

## Programmable Controller

## MELSEC iQ-R

MELSEC iQ-R Statistical Analysis Function Block Library Reference (Basic)

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# 1 OVERVIEW

The FB library in this manual is for statistical analysis.

## 1.1 FB Library List

The following table lists the FB library in this manual.

Name	Description
M+DataStatistics_MovingAverage_R	Calculates the moving average of the specified data.
M+DataStatistics_StandardDeviation_R	Obtains the standard deviation operation result of the specified data.
M+DataStatistics_StandardDeviationEx_R	Calculates the standard deviation from the specified data and a reference value.
M+DataStatistics_Variance_R	Obtains the distributed arithmetic operation result of the specified data.
M+DataStatistics_FrequencyDistribution_R	Obtains the frequency distribution operation result of the specified data.
M+DataStatistics_CalcCoefficient_R	Calculates the coefficient of correlation and the coefficient of determination from predicted values and observed values.

For the FB library, please consult your local Mitsubishi representative.

For how to register the FB library, refer to the GX Works3 Operating Manual.

## **1.2** System Configuration Example

The following figure shows a system configuration example to use the FB library in this manual.



(1) Power supply module

(2) CPU module

For the specifications of the modules, refer to the user's manual for the module used.

# **2** DETAILS OF THE FB LIBRARY

This chapter describes the details of the FB library.

## 2.1 M+DataStatistics\_MovingAverage\_R

#### Name

M+DataStatistics\_MovingAverage\_R

Overview								
Item	Description							
Functional overview	Calculates the moving average of the specified data.							
Symbol	M+DataStatistics_MovingAverage_R         (1)       B : i_bEN       o_bENO : B       (7)         (2)       UD : i_udMovingAverageNumber       o_bOK : B       (8)         (3)       UD : i_udSamplingPoints       o_bErr : B       (9)         (4)       UW : i_uDataType       o_uErrId : UW       (10)         (5)       UD : i_udMovingAverageDataAddr       (10)							

#### Labels to use

#### ■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udMovingAverageNumber	Number of moving average	Double Word [unsigned]	1 to 90000	Sets the number of moving average for the moving average operation.
(3)	i_udSamplingPoints	Number of sampling points	Double Word [unsigned]	1 to 90000	Sets the number of sampling points used for the moving average processing.
(4)	i_uDataType	Input data type selection	Word [unsigned]	0, 2	Specifies the data type of the input data. 0: Word [signed] 2: Single-precision real number
(5)	i_udInputDataAddr	Input data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where input data is stored.
(6)	i_udMovingAverageDataAddr	Output data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where the moving average result is stored. As the moving average results are output as single- precision real numbers (2-word), they are stored in file register within the range of "number of sampling points $\times$ 2", starting from the file register (ZR) specified with the output data start address.

\*1 The valid range varies depending on "File Register Setting" of "CPU Parameter".

#### ■Output labels

No.	Variable name	Name	Data type	Default value	Description
(7)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(8)	o_bOK	Normal completion	Bit	Off	The on state indicates that the moving average operation has been completed.
(9)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(10)	o_uErrld	Error code	Word [unsigned]	0	The error code of an error that occurred in the FB is returned.

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guage to use mber of steps el usage dependence ictional description	Engir — (T 515 s The r option • Lat • Lat The u option	neering tool he internal program steps number of steps of t			M	ELSEC iQ-R series			
guage to use ber of steps lusage lependence ctional description	- (T 515 s The r option • Lal • Lat The u	he internal program steps number of steps of f			G	X Works3 of version	n 1.055H or la	ater	
ber of steps I usage ependence stional description	515 s The r option • Lat The u	steps number of steps of t	of this I	B is not o	pen t	o the public.)			
el usage lependence stional description	• Lal • Lat The u	515 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and t options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.							
lependence ctional description	opuo	bel: 0.12K points (V tch label: 0.01K poi usage of labels emb ns setting of GX W	Vord) nts (Wor edded ir orks3. Fo	d) a prograr or the optic	m dep ons se	ends on the CPU m etting of GX Works3	odule used, t , refer to the	the devices specified as an argument GX Works3 Operating Manual.	an
tional description	No de	ependence							
	a a T "j ■Nur Mov ■Nur Mov Exa The f • i_u	ddress. The FB cal verage. And then th his FB calculates th " stands for the nur mber of calculation: ing average (j) = mber of calculation: ing average (j) = ample following figure sho udMovingAverageN	culates t culates t the FB stone moder of c s (j) < Nu $\frac{\sum_{i=1}^{j} x_i}{j}$ s (j) ≥ Nu $\frac{\sum_{i=j-N}^{j} N_i}{N}$ ws an op number (r	The average or the regular of the r	<ul> <li>infinite of sampling points starting norm the one specified with the input data age of input data values in the areas of the range specified by the number of result in file register areas in order starting from the output data start address ge with the following formula.</li> <li>ons, "x<sub>i</sub>" for i-th input data, and "M" for the number of moving average.</li> <li><sup>i</sup> moving average (M)</li> <li>f moving average (M)</li> <li>example of when values of each input label are as follows.</li> <li>average): 3</li> <li>ling points): 10</li> </ul>				mo s.
	• i_u	ıdSamplingPoints (ı ıdlnputDataAddr (ir	put data	of sampling start addr	g poir ress):	nts): 10 0 (ZR0)			
	• i_u • i_u • i_u	IdSamplingPoints (i IdInputDataAddr (ir IdMovingAverageD	put data ataAddr	of sampling start addr (output da	g poir ress): ta sta	ots): 10 0 (ZR0) rt address): 20 (ZR2	20)	Operation	
	• i_u • i_u • i_u • i_u No.	udSamplingPoints (i udInputDataAddr (ir udMovingAverageD Input data ZR0 (input data start	put data ataAddr	of sampling start addr (output da	g poir ress): ta sta No.	ts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start	20) ata 55	Operation Average of No.1	
	• i_u • i_u • i_u No.	adSamplingPoints ( adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1	put data ataAddr	of sampling start addr (output da	g poir ress): ta sta No.	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start address) ZR22	20) ata 55	Operation Average of No.1	
	• i_u • i_u • i_u • i_u No.	adSamplingPoints ( adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2	55 58 60	of sampling start addr (output da	g poir ress): ta sta No.	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start address) ZR22 ZR22	20) ata 55 56.5 57,66667	Operation Average of No.1 Average of No.1 and No.2	
	• i_u • i_u • i_u • i_u No. 1 2 3	adSamplingPoints (i adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR2	55 58 60	of sampling start addr (output da	g poir ress): ta sta No. 1 2 3	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start address) ZR22 ZR22 ZR24	20) ata 55 56.5 57.66667	Operation Average of No.1 Average of No.1 and No.2 Average of No.1, No.2, and No.3	
	• i_u • i_u • i_u • i_u No. 1 2 3 4	adSamplingPoints (in adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR3	55 58 60 40	of sampling start addr (output da	g poir ress): ta sta No. 1 2 3 4	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output data ZR20 (output data start address) ZR22 ZR24 ZR26 ZR20	20) ata 55 56.5 57.66667 52.66667	Operation Average of No.1 Average of No.1 and No.2 Average of No.1, No.2, and No.3 Average of No.2, No.3, and No.4	
	• i_u • i_u • i_u • i_u 1 2 3 4 5	adSamplingPoints (in adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR3 ZR4	55 58 60 90 90	of sampling start addr (output da	g poir ress): ta sta No. 1 2 3 4 5	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start address) ZR22 ZR24 ZR26 ZR28 ZR28	20) ata 55 56.5 57.66667 52.66667 63.33333	Operation Average of No.1 Average of No.1 and No.2 Average of No.1, No.2, and No.3 Average of No.2, No.3, and No.4 Average of No.3, No.4, and No.5	
	• i_u • i_u • i_u • i_u 1 2 3 4 5 6	adSamplingPoints (indInputDataAddr (in adInputDataAddr (in adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR3 ZR4 ZR5	55 58 60 90 60	of sampling start addr (output da	$  $ $  $ $  $ $  $ $  $ $  $ $  $	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start address) ZR22 ZR24 ZR26 ZR28 ZR30	20)       ata       55       56.5       57.66667       52.66667       63.33333       63.33333	Operation Average of No.1 Average of No.1 and No.2 Average of No.1, No.2, and No.3 Average of No.2, No.3, and No.4 Average of No.3, No.4, and No.5 Average of No.4, No.5, and No.6	
	• i_u • i_u • i_u • i_u 1 2 3 4 5 6 7	adSamplingPoints (in adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR3 ZR4 ZR5 ZR6	55           58           60           40           90           60           55	of sampling start addr (output da	g poir ress): ta sta 1 2 3 4 5 6 7	tts): 10 0 (ZR0) rt address): 20 (ZR2 Output data ZR20 (output data start address) ZR22 ZR24 ZR26 ZR26 ZR28 ZR30 ZR32	20)       at       55       56.5       57.66667       52.66667       63.33333       63.33333       63.33333	Operation Average of No.1 Average of No.1 and No.2 Average of No.1, No.2, and No.3 Average of No.2, No.3, and No.4 Average of No.3, No.4, and No.5 Average of No.4, No.5, and No.6 Average of No.5, No.6, and No.7	
	• i_u • i_u • i_u 1 2 3 4 5 6 7 8	adSamplingPoints (in adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR3 ZR4 ZR5 ZR6 ZR7	55           58           60           40           90           60           55           60           60           55           60           55           60           60           55           65	of sampling start addr (output da	g poir ress): ta sta 1 2 3 4 5 6 7 8	its): 10 0 (ZR0) it address): 20 (ZR2 Output da ZR20 (output data start address) ZR22 ZR24 ZR26 ZR26 ZR28 ZR30 ZR32 ZR32 ZR34	20)       ata       55       56.5       57.66667       52.66667       63.33333       63.33333       63.33333	Operation Average of No.1 Average of No.1 and No.2 Average of No.1, No.2, and No.3 Average of No.2, No.3, and No.4 Average of No.3, No.4, and No.5 Average of No.4, No.5, and No.6 Average of No.5, No.6, and No.7 Average of No.6, No.7, and No.8	
	• i_u • i_u • i_u 1 2 3 4 5 6 7 8 9	adSamplingPoints (in adInputDataAddr (ir adMovingAverageD Input data ZR0 (input data start address) ZR1 ZR2 ZR3 ZR4 ZR5 ZR6 ZR6 ZR7 ZR8	1         1           1         1	of sampling start addr (output da	g poir ress): ta sta 1 2 3 4 5 6 7 8 9	hts): 10 0 (ZR0) rt address): 20 (ZR2 Output da ZR20 (output data start address) ZR22 ZR24 ZR26 ZR26 ZR28 ZR30 ZR32 ZR32 ZR34 ZR36	20)       at       55       56.5       57.66667       52.66667       63.33333       63.33333       63.33333       63.33333       60       46.66667	OperationAverage of No.1Average of No.1 and No.2Average of No.1, No.2, and No.3Average of No.2, No.3, and No.4Average of No.3, No.4, and No.5Average of No.4, No.5, and No.6Average of No.5, No.6, and No.7Average of No.6, No.7, and No.8Average of No.7, No.8, and No.9	

