

MELSEC-F FX3 Series Industrial Numeric Calculation Sample Ladder Reference Manual

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Reference Manual Revision History

Reference Manual No.	Date of Revision	Details of Revision
SH(NA)-081864ENG-A	June, 2017	Newly Prepared

1. Outline

Outline of sample ladder

This program is a sample ladder for the system using the industrial numeric operation function with the FX3 series main unit.

Applicable devices

The applicable devices for this sample ladder are indicated below.

Model	Description		
Main unit			
	Series	Model	
	MELSEC-F Series	FX3S, FX3G, FX3GC, FX3U, FX3UC	
Engineering tool	GX Works2		
	Series	Language	Supported software version
	MELSEC-F Series	English	Version 1.545T and later
	GX Developer		
	Series	Language	Supported software version
	MELSEC-F Series	English	Version 8.119Z and later

System configuration

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

• FX3U(C)

Main unit FX3U(C)

• FX3G(C)

Main unit FX3G(C)

• FX3S

Main unit FX3S

Description of sample ladder function

The following functions are realized with this program.

No.	Project name	Description	Version
1	01_LD-FX3U_CPU_NumCalc_V100A_E	The moving average of "n" data is obtained.	Ver. 1.00A
2	02_LD-FX3U_CPU_NumCalc_V100A_E	The standard deviation of "n" data is obtained.	Ver. 1.00A
3	03_LD-FX3U_CPU_NumCalc_V100A_E	The 3 σ of "n" data is obtained.	Ver. 1.00A

Prerequisites for using sample ladder

■ Changing the PLC type

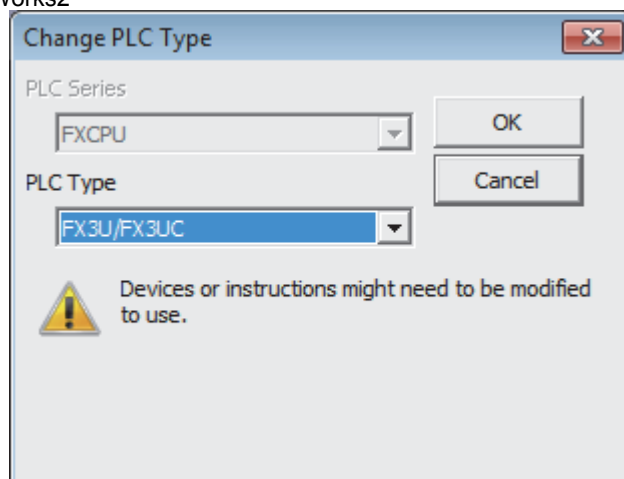
The sample ladder is provided with the model listed in the project name as shown below. When using with a model other than the provided project, change the PLC type using the engineering tool.

Example: With the following project name, the model is FX3U/FX3UC.

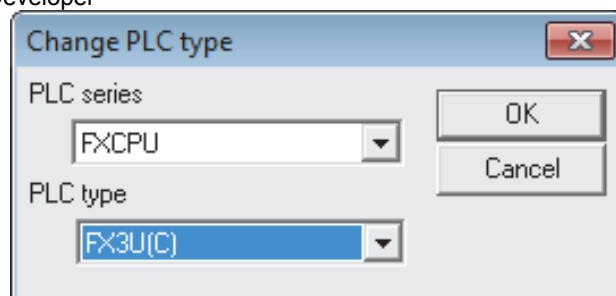
01_LD-FX3U_□□□_□□□_V100A_E

 [Project] -> [Change PLC Type]

•For GX Works2



•For GX Developer



When using a GX Developer project with FX3S, refer to the TECHNICAL BULLETIN "HIME-T-P-0118 Limitations and precautions when using FX3S Series with GX Developer".

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

FX3S/FX3G/FX3GC/FX3U/FX3UC Series Programming Manual - Basic & Applied Instruction Edition

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, special adapters, and expansion devices are not covered. Always read the User's Manual for the target product before starting use.

2. Sample Ladder

2. 1. Obtain Moving Average of n Data (01_LD-FX3U_CPU_NumCalc_V100A_E)

Outline of System

The moving average of "n" data is obtained.

■ Description of functions

- (1) When Execution Command (M0) is turned on, the simple moving average value of the input data is output.
- (2) The range of the total number "n" of the input data should be 1 to 100.
- (3) After Execution Command (M0) is turned on, this program will be completed in 1 scan.
- (4) When the total number of data is out of the range, Abnormal end (Y000) turns ON, and the process is halted. The error code is stored in Error code (D100). For the error codes, refer to Error code (D100) in the devices used.

* Supplement: In this sample ladder, the index register is backed up and recovered. However, this processing is not required if it is unnecessary to retain the index register values for any processing other than this sample processing.

Programs Used

This program is targeted for FX3S, FX3G, FX3GC, FX3U and FX3UC.

The projects used in this program are indicated below.

No.	Project name	Function name	Remark
1	01_LD-FX3U_CPU_NumCalc_V100A_E	Obtain Moving Average of n Data	This project is created with FX3U/FX3UC. When using with a model other than the provided project, change the PLC type using the engineering tool.

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: Program starts. OFF: Program does not start.
2	D0	Word	Input	Total Number of Data	The total number of the devices which store the input data is specified. [Effective range (decimal)] 1 to 100
3	D1	Word	Input	Newly Added Data	The data that is to be newly added to target data for average value calculation is specified. [Effective range (decimal)] -32768 to 32767

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 End	When this device is ON, it indicates that processing has finished.
3	Y000	Bit	Output	Abnormal End	When this device is ON, it indicates that an error has occurred in the program.
4	D100	Word	Output	Error Code	The error codes caused in the program are stored. [Error code (DEC)] 10: The total number of data is out of range.
5	D101	Word	Output	Target Data Moving Average Value	The moving average value (with sign) of the input data is output. Area for one word is used.

Input output device

No.	Device name	Data type	Kind	Device comment	Remark
1	D500 to D599	Word	Input output	Moving Average Data	The target calculation data for the moving average value is specified and after the program is executed, data of the calculated moving average value is stored.

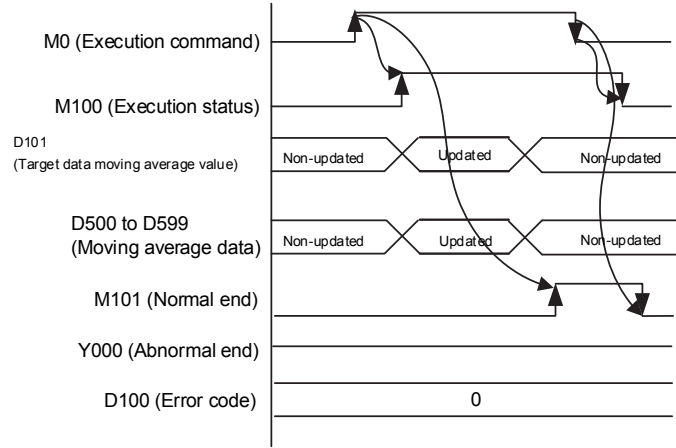
Internal device

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	ExeCommandBeforeStartMainProcess	The execution command flag before start main process is retained.
4	M203	Bit	Internal	Program Completed	The program completion flag is retained.
5	M204	Bit	Internal	Main Process Execution Completed	The main process execution completion 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	D50 to D51	Double word	Internal	Total Input Data Sum	Used for calculation of the total sum of the moving average data.
9	D52 to D53	Double word	Internal	TotalNumber of InputData(32bits)	The total number of the moving average data is retained.
10	D54 to D55	Double word	Internal	InputDataSum Calculation(32bits)	Used for retention of the moving average data for calculation of the total sum.
11	D56 to D57	Double word	Internal	DataAverageCalculation Quotient	The quotient of the calculation result for the average value of the moving average data is retained.
12	D58 to D59	Double word	Internal	DataAverageCalculation Remainder	The remainder of the calculation result for the average value of the moving average data is retained.
13	D60	Word	Internal	Total Number of Data Minus 1	The number of data of carry moving average data is retained.
14	D99	Word	Internal	IndexRegisterBackup and Recovery	Used for index register save.
15	D1000 to D1099	Word	Internal	Moving Average Calculation Data	When the moving average value is calculated, the moving average data that is to be calculated will be stored.

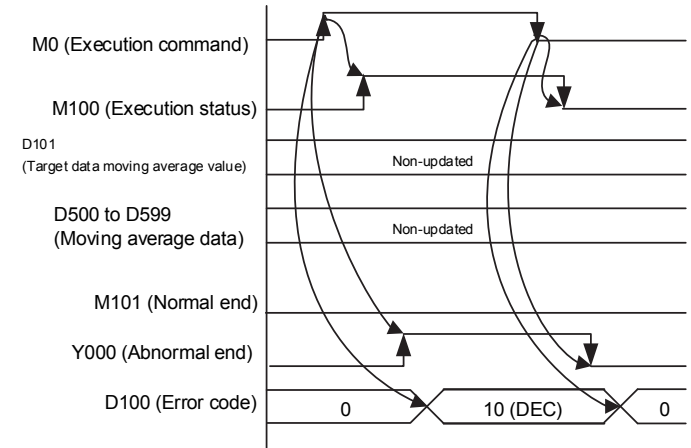
Operation of I/O signals

■ The timing chart for this program is shown below.

[In case of normal end]



[In case of abnormal end]



■ The processes of this program are given below.

The moving average value calculated from the input data of the last data and the newly added data is output.

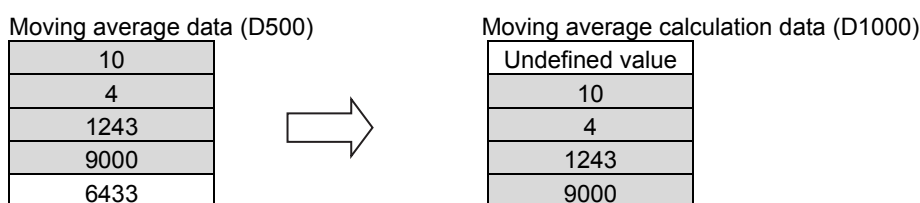
An output example when data of 5 words is set to the moving average data (D500) and 1500 is set to the newly added data (D1) is shown below.

Set 5 to the total number of data (D0).

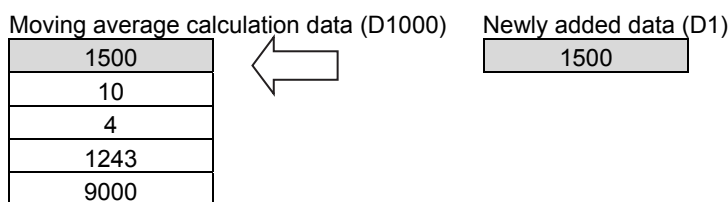
Input data

Moving average data (D500)		Newly added data (D1)	Total number of data (D0)
Device name	Value (Example)		
D500	10	1500	5
D501	4		
D502	1243		
D503	9000		
D504	6433		

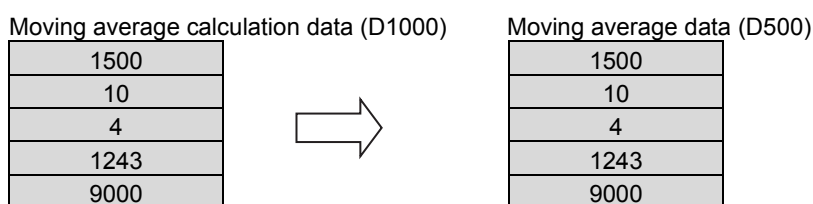
(1) Transfer the leading 4 words of the moving average data (D500) and store them to D1001 and later.



(2) Store the newly added data (D1) to the top of the moving average calculation data (D1000).



(3) Return 5 words of the total number of data (D0) from the moving average value calculation data (D1000) to the moving average data (D500).



(4) Calculate the average value of 5 words of the total number of data (D0) for the moving average value calculation data (D1000).

Store the calculation result to the moving average value (D101) of the target data.

$$(1500 + 10 + 4 + 1243 + 9000) \div 5 = 2351$$

Output data

Target data moving average value (D101)
2351

Version upgrade history

Version	Date	Description
Ver. 1.00A	June, 2017	First Edition

Program

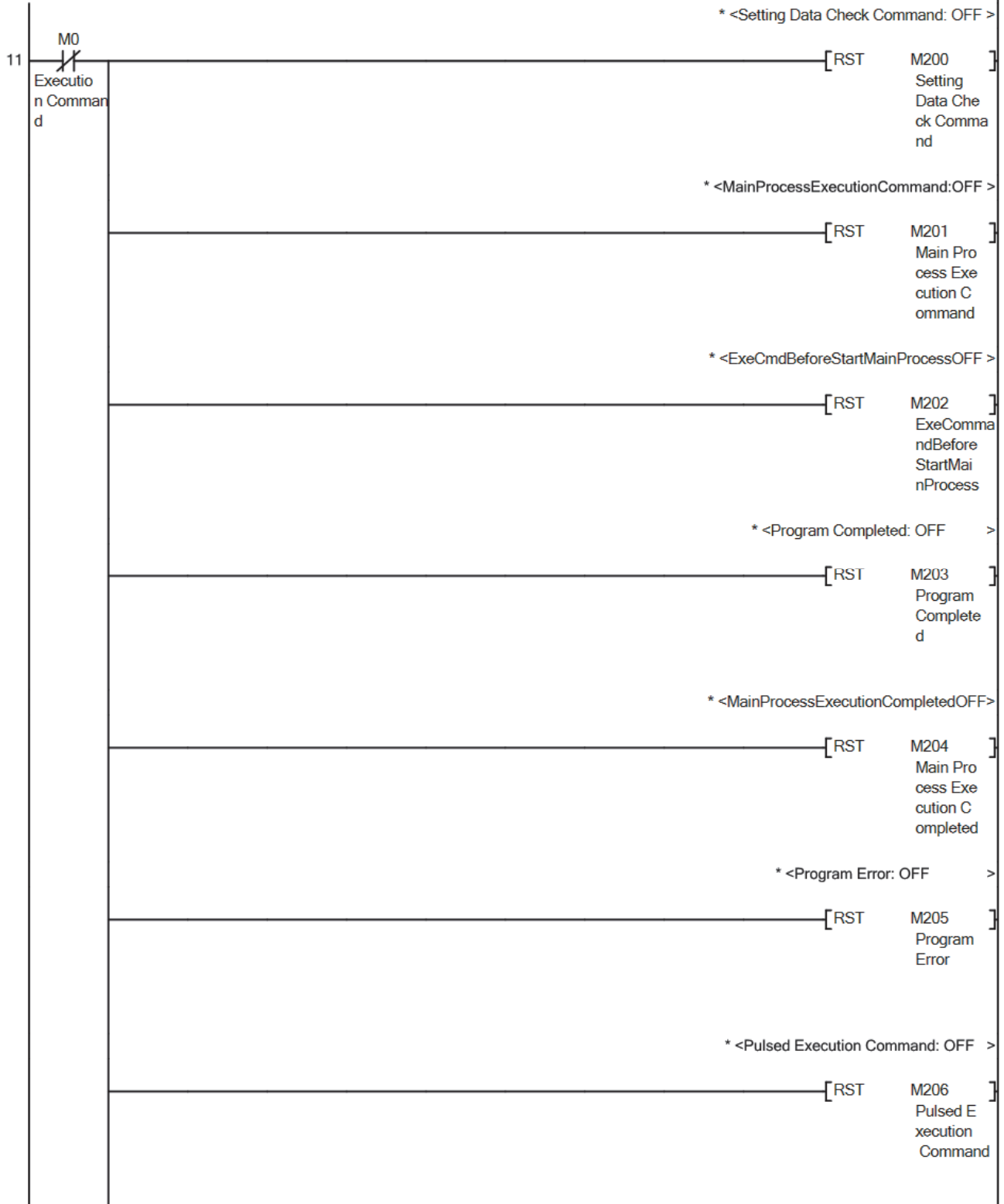
* Sample Ladder Name: 01_LD-FX3U_CPU_NumCalc_V100A_E
* Function: Obtain Moving Average of n Data
* Version: Ver.1.00A
*
* Backup Process of Index Register
*

