in Source 1 device. When an end delimiter is used, the BCC code must be immediately before or after the end delimiter. The SmartAXIS reads a specified number of BCC digits in the incoming data according to the receive format to calculate and compare the received BCC code with the BCC calculation results.

**BCC Calculation Start Position**

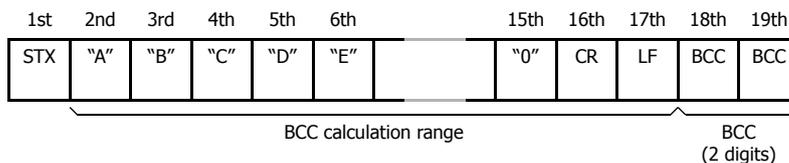
The start position for the BCC calculation can be specified from the first byte through the 15th byte. The BCC is calculated for the range starting at the designated position up to the byte immediately before the BCC of the receive data.

**Example: Received data consists of 17 bytes plus 2 BCC digits.**

(1) Calculation start position = 1



(2) Calculation start position = 2



**BCC Calculation Formula**

BCC calculation formula can be selected from XOR (exclusive OR), ADD (addition), ADD-2comp, Modbus ASCII, or Modbus RTU.

**Example: Incoming data consists of 41h, 42h, 43h, and 44h.**

(1) BCC calculation formula = XOR

Calculation result = 41h ⊕ 42h ⊕ 43h ⊕ 44h = 04h

(2) BCC calculation formula = ADD

Calculation result = 41h + 42h + 43h + 44h = 10Ah → 0Ah (Only the last 1 or 2 digits are used as BCC.)

(3) BCC calculation formula = ADD-2comp

Calculation result = FEh, F6h (2 digits without conversion)

(4) BCC calculation formula = Modbus ASCII

Calculation result = 88 (ASCII)

(5) BCC calculation formula = Modbus RTU

Calculation result = 85h 0Fh (binary)

## 25: USER COMMUNICATION INSTRUCTIONS

### Conversion Type

The BCC calculation result can be converted or not according to the assigned conversion type as described below:

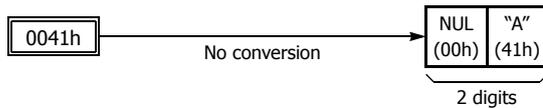
**Example: BCC calculation result is 0041h.**

(1) Binary to ASCII conversion



**Note:** On WindLDR, Modbus ASCII defaults to binary to ASCII conversion.

(2) No conversion

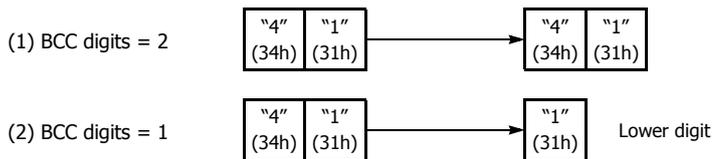


**Note:** On WindLDR, Modbus RTU defaults to no conversion.

### BCC Digits (Bytes)

The quantity of digits (bytes) of the BCC code can be selected from 1 or 2.

**Example:**

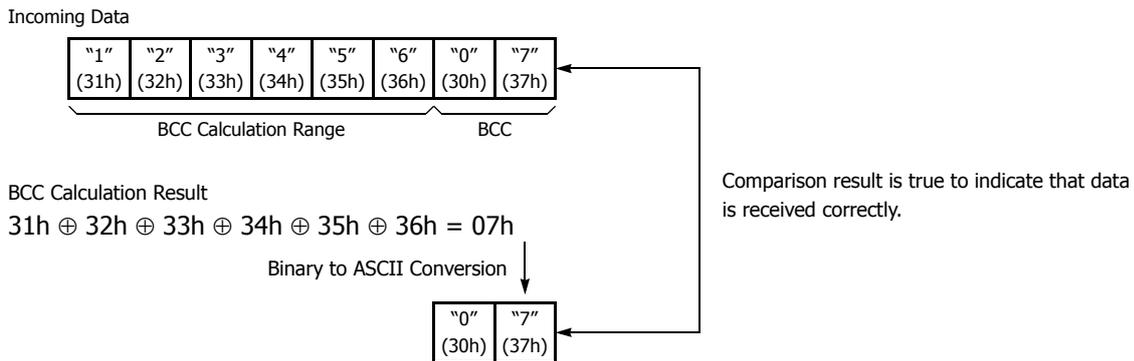


**Note:** On WindLDR, Modbus ASCII and Modbus RTU default is set to 2 digits.

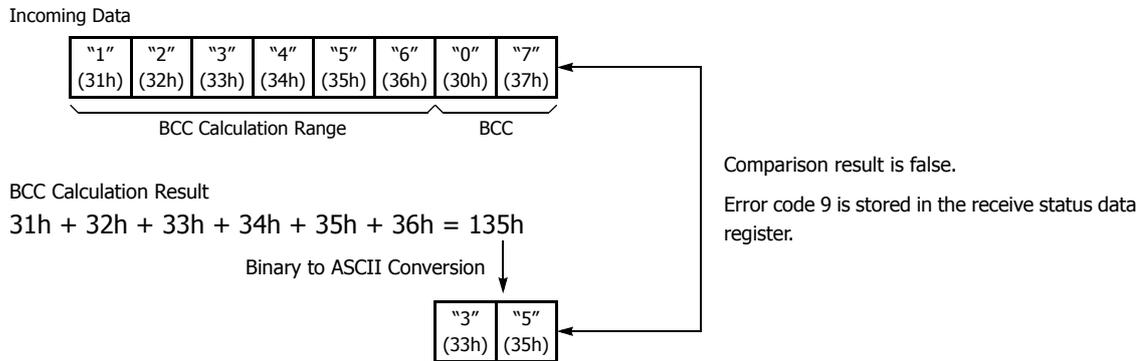
### Comparing BCC Codes

The SmartAXIS compares the BCC calculation result with the BCC code in the received incoming data to check for any error in the incoming communication due to external noises or other causes. If a disparity is found in the comparison, an error code is stored in the data register designated as receive status in the RXD instruction. For user communication error code, see Chapter 10 "User Communication Instructions" - "User Communication Error" in the SmartAXIS Pro/Lite User's Manual.

**Example 1:** BCC is calculated for the first byte through the sixth byte using the XOR format, converted in binary to ASCII, and compared with the BCC code appended to the seventh and eighth bytes of the incoming data.



**Example 2:** BCC is calculated for the first byte through the sixth byte using the ADD format, converted in binary to ASCII, and compared with the BCC code appended to the seventh and eighth bytes of the incoming data.



### Receive Completion Output

Designate an output, Q0 through Q21, or internal relay, M0 through M1277, as a device for the receive completion output.

When the start input for a RXD instruction is turned on, preparation for receiving data is initiated, followed by data conversion and storage. When the data receive operation sequence is complete, the designated output or internal relay is turned on.

### Conditions for Completion of Receiving Data

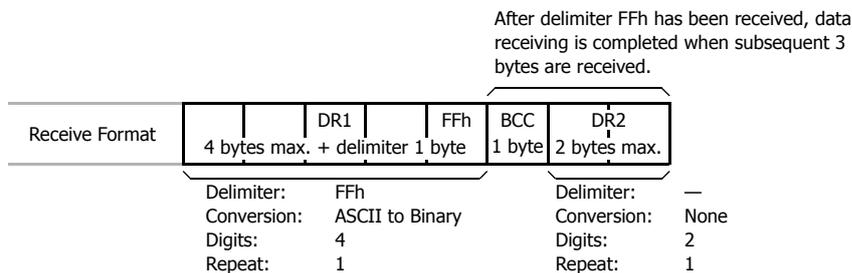
After starting to receive data, the RXD instruction can be completed in three ways depending on the designation of end delimiter and delimiter in the receive format.

