MITSUBISHI ELECTRIC

Programmable Controller

MELSEC iQ-F series

MELSEC iQ-F
FX5 Data Logging Function
Sample Ladder Reference

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1 SAMPLE LADDER LIST

This program is sample ladder for a system that uses the MELSEC iQ-F Series FX5U and FX5UC CPU module's data logging function.

Name	Description	Version
Standard deviation calculation	Standard deviation of the target data for logging can be calculated in ladder.	Ver. 1.00A

System configuration

The configuration of the system using this sample ladder is shown below.

- FX5U(C)

Prerequisites for using sample ladder

As shown below, the sample ladder is provided with the model listed in the project name.

Ex.

With the following project name, the model is FX5U/FX5UC.

LD-FX5U_□□□_□□□_V100A_E

The provided project is not guaranteed to run with the user's system. Check the device assignments and parameters, etc., and adjust them to the user's system specifications before starting use.

Related manuals

📖MELSEC iQ-F FX5 Programming Manual (Instructions, Standard Functions/Function Blocks)

📖MELSEC iQ-F FX5 User's Manual (Application)

📖GX Works3 Operating Manual

📖GX LogViewer Version 1 Operating Manual

Notice

This manual explains the functions of the sample ladder. The restrictions for using and the restrictions for combining the programmable controller, various expansion boards, extension adapters, and extension devices are not covered. Always read the User's Manual for the target product before starting use.

MEMO

2 SAMPLE LADDER

2.1 Standard Deviation Calculation

Name

Standard Deviation Calculation

Outline

Standard deviation of the target data for logging can be calculated in ladder.

Programs used

This program is targeted for FX5U and FX5UC.

The projects used in this program are indicated below.

No.	Project name	Program name	Remark
1	LD-FX5U_CPU_Logging_V100A_E	01_Standard Deviation Calculation	This project is created with FX5U/FX5UC.

Devices used

The devices used in this program are indicated below.

■Input device

No.	Device name	Data type	Kind	Device comment	Remark
1	M0	Bit	Input	Execution command	ON: The program starts. OFF: The program does not start.
2	M1	Bit	Input	Logging trigger	ON: Trigger present OFF: No trigger present When this device is ON, the logging target device value is input, and the standard deviation and average values are calculated.
3	D0	Word [signed]	Input	Logging target device value	Input the data for the logging target device. [Valid range (DEC)] -32768 to 32767
4	D1	Word [unsigned]/bit string [16-bit]	Input	Number of logging points	Designate the number of points to be logged (to calculate standard deviation). [Valid range (DEC)] 1 to 32768

■Output device

No.	Device name	Data type	Kind	Device comment	Remark
1	M100	Bit	Output	Execution status	ON: Execution command ON OFF: Execution command OFF
2	M101	Bit	Output	Normal completion	When this device is ON, it indicates that logging is in progress.
3	M102	Bit	Output	Logging completed	ON: Logging completed OFF: Logging incomplete When this device is ON, the number of points specified with number of logging points have been logged, and the calculation of the standard deviation has been completed.
4	Y0	Bit	Output	Error completion	When this device is ON, it indicates that an error has occurred in the program.
5	D100	Word [signed]	Output	Error code	The error code that occurred in the program is stored. [Error code (DEC)] 10: Number of logging points is out of range.
6	D102 to D103	Single-precision real number	Output	Standard deviation	The standard deviation value obtained from the input data is output as a single-precision real number. A 2-word area is used.
7	D104 to D105	Single-precision real number	Output	Average value	The average value obtained from the input data is output as a single-precision real number. A 2-word area is used.

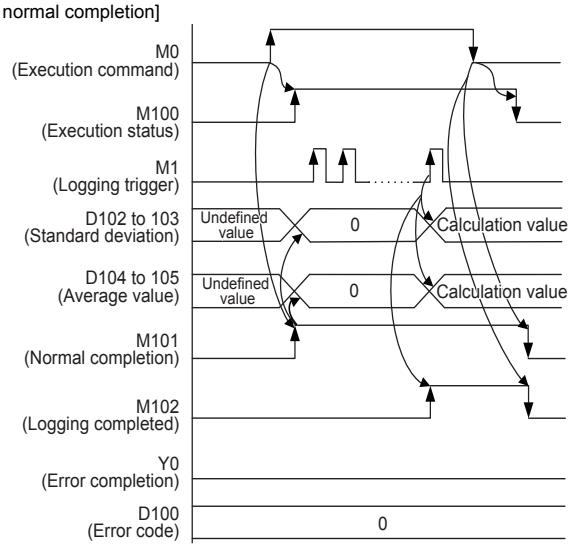
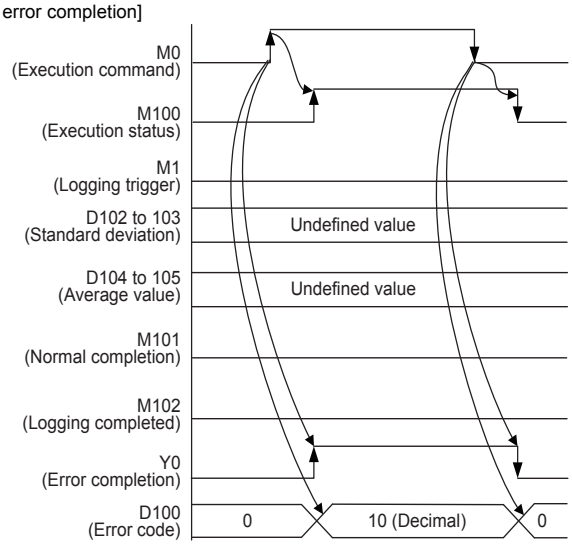
■Internal device

No.	Device name	Data type	Kind	Device comment	Remark
1	M200	Bit	Internal	Setting data check command	The setting data check command flag is retained.
2	M201	Bit	Internal	Main process execution command	The main process execution command flag is retained.
3	M202	Bit	Internal	Execution command of process before starting main process	The execution command flag of the process before starting main process is retained.
4	M203	Bit	Internal	Program completed	The program completed flag is retained.
5	M204	Bit	Internal	Main process execution completed	The main process execution completed flag is retained.
6	M205	Bit	Internal	Program error	The program error flag is retained.
7	M206	Bit	Internal	Pulsed execution command	The pulsed execution command flag is retained.
8	M210	Bit	Internal	Calculation execution switch	The calculation execution flag by the logging trigger ON condition is retained. This flag turns ON at each logging trigger ON condition, and turns OFF when the logging target data value has been imported.
9	D50 to D51	Double-word [unsigned]/bit string [32-bit]	Internal	Number of logging points	The specified number of logging points is retained.
10	D52 to D53	Double-word [unsigned]/bit string [32-bit]	Internal	Number of logging data input points	The number of storage points for the logged data is retained.
11	D54 to D55	Double-word [signed]	Internal	For logging data value calculation	This is used to calculate the total sum of the logging data.
12	D56	Word [signed]	Internal	Logging data value	The specified logging target device value is retained.
13	D58 to D59	Single-precision real number	Internal	Total sum of logging data (single-precision real number)	The total sum of the logging data (single-precision real number) is retained.
14	D60 to D61	Double-word [signed]	Internal	Total sum of logging data	The total sum of the logging data is retained.
15	D62 to D63	Single-precision real number	Internal	Square of arithmetic average (single-precision real number)	The square of the arithmetic average (single-precision real number) is retained.
16	D64 to D65	Single-precision real number	Internal	Logging data quantity (single-precision real number)	The logging data quantity (single-precision real number) is retained.
17	D66 to D69	Double-word [signed]	Internal	Results of square of X/N division	The results of the square of X/N division are retained.