Item		Description							
Functional des	scription	<ul> <li>(2) The input data used for the moving average operation are read from the file register (ZR), starting from the area of the address specified by i_udInputDataAddr (input data start address). This FB reads input data for the number of points set in i_udSamplingPoints (number of sampling points).</li> <li>(3) Operation results are stored in the file register (ZR), starting from the area of the address specified by i_udMovingAverageDataAddr (output data start address). The operation results are output as single-precision real numbers, within the range of "i_udSamplingPoints (number of sampling points) × 2".</li> <li>(4) It takes multiple scans until the moving average operation is completed. Thus, do not change the input data values used for the operation until the processing is completed. When the moving average operation is completed, o_bOK (normal completion) turns on.</li> <li>(5) If a value out of the range is set in i_udSamplingPoints (number of sampling points), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 105H is stored in o_uErrld (error code). For the error code, refer to the list of error code, ic::: Page 8 List of error code, ic:::: Page 8 List of error code, ic::::::: Page 8 List of error code, ic::::::::::::::::::::::::::::::::::::</li></ul>							
	a math ad	Page 8 List of error codes)							
FB compliation	n method	subroutine type							
FB operation	Normal	ruise execution type (multiple scan execution type)							
of I/O signals	completion	i_bEN o_bENO o_bENO o_bENO o_bOK o_bCK o_bErr o_uErrld 0FF 0FF 0FF 0							
		-							
	Error completion	i_bEN OFF ON OFF ON OFF OFF ON OFF ON OFF OFF							

Item	Description
Restrictions and precautions	<ol> <li>This FB does not include the error recovery processing. Prepare the error recovery processing separately to suit the user's system and the expected operation.</li> <li>This FB uses the long index registers LZ0, LZ1, and LZ2. Set the long index (LZ) to three points or greater in "Index Register Setting" of "CPU Parameter". (C MELSEC iQ-R CPU Module User's Manual (Application))</li> </ol>
	<ul> <li>(3) The FB cannot be used in an interrupt programs, do not use the corresponding index registers.</li> <li>(3) The FB cannot be used in an interrupt program.</li> <li>(4) Using the FB in a program that is to be executed only once, such as a subroutine program or a FOR-NEXT loop, has a problem that i_bEN (execution command) can no longer be turned off and normal operation is not possible; Always use the FB in a program that is capable of turning off the execution command.</li> <li>(5) The FB requires the configuration of the ladder for every input label</li> </ul>
	<ul> <li>(6) The FB requires the input data to be stored in the file register (ZR). In addition, an operation result data is output in the file register (ZR). Refer to the following examples and set the file register (ZR) capacity. For the setting method, refer to the MELSEC iQ-R CPU Module User's Manual (Application).</li> <li>When 0 is set in i_uDataType (input data type selection)</li> </ul>
	<ul> <li>Set the capacity of "i_udSamplingPoints (number of sampling points) × 3" for the file register (ZR).</li> <li>■When 2 is set in i_uDataType (input data type selection)</li> <li>Set the capacity of "i_udSamplingPoints (number of sampling points) × 4" for the file register (ZR).</li> <li>(7) This FB checks the input data values before the moving average operation execution to prevent an overflow from occurring during the operation. If a possibility of an overflow is detected at this check, o_bErr (error completion) turns on and 203H is stored in o_uErrId (error code). For the operation with the single-precision real number, an error may occur depending on the combination of input data values. Even after the input data values are checked, the instruction execution fault</li> </ul>
	<ul> <li>(operation error) may occur at the operation execution. In such a case, if "RAS Setting" of "CPU Parameter" is set to continue the processing even after an operation error occurs, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code).</li> <li>(8) If 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module due to an error outside FB while i_bEN (execution command) of this FB is on, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 204H is stored in o_uErrld (error code). However, if "RAS Setting" of "CPU Parameter" is set to stop the processing after an operation error occurs, 204H is not stored in o_uErrld (error code).</li> </ul>

The following table lists the performance values of this FB under the following conditions.