End Delimiter	Delimiter	Conditions for Completion of Receiving Data
With	With or Without	When a specified byte count of data (digits × repeat) has been received or when an end delimiter is received. When a BCC exists immediately after the end delimiter, the BCC is received before ending data receiving.
Without	With	After the last constant (including delimiter) designated in the RXD instruction has been received, data receiving is completed when the subsequent byte count of data has been received.
Without	Without	When a specified byte count of data (digits × repeat) has been received.

**Note:** Whenever a receive timeout has occurred, data receiving stops arbitrarily.

Data receiving is complete when one of the above three conditions is met. To abort a RXD instruction, use the special internal relay for user communication receive instruction cancel flag. See "User Communication Receive Instruction Cancel Flag" on page 25-20.

**Example:** A RXD instruction does not have an end delimiter and has a delimiter programmed in the receive format for data registers.



## 25: USER COMMUNICATION INSTRUCTIONS

### Receive Status

Designate a data register, D0-D1998, as a device to store the receive status information including a receive status code and a user communication error code.

#### Receive Status Code

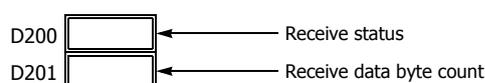
Receive Status Code	Status	Description
16	Preparing data receive	From turning on the start input for a RXD instruction to read the receive format, until the RXD instruction is enabled by an END processing
32	Receiving data	From enabling the RXD instruction by an END processing, until incoming data is received
48	Data receive complete	From receiving incoming data, until the received data is converted and stored in data registers according to the receive format
64	Receive instruction complete	All data receive operation is completed and the next data receive is made possible
128	User communication receive instruction cancel flag active	RXD instructions are cancelled by special internal relay for user communication receive instruction cancel flag, such as M8022 or M8023

If the receive status code is other than shown above, a receive instruction error is suspected. See Chapter 10 "User Communication Instructions" - "User Communication Error" in the SmartAXIS Pro/Lite User's Manual.

### Receive Data Byte Count

The data register next to the device designated for receive status stores the byte count of data received by the RXD instruction. When a start delimiter, end delimiter, and BCC are included in the received data, the byte counts for these codes are also included in the receive data byte count.

**Example:** Data register D200 is designated as a device for receive status.



### User Communication Receive Instruction Cancel Flag

Special internal relays for user communication receive instruction cancel flag are used to cancel all RXD instructions for each port. While the SmartAXIS has completed receive format and is ready for receiving incoming data, turning on the user communication receive instruction cancel flag cancels all RXD instructions for each port. This function is useful to cancel receive instructions only, without stopping the SmartAXIS.

To make the cancelled RXD instructions active, turn off the flag and turn on the input to the RXD instruction again.

Device Address	Description	CPU Stopped	Power OFF	R/W
M8022	User Communication Receive Instruction Cancel Flag (Port 2)	Cleared	Cleared	W
M8023	User Communication Receive Instruction Cancel Flag (Port 3)	Cleared	Cleared	W

"R/W" is the abbreviation for read/write. When R/W, it can be read and written. When R, it can only be read. When W, it can only be written.

### ETXD (User Communication Transmit over Ethernet)



The ETXD instruction converts transmission data to the specified data type and sends it to the external device connected over Ethernet.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	X	X	X	—

When the input is on, the transmission data designated by S1 is transmitted to the device connected with the specified connection.

When transmission is complete, the device designated by D1 is turned on. Transmit status (the transmission status and error code) is stored to the device designated by D2.

The byte count of transmitted data is stored to D2+1.

Apart from the connection settings, the settings of ETXD and TXD instructions are the same. For details on TXD instruction, see "TXD (Transmit)" on page 25-1.

The ETXD instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

**Note:** For details on the user communication client and user communication server specifications and for details on user communication over Ethernet, see Chapter 10 "User Communication" - "User Communication over Ethernet" in the SmartAXIS Pro/Lite User's Manual.

### ERXD (User Communication Receive over Ethernet)



The ERXD instruction receives data from an external device connected over Ethernet, converts the received data in the specified format, and stores the converted data to data registers.

#### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	X	X	X	—

When the input is on, the received data designated by S1 is received from the device connected with the specified connection.

When all data has been received, the device designated by D1 is turned on. Receive status (the receive status and error code) is stored to the device designated by D2.

The byte count of received data is stored to D2+1.

When user communication receive instruction cancel flag (M8100, M8101, M8102) is turned on while receiving incoming data, the execution of all active receive instructions for the corresponding connection is canceled.

Apart from the connection settings and the allocation of the user communication receive instruction cancel flags, the settings of ERXD and RXD instructions are the same. For details on RXD instruction, see "RXD (Receive)" on page 25-7.

The ERXD instruction cannot be used in an interrupt program.

If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.

**Note:** For details on the user communication client and user communication server specifications and for details on user communication over Ethernet, see Chapter 10 "User Communication" - "User Communication over Ethernet" in the SmartAXIS Pro/Lite User's Manual.



# 26: DATA LOG INSTRUCTIONS

## Introduction

The data log instructions save log data for specified devices to the SD memory card.

## DLOG (Data Log)



The DLOG instruction saves the values of the specified devices in the specified data format as a CSV file on the SD memory card.

When the input is on, the date and time and the values of the specified devices are output to the CSV file in the folder assigned by S1. When the execution of the instruction finishes, the device assigned by D1 is turned on and the execution status is stored to the device assigned by D2.

When the folder assigned by S1 does not exist on the SD memory card, that folder is created. The folder path is "DATA0001\DATALOG\User specified folder." For details on the folder structure, see Chapter 5 "Special Functions" - "SD Memory Card" in the SmartAXIS Pro/Lite User's Manual.

The CSV file name is "DATE.csv." The date when the DLOG instruction is turned on is used as DATE.

Example: If the date is September 30, 2011, the file name is "20110930.csv".

When a CSV file with the same date does not exist in the folder designated by S1, the CSV file is created and the header and the log data is output.

### Output example

Time	D0010	← Header
2011/09/07 08:30:23	12345	← Log data

When a CSV file with the same date already exists in the folder designated by S1, only the log data is appended to the CSV file.

### Output example

Time	D0010	
2011/09/07 08:30:23	12345	
2011/09/07 17:30:23	1212	← Appended log data

When the execution of DLOG instruction finishes, the device designated by D1 is turned on and the status code is stored to the device designated by D2 according to the execution result. For status codes, see "3. D2 (destination 2): Execution status" on page 26-3.

### Notes:

- The time required to create a new CSV file (create a file and output header) is 510  $\mu$ s.
- When the SmartAXIS starts running and DLOG instruction is executed, the header is appended to the CSV file even if the same DLOG instruction was executed previously within the same day.

### Output example

Time	D0010	← Header
2011/09/07 08:30:23	12345	← Log data
Time	D0020	← Appended header
2011/09/07 17:30:23	1212	← Log data

- For details on the SD memory card specification, see Chapter 5 "Special Functions" - "SD Memory Card" in the SmartAXIS Pro/Lite User's Manual.

## 26: DATA LOG INSTRUCTIONS

### Notes:

- The number of DLOG instructions that can be programmed in a user program is 48. However, make sure that the folder name specified by the DLOG instruction is not duplicated by any folder names specified by the other DLOG instructions. When the folders are duplicated, log data with a mixed format is output to the same CSV file.
- The DLOG instruction cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.
- While the input to DLOG instruction is on, log data is repeatedly output to the CSV file. When you want to output the log data only one time, add a SOTU (single output up instruction) or SOTD (single output down instruction) to the input condition. For SOTU or SOTD, see "SOTU and SOTD (Single Output Up and Down)" on page 5-26.
- The process of writing data to the SD memory card for the DLOG instruction takes several scans. Once a DLOG instruction is executed, the process continues until the log data transfer is complete, regardless of any change in the instruction input. While the log data is being written to the SD memory card, instructions are not being executed, even when the inputs to DLOG instructions are turned on. To execute the DLOG instruction again, confirm that the previous data transfer process has finished, and then execute the instruction.