No.	Device name	Data type	Kind	Device comment	Remark
18	D70 to D71	Double-word [signed]	Internal	Sum of quotient	The sum of the quotient is retained.
19	D72 to D73	Double-word [signed]	Internal	Sum of remainder	The sum of the remainder is retained.
20	D74 to D75	Single-precision real number	Internal	Sum of quotient (single-precision real number)	The sum of the quotient (single-precision real number) is retained.
21	D76 to D77	Single-precision real number	Internal	Sum of remainder (single-precision real number)	The sum of the remainder (single-precision real number) is retained.
22	D78 to D79	Single-precision real number	Internal	Variance value (single-precision real number)	The variance value (single-precision real number) is retained.
23	D80 to D81	Double-word [signed]	Internal	Square of logging data	The square of the logging data is retained.

Details of functions

Item	Description	
Applicable devices	CPU module	FX5U CPU, FX5UC CPU
	Engineering tool	GX Works3 Version 1.030G or later CPU Module Logging Configuration Tool Version 1.64S or later
Languages used	Ladder	
Number of basic steps	333 steps The number of FB steps integrated in the program varies depending on the CPU module used, the input/output definition, and the setting options of GX Works3. For the setting options of GX Works3, refer to 📖GX Works3 Operating Manual.	
Description of functions	• When Execution command (M0) is turned on, the Execution status (M100) outputs ON to start the logging data standard deviation calculation process. • When the input value is incorrect, Error completion (Y0) will be turned on, and the processing will be suspended. The error code is stored in Error code (D100). For the error codes, refer to the Error code (D100) in the devices used. • If the input value is correct, Normal completion (M101) ON is output. • When the Logging trigger (M1) changes from OFF to ON, the Logging target device value (D0) is imported. • If the specified number of logging points is not reached, Logging completed (M102) remains OFF (Logging incomplete). If the number of logged points reaches the specified number of logging points, Logging completed (M102) turns ON (logging completed), and the Standard deviation (D102, D103) and Average value (D104, D105) are output. • When logging is completed, a calculation will not be executed even if the Logging trigger (M1) subsequently turns ON. • To execute the calculation again, change the Execution command (M0) from OFF to ON, and input the Logging trigger (M1) and Logging target device value (D0). * Supplement: The standard deviation of the data collected in the SD memory card by the data logging function can be obtained. Refer to ☞ Page 9 Methods for linking with data logging function for details.	

Item	Description
Timing chart of I/O signals	[For normal completion]  [For error completion] 
Restrictions or precautions	• This program does not include the error recovery processing. Program the error recovery processing separately in accordance with the required system operation. • This program cannot be used as an interrupt program. • The usage methods are limited when obtaining the standard deviation of the data collected in the SD memory card in sequence with the data logging function. Refer to ☞ Page 9 Methods for linking with data logging function for details. • The standard deviation and average value calculation results are 32-bit single precision real numbers, so there are seven significant digits. Hence, if the value exceeds seven significant digits, the eighth digit is rounded off.

Error code

Error code (DEC)	Description	Handling method
10	Number of logging points (D1) is out of range. Number of logging points is set to a value other than 1 to 32768.	Review the setting, and then execute sample ladder again.

Explanation of process

■The processes of this program are given below.

Each time the Logging trigger (M1) changes from OFF to ON, the logging target device value is imported as logging data.

When the number of imported logging data points reaches the specified number of logging points, the standard deviation and average values obtained from the logging data for the number of logged points are output as single-precision real numbers.

The standard deviation σ is obtained with the following method.

When the logging data are assumed to be X1, X2, ... Xn, the arithmetic average can be obtained by the following formula.

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

At this time, the values obtained with the following method using the average is the variance.

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n} (x_i - \bar{x})^2$$

The positive square root of the variance is the standard deviation σ.

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

As an example, set 5 for the Number of logging points (D1), which is the input device, and set the values in the following table as the Logging target device value (D0) each time the Logging trigger (M1) turns ON. The Standard deviation (D102, 103) and Average value (D104, 105), which are the output, will be the values listed below for the output device.

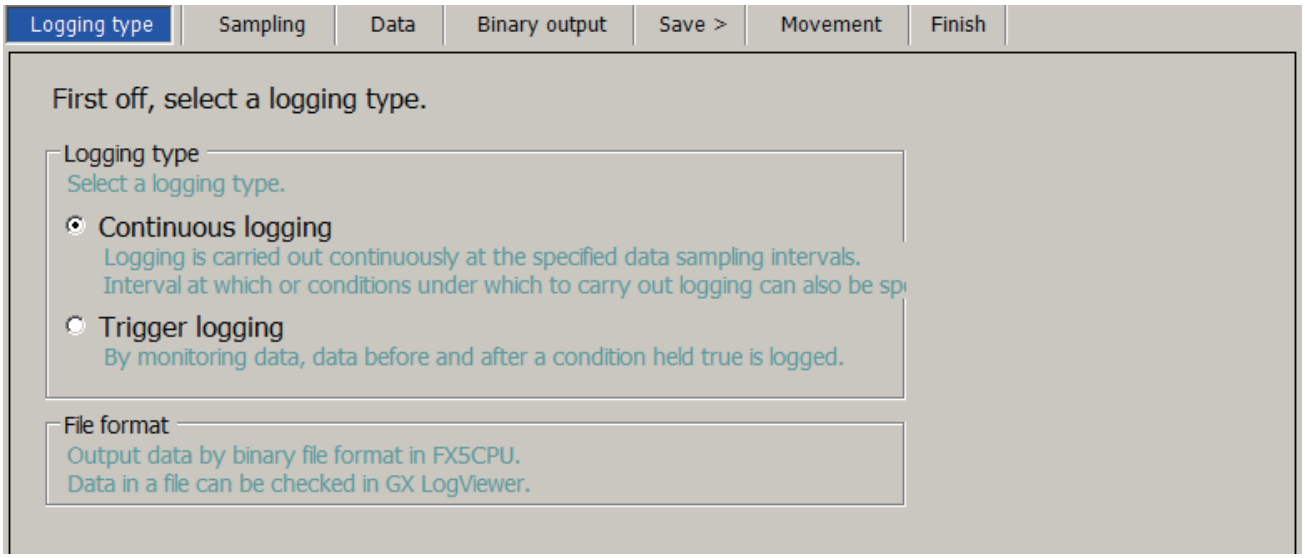
Input devices			Output devices	
Number of logging points (D1)	**Logging trigger (M1)**	**Logging target device value (D0)**	**Standard deviation (D102,103)**	**Average value (D104,105)**
5	1st trigger	2	2.828427	6.0
	2nd trigger	4		
	3rd trigger	6		
	4th trigger	8		
	5th trigger	10		

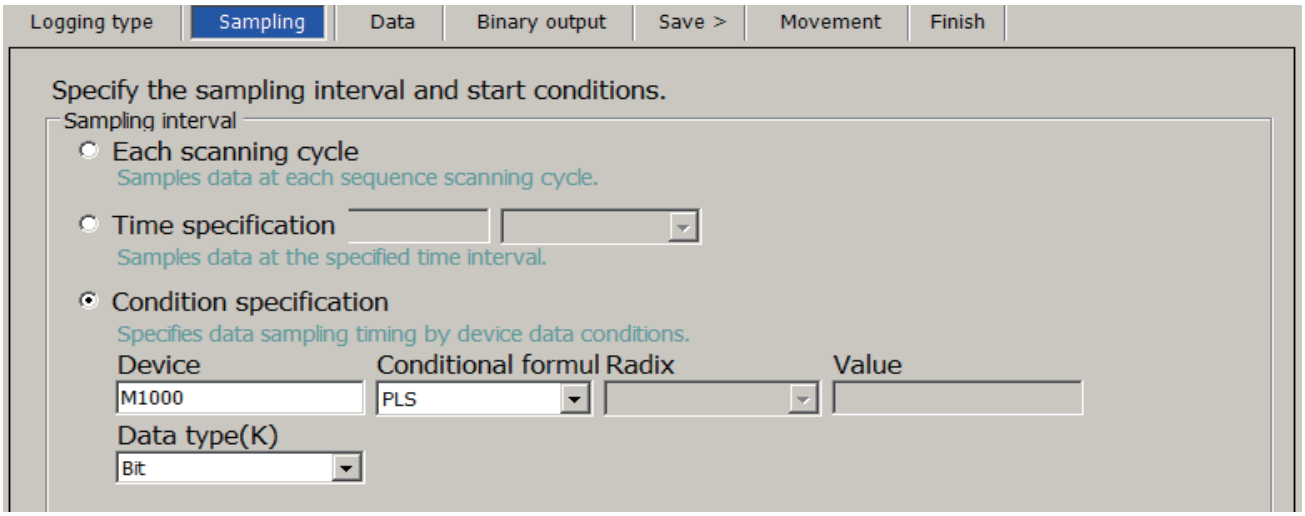
■Methods for linking with data logging function

The method for obtaining the standard deviation of the data collected in the SD memory card by the data logging function is explained below.