CPU module: R16CPU

- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label			Time required for	Maximum scan time	Number of the scans	
Number of sampling points	Input data type Number of moving average		the processing <sup>~1</sup>		required for the processing	
100 points	0: Word [signed]	1	0.474ms	0.21ms	5 scans	
		50	0.488ms 0.209ms			
		100	0.473ms	0.211ms		
	2: Single-precision real	1	0.473ms	0.211ms		
	number	50	0.486ms	0.209ms		
		100	0.476ms	0.209ms		
45000 points	0: Word [signed]	1	254ms	0.22ms	2250 scans	
		22500	255ms	0.211ms		
		45000	254ms	0.213ms		
	2: Single-precision real	1	256ms	0.213ms		
	number	22500	258ms	0.22ms		
		45000	256ms	0.216ms		
90000 points	0: Word [signed]	1	508ms	0.215ms	4500 scans	
		45000	510ms	0.215ms		
		90000	507ms	0.216ms		
	2: Single-precision real	1	512ms	0.219ms		
	number	45000	516ms	0.221ms		
		90000	511ms	0.219ms		

\*1 The time required from start to end of the processing

List of error	List of error codes							
Error code	Description	Action						
103H	A value out of the range is set in i_uDataType (input data type selection).	Set 0 or 2 in i_uDataType (input data type selection). Review and correct the setting and then execute the FB again.						
105H	A value out of the range is set in i_udSamplingPoints (number of sampling points).	Set a value of 1 to 90000 in i_udSamplingPoints (number of sampling points). Review and correct the setting and then execute the FB again.						
115H	A value out of the range is set in i_udMovingAverageNumber (number of moving average).	Set the value that satisfies the following conditions in         i_udMovingAverageNumber (number of moving average).         • i_udMovingAverageNumber (number of moving average) ≥         1         • i_udMovingAverageNumber (number of moving average) ≤         i_udMovingAverageNumber (number of moving average) ≤         i_udMovingAverageNumber (number of moving average) ≤         i_udSamplingPoints (number of sampling points)         Review and correct the setting and then execute the FB again.						
11DH	Some areas of input data and output data are overlapped.	<ul> <li>Review the following settings so that the input data areas and the output data areas are not overlapped.</li> <li>i_udSamplingPoints (number of sampling points)</li> <li>i_udInputDataAddr (input data start address)</li> <li>i_udMovingAverageDataAddr (output data start address)</li> <li>Review and correct the settings and then execute the FB again.</li> </ul>						
200H	Although the value set in i_uDataType (input data type selection) is Single-precision real number, the stored input data is not a single- precision real number.	Store the input data as a single-precision real number in the file register (ZR). Review and correct the input data and then execute the FB again.						
203H	An overflow has occurred in the FB during the operation.	Review and correct the input data stored in the file register (ZR) and then execute the FB again. When 3403H is stored in the special register SD0 (Latest self- diagnostic error code) of the CPU module, refer to the MELSEC iQ-R CPU Module User's Manual (Application).						
204H	The processing of the FB has been interrupted due to an overflow in an operation other than that of this FB.	An overflow has occurred in the operation other than that of this FB, and 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module. Refer to the MELSEC iQ-R CPU Module User's Manual (Application).						
205H	i_bEN (execution command) has been turned off during the processing.	Do not turn off i_bEN (execution command) until o_bOK (normal completion) or o_bErr (error completion) turns on.						

M+DataStatistics\_StandardDeviation\_R

#### Overview

Item	Description						
Functional overview	Obtains the standard deviation operation result of the specified data.						
Symbol							
0,		M+DataStatistics	s_StandardDeviation_R				
	(1) —	B : i_bEN	o_bENO: B	(5)			
	(2) —	UD:i_udSize	o_bOK: B	(6)			
	(3) —	UW:i_uDataType	o_bErr: B	(7)			
	(4) —	UD:i_udInputDataAddr	o_uErrld:UW	(8)			
			o_eStandardDeviationData : E	(9)			

#### Labels to use

#### ■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udSize	Number of data points	Double Word [unsigned]	1 to 90000	Sets the number of input data points for the standard deviation operation.
(3)	i_uDataType	Input data type selection	Word [unsigned]	0, 2	Specifies the data type of the input data. 0: Word [signed] 2: Single-precision real number
(4)	i_udInputDataAddr	Input data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where input data is stored.

\*1 The valid range varies depending on "File Register Setting" of "CPU Parameter".

#### ■Output labels

No.	Variable name	Name	Data type	Default value	Description
(5)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(6)	o_bOK	Normal completion	Bit	Off	The on state indicates that the standard deviation operation has been completed.
(7)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(8)	o_uErrld	Error code	Word [unsigned]	0	The error code of an error that occurred in the FB is returned.
(9)	o_eStandardDeviationData	Output data	Single-precision real number	0	The standard deviation operation result is stored.

FB details						
Item	Des	cription				
Relevant devices	CPU	l module		MELSEC iQ-R series		
	Engi	neering tool		GX Works3 of version 1.055H or later		
Language to use	٦) —	The internal program of this FB is no	ot op	en to the public.)		
Number of steps	474 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.					
Label usage	Label: 0.1K points (Word)     Latch label: 0.01K points (Word) The usage of labels embedded in a program depends on the CPU module used, the devices specified as an argument, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.					
FB dependence	No c	lependence				
Functional description(1) As i_bEN (execution command) turns on, this FB calculates a standard deviation of th This FB calculates the standard deviation with the following formula. "N" stands for the number of data points, "x <sub>i</sub> " for i-th data, and "x" for the average of in for the number of data points (N) starting from the one specified with the input data st Standard deviation = $\sqrt{\frac{1}{N}\sum_{i=1}^{N} (x_i - \bar{x})^2}$				, this FB calculates a standard deviation of the specified input data values. n with the following formula. "x <sub>i</sub> " for i-th data, and "x" for the average of input data values in file register areas from the one specified with the input data start address.		
	<ul> <li>Example</li> <li>The following figures show an operation example of when values of each input label are as follows.</li> <li>i_udSize (number of data points): 3</li> <li>i_udInputDataAddr (input data start address): 0 (ZR0)</li> <li>i_uDataType (input data type selection): 0</li> </ul>					
	No.	Input data				
	1	ZR0 (input data start address)	10			
	2	ZR1	20			
	3	ZR2	30			
	In this case, $\overline{x}$ is $(10 + 20 + 30)/3 = 20$ . The following value is obtained by applying the above values to the formula to calculate the standard deviation.					
	<b>√</b> -	3	<u>o)</u>	≒ 8.16		
	<ul> <li>(2) The input data used for the standard deviation operation are read from the file register (ZR), starting from the area of the address specified by i_udInputDataAddr (input data start address). This FB reads input data for the number of points set in i_udSize (number of data points).</li> <li>(2) The answering result is automatic a single point in the start address.</li> </ul>					
	<ul> <li>(3) The operation result is output as a single-precision real number to o_estandard DeviationData (output data).</li> <li>(4) It takes multiple scans until the standard deviation operation is completed. Thus, do not change the input data values used for the operation until the processing is completed. When the standard deviation operation is completed, o_bOK (normal completion) turns on.</li> <li>(5) The operation until the processing is completed. When the standard deviation operation is completed, o_bOK (normal completion) turns on.</li> </ul>					
	(b) If a value out of the range is set in i_udsize (number of data points), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 105H is stored in o_uErrld (error code). For the error code, refer to the list of error codes. (CP Page 12 List of error codes)					
	(6) If a value out of the range is set in i_uDataType (input data type selection), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 103H is stored in o_uErrld (error code). For the error code, refer to the list of error codes. (EP Page 12 List of error codes)					
	<ul> <li>(7) If an overflow occurs during the standard deviation operation, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 203H is stored in o_uErrld (error code). For the error code, refer to the list of error codes.</li> <li>(C) Page 12 List of error codes)</li> </ul>					
	(8) If i_bEN (execution command) is turned off before o_bOK (normal completion) or o_bErr (error completion) turns on, o_bErr (error completion) turns on in one scan. In addition, 205H is stored in o_uErrld (error code) in one scan. For the error code, refer to the list of error codes. (I Page 12 List of error codes)					
	(9) When a single-precision real number is set in i_uDataType (input data type selection) and the value stored in the file register (ZR) is not a single-precision real number, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 200H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (					
FB compilation method	Sub	routine type				
FB operation	Pulse execution type (multiple scan execution type)					

Item		Description
Timing chart Norma of I/O signals compl	al	i_bEN OFF ON OFF OFF ON Unexecuted Unexecuted OFF OFF OFF OFF
Error compl	letion	o_uErrid U i_bEN OFF ON o_bENO OFF ON
		Standard deviation arithmetic operation o_bOK o_bErr OFF
Restrictions and precautions		o_uErrid       0       Error code       0         (1) This FB does not include the error recovery processing. Prepare the error recovery processing separately to suit the user's system and the expected operation.         (2) This FB uses the long index register LZO. When using interrupt programs, do not use the corresponding index register.         (3) The FB cannot be used in an interrupt program.         (4) Using the FB in a program that is to be executed only once, such as a subroutine program or a FOR-NEXT loop, has a problem that i_bEN (execution command) can no longer be turned off and normal operation is not possible; Always use the FB in a program that is capable of turning off the execution command.         (5) The FB requires the configuration of the ladder for every input label.         (6) The FB requires the input data to be stored in the file register (ZR). Refer to the following examples and set the file register (ZR) capacity. For the setting method, refer to the MELSEC iQ-R CPU Module User's Manual (Application).         When 0 is set in i_uDataType (input data type selection)         Set the capacity of 'i_udSize (number of data points) for the file register (ZR).         (7) This FB checks the input data values before the standard deviation operation execution to prevent an overflow from occurring during the operation. If a possibility of an overflow is detected at this check, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code). For the operation with the single-precision real number, an error may occur depending on the combination of input data values. Even after the input data values are checked, the instruction execution fault (operation error) may occur at the operation exe

The following table lists the performance values of this FB under the following conditions.