### Applicable SmartAXIS

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X	X	—

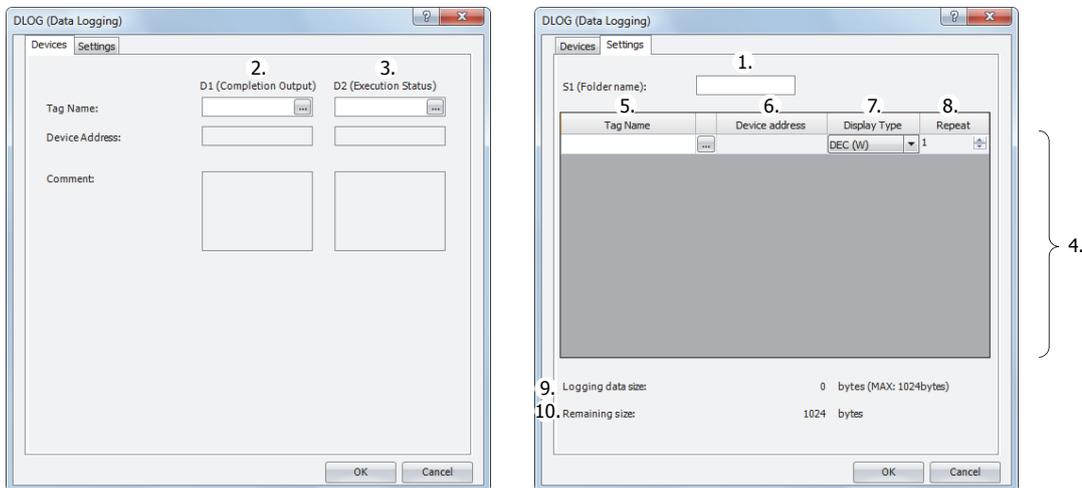
### Valid Devices

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Folder name (Note)	—	—	—	—	—	—	—	—	—
D1 (Destination 1)	Completion output	—	X	▲	—	—	—	—	—	—
D2 (Destination 2)	Execution status	—	—	—	—	—	—	X	—	—

**Note:** Specify the folder name by entering characters.

▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

### Settings



#### 1. S1 (source 1): Folder name

Specify the folder name on the SD memory card to store the log data with a desired text up to 8 single-byte alphanumeric characters.

### Notes:

- The following single-byte characters cannot be used in the folder names:  
/ \ : \* ? " < > | # { } % & ~
- Consecutive periods cannot be used in folder names.
- A period cannot be used at the start or the end of the folder name.
- Single-byte spaces at the start or the end of the folder name are omitted.

**2. D1 (destination 1): Completion output**

Specify the device that turns on when the transfer of log data to a SD card and the execution of the DLOG instruction are complete. This device is turned on regardless of the success or failure of transferring log data to the SD memory card.

**3. D2 (destination 2): Execution status**

Specify the device to store the status code. One of the following status codes is stored according to the DLOG instruction execution status and result.

Status code	Status	Description
0	Normal	—
1	SD memory card insertion error	The SD memory card is not inserted
2	SD memory card capacity error	The SD memory card is full
3	SD memory card writing error	Writing log data to the SD memory card fails
4	CSV file capacity error	The CSV file exceeds 5 MB
5	SD memory card protection error	The SD memory card is write protected
6	SD memory card access error	DLOG instruction is executed while another DLOG instruction or TRACE instruction is being executed
7	Characters conversion error	Converting log data to numeric characters fails
8	Folder creation error	Creating the folder fails
9	CSV file open error	Opening the CSV file fails
32	Executing DLOG instruction	Writing log data to SD memory card is in progress

**4. Settings**

The list of log data to be output to the CSV files.

Display type	Valid Devices
DEC(W)	TC, TP, CC, CP, D
DEC(I)	D
DEC(D)	CC, CP, D
DEC(L)	D
DEC(F)	D
HEX(W)	TC, TP, CC, CP, D
HEX(D)	CC, CP, D
BIN(B)	I, Q, M, R, T, C

**5. Tag Name**

Enter tag names or device addresses to specify the devices whose values are output to the CSV files.

**6. Device Address**

When the devices are specified as tag names, the corresponding device addresses are shown.

**7. Display Type**

Select the display type from the following table for each device for when the device values are output to the CSV file.

Display type	Range	Maximum characters
DEC(W)	0 to 65,535	5
DEC(I)	-32,768 to 32,767	6
DEC(D)	0 to 4,294,967,295	10
DEC(L)	-2,147,483,648 to 2,147,483,647	11
DEC(F)	-3.402823E+38 to 3.402823E+38	13
HEX(W)	0000 to FFFF	4
HEX(D)	00000000 to FFFFFFFF	8
BIN(B)	0 or 1	1

## 26: DATA LOG INSTRUCTIONS

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### 8. Repeat

The data in as many consecutive devices as the specified repeat, starting from the specified device address, are output to the SD memory card.

For example, when the display type of D10 is DEC(W) and the repeat is set to 5, the data is output to SD memory card as follows.

Time	D0010	D0011	D0012	D0013	D0014	← Header
2011/09/07 15:40:00	12345	1	5	12	111	← Log data 1
2011/09/07 15:41:00	1212	3	7	35	222	← Log data 2
2011/09/07 15:42:00	345	4	99	79	333	← Log data 3

### 9. Logging data size

The amount of memory that the DLOG instruction uses for the current log settings is shown. The amount of memory used increases when a device to log the data is added. You can register up to a maximum of 64 devices (the total amount of memory must be less than or equal to 1,024 bytes). One byte of memory area is required for each character.

### 10. Remaining size

The amount of free memory (the difference between the logging data size and 1,024 bytes) is shown.

## CSV File Output Format and File Format Configuration

The CSV file output format is as follows. You can change the separating character for each data and the decimal symbol for floating point numbers that are output to the CSV files on the Function Area Settings dialog box.

- **Output format**

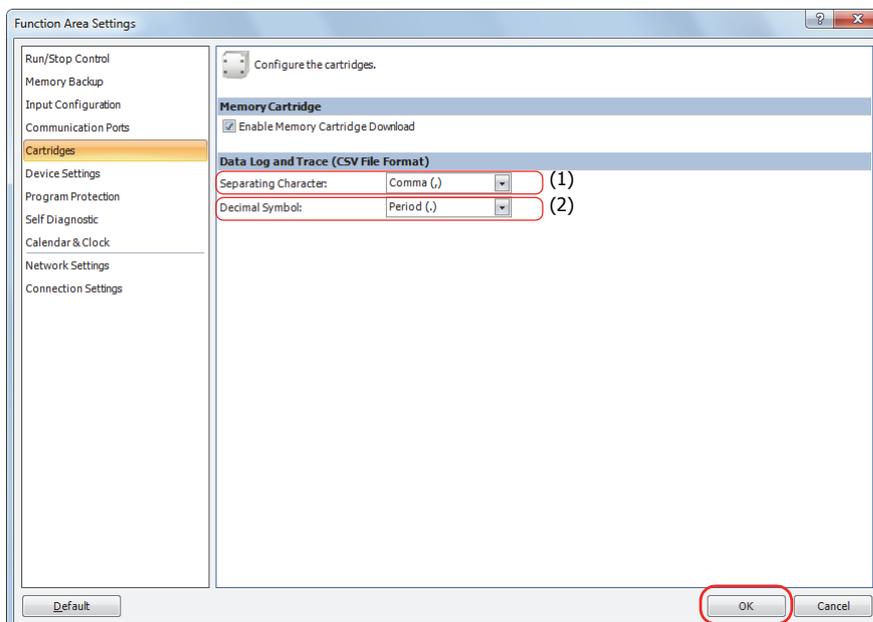
```
Time,D0010,D0020,D0030,D0050,D0060
2011/09/07 15:40:00,12345,1,5,12,111
2011/09/07 15:41:00,1212,3,7,35,222
2011/09/07 15:42:00,345,4,99,79,333
:
:
```

When the DLOG instruction is executed and the CSV file for the same date does not exist in the folder designated by S1, a new CSV file is created and the header and the log data 1 are output as shown in above output format example. If the DLOG instruction is executed again on the same date, the log data 2 is appended to the CSV file. Similarly, if the DLOG instruction is executed again on the same date, log data 3 is appended to the CSV file.