1. Data set with CPU Module Logging Configuration Tool

With the CPU Module Logging Configuration Tool, the logging type is set as continuous logging and the sampling interval as condition specification, and the type of device specified with the condition specification is a bit device.





2. Data input in sample ladder

Input the ON/OFF state of the bit device specified in the sampling interval condition specification of the CPU Module Logging Configuration Tool to the sample ladder input device logging trigger. The value of the device that is the collection target for the CPU Module Logging Configuration Tool is input for the input device logging target device value.[*1]

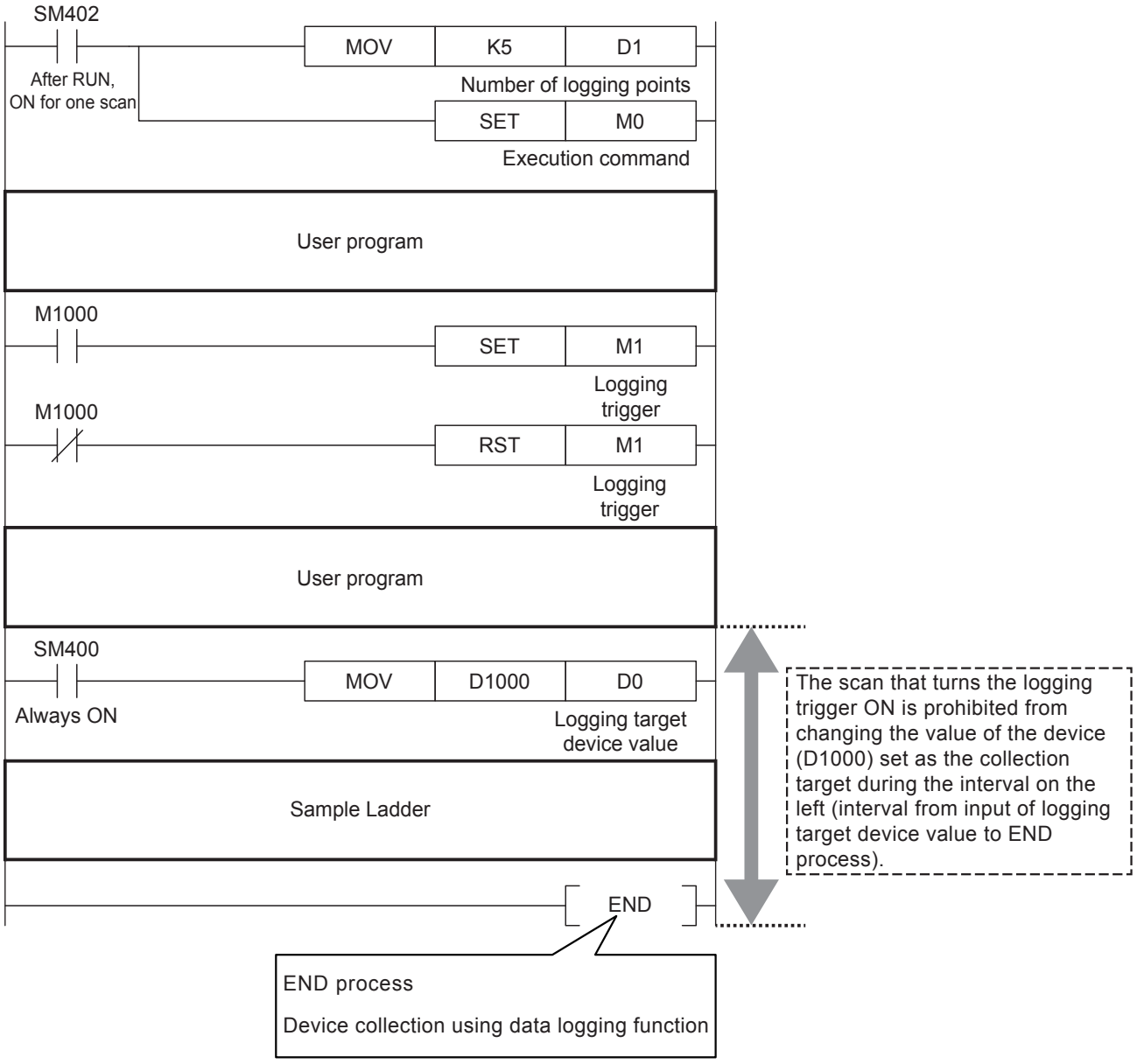
*1 The usage methods are limited to make the data logged in the SD memory card the same value as the data input in the sample ladder. Refer to ☞ Page 10 Logging a device for which the value is updated in a process other than the END process (data register, etc.) and ☞ Page 11 Logging a device for which the value is updated with the END process (special register, etc.) for details.
For a device in which the value is updated in the END process, refer to the END process in 🕮MELSEC iQ-F FX5 User's Manual (Application).

■Logging a device for which the value is updated in a process other than the END process (data register, etc.)

An example of inputting to the sample ladder with the CPU Module Logging Configuration Tool when the internal relay M1000 rising edge is specified for the sampling interval condition specification and the data register D1000 is specified for the sampling target is shown below.

To make the data logged in the SD memory card and the data input in the sample ladder the same value, in a scan that turns the logging trigger ON, the value input in the logging target device value of the sample ladder's input device must not be changed until the device collection is executed with the data logging function at the END process of the same scan.

To prevent the value input in the logging target device value from being changed unintentionally, the ladder that inputs the value in the logging target device value and this sample ladder should be placed just before the END process.