- CPU module: R16CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label		Time required for the	Maximum scan time	Number of the scans	
Number of data Input data type points		processing <sup>1</sup>		required for the processing	
2 points	0: Word [signed]	0.148ms	0.21ms	2 scans	
	2: Single-precision real number	0.138ms	0.206ms		
45000 points	0: Word [signed]	643ms	0.28ms	4500 scans	
	2: Single-precision real number	647ms	0.275ms		
90000 points	0: Word [signed]	1290ms	0.278ms	9000 scans	
	2: Single-precision real number	1300ms	0.28ms		

\*1 The time required from start to end of the processing

#### List of error codes

Error code	Description	Action			
103H	A value out of the range is set in i_uDataType (input data type selection).	Set 0 or 2 in i_uDataType (input data type selection). Review and correct the setting and then execute the FB again.			
105H	A value out of the range is set in i_udSize (number of data points).	Set a value of 1 to 90000 in i_udSize (number of data points). Review and correct the setting and then execute the FB again.			
200H	Although the value set in i_uDataType (input data type selection) is Single-precision real number, the stored input data is not a single- precision real number.	Store the input data as a single-precision real number in the file register (ZR). Review and correct the input data and then execute the FB again.			
203H	An overflow has occurred in the FB during the operation.	Review and correct the input data stored in the file register (ZR) and then execute the FB again. When 3403H is stored in the special register SD0 (Latest self- diagnostic error code) of the CPU module, refer to the MELSEC iQ-R CPU Module User's Manual (Application).			
204H	The processing of the FB has been interrupted due to an overflow in an operation other than that of this FB.	An overflow has occurred in the operation other than that of this FB, and 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module. Refer to the MELSEC iQ-R CPU Module User's Manual (Application).			
205H	i_bEN (execution command) has been turned off during the processing.	Do not turn off i_bEN (execution command) until o_bOK (normal completion) or o_bErr (error completion) turns on.			

 $M + DataStatistics\_StandardDeviationEx\_R$ 

#### Overview

Item	Description
Functional overview	Calculates the standard deviation from the specified data and a reference value.
Symbol	M+DataStatistics_StandardDeviationEx_R
	(1) — B : i_bEN
	(2) — UD : i_udSize
	(3) — UW : i_uDataType o_bErr : B — (8)
	(4) — UD : i_udInputDataAddr o_uErrId : UW — (9)
	(5) — E : i_eRefValue o_eStandardDeviationData : E — (10)

#### Labels to use

#### ■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udSize	Number of data points	Double Word [unsigned]	1 to 90000	Sets the number of input data points for the standard deviation operation.
(3)	i_uDataType	Input data type selection	Word [unsigned]	0, 2	Specifies the data type of the input data. 0: Word [signed] 2: Single-precision real number
(4)	i_udInputDataAddr	Input data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where input data is stored.
(5)	i_eRefValue	Reference value	Single-precision real number	• $-2^{128}$ to $-2^{-126}$ (E-3.40282347+38 to E-1.17549435-38) • 0 • $2^{-126}$ to $2^{128}$ (E1.17549435-38 to E3.40282347+38)	Sets a reference value for the standard deviation operation.

\*1 The valid range varies depending on "File Register Setting" of "CPU Parameter".

#### ■Output labels

No.	Variable name	Name	Data type	Default value	Description
(6)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(7)	o_bOK	Normal completion	Bit	Off	The on state indicates that the standard deviation operation has been completed.
(8)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(9)	o_uErrld	Error code	Word [unsigned]	0	The error code of an error that occurred in the FB is returned.
(10)	o_eStandardDeviationData	Output data	Single-precision real number	0	The standard deviation operation result is stored.

FB details							
Item	Description						
Relevant devices	CPU module	MELSEC iQ-R series					
	Engineering tool	GX Works3 of version 1.055H or later					
Language to use	— (The internal program of this FB is r	not open to the public.)					
Number of steps	1121 steps The number of steps of the FB embedo options setting of GX Works3. For the	1121 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.					
Label usage	<ul> <li>Label: 0.01K points (Word)</li> <li>Latch label: 0.01K points (Word)</li> <li>The usage of labels embedded in a program depends on the CPU module used, the devices specified as an argument, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.</li> </ul>						
FB dependence	No dependence						
Functional description	rns on, this FB calculates a standard deviation from the specified input data and a eviation with the following formula. points, "x <sub>i</sub> " stands for i-th data, and "y" stands for the reference value. $$ $-\overline{y}$ ) <sup>2</sup>						
	<ul> <li>i_udSize (number of data points): 3</li> <li>i_udIputDataAddr (input data start address): 0 (ZR0)</li> <li>i_uDataType (input data type selection): 0</li> <li>i_eRefValue (reference value): 20</li> </ul>						
	No. Input data						
	1   ZR0 (input data start address)	10					
	2 ZR1	20					
	3 ZR2	30					
	<ul> <li>The following value is obtained by applying the above values to the formula to calculate the standard deviation.</li> <li>√(10 - 20)<sup>2</sup> + (20 - 20)<sup>2</sup> + (30 - 20)<sup>2</sup>/3 = 8.16</li> <li>(2) The input data used for the standard deviation operation are read from the file register (ZR), starting from the area of the address specified by i_udlnputDataAddr (input data start address). This FB reads input data for the number of points set in i_udSize (number of data points).</li> <li>(3) The operation result is output as a single-precision real number to o_eStandardDeviationData (output data).</li> <li>(4) It takes multiple scans until the standard deviation operation is completed. Thus, do not change the input data values used for the operation until the processing is completed. When the standard deviation operation is completed, o_bOK (normal completion) turns on.</li> <li>(5) If a value out of the range is set in i_udSize (number of data points), o_bErr (error completion) turns on and the processing</li> </ul>						
	<ul> <li>codes. (FF Page 16 List of error codes)</li> <li>(6) If a value out of the range is set in i_uDataType (input data type selection), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 103H is stored in o_uErrld (error code). For the error code, refer to the list of error codes)</li> <li>(7) If an overflow occurs during the standard deviation operation, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 203H is stored in o_uErrld (error code). For the error code, refer to the list of error codes)</li> <li>(7) If an overflow occurs during the standard deviation operation, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 203H is stored in o_uErrld (error code). For the error code, refer to the list of error codes. (FF Page 16 List of error codes)</li> <li>(8) If i_bEN (execution command) is turned off before o_bOK (normal completion) or o_bErr (error completion) turns on, o_bErr (error completion) turns on in one scan. In addition, 205H is stored in o_uErrld (error code) in one scan. For the error code, refer to the list of error codes. (FF Page 16 List of error codes)</li> <li>(9) When a single-precision real number is set in i_uDataType (input data type selection) and the value stored in the file register (ZR) is not a single-precision real number, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 200H is stored in o_uErrld (error code, refer to the list of error codes. (FF Page 16 List of error codes)</li> </ul>						
FB compilation method	Subroutine type						
FB operation	Pulse execution type (multiple scan ex	xecution type)					