When the date changes and the DLOG instruction is executed, a new CSV file with a new file name is created and the header and the log data is output.

### File format configuration procedure

1. From the WindLDR menu bar, select **Configuration > Cartridges**.
2. Under **Data Log and Trace (CSV File Output)**, configure the separating character and the decimal symbol.  
The separating characters and the decimal symbols that are contained in the CSV file vary by country and region. You can select the symbols to use from the following:
  - (1) Separating character: "," (comma) or ";" semicolon
  - (2) Decimal symbol: "." (period) or "," (comma)
3. Click the **OK** button to close the dialog box.



## 26: DATA LOG INSTRUCTIONS

### Examples: DLOG

When M0 is turned on, the decimal values of D0 through D5 (data type W (word)) and D10 (data type F (floating point)) are saved in a CSV file in the "RESULT" folder on the SD memory card every 10 seconds.

#### Output example

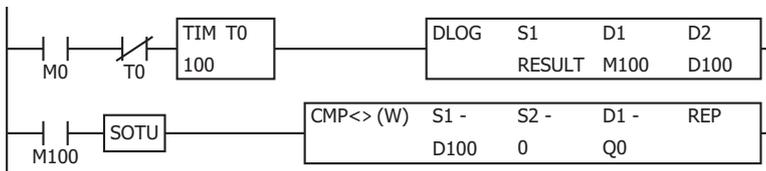
Time	D0000	D0001	D0002	D0003	D0004	D0005	D0010
2012/02/06 10:20:30	12345	0	0	56789	0	0	-3.402823E+38
2012/02/06 10:20:40	12345	0	0	56789	0	0	-3.402823E+38
2012/02/06 10:20:50	12345	0	0	56789	0	0	-3.402823E+38

The sample user program described below operates as follows.

- M100 is turned on when the transfer of log data has finished transferring to the SD memory card is complete.
- The DLOG instruction status code is stored in D100.
- The status code saved in D100 is checked and Q0 is turned on if an error occurs.

#### • Configuration Procedure

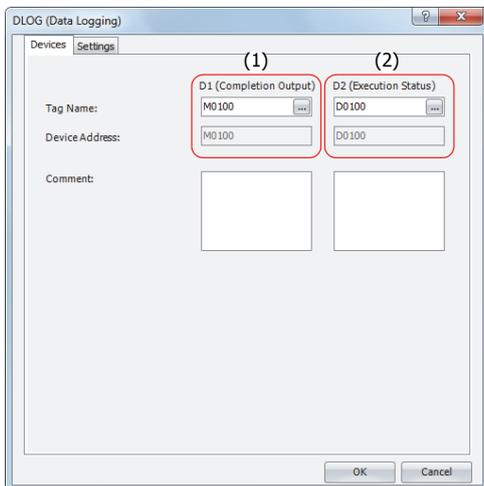
##### 1. Insert the instructions in the Ladder editor.



##### 2. Configure the DLOG instruction.

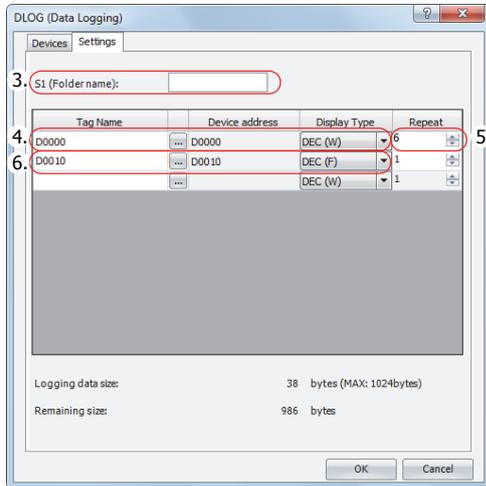
Configure the Devices tab.

- (1) Designate M100 as D1 (Completion Output).
- (2) Designate D100 as D2 (Execution Status).



Configure the Settings tab.

- (3) Enter "RESULT" in S1 (Folder Name).
- (4) Configure D0 to output the decimal value of D0 to the CSV files with the data type W (word).
- (5) Set the repeat to 6 to output the values of D0 through D5 to the CSV files.
- (6) Configure D10 to output the decimal value of D10 to the CSV files with the data type F (float).



The configuration is now completed.

• **Operation Description**

10 seconds after M0 is turned on, the DLOG instruction is executed one time. When the DLOG instruction is executed, the data of D0 through D5 and D10 are output to the CSV file on the SD memory card as decimal values along with the current date and time.

The saved location of CSV files is DATA0001\DATALOG\RESULT. The oldest data is saved at the top of the log data, and the latest data is saved at the bottom of the log data.

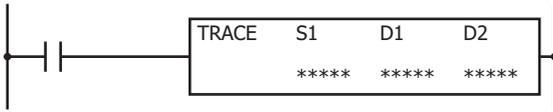
When the execution of the DLOG instruction is complete, the completion output M100 is turned on and the CMP instruction is executed once. The CMP instruction compares the status code stored in the execution status D100 with 0 and turns Q0 on or off. Q0 is turned on when an error occurs in the DLOG instruction.

While M0 is on, the log data is appended to the CSV file every 10 seconds.

**Output results**

Time	D0000	D0001	D0002	D0003	D0004	D0005	D0010
2012/02/06 10:20:30	12345	0	0	56789	0	0	-3.402823E+38
2012/02/06 10:20:40	12345	0	0	56789	0	0	-3.402823E+38
2012/02/06 10:20:50	12345	0	0	56789	0	0	-3.402823E+38

**TRACE (Data Trace)**



The TRACE instruction saves the values for the previous number of scans for the specified device in the specified data format as a CSV file on the SD memory card.

When the input is turned on, the date and time and the values of the previous scans for the specified device are output to the CSV file in the folder assigned by S1. When the execution of the instruction finishes, the device assigned by D1 is turned on and the execution status is stored to the device assigned by D2.

When the folder assigned by S1 does not exist on the SD memory card, that folder is created. The folder path is "DATA0001\TRACE\User specified folder." For details on the folder structure, see Chapter 5 "Special Functions" - "SD Memory Card" in the SmartAXIS Pro/Lite User's Manual.

The CSV file name is "DATE.csv." The date when the TRACE instruction is turned on is used as DATE.

Example: If the date is September 30, 2011, the file name is "20110930.csv".

When a CSV file with the same date does not exist in the folder designated by S1, the CSV file is created and the trace data is output. The oldest data is output at the top of the trace data, and the latest data is output at the bottom of the trace data.

**Output example**

Triggered at:	2012/02/06 08:30:23	← Header row 1
Scan	D0010	← Header row 2
Old	12345	← Data 2 scans before
	12345	← Data 1 scan before
New	12345	← Latest data

When a CSV file for the same date already exists in the folder designated by S1, the header and trace data are appended to the CSV file.

**Output example**

Triggered at:	2012/02/06 08:30:23	
Scan	D0010	
Old	12345	
	12345	
New	12345	
Triggered at:	2012/02/06 17:16:15	← Appended header row 1
Scan	D0010	← Appended header row 2
Old	1212	← Appended data 2 scans before
	1212	← Appended data 1 scan before
New	1212	← Appended latest data

When the execution of the TRACE instruction finishes, the device designated by D1 is turned on and the status code is stored to the device designated by D2 according to the execution result. For status codes, see "3. D2 (destination 2): Execution status" on page 26-10.

**Notes:**

- The TRACE instruction accumulates data while SmartAXIS is running but does not accumulate data when SmartAXIS is stopped.
- Data is accumulated while SmartAXIS is running even when the input to the TRACE instruction is off.
- When the input to the TRACE instruction is turned on, the accumulated data is output to the CSV file.
- The time required to create a new CSV file (create a file and output header) is 870 μs.
- Trace data is accumulated even when the MCS (master control set) instruction is on.