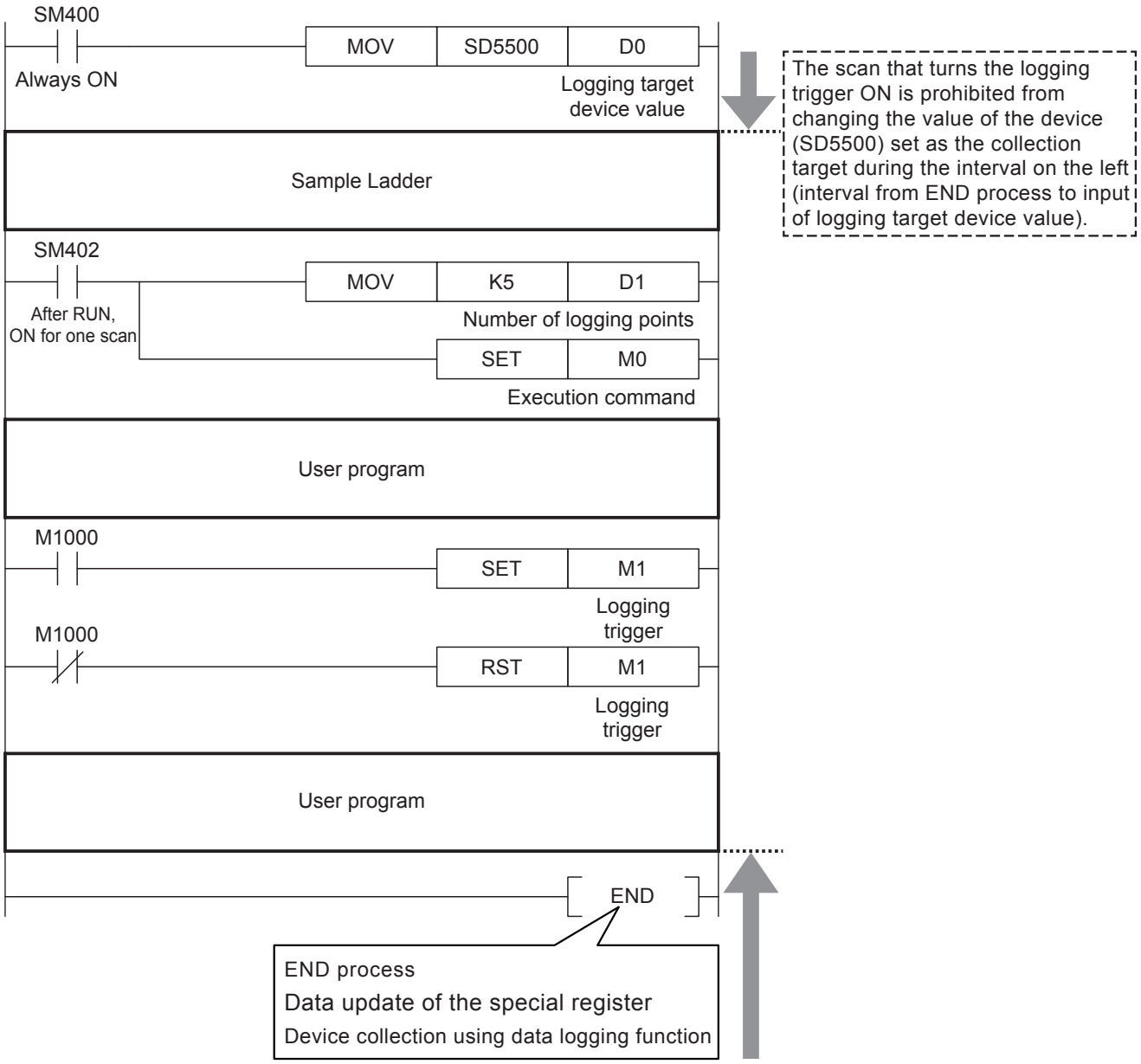


■Logging a device for which the value is updated with the END process (special register, etc.)

An example of inputting to the sample ladder with the CPU Module Logging Configuration Tool when the internal relay M1000 rising edge is specified for the sampling interval condition specification and the special register SD5500 (device for which value is updated with END process) is specified for the sampling target is shown below.

To make the data logged in the SD memory card and the data input in the sample ladder the same value, the device collection by the data logging function in the END process must turn ON the logging trigger at the next scan executed, and execute the sample ladder.

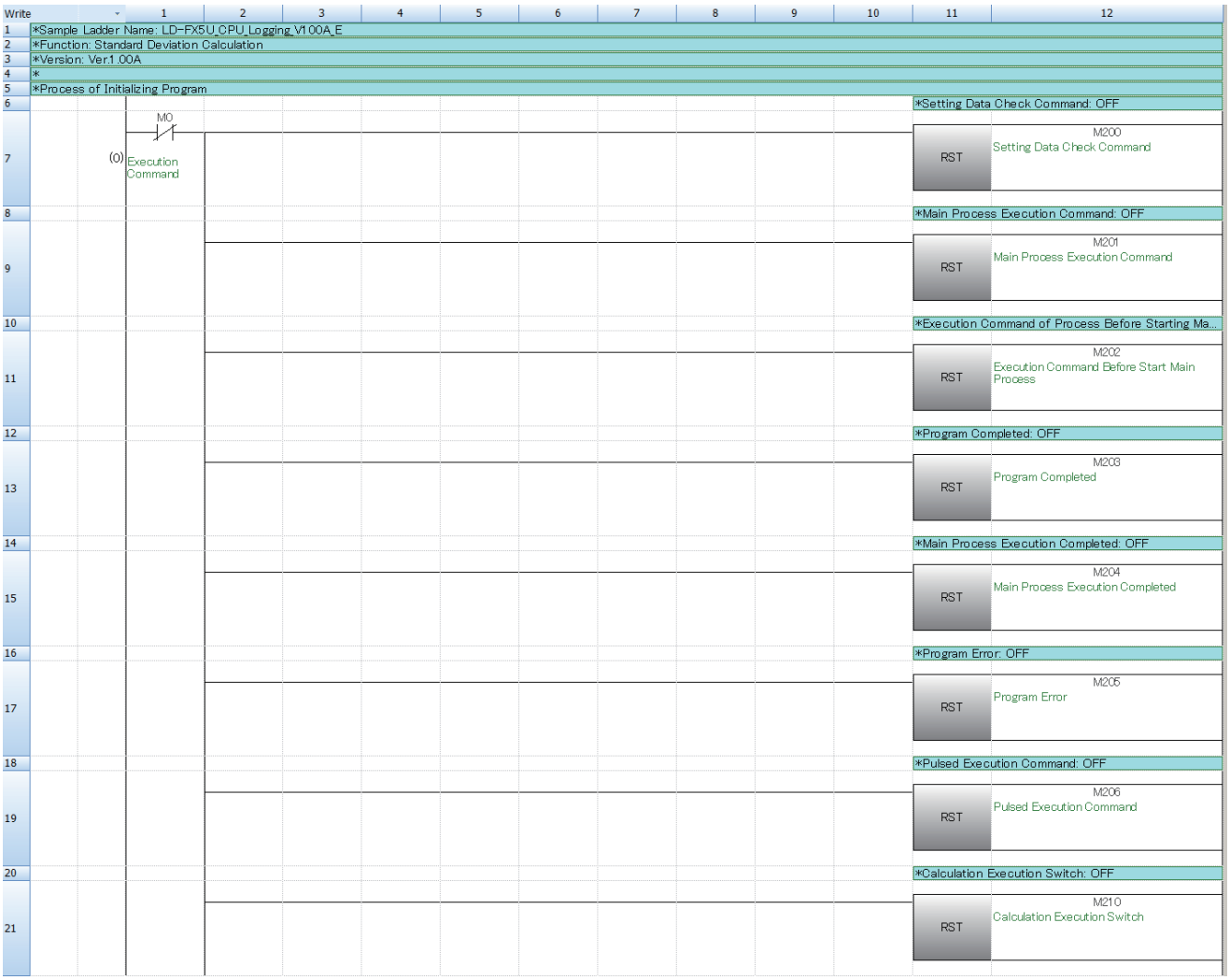
To prevent the value input in the logging target device value from being changed unintentionally, the ladder that inputs the value in the logging target device value and this sample ladder should be placed at the head of the program.