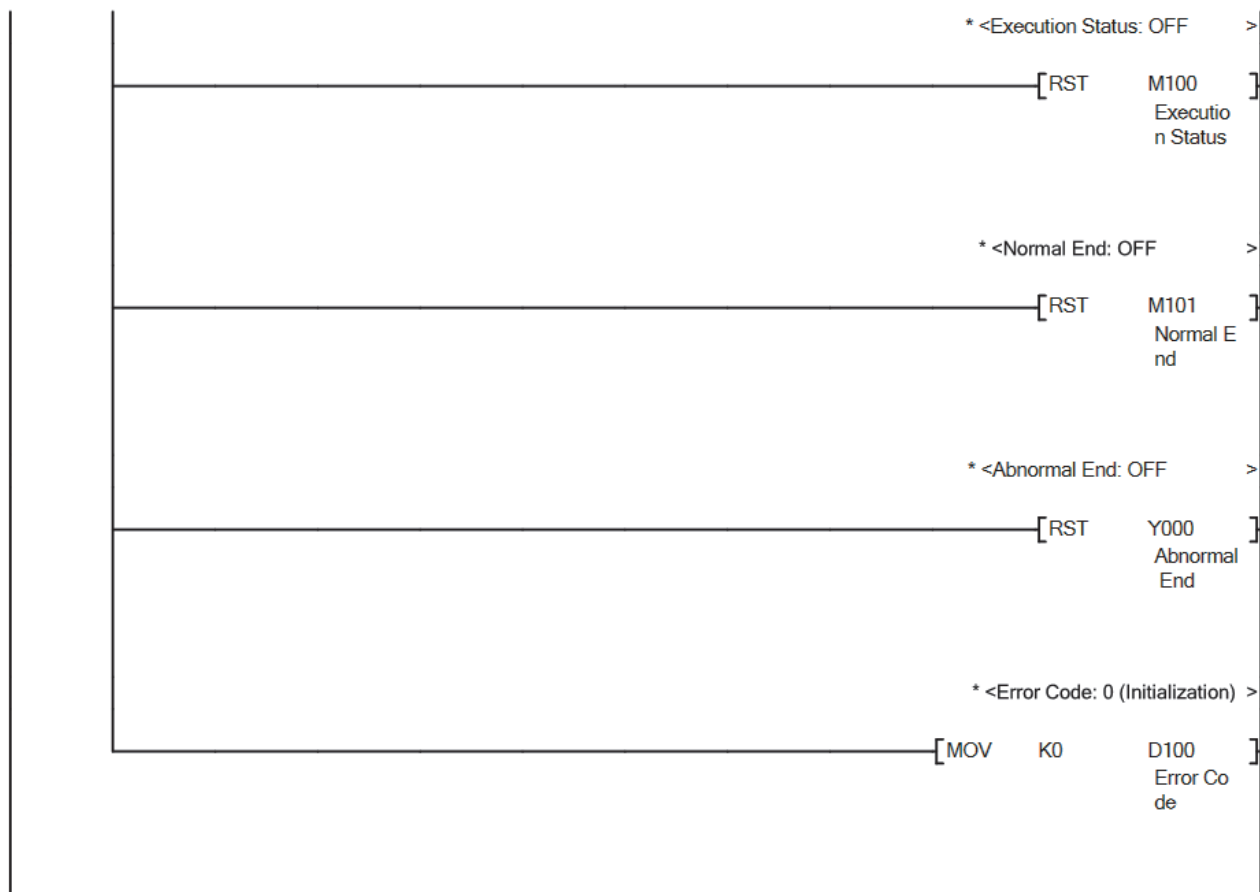


*

* Process of Initializing Program

*





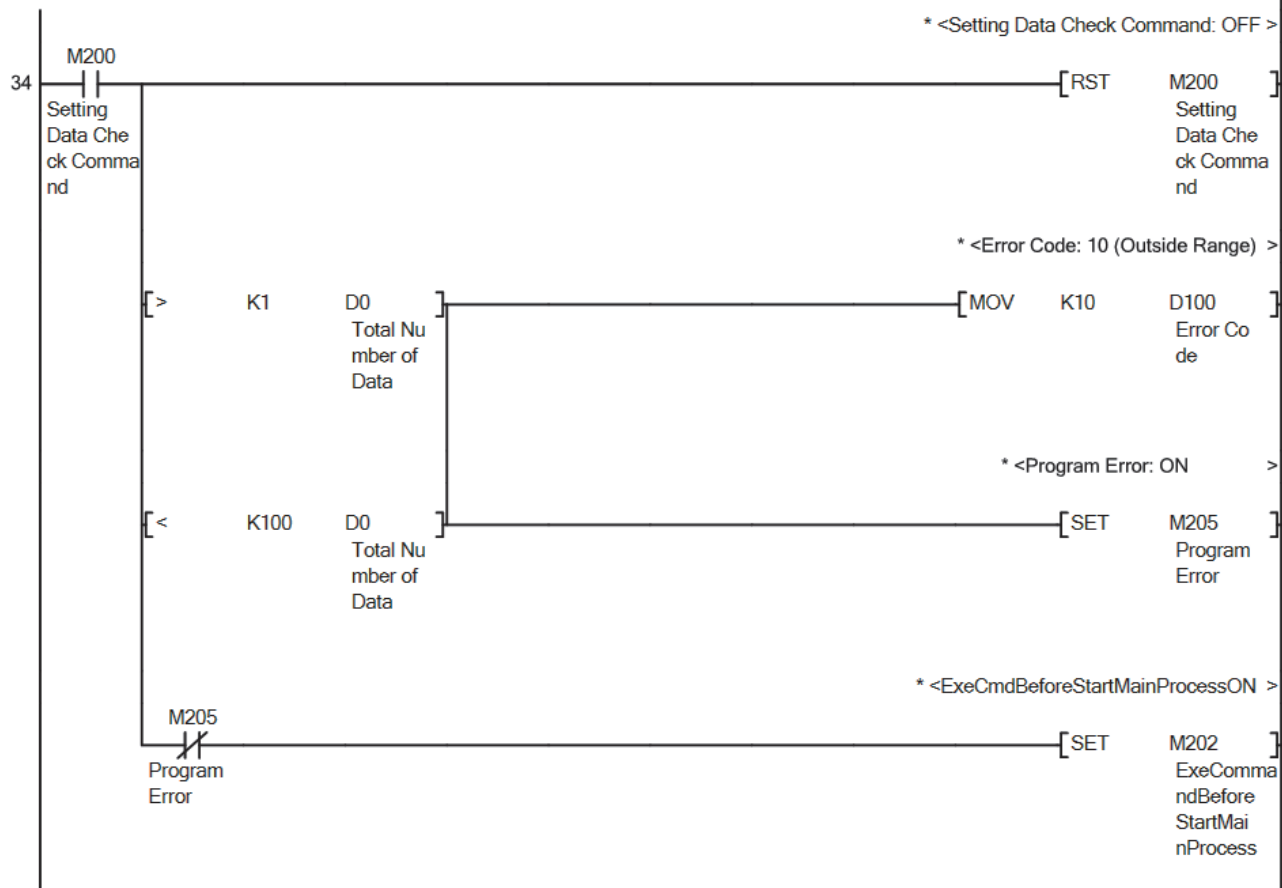
*
 * Process of Executing Program
 *



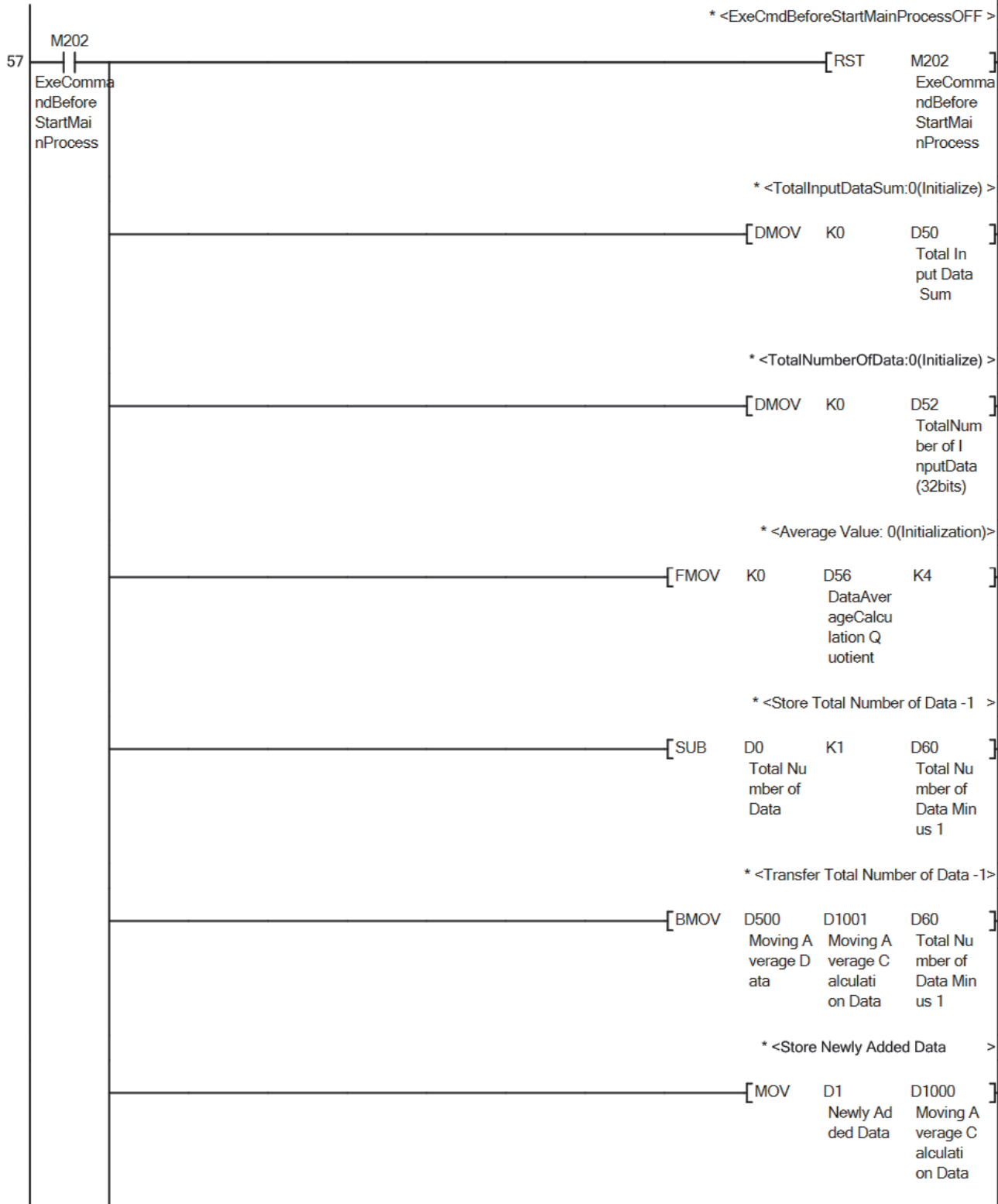
*

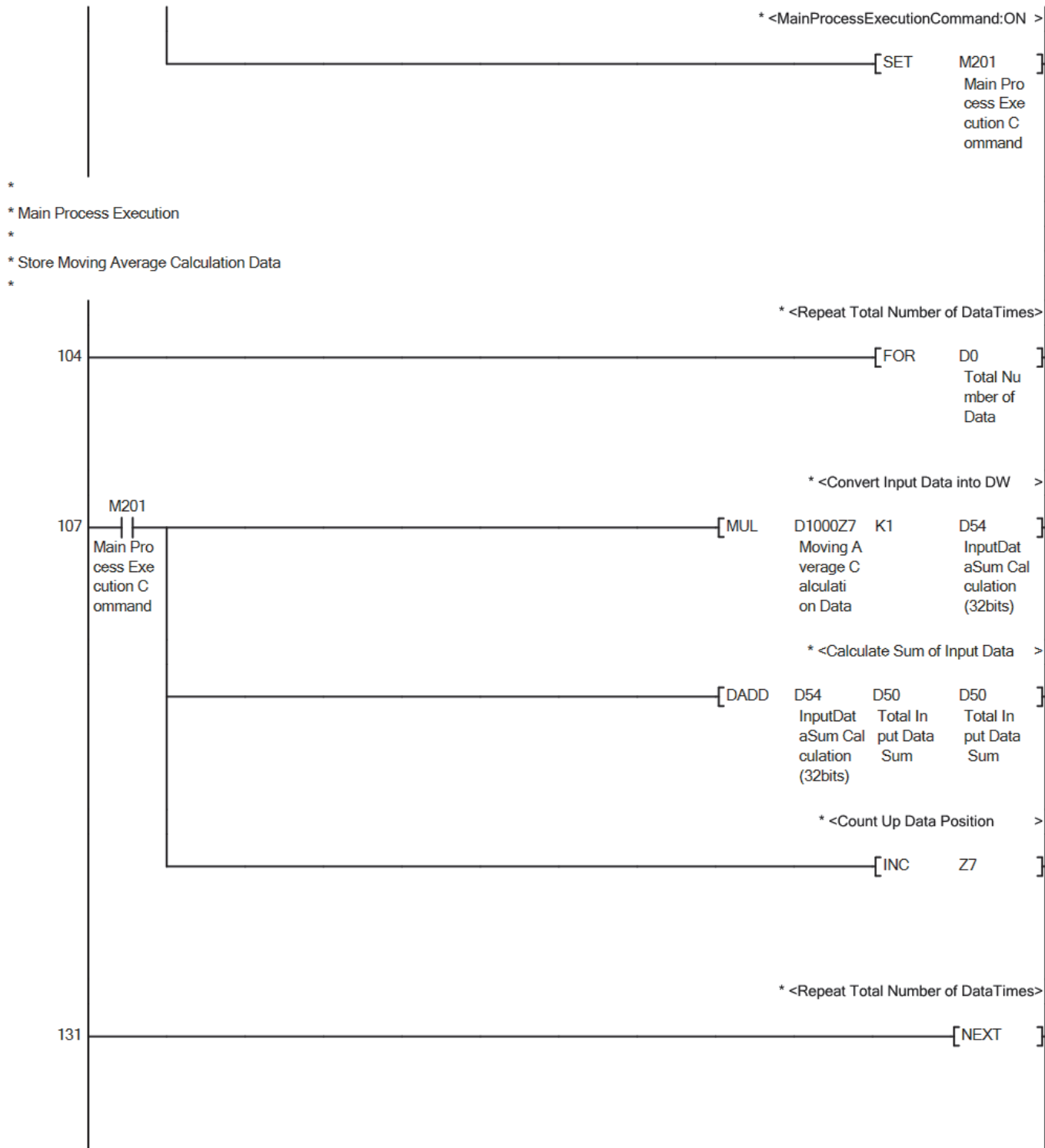
* Process of Checking Preset Data

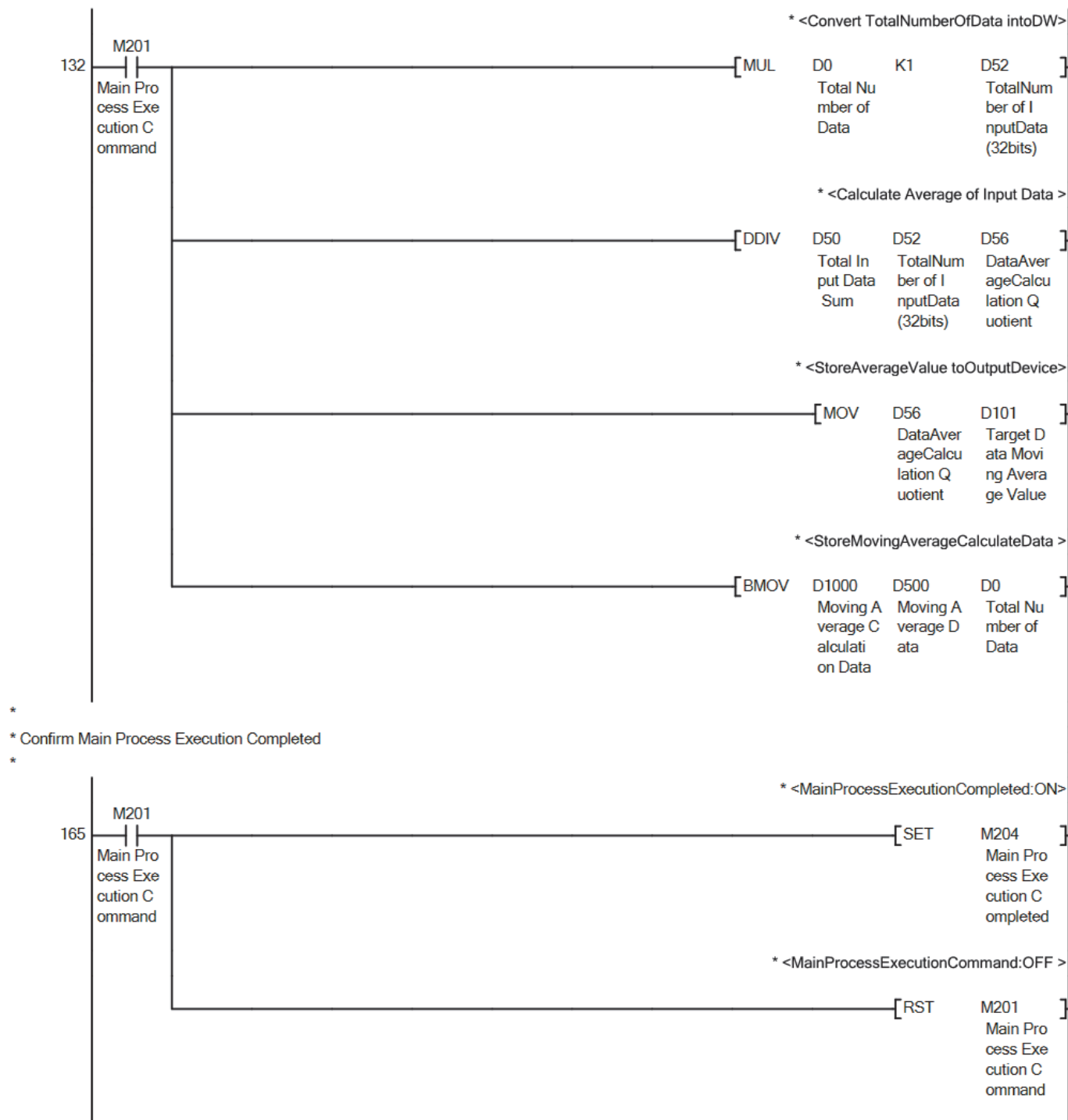
*



*
 * Process Before Starting Main Process
 *



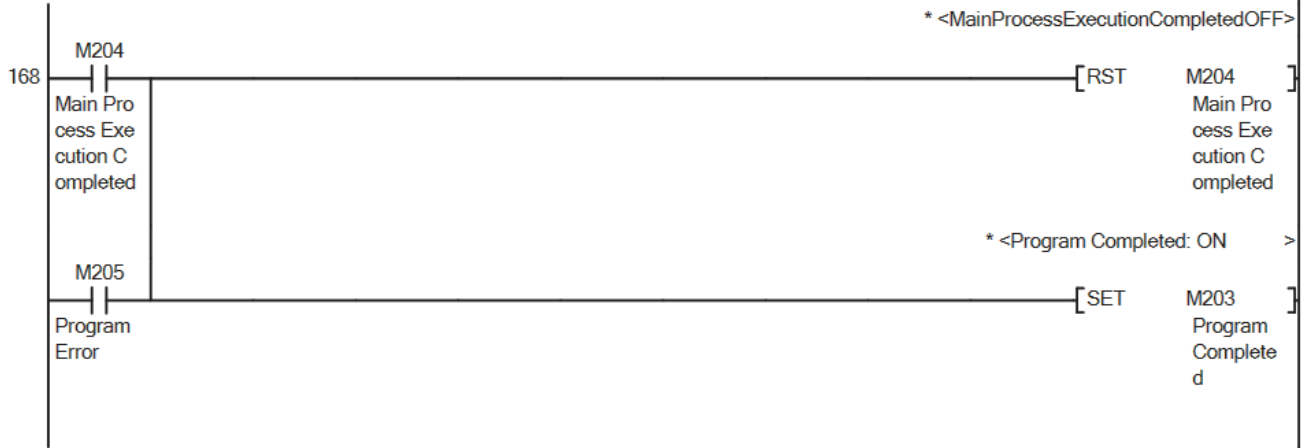




*

* Confirm Program Completion

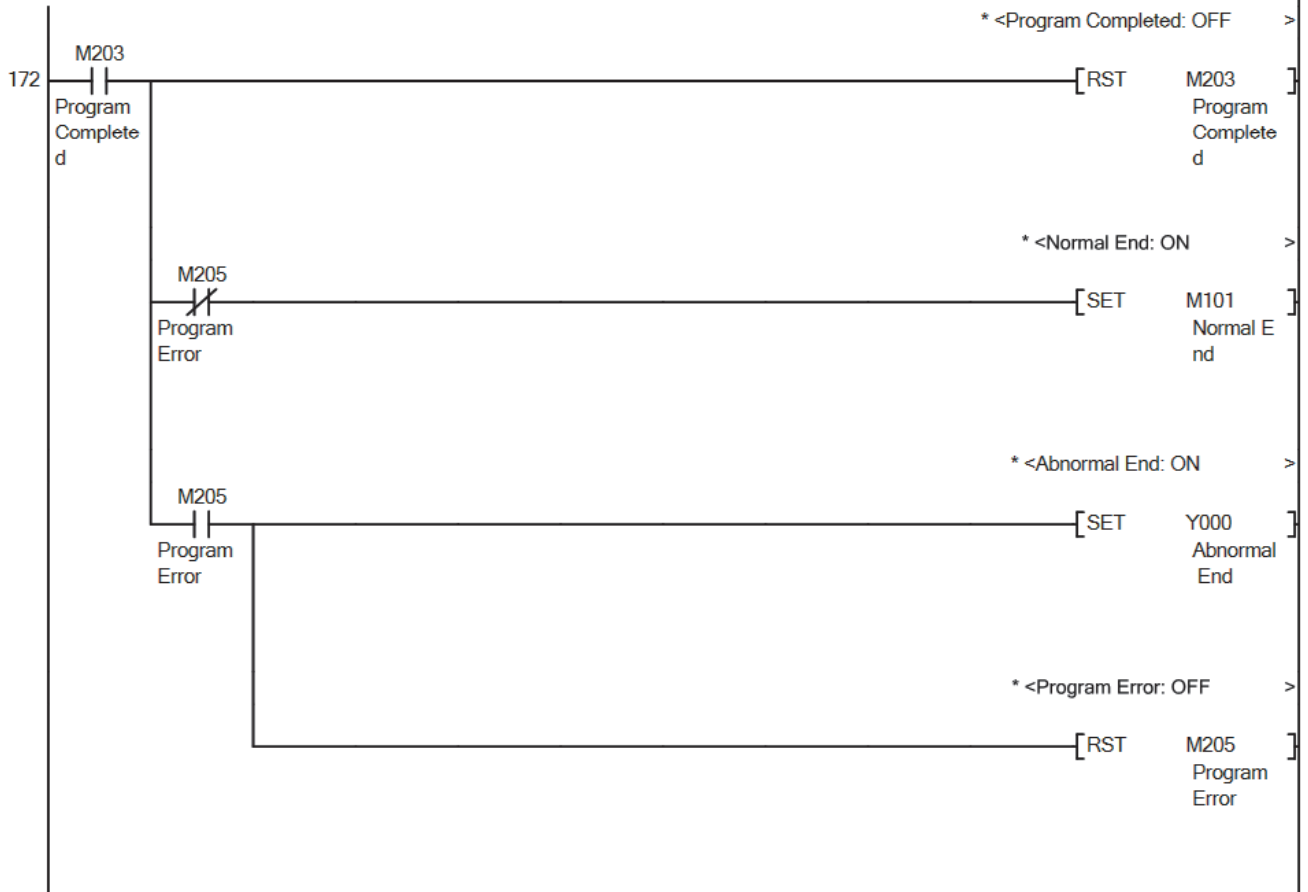
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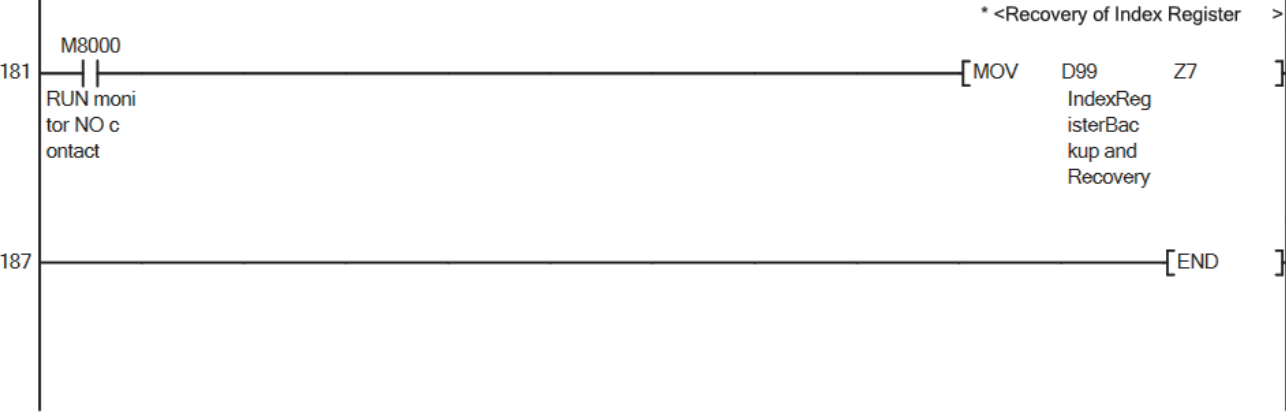
*

* Process of Program Completion

*



*
* Recovery Process of Index Register
*



2. 2. Obtain Standard Deviation of n Data (02_LD-FX3U_CPU_NumCalc_V100A_E)

Outline of System

The standard deviation of "n" data is obtained.

■ Description of functions

- (1) When Execution command (M0) is turned on, the standard deviation (σ) of word (with sign) will be calculated and will be stored to the output devices (D102, D103).
- (2) The range of the total number "n" of the input data should be 1 to 100.
- (3) After Execution command (M0) is turned on, this program will be completed in 1 scan.
- (4) When the total number of data is out of the range, Abnormal end (Y000) turns ON, and the process is halted. The error code is stored in Error code (D100). For the error codes, refer to Error code (D100) in the devices used.

* Supplement: In this sample ladder, the index register is backed up and recovered. However, this processing is not required if it is unnecessary to retain the index register values for any processing other than this sample processing.

Programs Used

This program is intended for FX3S, FX3G, FX3GC, FX3U and FX3UC.

The projects used in this program are indicated below.

No.	Project name	Function name	Remark
1	02_LD-FX3U_CPU_NumCalc_V100A_E	Obtain Standard Deviation of n Data	This project is created with FX3U/FX3UC. When using with a model other than the provided project, change the PLC type using the engineering tool.

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: Program starts. OFF: Program does not start.
2	D0	Word	Input	Total Number of Data	The total number of devices which store the values whose standard deviation is to be calculated is specified. [Effective range] 1 to 100
3	D500 to D599	Word	Input	Input Data	The values whose standard deviation is to be calculated is specified.

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 End	When this device is ON, it indicates that processing has finished.
3	Y000	Bit	Output	Abnormal End	When this device is ON, it indicates that an error has occurred in the program.
4	D100	Word	Output	Error Code	The error codes caused in the program are stored. [Error code (DEC)] 10: The total number of data is out of range.
5	D102 to D103	Single-precision real number	Output	Standard Deviation	The standard deviation value calculated from input data is output as a single-precision real number. Area for two words is used.

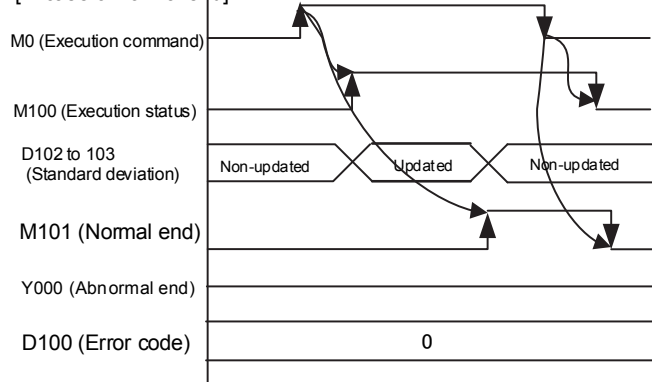
Internal device

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	ExeCommandBeforeStartMainProcesses	The execution command flag before start main process is retained.
4	M203	Bit	Internal	Program Completed	The program completion flag is retained.