**Notes:**

- The maximum number of TRACE instructions that can be programmed in a user program is three. Make sure that the folder name specified by the TRACE instruction is not duplicated by any of the folder names specified by the other TRACE instructions. When the folders are duplicated, trace data with a mixed format is output to the same CSV file.
- The number of scans of which the trace data can be saved to the CSV file when the TRACE instruction is executed one time depends on the number of devices specified to trace and the display type for each device. For details, see "9. Trace data size" on page 26-11.
- The TRACE instruction cannot be used in an interrupt program. If used, a user program execution error will result, turning on special internal relay M8004 and the ERR LED on the SmartAXIS. For details about the user program execution errors, see "User Program Execution Errors" on page 4-13.
- Trace data is not accumulated when the TRACE instruction is skipped by the JMP (jump) instruction. For the JMP (jump) instruction, see "JMP (Jump) and JEND (Jump End)" on page 5-29.
- While the input to the TRACE instruction is on, the trace data is repeatedly output to the CSV file. When you want to output the trace data only one time, add a SOTU (single output up instruction) or SOTD (single output down instruction) to the input conditions. For SOTU (single output up instruction) or SOTD (single output down instruction), see "Basic Instructions" - "SOTU and SOTD (Single Output Up and Down)" on page 5-26.
- The data writing process to the SD memory card for the TRACE instruction takes several scans. Once a TRACE instruction is executed, the process continues until the trace data transfer is complete, regardless of any change in the instruction input. While the trace data is being written to the SD memory card, the instruction is not executed even when the input to the TRACE instructions are turned on. To execute the TRACE instruction again, confirm that the previous data writing process has finished, and then execute the instruction.

**Applicable SmartAXIS**

FT1A-12	FT1A-24	FT1A-40	FT1A-48	FT1A-Touch
—	—	X	X	—

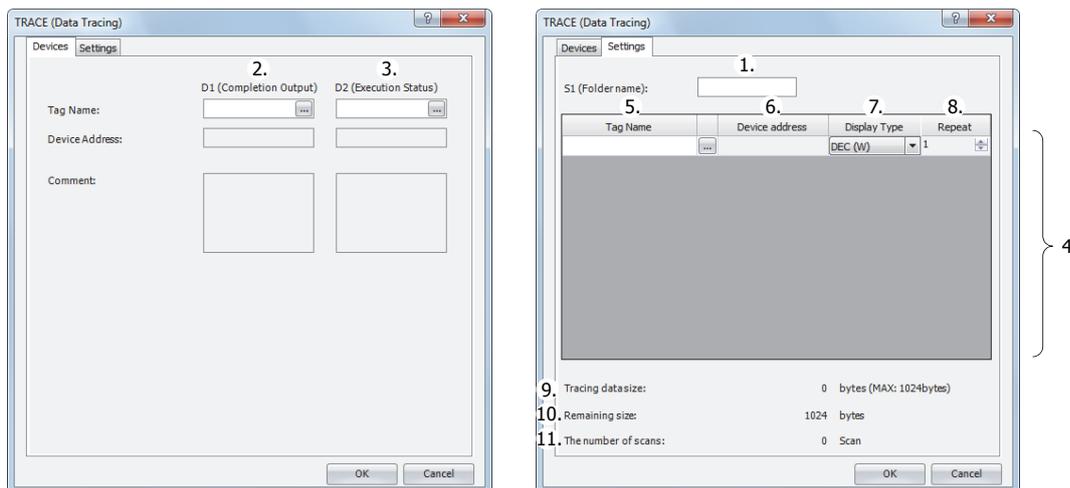
**Valid Devices**

Device	Function	I	Q	M	R	T	C	D	Constant	Repeat
S1 (Source 1)	Folder name (Note)	—	—	—	—	—	—	—	—	—
D1 (Destination 1)	Completion output	—	X	▲	—	—	—	—	—	—
D2 (Destination 2)	Execution status	—	—	—	—	—	—	X	—	—

**Note:** Specify the folder name by entering characters.

▲ Internal relays M0 through M1277 can be designated as D1. Special internal relays cannot be designated as D1.

**Settings**



**1. S1 (source 1): Folder name**

Specify the folder name on the SD memory card that will store the trace data using up to 8 single-byte alphanumeric characters.

**Notes:**

- The following single-byte characters cannot be used in folder names:  
/ \ : \* ? " < > | # { } % & ~
- Consecutive periods cannot be used in folder names.
- A period cannot be used at the start or the end of the folder name.
- Single-byte spaces at the start or the end of the folder name are omitted.

## 26: DATA LOG INSTRUCTIONS

### 2. D1 (destination 1): Completion output

Specifies the device that turns on when the transfer of trace data to SD card and the execution of the TRACE instruction are complete. This device turns on regardless of the success or failure of the transfer of trace data to the SD memory card.

### 3. D2 (destination 2): Execution status

Specifies the data register to store the status code. One of the following status codes is stored according to the TRACE instruction execution status and result.

Status code	Status	Description
0	Normal	—
1	SD memory card insertion error	The SD memory card is not inserted
2	SD memory card capacity error	The SD memory card is full
3	SD memory card writing error	Writing trace data to the SD memory card fails
4	CSV file capacity error	The CSV file exceeds 5 MB
5	SD memory card protection error	The SD memory card is write protected
6	SD memory card access error	The TRACE instruction is executed while another DLOG instruction or TRACE instruction is being executed
7	Characters conversion error	Converting trace data to numeric characters fails
8	Folder creation error	Creating the folder fails
9	CSV file open error	Opening the CSV file fails
32	Executing TRACE instruction	Writing trace data to SD memory card fails

### 4. Settings

The list of trace data to be output to the CSV files.

Display type	Valid Devices
DEC(W)	TC, TP, CC, CP, D
DEC(I)	D
DEC(D)	CC, CP, D
DEC(L)	D
DEC(F)	D
HEX(W)	TC, TP, CC, CP, D
HEX(D)	CC, CP, D
BIN(B)	I, Q, M, R, T, C

### 5. Tag Name

Enter tag names or device addresses to specify the devices to the CSV files.

### 6. Device Address

When the devices are specified as tag names, the corresponding device addresses are shown.

### 7. Display Type

Select the display type from the following table for each device for when the device values are output to the CSV file.

Display type	Range	Maximum characters
DEC(W)	0 to 65,535	5
DEC(I)	-32,768 to 32,767	6
DEC(D)	0 to 4,294,967,295	10
DEC(L)	-2,147,483,648 to 2,147,483,647	11
DEC(F)	-3.402823E+38 to 3.402823E+38	13
HEX(W)	0000 to FFFF	4
HEX(D)	00000000 to FFFFFFFF	8
BIN(B)	0 or 1	1

**8. Repeat**

The data in as many consecutive devices as the specified repeat, starting from the specified device address, are output to the SD memory card.

For example, when the display type of D10 is DEC(W) and the repeat is set to 8, the data is output to SD memory card as follows.

Triggered at:	2011/9/7 15:40								← Header row 1
Scan	D0010	D0011	D0012	D0013	D0014	D0015	D0016	D0017	← Header row 2
Old	1	9	17	25	33	41	49	57	← Data 7 scans before
	2	10	18	26	34	42	50	58	← Data 6 scans before
	3	11	19	27	35	43	51	59	← Data 5 scans before
	4	12	20	28	36	44	52	60	← Data 4 scans before
	5	13	21	29	37	45	53	61	← Data 3 scans before
	6	14	22	30	38	46	54	62	← Data 2 scans before
	7	15	23	31	39	47	55	63	← Data 1 scan before
New	8	16	24	32	40	48	56	64	← Latest data

**9. Trace data size**

The amount of memory that the TRACE instruction uses for the current trace settings is shown. The amount of memory used increases when a device to trace the data is added. You can register up to a maximum of 64 devices (the total amount of memory must be less than or equal to 1,024 bytes). One byte of memory area is required for each character.

**10. Remaining size**

The amount of free memory (the difference between the trace data size and 1,024 bytes) is shown.