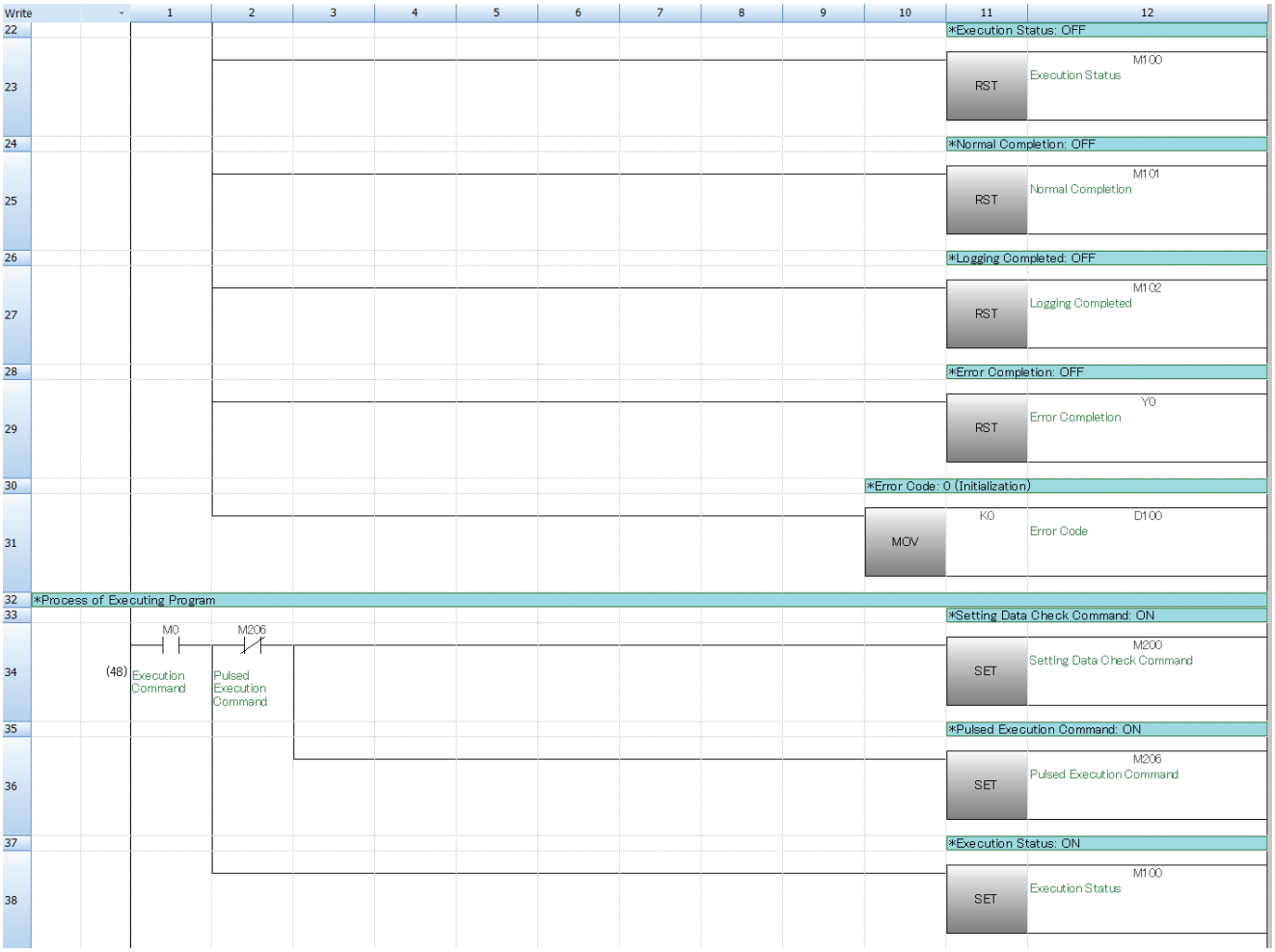


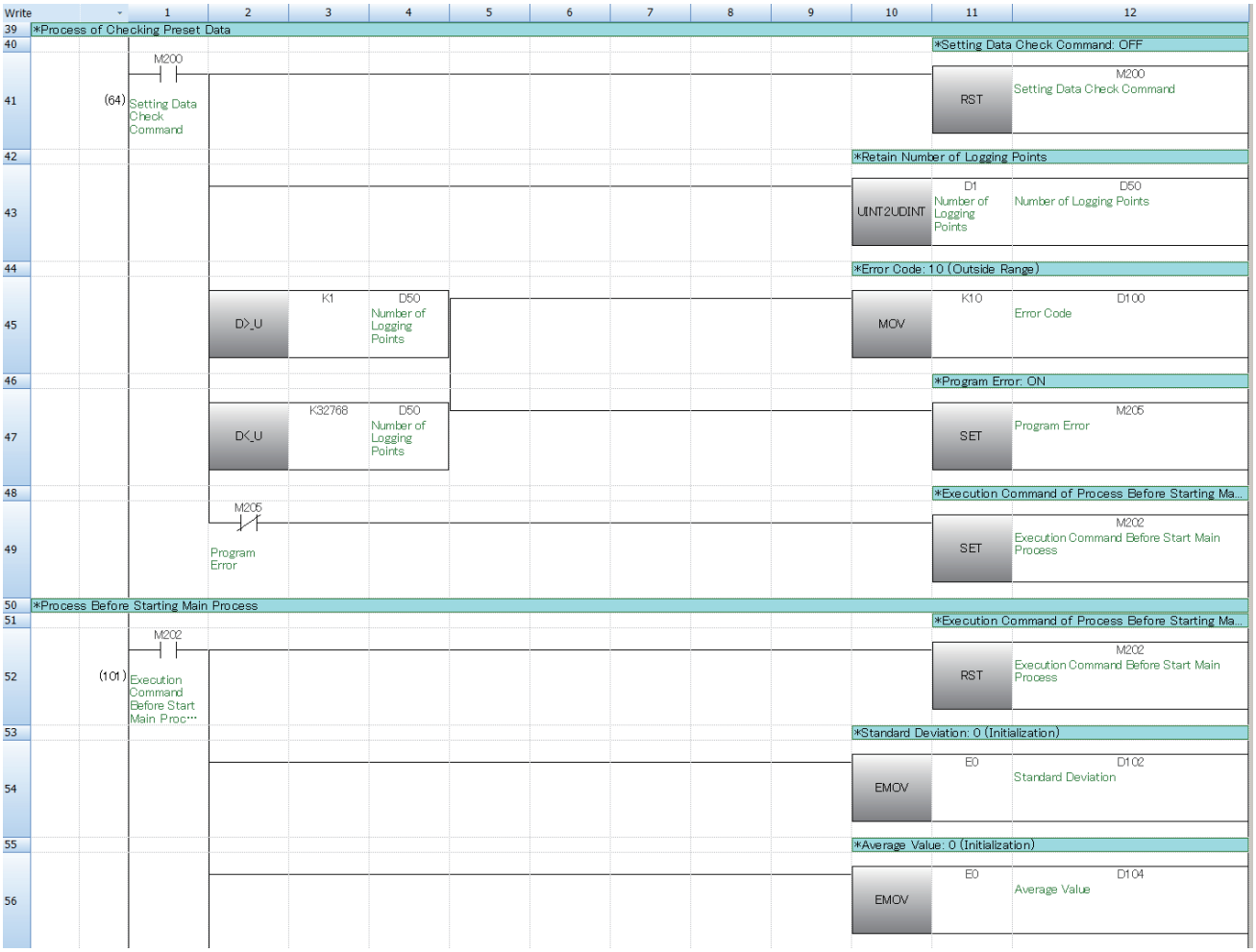
Version upgrade history

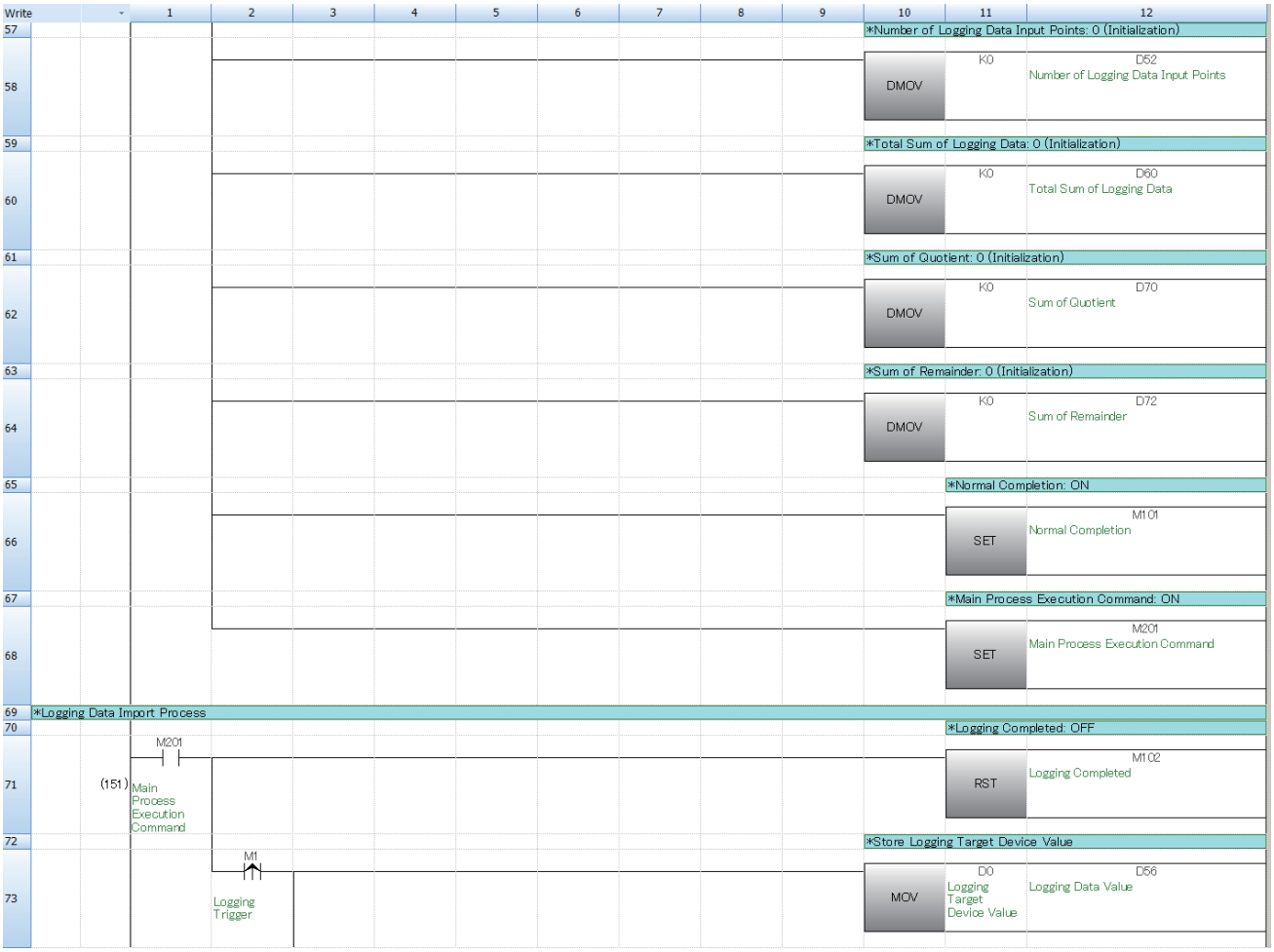
Version	Date	Description
Ver. 1.00A	February 2017	First Edition