5	M204	Bit	Internal	Main Process Execution Completed	The main process execution completion 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	D50 to D51	Double word	Internal	Total Input Data Sum	Used for calculation of the total sum of the input data.
9	D52 to D53	Double word	Internal	TotalNumber of InputData(32bits)	The total number of the input data is retained.
10	D54 to D55	Single-precision real number	Internal	TotalNumber of InputData(Single)	The total number of the input data (single-precision real number) is retained.
11	D56 to D57	Double word	Internal	Square of X/N Division Quotient	The quotient of the division result of square of X/N is retained.
12	D58 to D59	Double word	Internal	Square of X/N Division Remainder	The remainder of the division result of square of X/N is retained.
13	D60 to D61	Single-precision real number	Internal	InputDataArithmeticAverageSingle	The calculation result of the input data average (single-precision real number) is retained.
14	D62 to D63	Double word	Internal	InputDataSum Calculation(32bits)	The input data used for calculation of the sum of the input data is retained.
15	D64 to D65	Double word	Internal	Sum of Quotient	The sum of quotient of the division result of square of X/N is retained.
16	D66 to D67	Double word	Internal	Sum of Remainder	The sum of remainder of the division result of square of X/N is retained.
17	D68 to D69	Single-precision real number	Internal	Sum of Quotient (Single)	The sum of quotient (single-precision real number) is retained.
18	D70 to D71	Single-precision real number	Internal	Sum of Remainder (Single)	The sum of remainder (single-precision real number) is retained.
19	D72 to D73	Single-precision real number	Internal	Variance Value (Single)	The variance value (single-precision real number) is retained.
20	D74 to D75	Double word	Internal	Square of Input Data	The square of the input data used for calculation is retained.
21	D76 to D77	Single-precision real number	Internal	SquareofArithmeticAverageSingle	The square of the average value (single-precision real number) used for calculation is retained.
22	D78 to D79	Single-precision real number	Internal	Total Input Data Sum (Single)	The total sum of the input data (single-precision real number) used for calculation is retained.
23	D99	Word	Internal	IndexRegisterBackup and Recovery	Used for index register save.

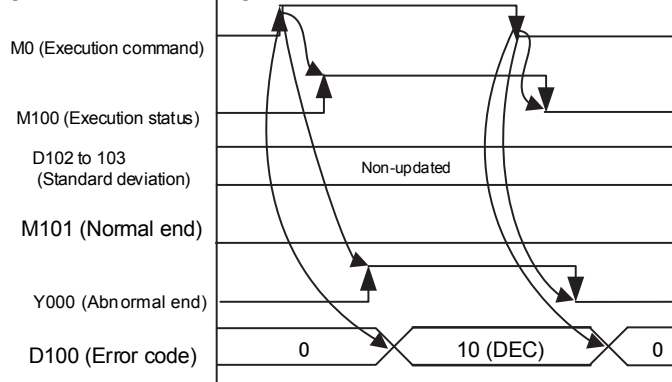
Operation of I/O signals

■ The timing chart for this program is shown below.

[In case of normal end]



[In case of abnormal end]



■ The processes of this program are given below.

The standard deviation value calculated from input data for the number of data is output as a single-precision real number.

The standard deviation σ should be obtained as follows:

When “n” input data is X_1, X_2, \dots, X_n , these arithmetic average can be determined by the following formula.

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n X_i$$

The variance can be obtained by using average as shown below.

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

The positive square root of this variance should be the standard deviation σ .

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

An output example when data of 5 words is set to the input data (D500) is shown below.

Set 5 to the total number of data (D0).