**11. The number of scans**

How many scans of trace data can be accumulated with the current trace settings is shown. The number of scans of data that can be accumulated depends on the format of the trace data to output. If there is little data to output per scan, the data for many scans can be accumulated.

**CSV File Output Format and File Format Configuration**

The CSV file output format is as follows. You can change the separating character for each data and the decimal symbol for floating point numbers that are output to the CSV files on the Function Area Settings dialog box.

• **Output format**

```

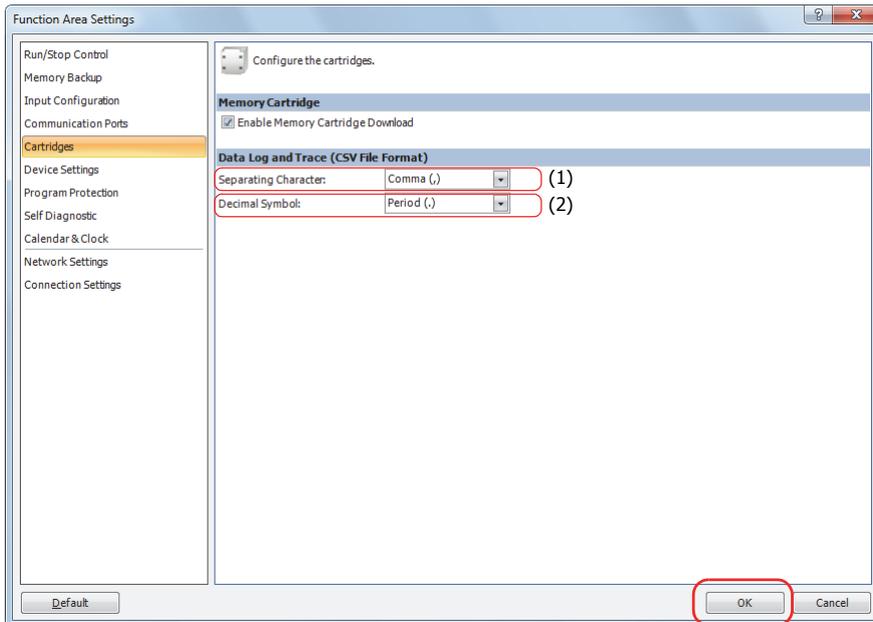
Triggered at:,2011/09/07 15:40,,,,,,
Scan,D0010,D0020,D0030,D0040,D0050,D0060,D0070,D0080
Old,1,9,17,25,33,41,49,57
,2,10,18,26,34,42,50,58
,3,11,19,27,35,43,51,59
,4,12,20,28,36,44,52,60
,5,13,21,29,37,45,53,61
,6,14,22,30,38,46,54,62
,7,15,23,31,39,47,55,63
New,8,16,24,32,40,48,56,64
:
:
:
    
```

When the TRACE instruction is executed and the CSV file for the same date does not exist in the folder designated by S1, a new CSV file is created and the trace data is output as shown in above output format example. When the date changes and the TRACE instruction is executed, a new CSV file is created with a new file name.

## 26: DATA LOG INSTRUCTIONS

### File format configuration procedure

1. From the WindLDR menu bar, select **Configuration > Cartridges**.
2. Under **Data Log and Trace (CSV File Output)**, configure the separating character and the decimal symbol.  
The separating characters and the decimal symbols that are contained in the CSV file vary by country and region. You can select the symbols to use from the following:
  - (1) Separating character: "," (comma) or ";" semicolon
  - (2) Decimal symbol: "." (period) or "," (comma)
3. Click the **OK** button to close the dialog box.



### Examples: TRACE

When M0 is turned on, the accumulated data of D0 through D5 (data type W (word)) and D10 (data type F (floating point)) are saved as decimal values in a CSV file on the "RESULT" folder on the SD memory card.

### Output sample

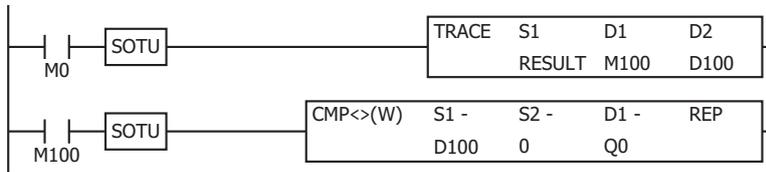
Triggered at:	2012/02/06 10:20:30						
Scan	D0000	D0001	D0002	D0003	D0004	D0005	D0010
Old	12345	2	12345	56789	1	56789	-3.402823E+38
	12345	2	12347	56789	1	56788	-3.402823E+38
	12345	2	12349	56789	1	56787	-3.402823E+38
:	:	:	:	:	:	:	:
	12345	2	12379	56789	1	56772	-3.402823E+38
	12345	2	12381	56789	1	56771	-3.402823E+38
New	12345	2	12383	56789	1	56770	-3.402823E+38

The sample user program described below operates as follows.

- M100 is turned on when the writing trace data to the SD memory card completes.
- The TRACE instruction status code is stored to D100.
- The execution status saved in D100 is checked and Q0 is turned on if an error occurs.

• Configuration Procedure

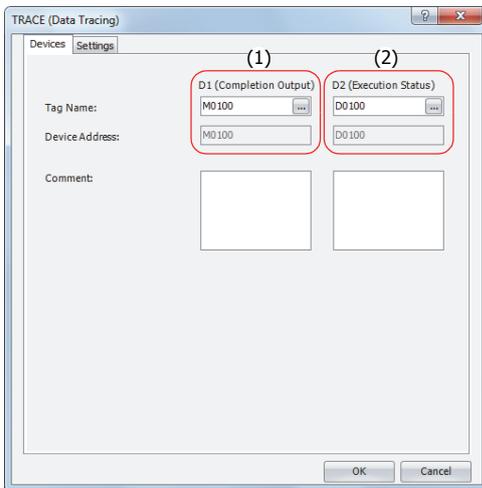
1. Insert the instructions in the Ladder editor.



2. Configure the TRACE instruction.

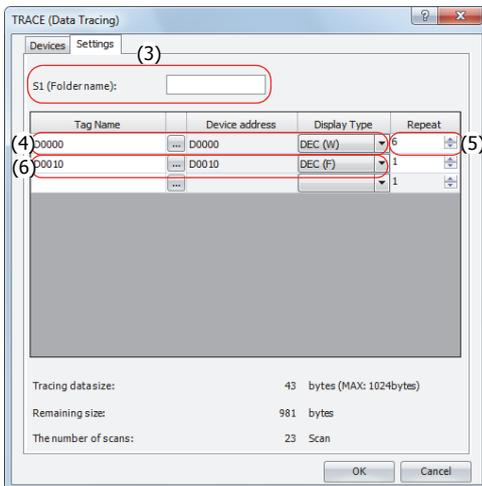
Configure the Devices tab.

- (1) Designate M100 as D1 (Completion Output).
- (2) Designate D100 as D2 (Execution Status).



Configure the Settings tab.

- (3) Enter "RESULT" in S1 (Folder Name).
- (4) Configure D0 to output the decimal value of D0 to the CSV files with the data type W (word).
- (5) Set the repeat to 6 to output the values of D0 through D5 to the CSV files.
- (6) Configure D10 to output the value of D10 to the CSV files with the data type F (float).



The configuration is now completed.

## 26: DATA LOG INSTRUCTIONS

### • Operation Description

When M0 is turned on, the TRACE instruction is executed one time. When the TRACE instruction is executed, the data of D0 through D5 and D10 in the previous 20 scans is output to a CSV file on the SD memory card as decimal values along with the date and time of the execution.

The saved location of CSV files is DATA0001\TRACE\RESULT. The oldest data is saved at the top of the trace data, and the latest data is saved at the bottom of the trace data.

When the execution of the TRACE instruction completes, the completion output M100 is turned on and the CMP instruction is executed once. The CMP instruction compares the status code stored in the execution status D100 with 0 and turns Q0 on or off. Q0 is turned on when an error occurs in the TRACE instruction.