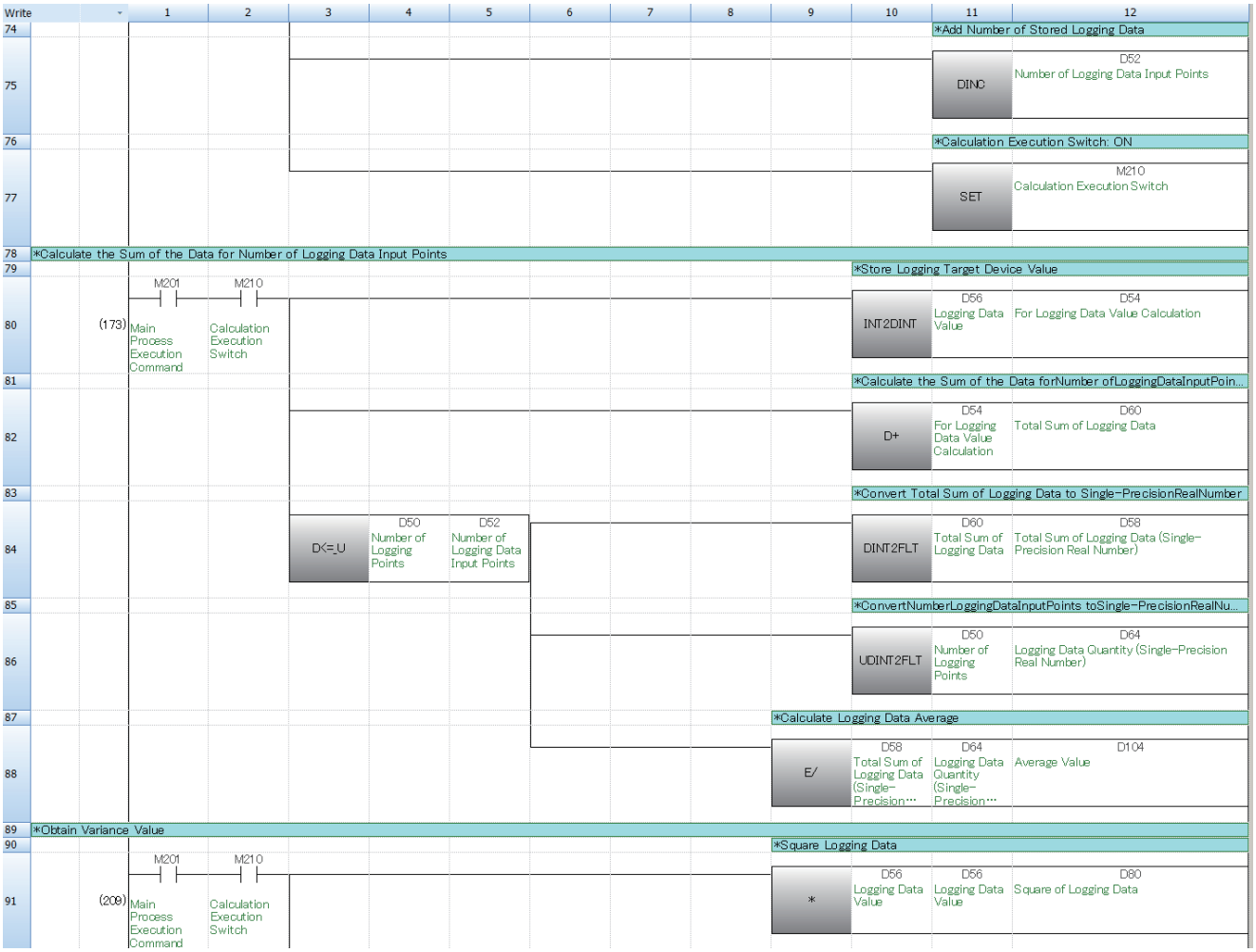
Program

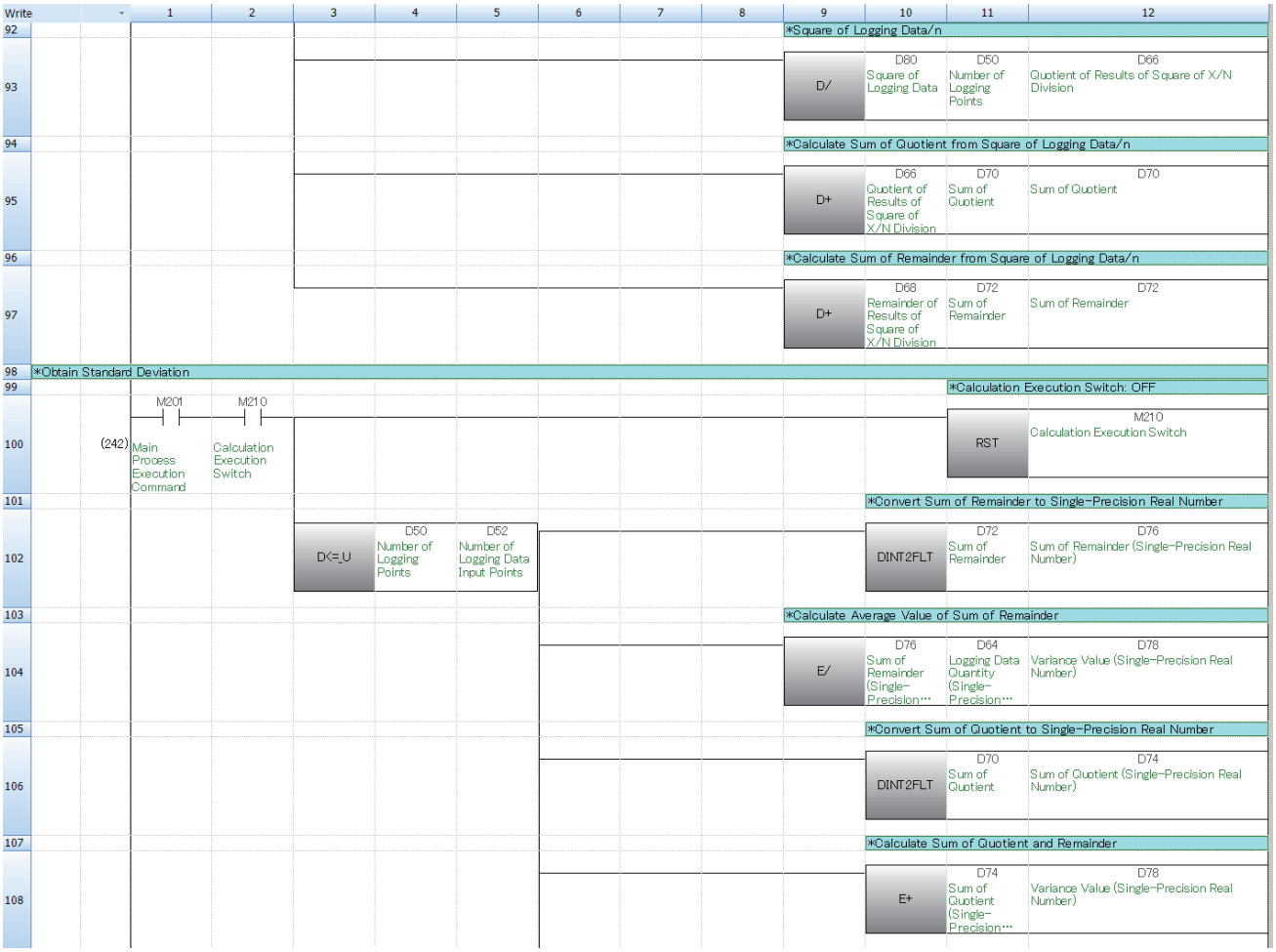

Write
1 *Sample Ladder Name: LD-FX5U_CPU_Logging_V100A_E
2 *Function: Standard Deviation Calculation
3 *Version: Ver.1.00A
4 *
5 *Process of Initializing Program
6 *Setting Data Check Command: OFF
M0
(0) Execution Command
RST M200 Setting Data Check Command
8 *Main Process Execution Command: OFF
RST M201 Main Process Execution Command
10 *Execution Command of Process Before Starting Ma...
RST M202 Execution Command Before Start Main Process
12 *Program Completed: OFF
RST M203 Program Completed
14 *Main Process Execution Completed: OFF
RST M204 Main Process Execution Completed
16 *Program Error: OFF
RST M205 Program Error
18 *Pulsed Execution Command: OFF