Input data

Input data (D500)		Total number of data (D0)
Device name	Value (Example)	
D500	2	5
D501	4	
D502	6	
D503	8	
D504	10	

Output data

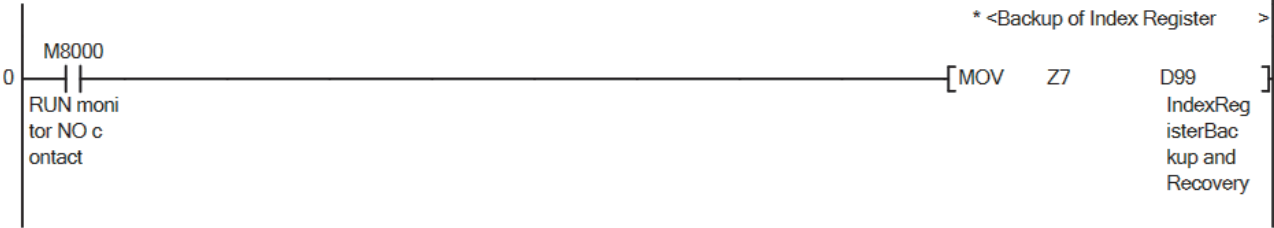
Standard deviation (D102, D103)
2.8284271

Version upgrade history

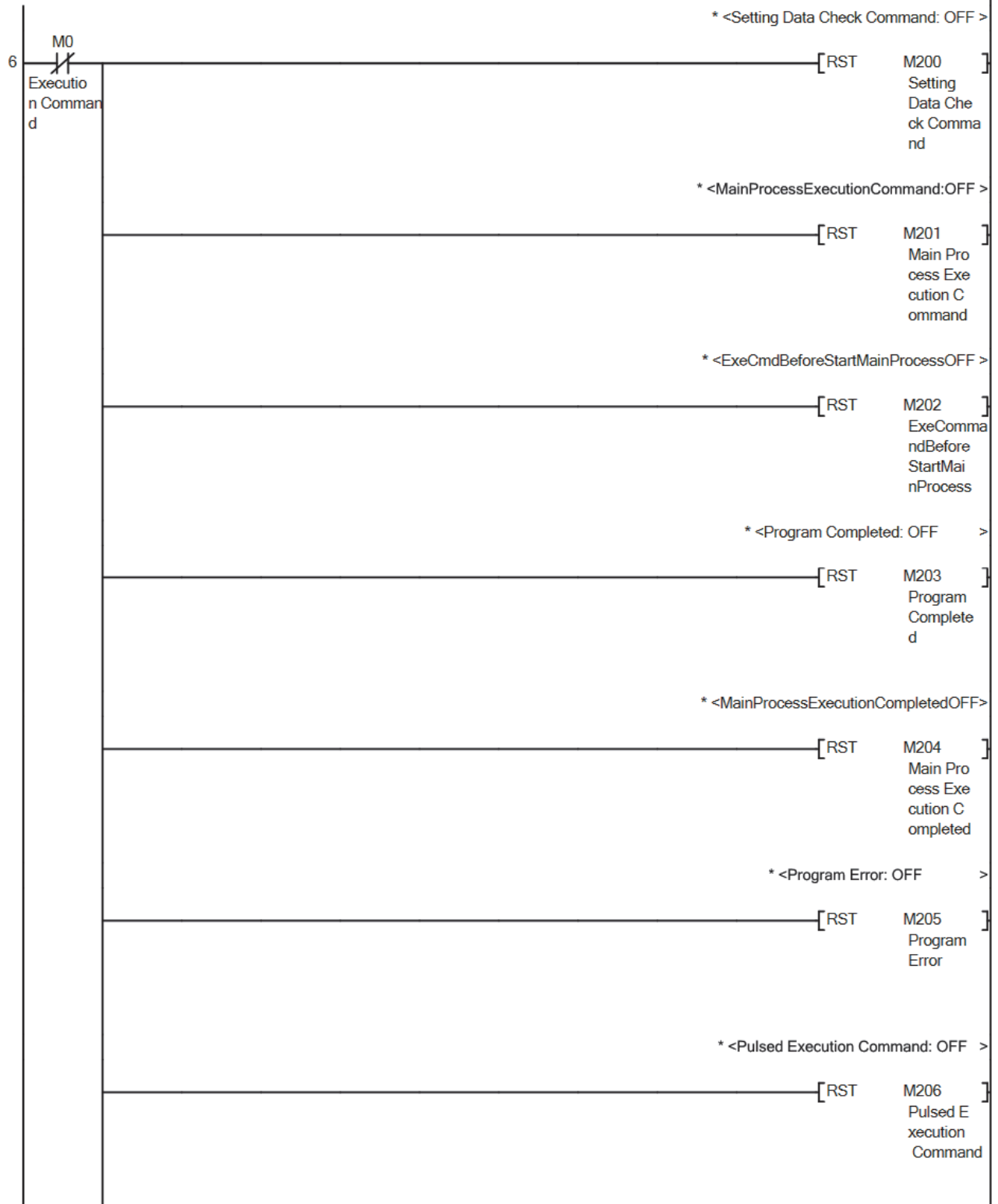
Version	Date	Description
Ver. 1.00A	June, 2017	First Edition

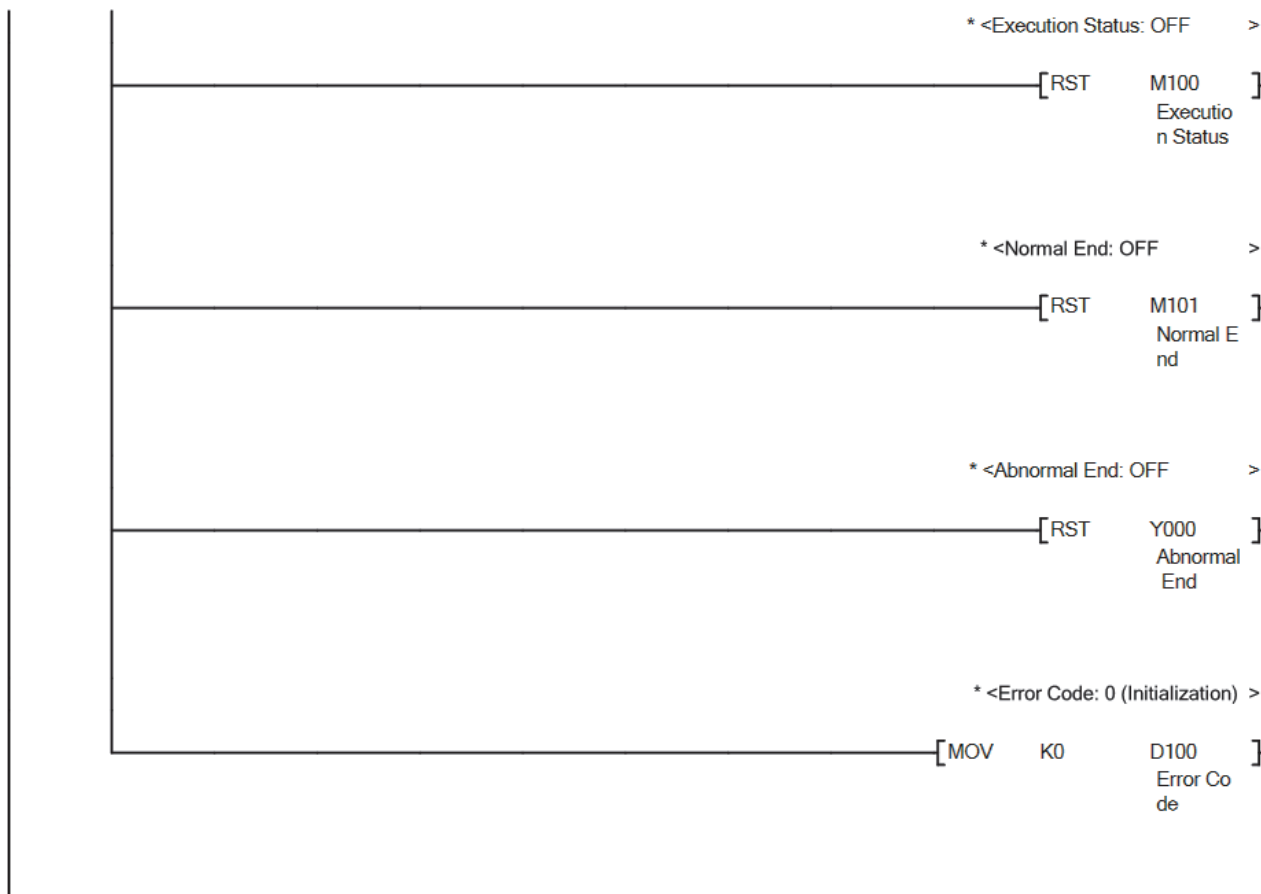
Program

* Sample Ladder Name: 02_LD-FX3U_CPU_NumCalc_V100A_E
* Function: Obtain Standard Deviation of n Data
* Version: Ver.1.00A
*
* Backup Process of Index Register
*