Item		Description				
Timing chart	Normal	ON				
of I/O signals	completion	i_bEN				
			N			
		o_bENO				
		Standard deviation Unexecuted	Executing			
		arithmetic operation				
		o_bOK				
		o_bErr				
		o_uErrld	0			
	Error					
	completion					
		o_bENO				
		Standard deviation	Unexecuted			
		arithmetic operation				
		o_bOK				
		o_bErr				
		o_uErrld 0	Error code 0			
Restrictions and precautions		(1) This EB does not include the error recovery pro	cessing. Prepare the error recovery processing separately to suit the user's			
		system and the expected operation.				
		<ul> <li>(2) This FB uses the long index register LZ0. When using interrupt programs, do not use the corresponding index register.</li> <li>(3) The FB cannot be used in an interrupt program.</li> </ul>				
		<ul> <li>(3) The FB cannot be used in an interrupt program</li> <li>(4) Using the FB in a program that is to be execute</li> </ul>	d only once, such as a subroutine program or a FOR-NEXT loop, has a			
		problem that i_bEN (execution command) can i	o longer be turned off and normal operation is not possible; Always use the			
		FB in a program that is capable of turning off th	e execution command.			
		(5) The FB requires the configuration of the ladder	for every input label.			
		(6) The FB requires the input data to be stored in the file register (ZR). Refer to the following examples and set the file register (ZR) capacity For the setting method, refer to the MELSEC IO R CPLI Medule User's Manual (Application)				
		ערין טעאפטוע. רטו נוויפ צפעווויט וויפווטט, ופופו וט נוויפ ואבו⊃בט וע-א טייט Module User's Manual (Application). ■When 0 is set in i_uDataType (input data type selection)				
		Set the capacity of i_udSize (number of data points	) for the file register (ZR).			
		When 2 is set in i_uDataType (input data type se	ection)			
		Set the capacity of "i_udSize (number of data point	s) $\times$ 2" for the file register (ZR).			
		(7) This FB checks the input data values before the standard deviation operation execution to prevent an overflow from				
		occurring during the operation. If a possibility of an overflow is detected at this check, o_bErr (error completion) turns on and 203H is stored in o, uErrid (error code). For the operation with the single-precision real number an error may occur				
		depending on the combination of input data values. Even after the input data values are checked, the instruction execution				
		fault (operation error) may occur at the operation	n execution. In such a case, if "RAS Setting" of "CPU Parameter" is set to			
		continue the processing even after an operation	error occurs, o_bErr (error completion) turns on and 203H is stored in			
		o_u⊑rrid (error code). (8) If 3403H is stored in the special register SD0 /I	atest self-diagnostic error code) of the CPU module due to an error outside			
		FB while i_bEN (execution command) of this F	B is on, o_bErr (error completion) turns on and the processing of the FB is			
		interrupted. In addition, 204H is stored in o_uE	rld (error code). However, if "RAS Setting" of "CPU Parameter" is set to			
		stop the processing after an operation error oc	urs, 204H is not stored in o_uerrid (error code).			

The following table lists the performance values of this FB under the following conditions.

- CPU module: R120CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label		Time required for the	Maximum scan time	Number of the scans
Number of data Input data type points		processing <sup>*1</sup>		required for the processing
2 points	0: Word [signed]	0.217ms or less	0.217ms	1 scan
	2: Single-precision real number	0.217ms or less	0.217ms	
45000 points	0: Word [signed]	402.000ms	0.280ms	2250 scans
	2: Single-precision real number	405.000ms	0.283ms	
90000 points	0: Word [signed]	804.000ms	0.281ms	4500 scans
	2: Single-precision real number	809.000ms	0.282ms	

\*1 The time required from start to end of the processing

#### List of error codes

Error code	Description	Action			
103H	A value out of the range is set in i_uDataType (input data type selection).	Set 0 or 2 in i_uDataType (input data type selection). Review and correct the setting and then execute the FB again.			
105H	A value out of the range is set in i_udSize (number of data points).	Set a value of 1 to 90000 in i_udSize (number of data points). Review and correct the setting and then execute the FB again.			
200H	Although the value set in i_uDataType (input data type selection) is Single-precision real number, the stored input data is not a single-precision real number.	Store the input data as a single-precision real number in the file register (ZR). Review and correct the input data and then execute the FB again.			
203H	An overflow has occurred in the FB during the operation.	Review and correct the input data stored in the file register (ZR) and then execute the FB again. When 3403H is stored in the special register SD0 (Latest self- diagnostic error code) of the CPU module, refer to the MELSEC iQ-R CPU Module User's Manual (Application).			
204H	The processing of the FB has been interrupted due to an overflow in an operation other than that of this FB.	An overflow has occurred in the operation other than that of this FB, and 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module. Refer to the MELSEC iQ-R CPU Module User's Manual (Application).			
205H	i_bEN (execution command) has been turned off during the processing.	Do not turn off i_bEN (execution command) until o_bOK (normal completion) or o_bErr (error completion) turns on.			

M+DataStatistics\_Variance\_R

#### Overview

Item	Description					
Functional overview	Obtains the distributed arithmetic operation result of the specified data.					
Symbol	$(1) - \begin{bmatrix} M+DataStatistics_Variance_R\\ B : i_bEN & o_bENO : B - (5) \end{bmatrix}$					
	$ \begin{array}{c} (2) & & & \\ (3) & & & \\ (4) & & & \\ (4) & & & \\ (4) & & & \\ (4) & & & \\ (4) & & & \\ (4) & & & \\ (4) & & & \\ (5) & & \\ (6) & & \\ $					
	o_eVarianceData : E — (9)					

#### Labels to use

#### ■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udSize	Number of data points	Double Word [unsigned]	1 to 90000	Sets the number of input data points for the distributed arithmetic operation.
(3)	i_uDataType	Input data type selection	Word [unsigned]	0, 2	Specifies the data type of the input data. 0: Word [signed] 2: Single-precision real number
(4)	i_udInputDataAddr	Input data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where input data is stored.

\*1 The valid range varies depending on "File Register Setting" of "CPU Parameter".

#### ■Output labels

No.	Variable name	Name	Data type	Default value	Description
(5)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(6)	o_bOK	Normal completion	Bit	Off	The on state indicates that the distributed arithmetic operation has been completed.
(7)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(8)	o_uErrld	Error code	Word [unsigned]	0	The error code of an error that occurred in the FB is returned.
(9)	o_eVarianceData	Output data	Single-precision real number	0	The distributed arithmetic operation result is stored.

-B details									
Item	Des	cription							
Relevant devices	CPU	module		MELSEC iQ-R series					
	Engi	neering tool		GX Works3 of version 1.055H or later					
Language to use	T) —	he internal program of this FB is no	ot ope	en to the public.)					
Number of steps	471 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.								
Label usage	• La • La The optic	Label: 0.1K points (Word)     Latch label: 0.01K points (Word) The usage of labels embedded in a program depends on the CPU module used, the devices specified as an argument, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.							
FB dependence	No d	lependence							
Functional description	<ul> <li>(1) As i_bEN (execution command) turns on, this FB calculates variance of the specified input data values. This FB calculates the variance with the following formula.         "N" stands for the number of data points, "x<sub>i</sub>" for i-th data, and "x" for the average of input data values in file register areas for the number of data points (N) starting from the one specified with the input data start address.     <li>Variance = 1/N ∑<sub>i=1</sub><sup>N</sup> (x<sub>i</sub> - x̄)<sup>2</sup></li> <li>■Example         The following figures show an operation example of when values of each input label are as follows         </li> </li></ul>								
	•i_u •i_u •i_u	udSize (number of data points): 3 udInputDataAddr (input data start a uDataType (input data type selectio	ddres n): 0	ss): 0 (ZR0)					
	No.	Input data							
	1	ZR0 (input data start address)	10						
	2	ZR1	20						
	3	ZR2	30						
	In this case, $\overline{x}$ is $(10 + 20 + 30)/3 = 20$ . The following value is obtained by applying the above values to the formula to calculate the variance. $\frac{(10 - 20)^2 + (20 - 20)^2 + (30 - 20)^2}{3} \rightleftharpoons 66.66$								
	(2) T (3) T (4) F (4) F (5) F (7) F (6) F (7) F	The input data used for the distribute address specified by i_udInputDataA _udSize (number of data points). The operation result is output as a s it takes multiple scans until the distri- issed for the operation until the proce- normal completion) turns on. If a value out of the range is set in i_ of the FB is interrupted. In addition, codes. (IP Page 20 List of error co- f a value out of the range is set in i_ of error codes. (IP Page 20 List of f an overflow occurs during the distri- he FB is interrupted. In addition, 200 F j_bEN (execution command) is tur o_bErr (error completion) turns on in error code, refer to the list of error co- Vhen a single-precision real numbe egister (ZR) is not a single-precision nterrupted. In addition, 200H is store avae 20 List of error codes)	ed ari Addr ingle ibute essin udSi: uDat In ad erro ribute 3H is ned o none odes. r is s n rea ed in	thmetic operation are read from the file register (ZR), starting from the area of the (input data start address). This FB reads input data for the number of points set in -precision real number to o_eVarianceData (output data). d arithmetic operation is completed. Thus, do not change the input data values g is completed. When the distributed arithmetic operation is completed, o_bOK ze (number of data points), o_bErr (error completion) turns on and the processing d is stored in o_uErrld (error code). For the error code, refer to the list of error of data type selection), o_bErr (error completion) turns on and the didition, 103H is stored in o_uErrld (error code). For the error code, refer to the list of error codes) ed arithmetic operation, o_bErr (error completion) turns on and the processing of stored in o_uErrld (error code). For the error code, refer to the list of error codes). For the error code, refer to the list of error codes) ed arithmetic operation, o_bErr (error completion) turns on and the processing of stored in o_uErrld (error code). For the error code, refer to the list of error codes). For the error code, refer to the list of error codes. In addition, 205H is stored in o_uErrld (error code) in one scan. For the error codes) et in i_uDataType (input data type selection) and the value stored in the file I number, o_bErr (error completion) turns on and the processing of the FB is o_uErrld (error code). For the error code, refer to the list of error codes)					
FB compilation method	Subr	outine type							
FB operation	Puls	e execution type (multiple scan exe	cutio	in type)					
	1								