RST M206 Pulsed Execution Command
20 *Calculation Execution Switch: OFF
RST M210 Calculation Execution Switch

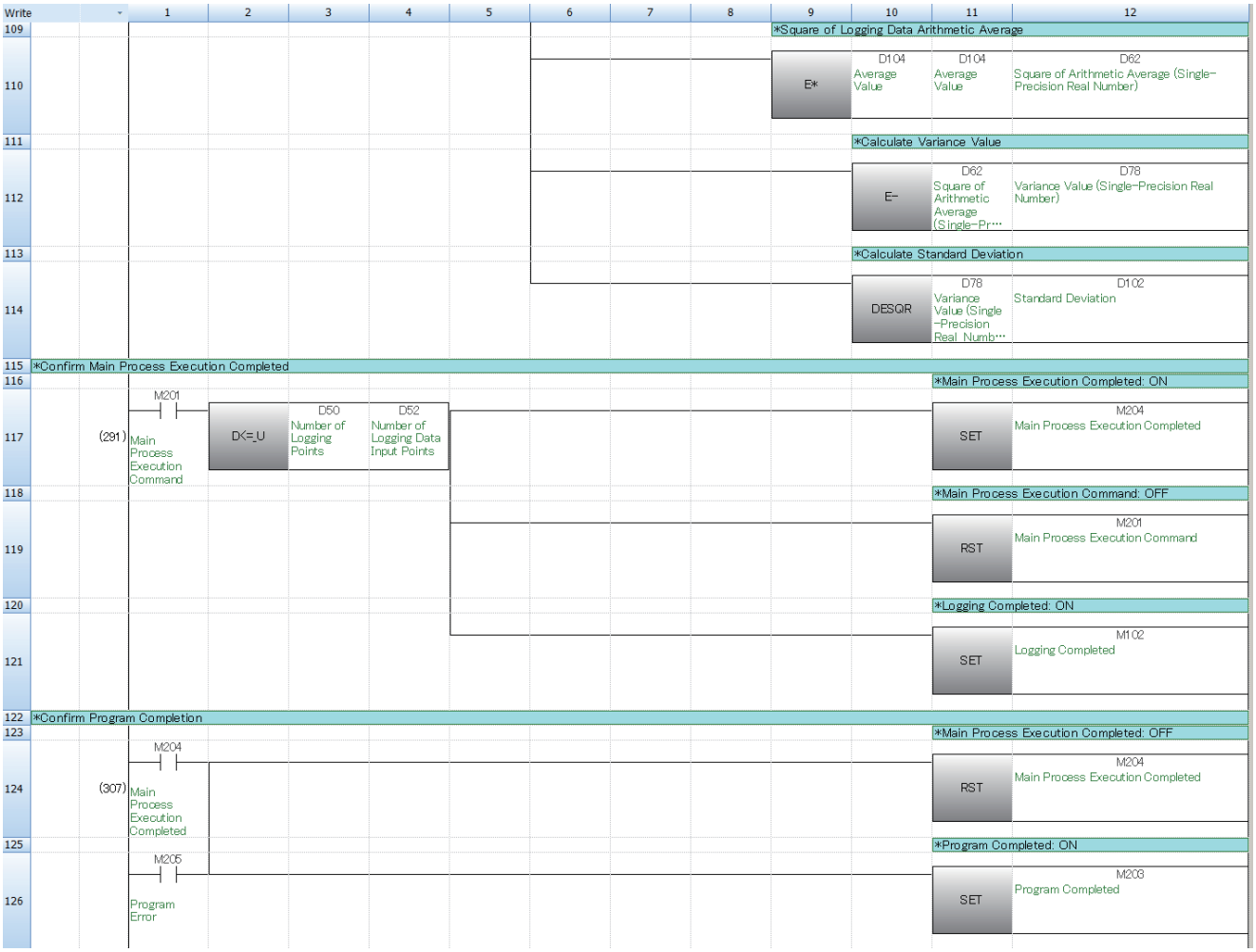

Write
1
2
3
4
5
6
7
8
9
10
11
12
22
*Execution Status: OFF
23
M100
RST
Execution Status
24
*Normal Completion: OFF
25
M101
RST
Normal Completion
26
*Logging Completed: OFF
27
M102
RST
Logging Completed
28
*Error Completion: OFF
29
Y0
RST
Error Completion
30
*Error Code: 0 (Initialization)
31
K0
D100
MOV
Error Code
32
*Process of Executing Program
33
*Setting Data Check Command: ON
34
M0
M206
(48)
Execution Command
Pulsed Execution Command
M200
SET
Setting Data Check Command
35
*Pulsed Execution Command: ON
36
M206
SET
Pulsed Execution Command
37
*Execution Status: ON
38
M100
SET
Execution Status