### Output results

Triggered at:	2012/02/06 10:20:30						
Scan	D0000	D0001	D0002	D0003	D0004	D0005	D0010
Old	12345	2	12345	56789	1	56789	-3.402823E+38
	12345	2	12347	56789	1	56788	-3.402823E+38
	12345	2	12349	56789	1	56787	-3.402823E+38
	12345	2	12351	56789	1	56786	-3.402823E+38
	12345	2	12353	56789	1	56785	-3.402823E+38
	12345	2	12355	56789	1	56784	-3.402823E+38
	12345	2	12357	56789	1	56783	-3.402823E+38
	12345	2	12359	56789	1	56782	-3.402823E+38
	12345	2	12361	56789	1	56781	-3.402823E+38
	12345	2	12363	56789	1	56780	-3.402823E+38
	12345	2	12365	56789	1	56779	-3.402823E+38
	12345	2	12367	56789	1	56778	-3.402823E+38
	12345	2	12369	56789	1	56777	-3.402823E+38
	12345	2	12371	56789	1	56776	-3.402823E+38
	12345	2	12373	56789	1	56775	-3.402823E+38
	12345	2	12375	56789	1	56774	-3.402823E+38
	12345	2	12377	56789	1	56773	-3.402823E+38
	12345	2	12379	56789	1	56772	-3.402823E+38
New	12345	2	12381	56789	1	56771	-3.402823E+38

# APPENDIX

## Execution Times for Instructions

Execution times for basic and advanced instructions of the SmartAXIS are listed below.  
Repeat is not assigned for any device.

Instruction	Device and Condition	Execution Time (μs)	
		SmartAXIS Pro / Lite	SmartAXIS Touch
LOD, LODN	—	0.85	1.58
	Using data register	2.01	2.71
OUT, OUTN	—	0.81	1.13
	Using data register	1.92	2.17
SET, RST	—	0.81	1.08
	Using data register	1.96	2.17
AND, ANDN, OR, ORN	—	0.65	0.81
	Using data register	1.94	2.46
AND LOD, OR LOD	—	0.57	0.85
BPS	—	0.94	0.99
BRD	—	0.94	0.99
BPP	—	0.94	0.99
SOTU, SOTD	—	1.22	2.16
TML, TIM, TMH, TMS	—	3.19	5.45
TMLO, TIMO, TMHO, TMSO	—	3.19	5.45
CNT, CDP, CUD	—	3.16	4.33
CNTD, CDPD, CUDD	—	24.86	126.1
SFR, SFRN	N bits	—	42.7+0.4n
CC=, CC>=	—	2.06	2.38
DC=, DC>=	—	2.06	2.94
MCS, MCR, JMP, JEND	—	—	0.91
END	—	—	—
NOP	—	—	—
MOV, MOVN (W, I)	M → M	19.36	44.7
	D → D	4.16	4.30
MOV, MOVN (D, L)	M → M	19.36	84.5
	D → D	19.36	84.5
MOV (F)	—	19.36	84.5
IMOV, IMOVN (W)	M+D → M+D	15.86	84.4
	D+D → D+D	8.16	7.70
IMOV, IMOVN (D)	D+D → D+D	22.66	87.9
IMOV (F)	—	22.66	87.9
IBMV, IBMVN	M+D → M+D	15.76	47.5
	D+D → D+D	15.76	47.5
BMOV	D → D	21.36 + 1.3n	90.3+1.4n
NSET (W, I)	D → D	2.86 + 1.6n	1.8+2.5n
NSET (D, L)	D → D	2.86 + 1.6n	1.8+83.0n
NSET (F)	D → D	2.86 + 1.6n	1.8+83.0n
NRS (W, I)	D, D → D	11.68	16.5
NRS (D, L)	D, D → D	88.96	732.5

**APPENDIX**

Instruction	Device and Condition	Execution Time (μs)	
		SmartAXIS Pro / Lite	SmartAXIS Touch
<b>NRS (F)</b>	D, D → D	88.96	732.5
<b>XCHG (W)</b>	D ↔ D	4.86	5.10
<b>XCHG (D)</b>	D ↔ D	33.76	166.5
<b>TCCST (W)</b>	D → T	4.49	4.81
<b>TCCST (D)</b>	D → T	12.3	85.5
<b>CMP (=, &lt;&gt;, &lt;, &gt;, &lt;=, &gt;=) (W, I)</b>	D ↔ D → M	14.26	47.0
<b>CMP (=, &lt;&gt;, &lt;, &gt;, &lt;=, &gt;=) (D, L)</b>	D ↔ D → M	28.06	127.5
<b>CMP (=, &lt;&gt;, &lt;, &gt;, &lt;=, &gt;=) (F)</b>	D ↔ D → M	28.06	127.5
<b>ICMP (&gt;=)</b>	D ↔ D ↔ D → M	36.56	169.5
<b>ICMP (D, L, F)</b>	D ↔ D ↔ D → M	57.36	557.5
<b>LC (=, &lt;&gt;, &lt;, &gt;, &lt;=, &gt;=) (W, I)</b>	D ↔ D	4.68	5.00
<b>LC (=, &lt;&gt;, &lt;, &gt;, &lt;=, &gt;=) (D, L)</b>	D ↔ D	19.66	86.5
<b>LC (=, &lt;&gt;, &lt;, &gt;, &lt;=, &gt;=) (F)</b>	D ↔ D	19.66	86.5
<b>ADD (W, I)</b>	M + M → D	20.86	86.5
	D + D → D	13.76	47.3
<b>ADD (D, L)</b>	M + M → D	34.86	166.3
	D + D → D	34.86	167.3
<b>ADD (F)</b>	D + D → D	35.86	171.9
<b>SUB (W, I)</b>	M - M → D	20.86	86.5
	D - D → D	13.76	47.3
<b>SUB (D, L)</b>	M - M → D	34.86	166.3
	D - D → D	34.86	167.3
<b>SUB (F)</b>	D - D → D	35.86	171.9
<b>MUL (W, I)</b>	M × M → D	20.36	86.5
	D × D → D	13.36	47.3
<b>MUL (D, L)</b>	M × M → D	34.76	166.3
	D × D → D	34.76	167.3
<b>MUL (F)</b>	D × D → D	35.76	171.9
<b>DIV (W, I)</b>	M ÷ M → D	14.36	86.5
	D ÷ D → D	6.36	9.80
<b>DIV (D, L)</b>	M ÷ M → D	34.96	166.3
	D ÷ D → D	34.96	167.3
<b>DIV (F)</b>	D ÷ D → D	36.66	171.9
<b>INC (W, I)</b>	—	11.86	44.7
<b>INC (D, L)</b>	—	25.66	124.5
<b>DEC (W, I)</b>	—	11.86	44.7
<b>DEC (D, L)</b>	—	25.66	124.5
<b>ROOT (W)</b>	$\sqrt{D} \rightarrow D$	7.36	5.50
<b>ROOT (D)</b>	$\sqrt{D} \rightarrow D$	21.76	86.7
<b>ROOT (F)</b>	$\sqrt{D} \rightarrow D$	19.66	886.5
<b>SUM (W, I)</b>	D, D → D	13.16 + 0.8n	47.6+1.1n
<b>SUM (D, L)</b>	D, D → D	21.36 + 7.6n	90.5+41.5n
<b>SUM (F)</b>	D, D → D	21.36 + 9.2n	90.5+45.0n
<b>ANDW, ORW, XORW (W)</b>	M · M → D	20.16	46.1
	D · D → D	5.36	5.70
<b>ANDW, ORW, XORW (D)</b>	D · D → D	27.06	127.1
<b>SFTL, SFTR</b>	N_B = 100	18.76	56.1