*
 * Process of Initializing Program
 *





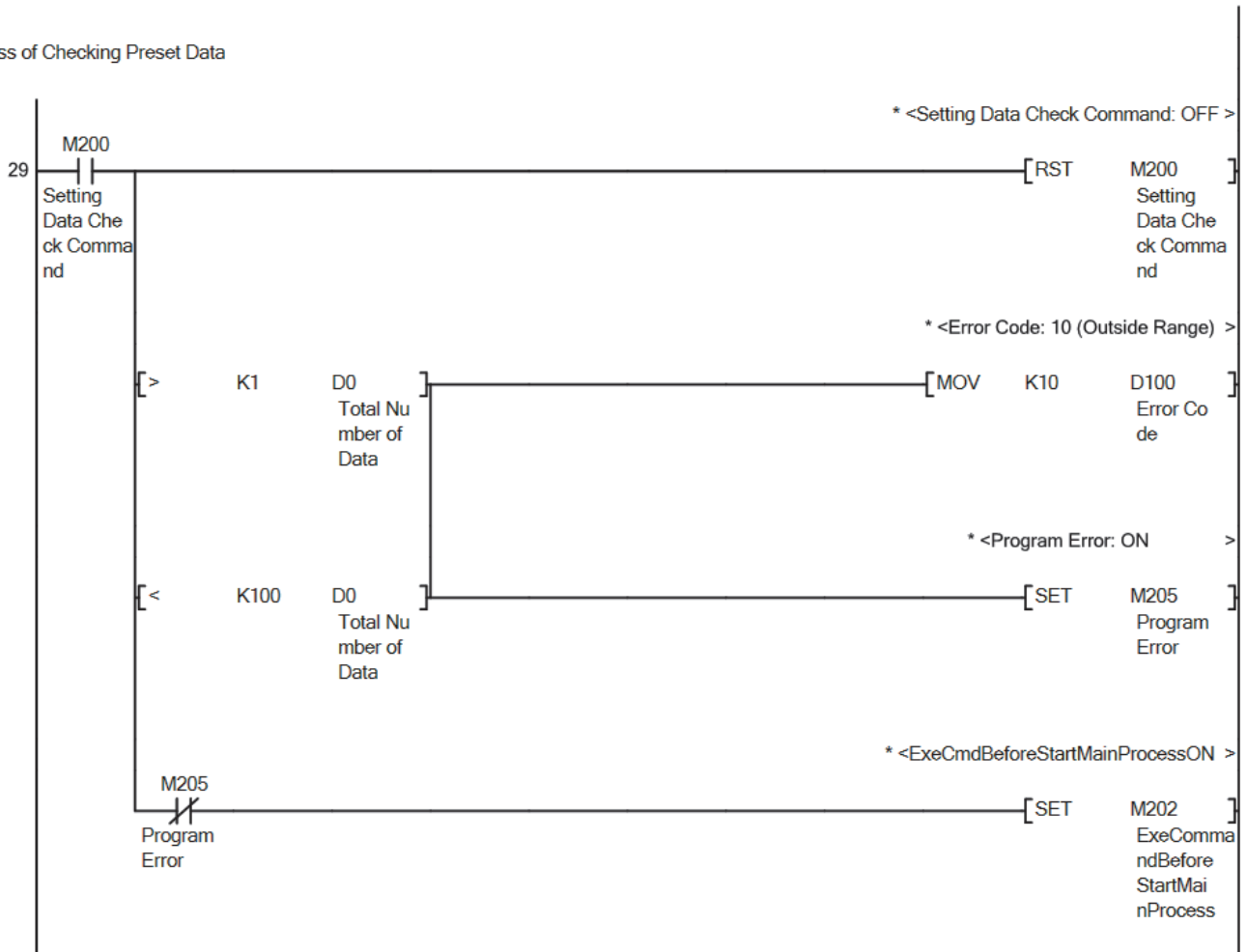
*
 * Process of Executing Program
 *

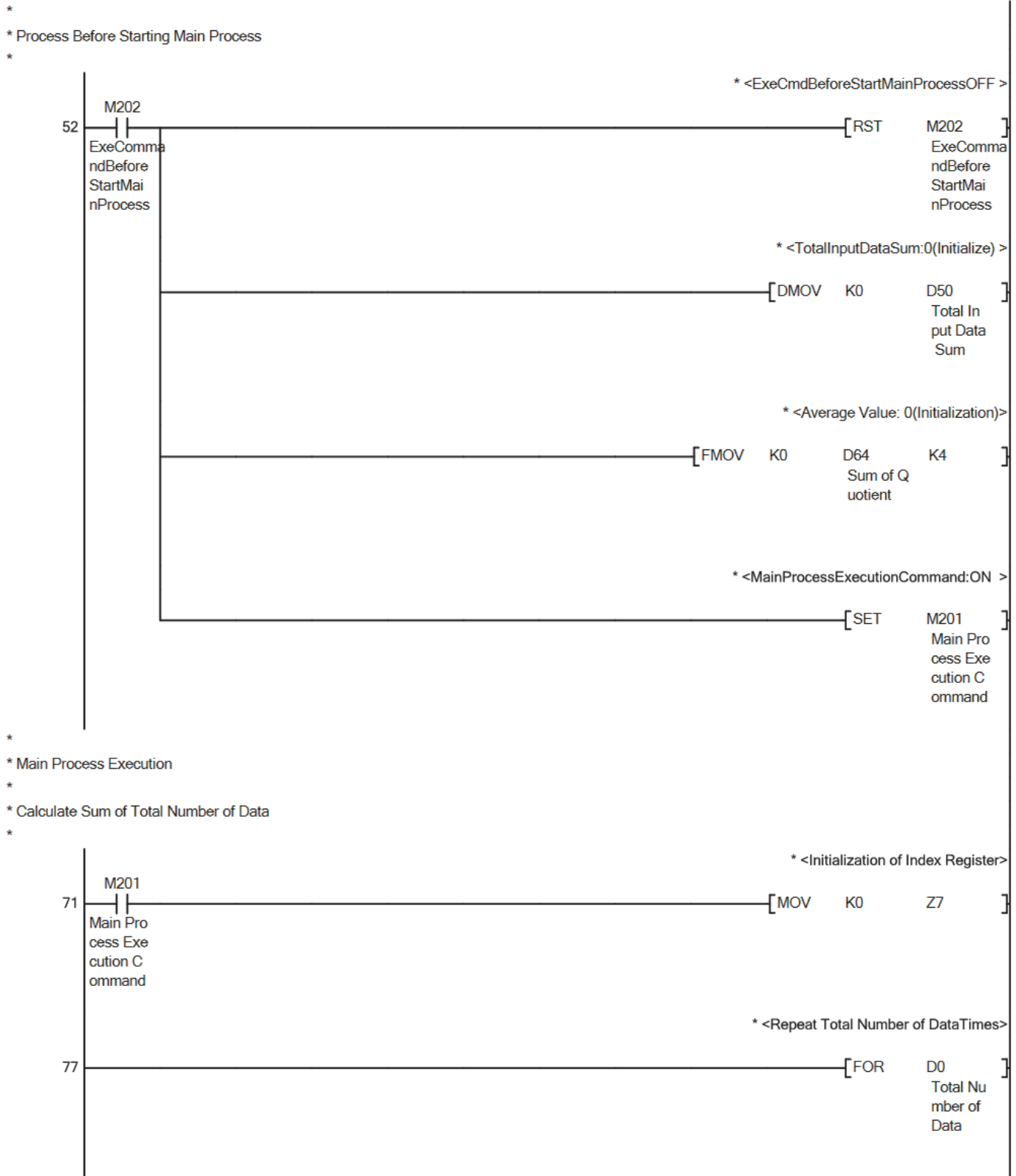


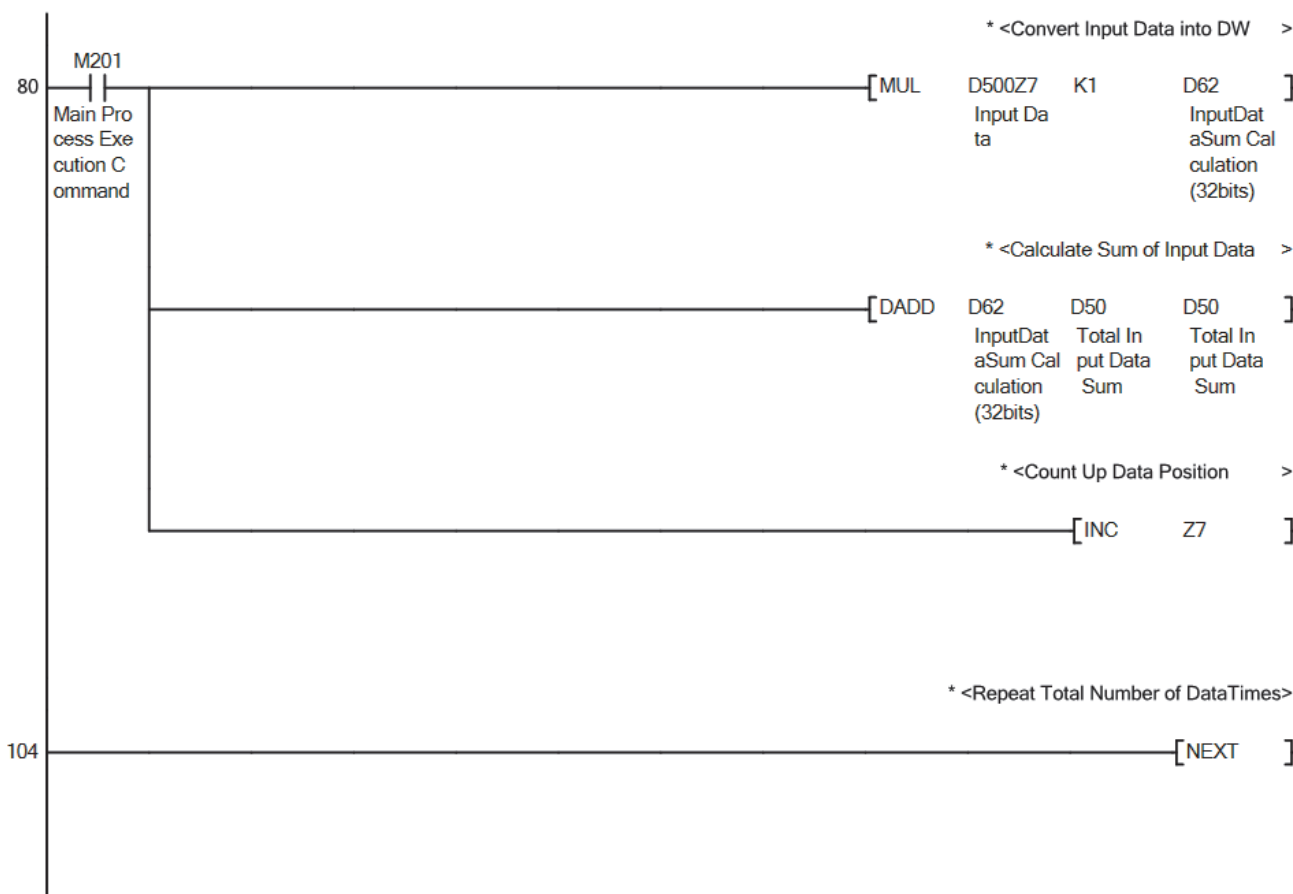
*

* Process of Checking Preset Data

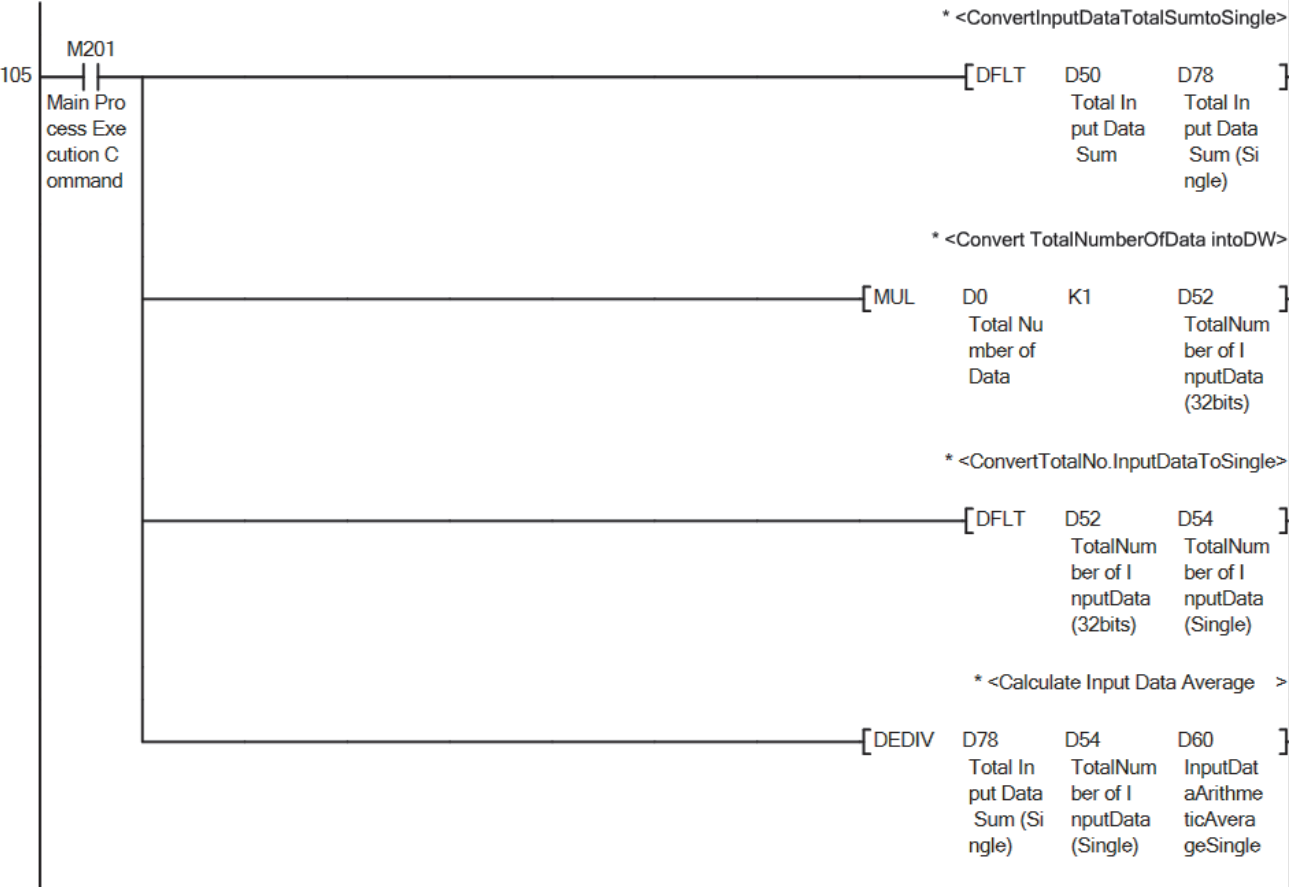
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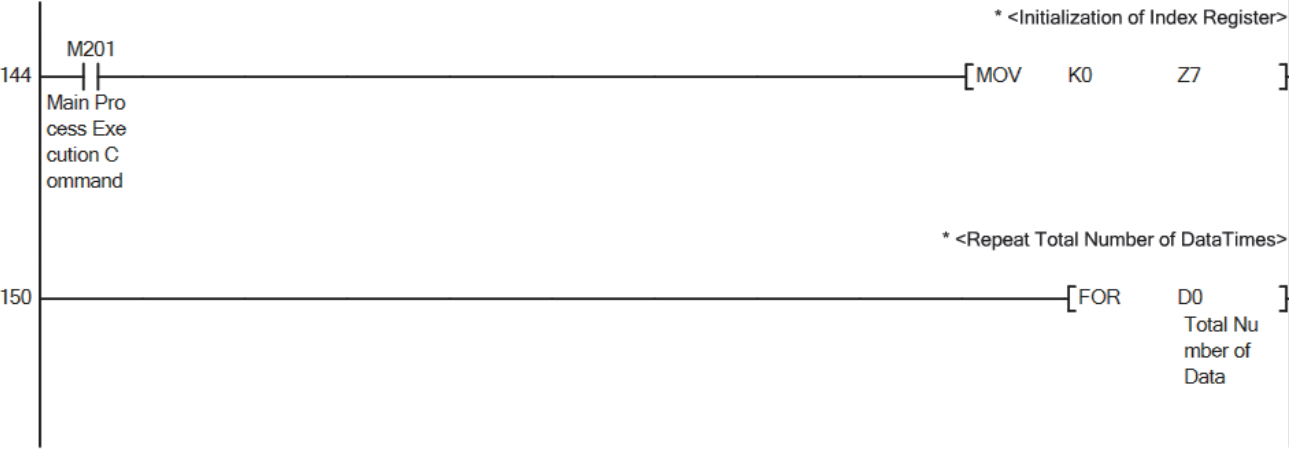


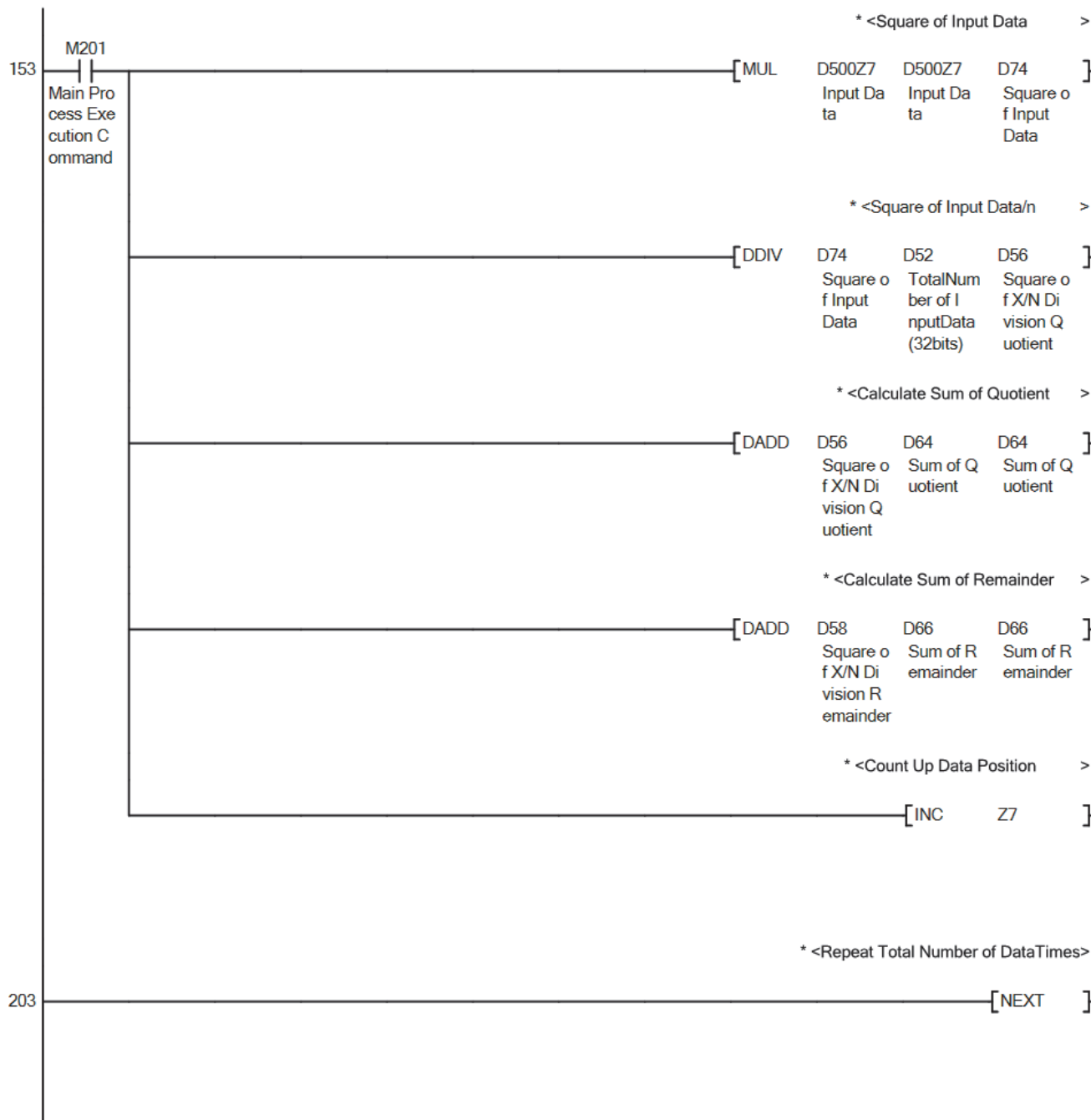


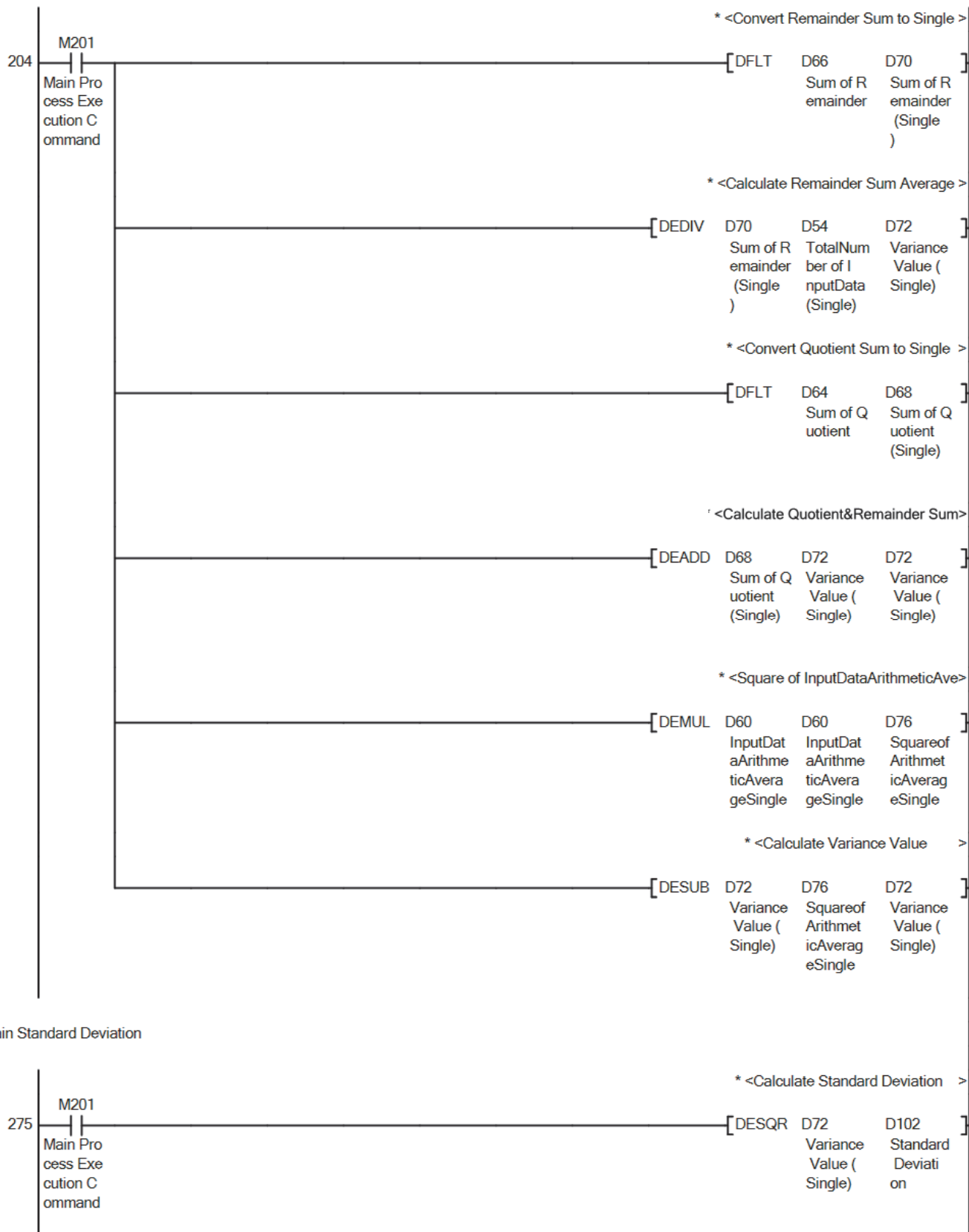
*
* Obtain Arithmetic Average of Input Data
*