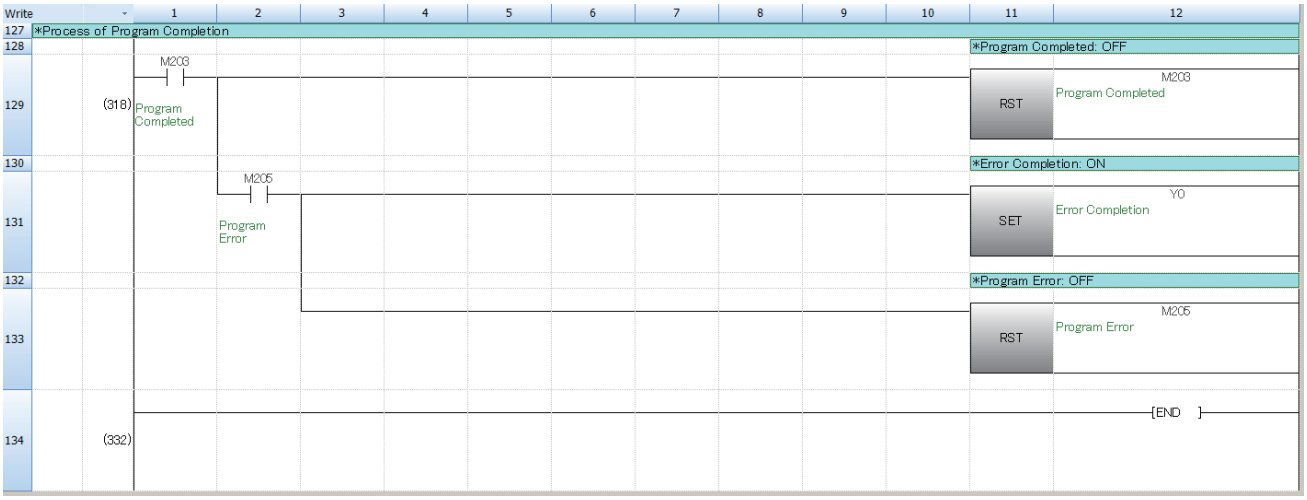

Write
1
2
3
4
5
6
7
8
9
10
11
12
39 *Process of Checking Preset Data
40
*Setting Data Check Command: OFF
M200
41
(64)
Setting Data Check Command
RST
M200
Setting Data Check Command
42
*Retain Number of Logging Points
43
UINT2UDINT
D1
Number of Logging Points
D50
Number of Logging Points
44
*Error Code: 10 (Outside Range)
45
D>_U
K1
D50
Number of Logging Points
MOV
K10
D100
Error Code
46
*Program Error: ON
47
D<_U
K32768
D50
Number of Logging Points
SET
M205
Program Error
48
*Execution Command of Process Before Starting Ma...
M205
49
Program Error
SET
M202
Execution Command Before Start Main Process
50
*Process Before Starting Main Process
51
*Execution Command of Process Before Starting Ma...
M202
52
(101)
Execution Command Before Start Main Proc...
RST
M202
Execution Command Before Start Main Process
53
*Standard Deviation: 0 (Initialization)
54
EMOV
E0
D102
Standard Deviation
55
*Average Value: 0 (Initialization)
56
EMOV
E0
D104
Average Value


Write
1
2
3
4
5
6
7
8
9
10
11
12
57
*Number of Logging Data Input Points: 0 (Initialization)
58
DMOV
K0
D52
Number of Logging Data Input Points
59
*Total Sum of Logging Data: 0 (Initialization)
60
DMOV
K0
D60
Total Sum of Logging Data
61
*Sum of Quotient: 0 (Initialization)
62
DMOV
K0
D70
Sum of Quotient
63
*Sum of Remainder: 0 (Initialization)
64
DMOV
K0
D72
Sum of Remainder
65
*Normal Completion: ON
66
SET
M101
Normal Completion
67
*Main Process Execution Command: ON
68
SET
M201
Main Process Execution Command
69
*Logging Data Import Process
70
*Logging Completed: OFF
71
M201
(151)
Main Process Execution Command
RST
M102
Logging Completed
72
*Store Logging Target Device Value
73
M1
Logging Trigger
MOV
D0
Logging Target Device Value
D56
Logging Data Value


Write
*Add Number of Stored Logging Data
DINC
D52
Number of Logging Data Input Points
*Calculation Execution Switch: ON
SET
M210
Calculation Execution Switch
*Calculate the Sum of the Data for Number of Logging Data Input Points
*Store Logging Target Device Value
M201
M210
(173)
Main Process Execution Command
Calculation Execution Switch
INT2DINT
D56
Logging Data Value
D54
For Logging Data Value Calculation
*Calculate the Sum of the Data forNumber ofLoggingDataInputPoin...
D+
D54
For Logging Data Value Calculation
D60
Total Sum of Logging Data
*Convert Total Sum of Logging Data to Single-PrecisionRealNumber
D<=_U
D50
Number of Logging Points
D52
Number of Logging Data Input Points
DINT2FLT
D60
Total Sum of Logging Data
D58
Total Sum of Logging Data (Single-Precision Real Number)
*ConvertNumberLoggingDataInputPoints toSingle-PrecisionRealNu...
UDINT2FLT
D50
Number of Logging Points
D64
Logging Data Quantity (Single-Precision Real Number)
*Calculate Logging Data Average
E/
D58
Total Sum of Logging Data (Single-Precision...
D64
Logging Data Quantity (Single-Precision...
D104
Average Value
*Obtain Variance Value
*Square Logging Data
M201
M210
(209)
Main Process Execution Command
Calculation Execution Switch
*
D56
Logging Data Value
D56
Logging Data Value
D80
Square of Logging Data


Write
1
2
3
4
5
6
7
8
9
10
11
12
92
*Square of Logging Data/n
93
D/
D80
Square of Logging Data
D50
Number of Logging Points
D66
Quotient of Results of Square of X/N Division
94
*Calculate Sum of Quotient from Square of Logging Data/n
95
D+
D66
Quotient of Results of Square of X/N Division
D70
Sum of Quotient
D70
Sum of Quotient
96
*Calculate Sum of Remainder from Square of Logging Data/n
97
D+
D68
Remainder of Results of Square of X/N Division
D72
Sum of Remainder
D72
Sum of Remainder
98
*Obtain Standard Deviation
99
*Calculation Execution Switch: OFF
M201
M210
100
(242)
Main Process Execution Command
Calculation Execution Switch
RST
M210
Calculation Execution Switch
101
*Convert Sum of Remainder to Single-Precision Real Number
102
D<=_U
D50
Number of Logging Points
D52
Number of Logging Data Input Points
DINT2FLT
D72
Sum of Remainder
D76
Sum of Remainder (Single-Precision Real Number)
103
*Calculate Average Value of Sum of Remainder
104
E/
D76
Sum of Remainder (Single-Precision…
D64
Logging Data Quantity (Single-Precision…
D78
Variance Value (Single-Precision Real Number)
105
*Convert Sum of Quotient to Single-Precision Real Number
106
DINT2FLT
D70
Sum of Quotient
D74
Sum of Quotient (Single-Precision Real Number)
107
*Calculate Sum of Quotient and Remainder
108
E+
D74
Sum of Quotient (Single-Precision…
D78
Variance Value (Single-Precision Real Number)


Write
*Square of Logging Data Arithmetic Average
E*
D104
Average Value
D104
Average Value
D62
Square of Arithmetic Average (Single-Precision Real Number)
*Calculate Variance Value
E-
D62
Square of Arithmetic Average (Single-Pr…
D78
Variance Value (Single-Precision Real Number)
*Calculate Standard Deviation
DESQR
D78
Variance Value (Single-Precision Real Numb…
D102
Standard Deviation
*Confirm Main Process Execution Completed
*Main Process Execution Completed: ON
M201
(291)
Main Process Execution Command
D<=_U
D50
Number of Logging Points
D52
Number of Logging Data Input Points
SET
M204
Main Process Execution Completed
*Main Process Execution Command: OFF
RST
M201
Main Process Execution Command
*Logging Completed: ON
SET
M102
Logging Completed
*Confirm Program Completion
*Main Process Execution Completed: OFF
M204
(307)
Main Process Execution Completed
RST
M204
Main Process Execution Completed
*Program Completed: ON
M205
Program Error
SET
M203
Program Completed


Write
1
2
3
4
5
6
7
8
9
10
11
12
127
*Process of Program Completion
128
*Program Completed: OFF
M203
129
(318)
Program Completed
RST
M203
Program Completed
130
*Error Completion: ON
M205
131
Program Error
SET
Y0
Error Completion
132
*Program Error: OFF
133
RST
M205
Program Error
134
(332)
END

REVISIONS

Revision data	Revision	Description
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MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE: TOKYO BUILDING, 2-7-3 MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN

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