Item		Description
Timing chart of I/O signals	Normal completion	
		operation Unexecuted Executing Unexecuted
		o_bOK
		o_bErr
		o_uErrld 0
	Error	
	completion	i_bEN OFF
		o_bENO
		Distributed arithmetic Unexecuted
		o_bOK
		o_uErrld 0 Error code 0
Restrictions an	d precautions	<ul> <li>(1) This FB does not include the error recovery processing. Prepare the error recovery processing separately to suit the user's system and the expected operation.</li> <li>(2) This FB uses the long index register LZ0. When using interrupt programs, do not use the corresponding index register.</li> <li>(3) The FB cannot be used in an interrupt program.</li> <li>(4) Using the FB in a program that is to be executed only once, such as a subroutine program or a FOR-NEXT loop, has a problem that i_bEN (execution command) can no longer be turned off and normal operation is not possible; Always use the FB in a program that is capable of turning off the execution command.</li> <li>(5) The FB requires the configuration of the ladder for every input label.</li> <li>(6) The FB requires the input data to be stored in the file register (ZR). Refer to the following examples and set the file register (ZR) capacity. For the setting method, refer to the MELSEC iQ-R CPU Module User's Manual (Application).</li> <li>(7) This FB checks the input data type selection)</li> <li>Set the capacity of "i_udSize (number of data points) for the file register (ZR).</li> <li>(7) This FB checks the input data values before the distributed arithmetic operation execution to prevent an overflow from occurring during the operation. If a possibility of an overflow is detected at this check, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code). For the operation with the single-precision real number, an error may occur depending on the combination of input data values. Even after the input data values are checked, the instruction execution fault (operation error) may occur at the operation execution. In such a case, if "RAS Setting" of "CPU Parameter" is set to continue the processing even after an operation error occurs, o_bErr (error completion) turns on and 203H is stored in error between the order of occurs, o_bErr (error completion) turns on and 203H is stored in endered of input data values. Even after the inp</li></ul>
		(8) If 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module due to an error outside FB while i_bEN (execution command) of this FB is on, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 204H is stored in o_uErrld (error code). However, if "RAS Setting" of "CPU Parameter" is set to stop the processing after an operation error occurs, 204H is not stored in o_uErrld (error code).

The following table lists the performance values of this FB under the following conditions.

- CPU module: R16CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label		Time required for the	Maximum scan time	Number of the scans	
Number of data points	Input data type	processing <sup>*1</sup>		required for the processing	
2 points	0: Word [signed]	0.132ms	0.207ms	2 scans	
	2: Single-precision real number	0.131ms	0.209ms		
45000 points	0: Word [signed]	640ms	0.277ms	4500 scans	
	2: Single-precision real number	645ms	0.278ms		
90000 points	0: Word [signed]	1280ms	0.278ms	9000 scans	
	2: Single-precision real number	1290ms	0.276ms		

\*1 The time required from start to end of the processing

#### List of error codes

Error code	Description	Action				
103H	A value out of the range is set in i_uDataType (input data type selection).	Set 0 or 2 in i_uDataType (input data type selection). Review and correct the setting and then execute the FB again.				
105H	A value out of the range is set in i_udSize (number of data points).	Set a value of 1 to 90000 in i_udSize (number of data points). Review and correct the setting and then execute the FB again.				
200H	Although the value set in i_uDataType (input data type selection) is Single-precision real number, the stored input data is not a single-precision real number.	Store the input data as a single-precision real number in the file register (ZR). Review and correct the input data and then execute the FB again.				
203H	An overflow has occurred in the FB during the operation.	Review and correct the input data stored in the file register (ZR) and then execute the FB again. When 3403H is stored in the special register SD0 (Latest self- diagnostic error code) of the CPU module, refer to the MELSEC iQ-R CPU Module User's Manual (Application).				
204H	The processing of the FB has been interrupted due to an overflow in an operation other than that of this FB.	An overflow has occurred in the operation other than that of this FB, and 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module. Refer to the MELSEC iQ-R CPU Module User's Manual (Application).				
205H	i_bEN (execution command) has been turned off during the processing.	Do not turn off i_bEN (execution command) until o_bOK (normal completion) or o_bErr (error completion) turns on.				

M+DataStatistics\_FrequencyDistribution\_R

#### Overview

Item       Description         Functional overview       Obtains the frequency distribution operation result of the specified data         Symbol       M+DataStatistics_FrequencyDistribution_R         (1)       B : i_bEN       o_bENO : B       (1)         (2)       UD : i_udSize       o_bOK : B       (1)         (3)       E : i_eLowerLimit       o_bErr : B       (1)         (4)       E : i_eUpperLimit       o_uErrId : UW       (1)         (5)       UW : i_ulnterval       (1)       (1)       (1)         (2)       UD : i_udInputDataAddr       (2)       (2)       (2)       (2)       (2)         (3)       E : i_eUpperLimit       o_bErr : B       (1)       (1)       (1)       (1)       (1)       (1)         (4)       E : i_eUpperLimit       o_uErrId : UW       (1)
Functional overview       Obtains the frequency distribution operation result of the specified data         Symbol       M+DataStatistics_FrequencyDistribution_R         (1)       B : i_bEN       o_bENO : B         (2)       UD : i_udSize       o_bOK : B         (3)       E : i_eLowerLimit       o_bErr : B         (4)       E : i_eUpperLimit       o_uErrld : UW         (5)       UW : i_ulnterval       (6)         (6)       UW : i_udInputDataAddr       (8)         (1)       UD : i_udFrequencyDataAddr       (1)
Symbol       M+DataStatistics_FrequencyDistribution_R         (1)       B       : i_bEN       o_bENO       : B       ()         (2)       UD       : i_udSize       o_bOK       : B       ()         (3)       E       : i_eLowerLimit       o_bErr       : B       ()         (4)       E       : i_eUpperLimit       o_uErrld       : UW       ()         (5)       UW       : i_ulnterval       ()       ()       ()         (6)       UW       : i_udInputDataAddr       ()       ()       ()         (8)       UD       : i_udFrequencyDataAddr       ()       ()

#### Labels to use

#### ■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udSize	Number of data points	Double Word [unsigned]	1 to 90000	Sets the number of input data points for the frequency distribution operation.
(3)	i_eLowerLimit	Lower limit value in whole intervals	Single-precision real number	$\begin{array}{c} \cdot \cdot 2^{128} \text{ to } \cdot 2^{-126} \\ (\text{E-}3.40282347+38 \\ \text{to} \\ \text{E-}1.17549435-38) \\ \cdot 0 \\ \cdot 2^{-126} \text{ to } 2^{128} \\ (\text{E}1.17549435-38 \text{ to} \\ \text{E}3.40282347+38) \end{array}$	Specifies the lower limit value in whole intervals for the frequency distribution. Set a smaller value than i_eUpperLimit (upper limit value in whole intervals).
(4)	i_eUpperLimit	Upper limit value in whole intervals	Single-precision real number	$\begin{array}{c} \cdot \cdot 2^{128} \text{ to } \cdot 2^{-126} \\ (\text{E-}3.40282347+38 \\ \text{to} \\ \text{E-}1.17549435-38) \\ \cdot 0 \\ \cdot 2^{-126} \text{ to } 2^{128} \\ (\text{E}1.17549435-38 \text{ to} \\ \text{E}3.40282347+38) \end{array}$	Specifies the upper limit value in whole intervals for the frequency distribution. Set a larger value than i_eLowerLimit (lower limit value in whole intervals).
(5)	i_uInterval	Number of intervals	Word [unsigned]	1 to 200	Specifies the number of intervals for the frequency distribution.
(6)	i_uDataType	Input data type selection	Word [unsigned]	0, 2	Specifies the data type of the input data. 0: Word [signed] 2: Single-precision real number
(7)	i_udInputDataAddr	Input data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where input data is stored.
(8)	i_udFrequencyDataAddr	Output data start address	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where output data is to be stored.