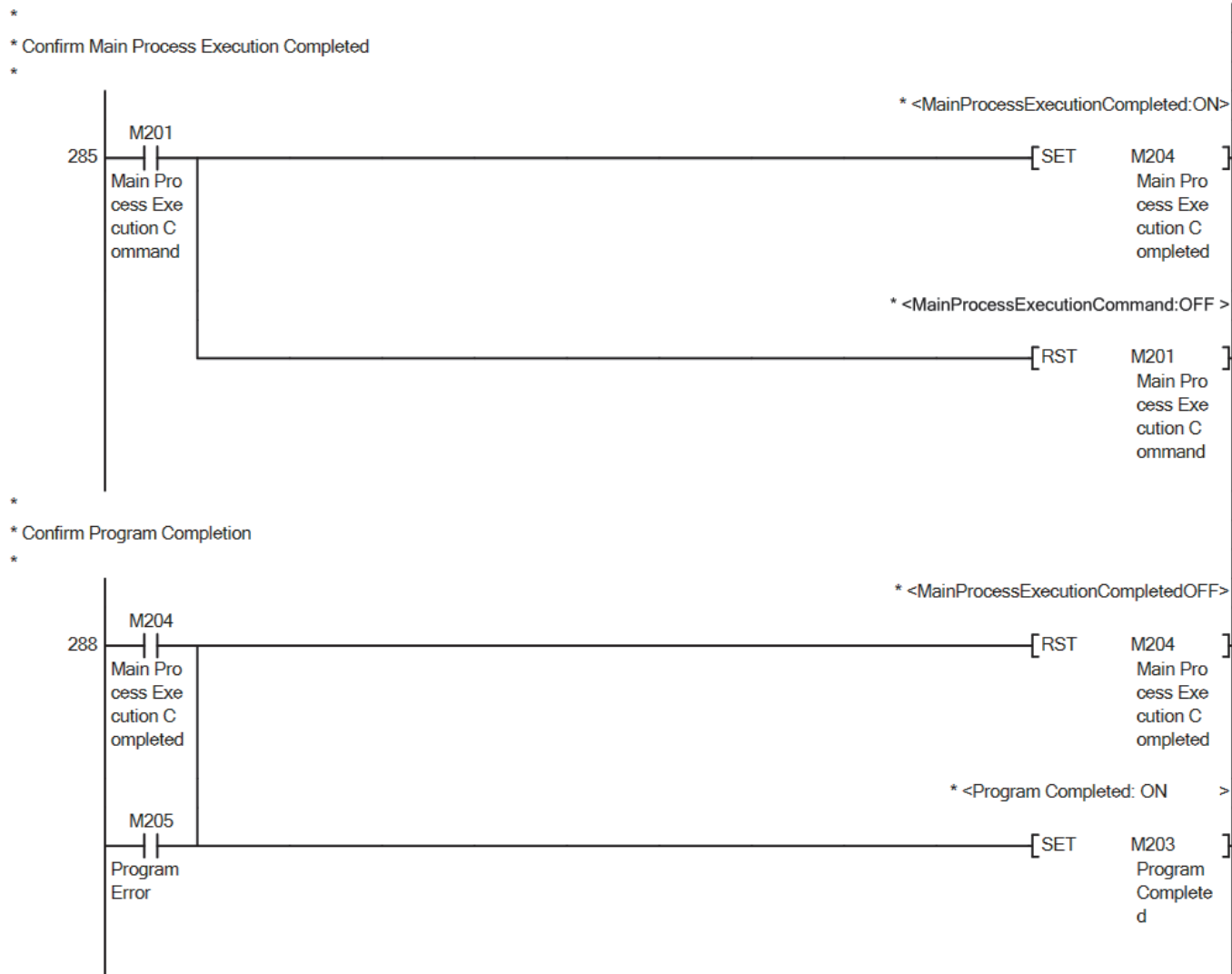


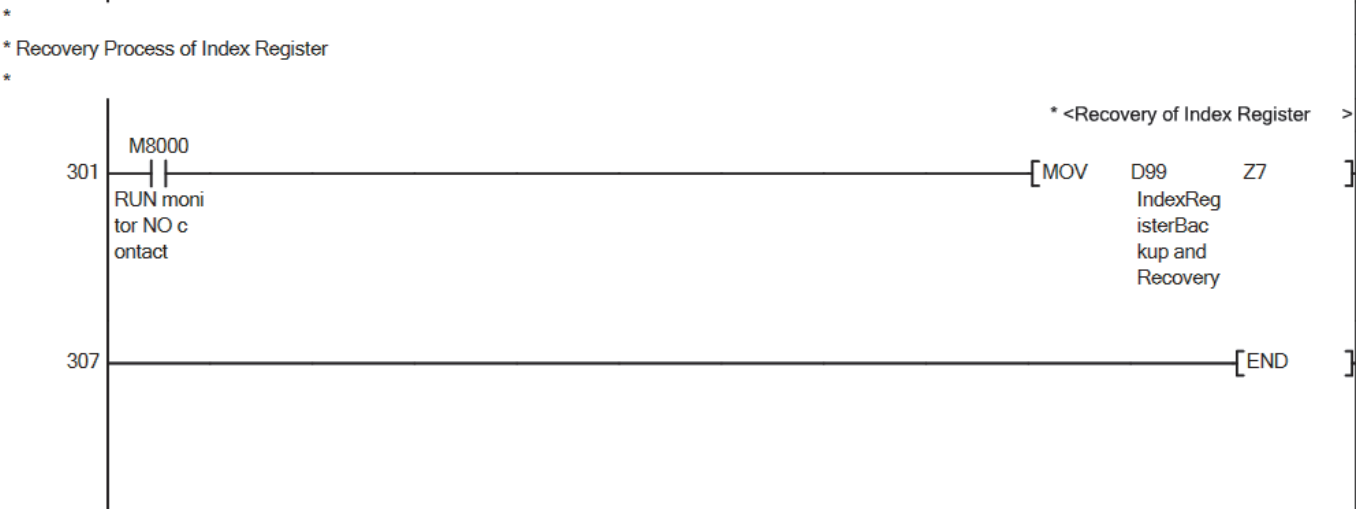
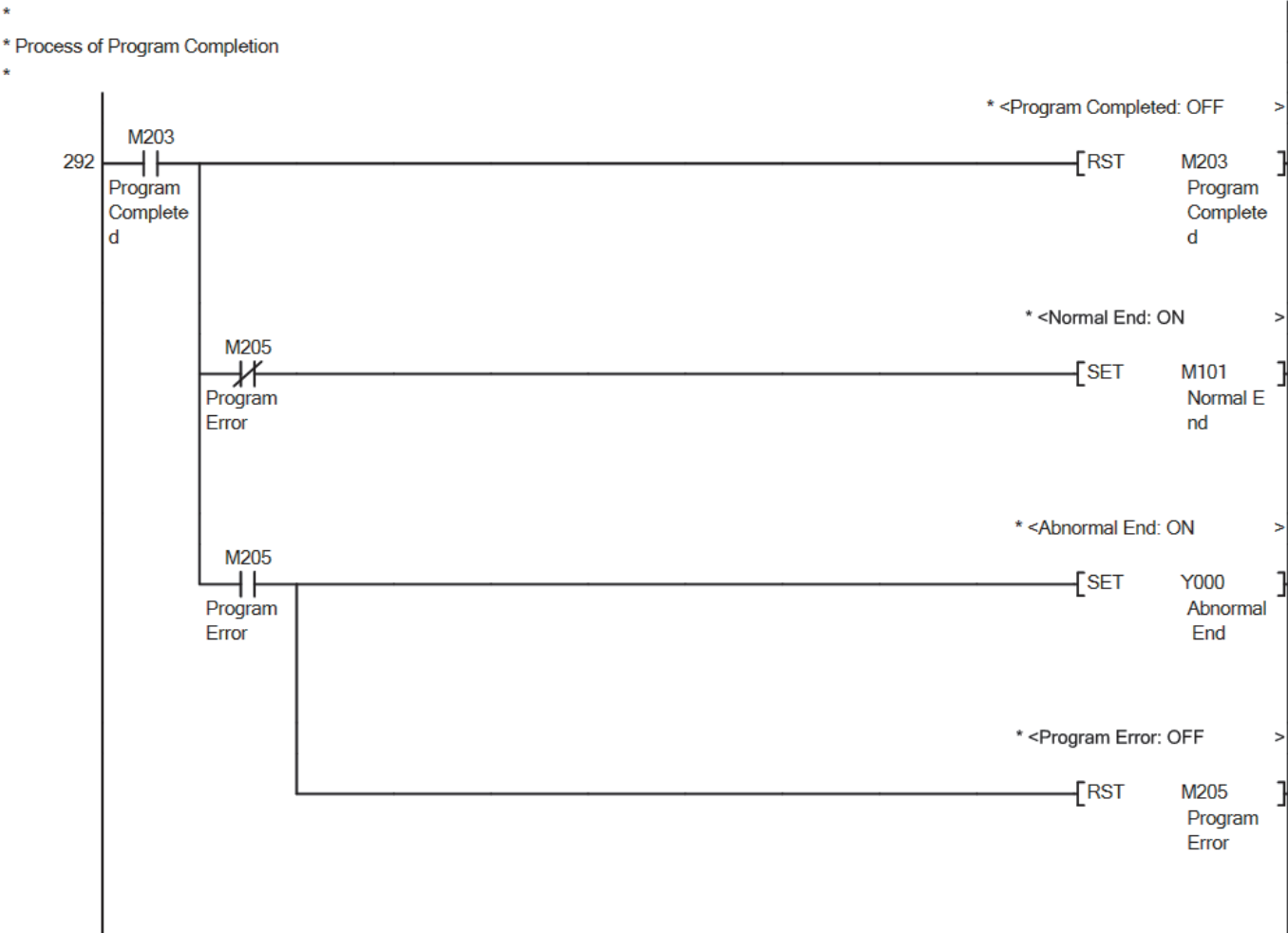
*
* Obtain Variance Value
*











2. 3. Obtain 3Sigma of n Data (03_LD-FX3U_CPU_NumCalc_V100A_E)

Outline of System

The 3σ of "n" data is obtained.

■ Description of functions

- (1) When Execution command (M0) is turned on, the standard deviation (σ) of word (with sign) will be calculated and the 3σ will be stored to the output devices (D102, D103).
- (2) The range of the total number "n" of the input data should be 1 to 100.
- (3) After Execution command (M0) is turned on, this program will be completed in 1 scan.
- (4) When the total number of data is out of the range, Abnormal end (Y000) turns ON, and the process is halted. The error code is stored in Error code (D100). For the error codes, refer to Error code (D100) in the devices used.

* Supplement: In this sample ladder, the index register is saved and restored. However, this processing is not required if it is unnecessary to retain the index register values for any processing other than this sample processing.

Programs Used

This program is targeted for FX3S, FX3G, FX3GC, FX3U and FX3UC.

The projects used in this program are indicated below.

No.	Project name	Function name	Remark
1	03_LD-FX3U_CPU_NumCalc_V100A_E	Obtain 3Sigma of n Data	This project is created with FX3U/FX3UC. When using with a model other than the provided project, change the PLC type using the engineering tool.

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: Program starts. OFF: Program does not start.
2	D0	Word	Input	Total Number of Data	The total number of devices which store the values whose 3σ is to be calculated is specified. [Effective range] 1 to 100
3	D500 to D599	Word	Input	Input Data	The values whose 3σ is to be calculated is specified.

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 End	When this device is ON, it indicates that processing has finished.
3	Y000	Bit	Output	Abnormal End	When this device is ON, it indicates that an error has occurred in the program.
4	D100	Word	Output	Error Code	The error codes caused in the program are stored. [Error code (DEC)] 10: The total number of data is out of range.
5	D102 to D103	Single-precision real number	Output	3Sigma	The value of the 3σ calculated from input data is output as a single-precision real number. Area for two words is used.

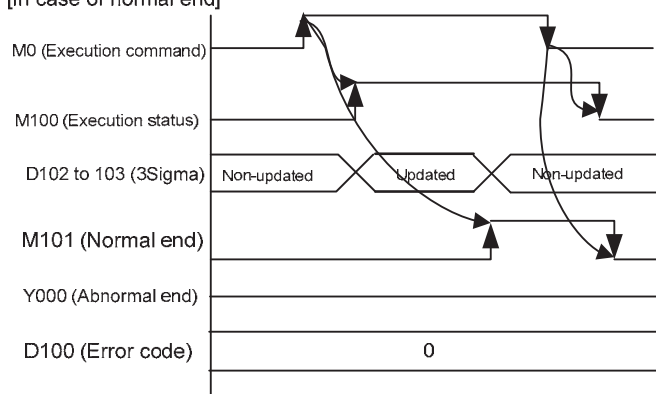
Internal device

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	ExeCommandBeforeStartMainProcesses	The execution command flag before start main process is retained.
4	M203	Bit	Internal	Program Completed	The program completion flag is retained.
5	M204	Bit	Internal	Main Process Execution Completed	The main process execution completion 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	D50 to D51	Double word	Internal	Total Input Data Sum	Used for calculation of the total sum of the input data.
9	D52 to D53	Double word	Internal	TotalNumber of InputData(32bits)	The total number of the input data is retained.
10	D54 to D55	Single-precision real number	Internal	TotalNumber of InputData(Single)	The total number of the input data (single-precision real number) is retained.
11	D56 to D57	Double word	Internal	Square of X/N Division Quotient	The quotient of the division result of square of X/N is retained.
12	D58 to D59	Double word	Internal	Square of X/N Division Remainder	The remainder of the division result of square of X/N is retained.
13	D60 to D61	Single-precision real number	Internal	InputDataArithmeticAverageSingle	The calculation result of the input data average (single-precision real number) is retained.
14	D62 to D63	Double word	Internal	InputDataSum Calculation(32bits)	The input data used for calculation of the sum of the input data is retained.
15	D64 to D65	Double word	Internal	Sum of Quotient	The sum of quotient of the division result of square of X/N is retained.
16	D66 to D67	Double word	Internal	Sum of Remainder	The sum of remainder of the division result of square of X/N is retained.
17	D68 to D69	Single-precision real number	Internal	Sum of Quotient (Single)	The sum of quotient (single-precision real number) is retained.
18	D70 to D71	Single-precision real number	Internal	Sum of Remainder (Single)	The sum of remainder (single-precision real number) is retained.
19	D72 to D73	Single-precision real number	Internal	Variance Value (Single)	The variance value (single-precision real number) is retained.
20	D74 to D75	Double word	Internal	Square of Input Data	The square of the input data used for calculation is retained.
21	D76 to D77	Single-precision real number	Internal	SquareofArithmeticAverageSingle	The square of the average value (single-precision real number) used for calculation is retained.
22	D78 to D79	Single-precision real number	Internal	Total Input Data Sum (Single)	The total sum of the input data (single-precision real number) used for calculation is retained.
23	D80 to D81	Single-precision real number	Internal	Standard Deviation (Single)	The standard deviation (single-precision real number) calculated from input data is retained.
24	D99	Word	Internal	IndexRegisterBackup and Recovery	Used for index register save.

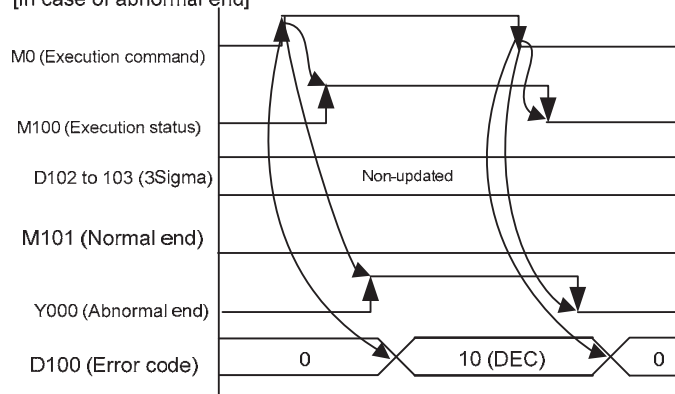
Operation of I/O signals

- The timing chart for this program is shown below.