Instruction	Device and Condition	Execution Time ( $\mu$ s)	
		SmartAXIS Pro / Lite	SmartAXIS Touch
BCDLS	D $\rightarrow$ D, S1 = 1	10.56	49.9
WSFT	D $\rightarrow$ D	22.56	91.3
ROTL, ROTR (W)	D, bits = 1	12.16	44.9
HTOB (W)	D $\rightarrow$ D	4.84	10.5
BTOH (W)	D $\rightarrow$ D	4.92	11.1
HTOA (W)	D $\rightarrow$ D	7.96	13.7
ATOH (W)	D $\rightarrow$ D	—	6.0
BTOA (W)	D $\rightarrow$ D	—	13.7
ATOB (W)	D $\rightarrow$ D	—	56.3
ENCO (W)	M $\rightarrow$ D, 16 bits	—	6.9
DECO	D $\rightarrow$ M	—	50.0
BCNT	M $\rightarrow$ D, 16 bits	—	—
ALT	—	10.86	42.7
CVDT	W, I, D, L $\rightarrow$ F	—	53.0
	F $\rightarrow$ W, I, D, L	—	56.3
DTDV (W)	D $\rightarrow$ D	—	8.90
DTCB (W)	D $\rightarrow$ D	—	10.4
SWAP (W)	—	4.22	8.9
SWAP (D)	—	19.06	89.7
WEEK	—	—	—
YEAR	—	—	—
MSG	—	—	—
LABEL	—	—	—
LJMP	—	—	—
LCAL	—	—	—
LRET	—	—	—
DJNZ	—	—	—
IOREF	—	—	46.8
HSCRF	—	—	46.8
DI	—	—	90.3
EL	—	—	54.1
XYFS	—	—	—
CVXTY	—	—	—
CVYTX	—	—	—
AVRG (W, I)	S3 = 10	—	6.38
AVRG (D, L)	S3 = 10	—	49.5
AVRG (F)	S3 = 10	—	55.1
PULS	—	—	—
PWM	—	—	—
RAMP	—	—	—
ZRN	—	—	—
ARAMP	—	—	—
DTML, DTIM, DTMH	—	—	60.2
DTMS	—	—	63.0
TTIM	—	—	60.3
RAD	F $\rightarrow$ F	—	143.9
DEG	F $\rightarrow$ F	—	143.9

Instruction	Device and Condition	Execution Time (μs)	
		SmartAXIS Pro / Lite	SmartAXIS Touch
SIN, COS	F → F	36.96	161.1
TAN	F → F	34.66	149.1
ASIN, ACOS	F → F	81.36	618.9
ATAN	F → F	72.96	616.5
LOGE, LOG10	F → F	43.56	206.0
EXP	F → F	37.56	172.5
POW	F → F	47.36	191.0
FIFO	—	—	129.0
FIEX	—	—	129.0
FOEX	—	—	129.0
NDSRC (W, I)	D, D, D → D	—	19.5
NDSRC (D, L)	D, D, D → D	—	782.5
NDSRC (F)	D, D, D → D	—	782.5
TADD	—	—	54.4
TSUB	—	—	54.4
HOUR	D → D, Y, D	—	20.6
HTOS	—	—	52.7
STOH	D → D	—	92.1
TXD	—	—	—
RXD	—	—	—
ETXD	—	—	—
ERXD	—	—	—
DLOG	—	—	—
TRACE	—	—	—

**Processing in One Scan**

While the SmartAXIS is running, the SmartAXIS performs operations repeatedly such as input refreshing, ladder program processing, and error checking.

A *scan* is the execution of all instructions from address zero to the END instruction. The time required for this execution is referred to as one *scan time*. The scan time varies with respect to program length.

The current value of the scan time is stored to special data register D8023 (scan time current value), and the maximum value of the scan time is stored to special data register D8024 (scan time maximum value). These values can be viewed on the PLC status screen of WindLDR while monitoring on a computer.

**Executing Program Instructions**

During the scan time, program instructions are processed sequentially starting with the first line of the ladder program, except for interrupt program execution. One scan time of a ladder program is approximately equal to the total execution time of each instruction shown on preceding pages.

**Watchdog Timer**

The watchdog timer monitors the time required for one program cycle (scan time) to prevent hardware malfunction. When the processing time for one scan exceeds the allowed time, a watchdog timer error occurs and the system is reset. If this is the case, place NOP instructions in the ladder diagram. The NOP instruction resets the watchdog timer. For details on the watchdog timer, see Chapter 5 "Special Functions" – "Watchdog Timer" in the SmartAXIS Pro/Lite User's Manual.

## Breakdown of END Processing Time

The END processing time depends on the SmartAXIS settings and system configuration. The maximum values for the END processing time are as follows.

Item	Execution Time
Housekeeping (built-in I/O service)	640 $\mu$ s

## Instruction Bytes

The byte quantities for basic and advanced instructions are listed below.

Basic Instruction	Qty of Bytes	
	When not using data registers	Using data registers
LOD	4	8
LODN	4	8
OUT	4	8
OUTN	4	8
SET	4	8
RST	4	8
AND	4	8
ANDN	4	8
OR	4	8
ORN	4	8
AND LOD	4	—
OR LOD	4	—
BPS	4	—
BRD	4	—
BPP	4	—
SOTU	4	—
SOTD	4	—
TML	8	—
TIM	8	—
TMH	8	—
TMS	8	—

Basic Instruction	Qty of Bytes	
	When not using data registers	Using data registers
TMLO	8	—
TIMO	8	—
TMHO	8	—
TMSO	8	—
CNT	8	—
CDP	8	—
CUD	8	—
CNTD	8	—
CDPD	8	—
CUDD	8	—
SFR	8	—
SFRN	8	—
CC=	8	—
CC>=	8	—
DC=	8	—
DC>=	8	—
MCS	4	—
MCR	4	—
JMP	4	—
JEND	4	—
END	4	—

Advanced Instruction	Qty of Bytes
NOP	4
MOV, MOVN	12 to 16
IMOV, IMOVN	16
IBMV, IBMVN	16 to 24
BMOV	12 to 16
NSET	12 to 1540
NRS	12 to 20
XCHG	12 to 16
TCCST	12 to 16
CMP (=, <>, <, >, <=, >=)	16 to 24
ICMP>=	16 to 28
LC (=, <>, <, >, <=, >=)	12 to 20
ADD, SUB, MUL, DIV	16 to 24
INC, DEC	8
ROOT	12 to 20
SUM	16 to 20
ANDW, ORW, XORW	16 to 24
SFTL, SFTR	12
BCDLS	12 to 16
WSFT	12 to 20
ROTL, ROTR	12
HTOB, BTOH	12 to 16
HTOA	12 to 20
ATOH	12 to 20
BTOA	12 to 20
ATOB	12 to 20
ENCO	12 to 16
DECO	12 to 16
BCNT	12 to 20
ALT	8
CVDT	12 to 20
DTDV	12 to 16
DTCB	12 to 16
SWAP	12 to 16
WEEK	20 to 532
YEAR	24 to 216
MSG	12 or more
LABEL	8
LJMP	8 to 12
LCAL	8 to 12
LRET	8
DJNZ	12 to 16

Advanced Instruction	Qty of Bytes
IOREF	12
HSCRF	8
DI	8
EI	8
XYFS	20 to 268
CVXTY, CVYTX	16 to 20
AVRG	16 to 24
PULS1, PULS2, PULS3, PULS4	24
PWM1, PWM2, PWM3, PWM4	24
RAMP1, RAMP2	28
ZRN1, ZRN2	20
ARAMP1, ARAMP2	36 to 240
DTML, DTIM, DTMH, DTMS	16 to 20
TTIM	8 to 12
RAD	12 to 16
DEG	12 to 16
SIN	12 to 16
COS	12 to 16
TAN	12 to 16
ASIN	12 to 16
ACOS	12 to 16
ATAN	12 to 16
LOGE	12 to 16
LOG10	12 to 16
EXP	12 to 16
POW	12 to 24
FIFO	20 to 24
FIEX	12
FOEX	12
NDSRC	16 to 24
TADD	16 to 20
TSUB	16 to 20
HOUR	16 to 24
HTOS	12 to 16
STOH	12 to 16
TXD	16 to 820
RXD	16 to 820
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ERXD	16 to 820
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TRACE	24 to 276

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