\*1 The valid range varies depending on "File Register Setting" of "CPU Parameter".

#### ■Output labels

No.	Variable name	Name	Data type	Default value	Description
(9)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(10)	o_bOK	Normal completion	Bit	Off	The on state indicates that the frequency distribution operation has been completed.
(11)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(12)	o_uErrld	Error code	Word [unsigned]	0	The error code of an error that occurred in the FB is returned.

#### FB details

Item	Description					
Relevant devices	CPU module	MELSEC iQ-R series				
	Engineering tool	GX Works3 of version 1.055H or later				
Language to use	— (The internal program of this FB is not open to the public.)					
Number of steps	603 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.					
Label usage	<ul> <li>Label: 0.07K points (Word)</li> <li>Latch label: 0K points (Word)</li> <li>The usage of labels embedded in a program depends on the CPU module used, the devices specified as an argument, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.</li> </ul>					
FB dependence	No dependence					

I	Description									
tional description	<ul> <li>(1) As i_bEN (executio This FB uses data i address. The FB ca each interval. And t</li> <li>Example</li> <li>The following figures sl</li> <li>i_udSize (number of</li> <li>i_eLowerLimit (lower</li> <li>i_eUpperLimit (uppe</li> <li>i_uInterval (number of</li> <li>i_uDataType (input of</li> <li>i_udInputDataAddr (i</li> <li>i_udFrequencyDataA</li> </ul>	n comma n file regi alculates then the F how an o data poir r limit valu r limit valu of interva lata type input data Addr (out	and) turna ster area how mar FB stores peration nts): 5 ue in who ue in who ls): 5 selection a start ac put data	s on, this I as for the r ny data (in s the resul example of ole interva ole interva n): 0 (Word ddress): 0 start addro	FB calcula number of put value t in file re of when v ls): 0 ls): 50 d [signed] (ZR0) ess): 10 (.	ates frequ data poir s) fall with gister are alues of c ) ZR10)	ency dist its startin in a rang as in orde each inpu	ribution c g from the le (a mini er starting t label are	of the specified input data values. e one specified with the input data star mum value to a maximum value) of g from the output data start address. e as follows.	
	No. Inpu	ut data								
	1 ZR0 (input data start a		10							
	2 ZR1		20							
	3 ZR2	3 ZR2								
	4 ZR3		-10							
	5 ZR4		60							
	When the frequency distribution operation is executed for these data, the result is output as follows.									
		ZR10	7R12	7R14	7R16	7R18	ZR20	7R22	1	
	Minimum value	21110	0.0	10.0	20.0	30.0	40.0	50.0		
	(including the value)		0.0	10.0	20.0	00.0	+0.0	00.0	-	
	Maximum value (excluding the value)	0.0	10.0	20.0	30.0	40.0	50.0	_		
	Stored value	1	0	1	1	1	0	1		
	<ul> <li>A width of the value range for the interval is calculated from "(Upper limit value in whole intervals - Lower limit value in whole intervals) ÷ Number of intervals".</li> <li>Since the result is output in double word, the required areas of the file register (ZR) to store the output data are "(i_ulnterval (number of intervals) + 2) × 2 points". For the above example, a total of 14 words ((5 + 2) × 2) are required.</li> <li>The number of input values that are smaller than i_eLowerLimit (lower limit value in whole intervals) is stored in ZR10 and ZR11 (double word).</li> <li>The number of input values that are equal to or larger than i_eUpperLimit (upper limit value in whole intervals) is stored in ZR22 and ZR23 (double word).</li> <li>(2) The input data used for the frequency distribution operation are read from the file register (ZR), starting from the area of the context and the input data used for the frequency distribution operation are read from the file register (ZR), starting from the area of the context and the input data used for the frequency distribution operation are read from the file register (ZR).</li> </ul>									

(3) Even if 0: Word [signed] is set in i\_uDataType (input data type selection), this FB executes the frequency distribution operation after converting input data to a single-precision real number.

Item		Description				
Item Functional description		<ul> <li>(4) Set a single-precisic value in whole intervalue of the operation result.</li> <li>(5) The operation result is udFrequencyData. the operation result.</li> <li>(6) It takes multiple scaused for the operation (normal completion)</li> <li>(7) If a value out of the of the FB is interrup codes. (IFF Page 2)</li> <li>(8) If a value out of the FB is interrup codes. (IFF Page 2)</li> <li>(9) If a value out of the processing of the FB is interrup codes. (IFF Page 2)</li> <li>(10) If a value out of the is is interrup codes. (IFF Page 2)</li> <li>(11) If an overflow occur the FB is interrup codes. (IFF Page 26 List of error code, refer to the code interrupted. In additi Page 26 List of error (14) When a single-precoregister (ZR) is not a interrupted. In additi Page 26 List of error Subroutine type</li> </ul>	a single-precision real number in i_eLowerLimit (lower limit value in whole intervals) and i_eUpperLimit (upper limit e in whole intervals). operation result is stored in the file register (ZR), starting from the area of the address specified by HrequencyDataAddr (output data start address). Data for "(i_uInterval (number of intervals) + 2) × 2 points" is output as operation result. The address area to which the operation result is output is initialized (0 clear) at FB execution. Kees multiple scans until the frequency distribution operation is completed. Thus, do not change the input data values d for the operation until the processing is completed. When the frequency distribution operation is completed, o_bOK mal completion) turns on. value out of the range is set in i_udSize (number of data points), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 105H is stored in o_uErrld (error code). For the error code, refer to the list of error es. (:? Page 26 List of error codes) value out of the range is set in i_uDataType (input data type selection), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 103H is stored in o_uErrld (error code). For the error code, refer to the list ror codes. (:? Page 26 List of error codes) value out of the range is set in i_uInterval (number of intervals), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 11BH is stored in o_uErrld (error code). For the error code, refer to list of error codes. (::? Page 26 List of error codes) value out of the range is set in i_uInterval (number of intervals), o_bErr (error completion) turns on and the processing re FB is interrupted. In addition, 203H is stored in o_uErrld (error code). For the error code, refer to the list of error codes. " Page 26 List of error codes) bEN (execution command) is turned off before o_bOK (normal completion) or o_bErr (error completion) turns on, Err (error completion) turns on in one scan.			
FB operation		Pulse execution type (m	nultiple scan execution type)			
Timing chart of I/O signals	Normal completion	i_bEN o_bENO Frequency distribution operation o_bOK o_bErr	OFF OFF OFF OFF			
		o_uErrld	0			
	Error completion	i_bEN o_bENO Frequency distribution operation o_bOK o_bErr	OFF OFF OFF OFF			
		o_uErrld	0 Error code 0			