[In case of normal end]



[In case of abnormal end]



- The processes of this program are given below.

The standard deviation value is calculated from input data for the number of data and the value multiplied by 3 is output as a single-precision real number.

To obtain standard deviation σ , refer to 2.2. Obtain the standard deviation of "n" data. (02_LD-FX3U_CPU_NumCalc_V100A_E)

An output example when data of 5 words is set to the input data (D500) is shown below.

Set 5 to the total number of data (D0).

Input data

Input data (D500)		Total number of data (D0)
Device name	Value (Example)	
D500	2	5
D501	4	
D502	6	
D503	8	
D504	10	

Output data

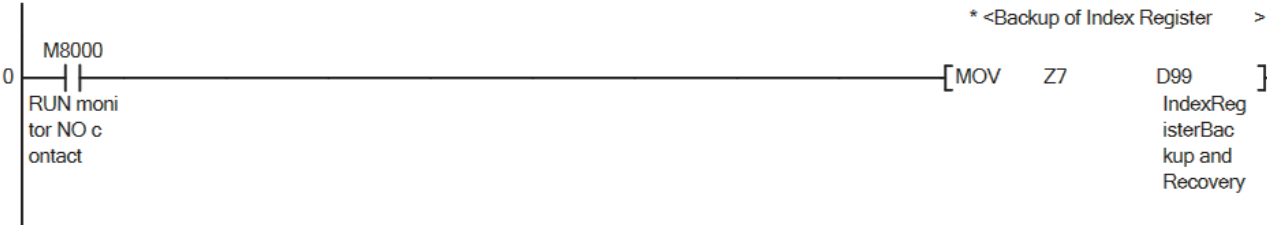
3 σ (D102, D103)
8.485281

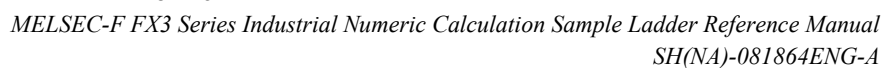
Version upgrade history

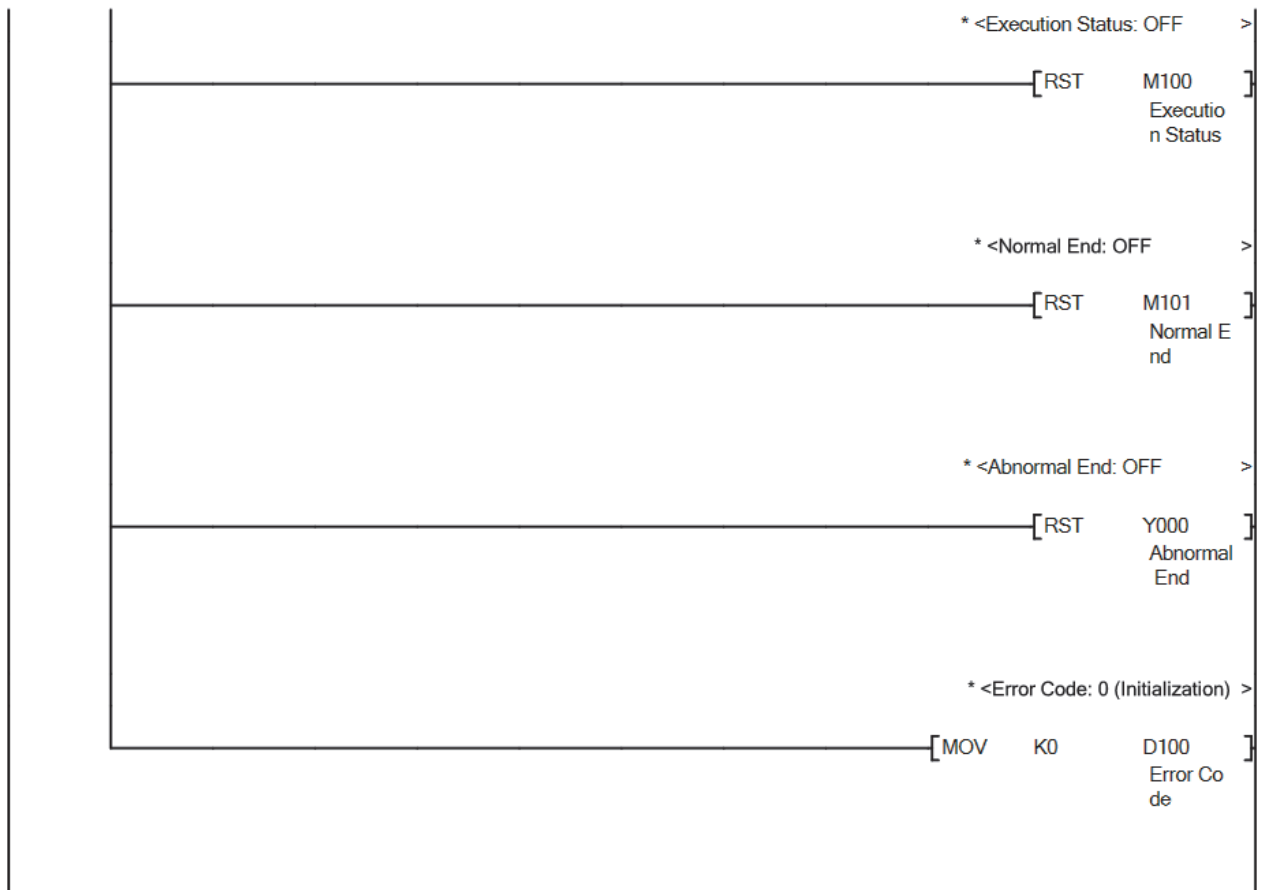
Version	Date	Description
Ver. 1.00A	June, 2017	First Edition

Program

* Sample Ladder Name: 03_LD-FX3U_CPU_NumCalc_V100A_E
* Function: Obtain 3Sigma of n Data
* Version: Ver.1.00A
*
* Backup Process of Index Register
*







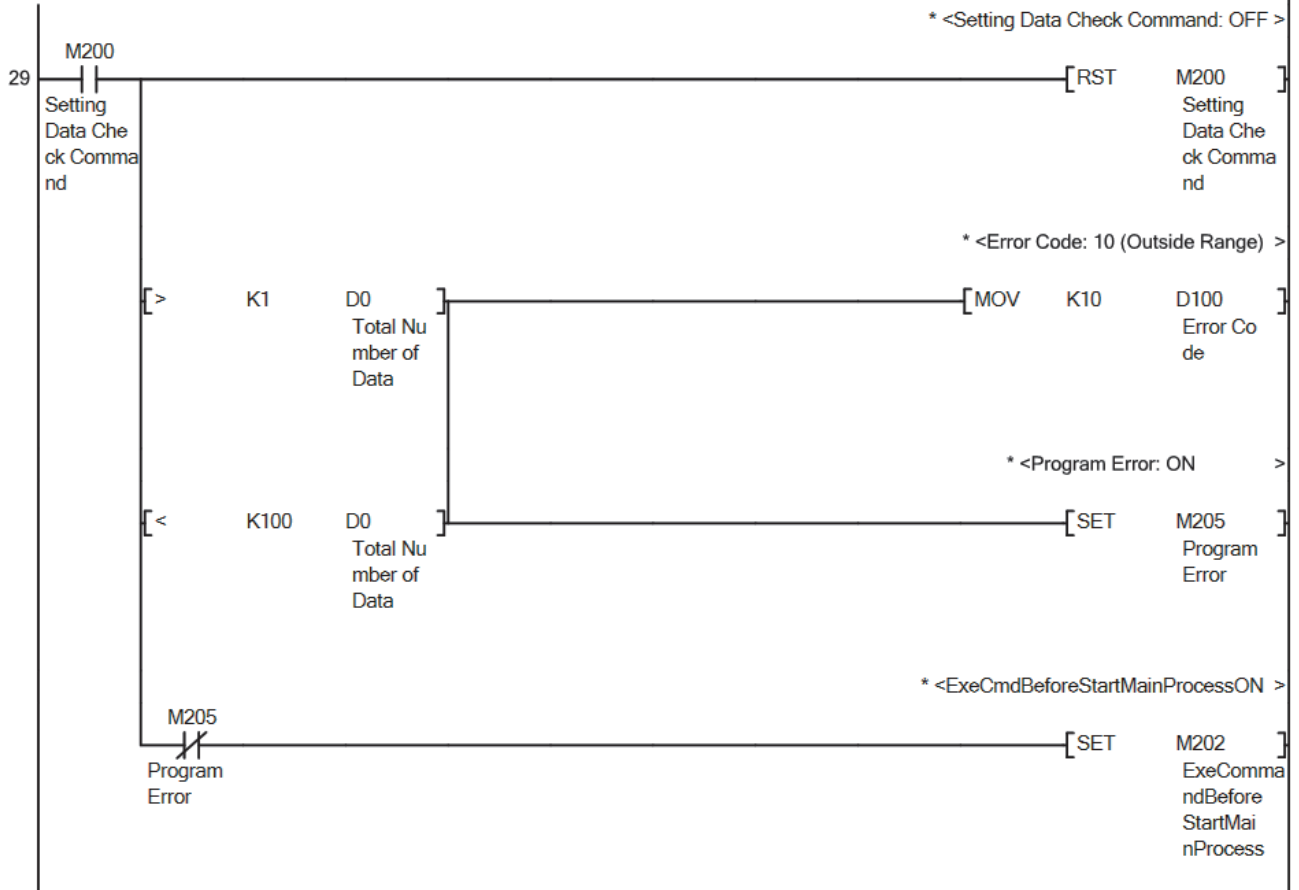
*
 * Process of Executing Program
 *

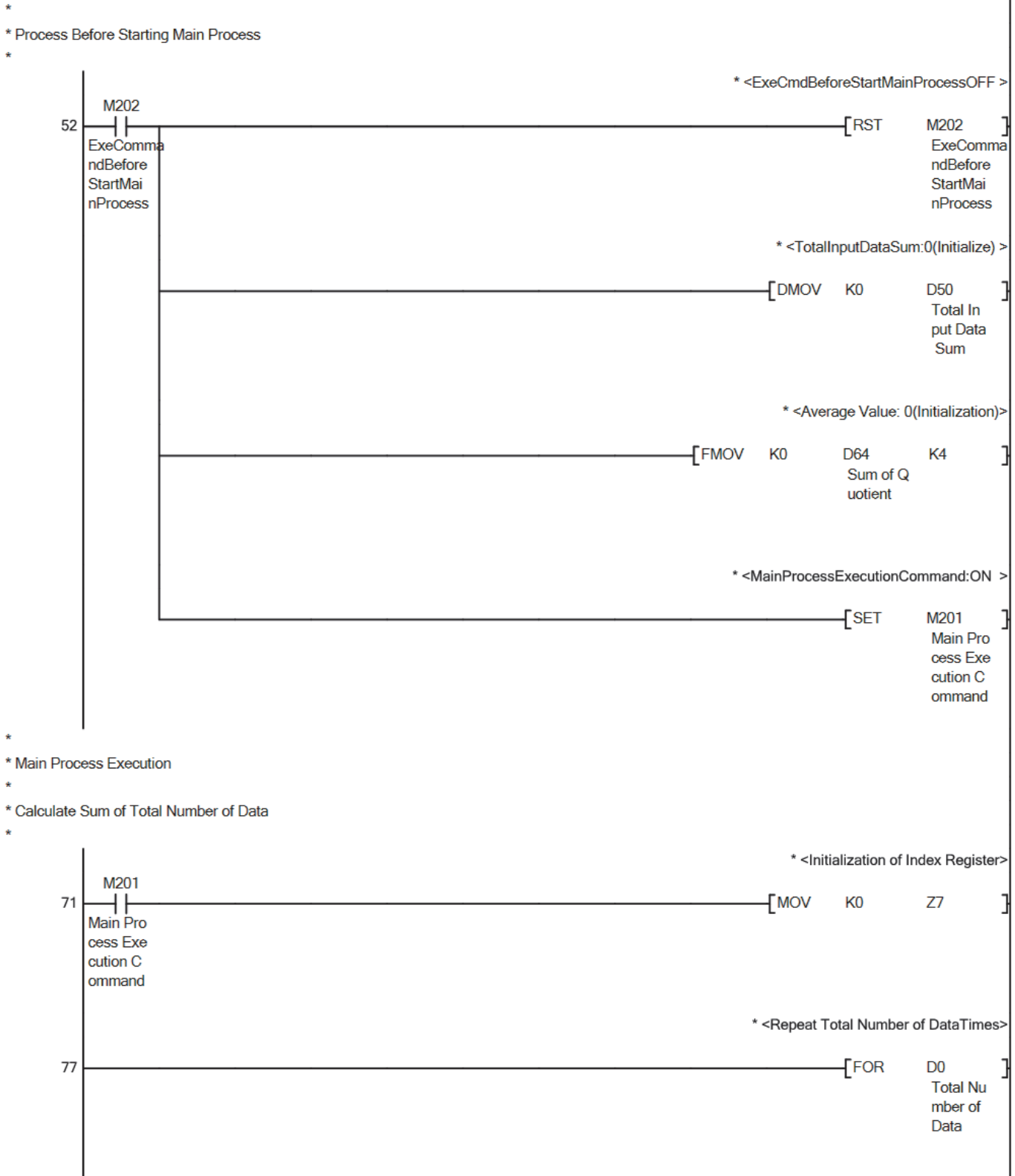


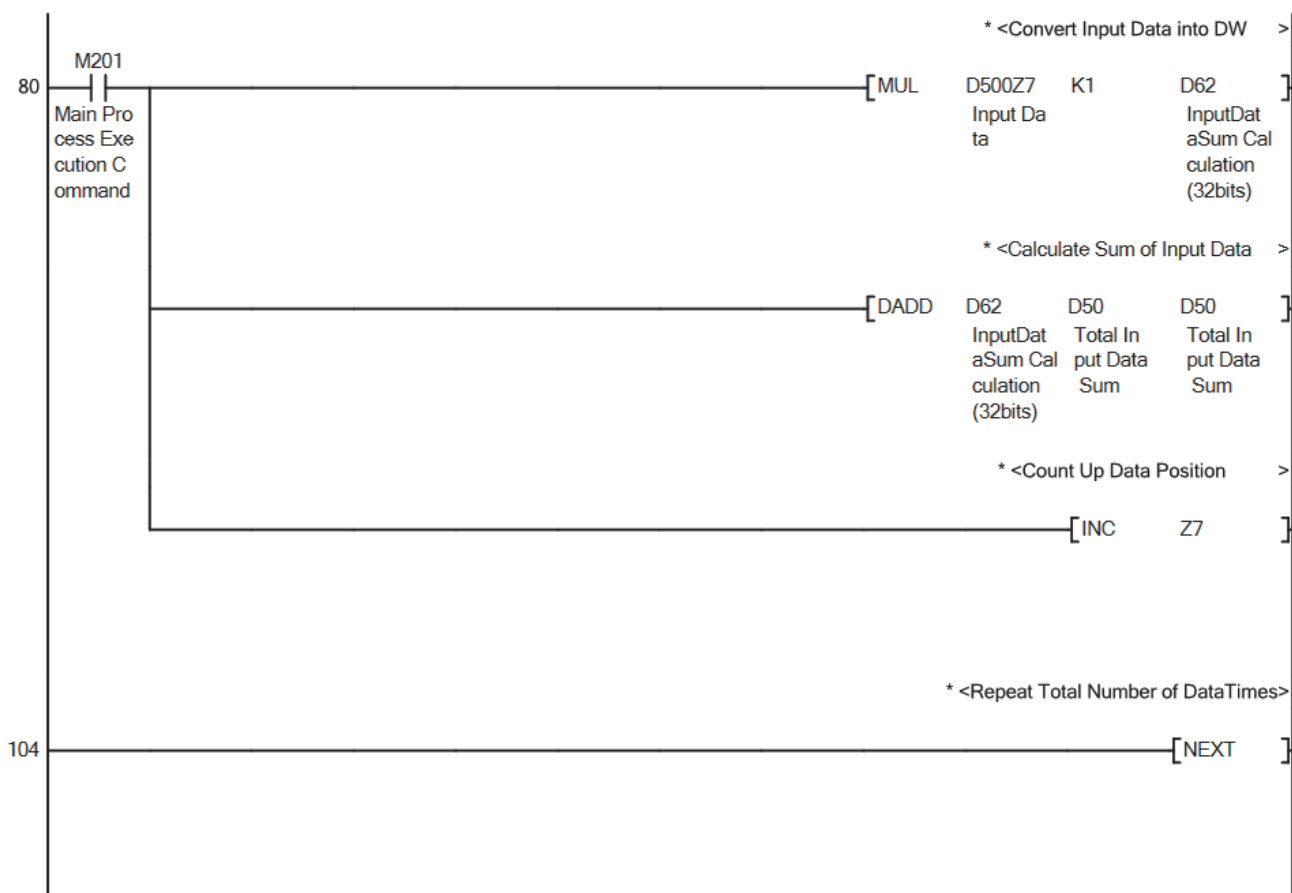
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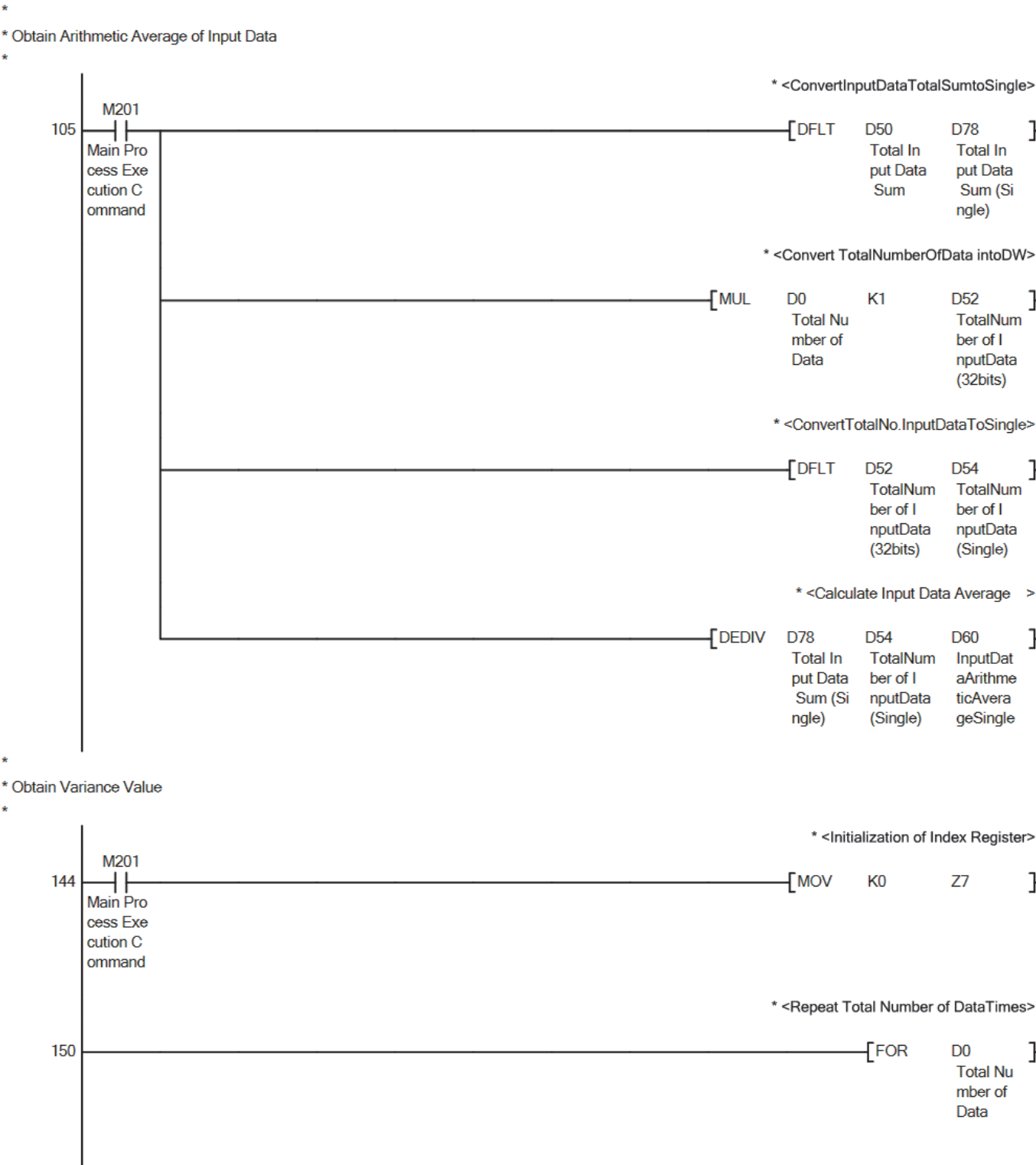
* Process of Checking Preset Data

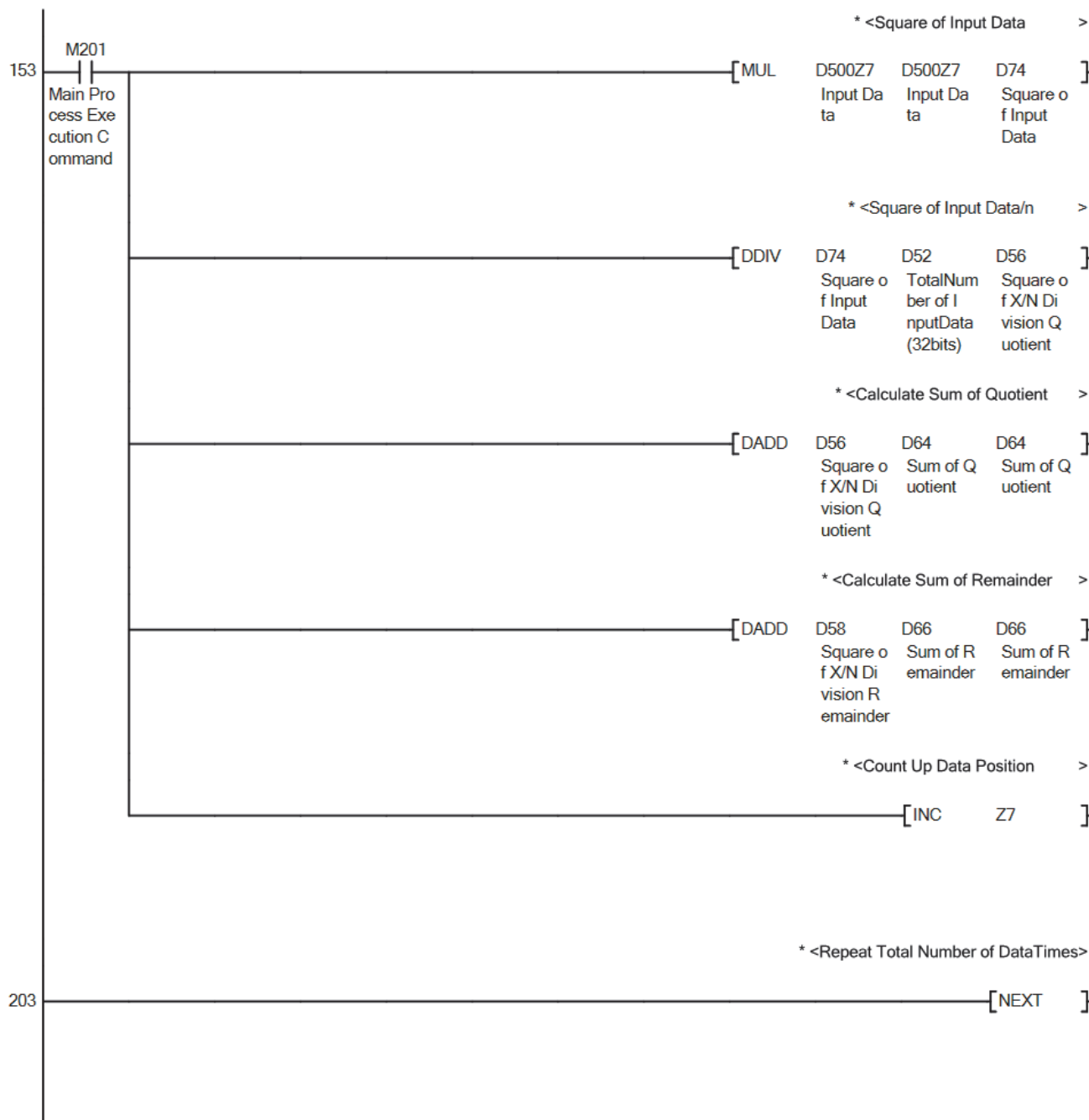
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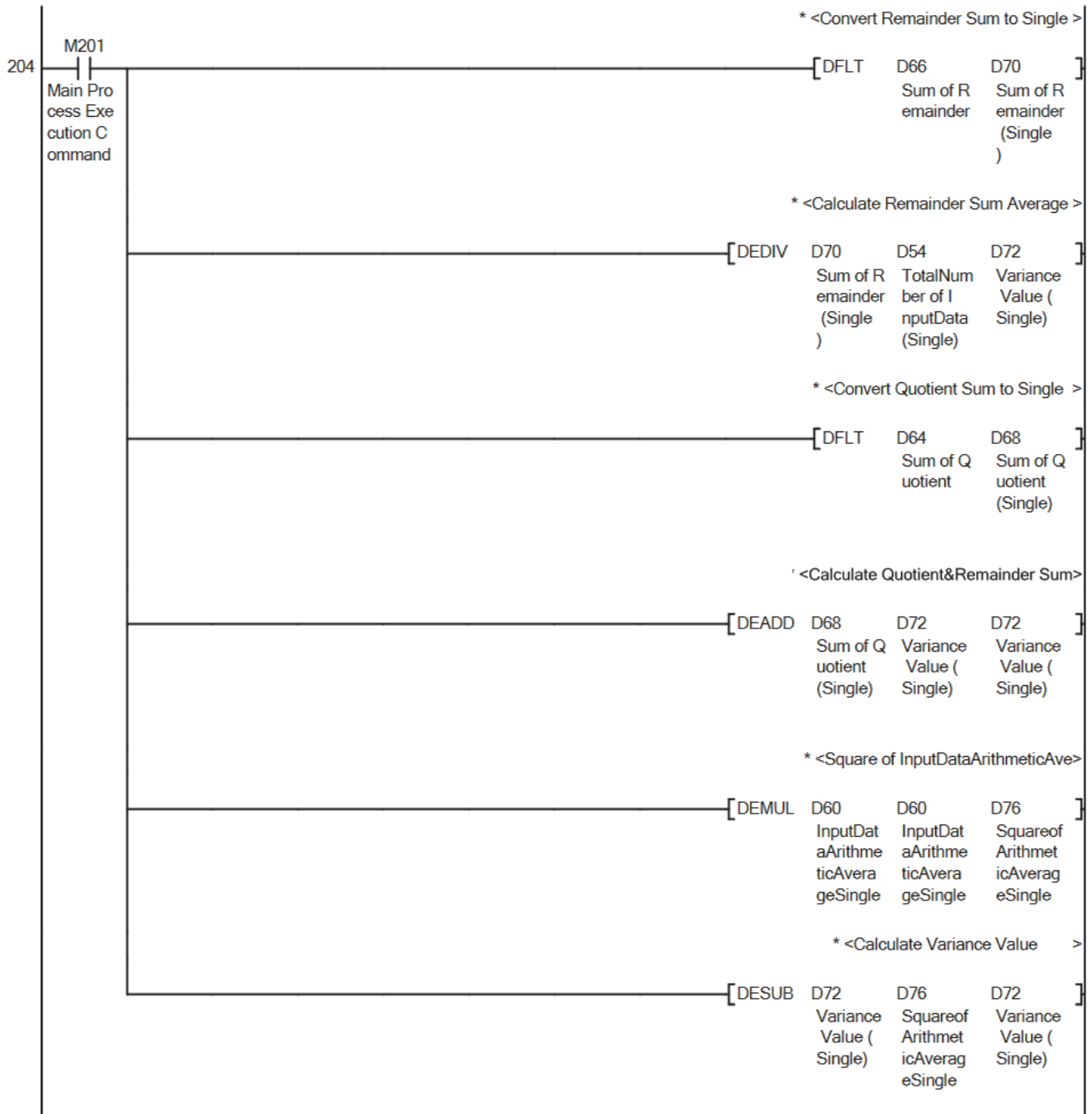








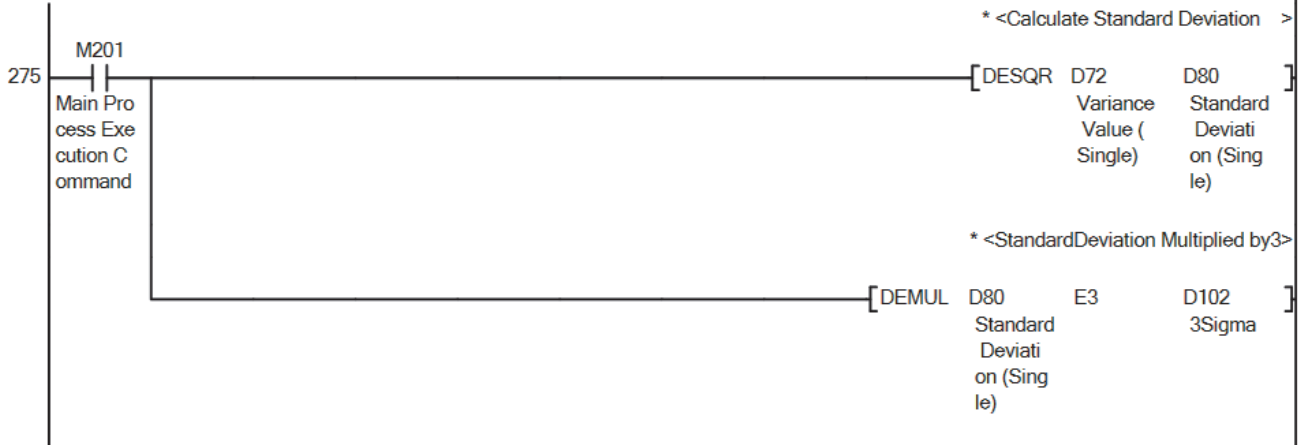




*

* Obtain Standard Deviation Multiplied by 3

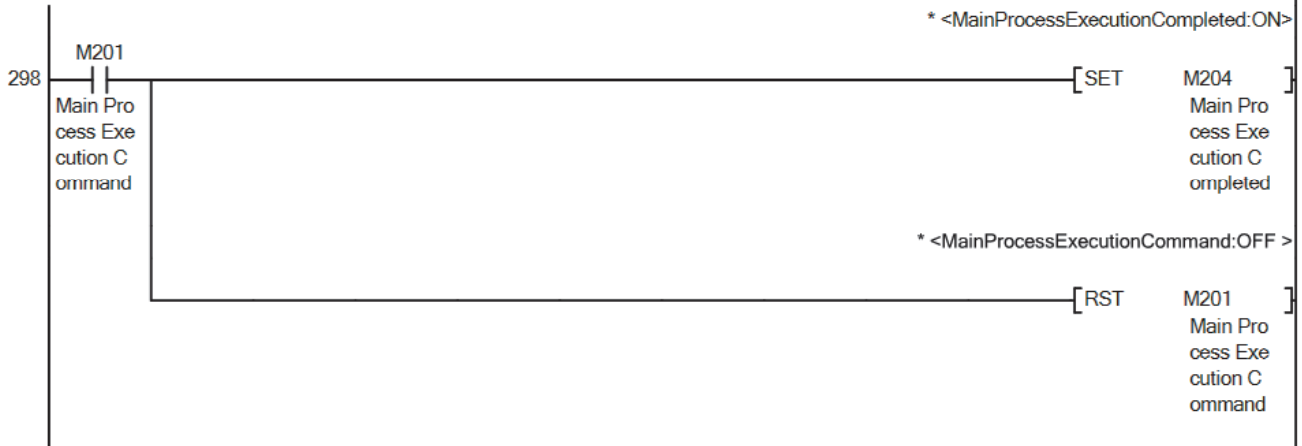
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*

* Confirm Main Process Execution Completed

*



*

* Confirm Program Completion

*