Item	Description
Restrictions and precautions	<ul> <li>(1) This FB does not include the error recovery processing. Prepare the error recovery processing separately to suit the user's system and the expected operation.</li> <li>(2) This FB uses the long index registers LZ0 and LZ1. Set the long index (LZ) to two points or greater in "Index Register Setting" of "CPU Parameter". (L MELSEC iQ-R CPU Module User's Manual (Application)) When using interrupt programs, do not use the corresponding index registers.</li> </ul>
	<ul> <li>(3) The FB cannot be used in an interrupt program.</li> <li>(4) Using the FB in a program that is to be executed only once, such as a subroutine program or a FOR-NEXT loop, has a problem that i_bEN (execution command) can no longer be turned off and normal operation is not possible; Always use the FB in a program that is capable of turning off the execution command.</li> <li>(5) The FB requires the configuration of the ladder for even input lobel</li> </ul>
	<ul> <li>(6) For the operation of this FB, a value equal to a maximum value in one interval is regarded to fit in the next interval.</li> <li>Example</li> </ul>
	When two intervals exist and one interval has a range of 0.0 (including 0.0) to 1.0 (excluding 1.0) and another has a range of 1.0 (including 1.0) to 2.0 (excluding 2.0), a value of 1.0 is regarded to fit in the latter interval that has the range of 1.0 (including 1.0) to 2.0 (excluding 2.0).
	(7) The FB requires the input data to be stored in the file register (ZR). In addition, output data in double word is output in the file register (ZR). Refer to the following examples and set the file register (ZR) capacity. For the setting method, refer to the MELSEC iQ-R CPU Module User's Manual (Application).
	Set the capacity of "i_udSize (number of data points) + (i_ulnterval (number of intervals) + 2) × 2" for the file register (ZR).
	<ul> <li>Set the capacity of "(i_udSize (number of data points) + i_ulnterval (number of intervals) + 2) × 2" for the file register (ZR).</li> <li>(8) This FB checks the input data values before the frequency distribution operation execution to prevent an overflow from occurring during the operation. If a possibility of an overflow is detected at this check, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code). For the operation with the single-precision real number, an error may occur depending on the combination of input data values. Even after the input data values are checked, the instruction execution fault (operation error) may occur at the operation error occurs, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code).</li> </ul>
	<ul> <li>(9) If 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module due to an error outside FB while i_bEN (execution command) of this FB is on, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 204H is stored in o_uErrld (error code). However, if "RAS Setting" of "CPU Parameter" is set to stop the processing after an operation error occurs, 204H is not stored in o_uErrld (error code).</li> <li>(10)The input data of the single-precision real number has a rounding error. Therefore, when the data for frequency distribution has an error, the intended operation result may not be obtained.</li> </ul>

The following table lists the performance values of this FB under the following conditions.

- CPU module: R16CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label		Time required for the	Maximum scan time	Number of the scans required for the processing
Number of data points	Input data type	processing <sup>1</sup>		
2 points	0: Word [signed]	0.213ms or less	0.213ms	1 scan
	2: Single-precision real number	0.213ms or less	0.213ms	
45000 points	0: Word [signed]	250ms	0.218ms	2250 scans
	2: Single-precision real number	253ms	0.221ms	
90000 points	0: Word [signed]	499ms	0.222ms	4500 scans
	2: Single-precision real number	505ms	0.22ms	

\*1 The time required from start to end of the processing

#### List of error codes

Error code	Description	Action			
103H	A value out of the range is set in i_uDataType (input data type selection).	Set 0 or 2 in i_uDataType (input data type selection). Review and correct the setting and then execute the FB again.			
105H	A value out of the range is set in i_udSize (number of data points).	Set a value of 1 to 90000 in i_udSize (number of data points). Review and correct the setting and then execute the FB again.			
11BH	A value out of the range is set in i_eUpperLimit (upper limit value in whole intervals).	Set a larger value than i_eLowerLimit (lower limit value in whole intervals) for i_eUpperLimit (upper limit value in whole intervals). Review and correct the setting and then execute the FB again.			
11CH	A value out of the range is set in i_uInterval (number of intervals).	Set a value of 1 to 200 in i_uInterval (number of intervals). Review and correct the setting and then execute the FB again.			
11DH	Some areas of input data and output data are overlapped.	Review the following settings so that the input data areas and the output data areas are not overlapped. • i_udSize (number of data points) • i_ulnterval (number of intervals) • i_udInputDataAddr (input data start address) • i_udFrequencyDataAddr (output data start address) Review and correct the settings and then execute the FB again.			
200H	Although the value set in i_uDataType (input data type selection) is Single-precision real number, the stored input data is not a single- precision real number.	Store the input data as a single-precision real number in the file register (ZR). Review and correct the input data and then execute the FB again.			
203H	An overflow has occurred in the FB during the operation.	Review and correct the lower limit value in whole intervals, upper limit value in whole intervals, and input data stored in the file register (ZR), and then execute the FB again. When 3403H is stored in the special register SD0 (Latest self- diagnostic error code) of the CPU module, refer to the MELSEC iQ-R CPU Module User's Manual (Application).			
204H	The processing of the FB has been interrupted due to an overflow in an operation other than that of this FB.	An overflow has occurred in the operation other than that of this FB, and 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module. Refer to the MELSEC iQ-R CPU Module User's Manual (Application).			
205H	i_bEN (execution command) has been turned off during the processing.	Do not turn off i_bEN (execution command) until o_bOK (normal completion) or o_bErr (error completion) turns on.			

M+DataStatistics\_CalcCoefficient\_R

#### Overview

Item	Description					
Functional overview	Calculates the coefficient of correlation and the coefficient of determination from predicted values and observed values.					
Symbol	M+DataStatistics_CalcCoefficient_R					
	(1) — B : i_bEN o_bENO : B — (6)					
	(2) — UD : i_udSize					
	(3) — UW : i_uDataType o_bErr : B — (8)					
	(4) — UD : i_udXaxisDataAddr o_uErrld : UW — (9)					
	(5) — UD : i_udYaxisDataAddr o_eCorrCoeff : E — (10)					
	o_eCoeffDetR2 : E (11)					

#### Labels to use

#### ■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udSize	Number of data points	Double Word [unsigned]	1 to 90000	Sets the number of input data points for the operation to calculate a coefficient of correlation and a coefficient of determination.
(3)	i_uDataType	Input data type selection	Word [unsigned]	0, 2	Specifies the data type of the input data. 0: Word [signed] 2: Single-precision real number
(4)	i_udXaxisDataAddr	Start address of data of predicted values (X-axis)	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where data of predicted values are stored.
(5)	i_udYaxisDataAddr	Start address of data of observed values (Y-axis)	Double Word [unsigned]	Valid device range <sup>*1</sup>	Specifies the start address of the file register (ZR) where data of observed values are stored.

\*1 The valid range varies depending on "File Register Setting" of "CPU Parameter".

#### ■Output labels

No.	Variable name	Name	Data type	Default value	Description
(6)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(7)	o_bOK	Normal completion	Bit	Off	The on state indicates that the operation to calculate a coefficient of correlation and a coefficient of determination has been completed.
(8)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(9)	o_uErrld	Error code	Word [unsigned]	0	The error code of an error that occurred in the FB is returned.
(10)	o_eCorrCoeff	Coefficient of correlation	Single-precision real number	0	The coefficient of correlation calculated from the data of predicted values and the data of observed values is returned.
(11)	o_eCoeffDetR2	Coefficient of determination	Single-precision real number	0	The coefficient of determination calculated from the data of predicted values and the data of observed values is returned.

FB details						
Item	Description	on				
Relevant devices	CPU modul	e	М	IELSEC iQ-R series		
	Engineering	tool	G	X Works3 of version 1.05	5H or later	
Language to use	- (The inte	— (The internal program of this FB is not open to the public.)				
Number of steps	2893 steps The numbe options sett	2893 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.				
Label usage	• Label: 4.0 • Latch lab The usage of options sett	<ul> <li>Label: 4.09K points (Word)</li> <li>Latch label: 0K points (Word)</li> <li>The usage of labels embedded in a program depends on the CPU module used, the devices specified as an argument, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.</li> </ul>				
FB dependence	No depende	ence				
Functional description	(1) As i_bE from spo The FB of deter (2) This FB Coefficie	N (execution comman ecified data of predicte stores a calculated co mination in o_eCoeffE calculates the coeffic ent of determination (f	nd) turns on, th ed values and pefficient of com DetR2 (coefficie ient of correlat R <sup>2</sup> ) = Coefficie	is FB calculates a coefficie observed values. relation in o_eCorrCoeff (o ent of determination). ion and the coefficient of o nt of correlation (R) × Coe	ent of correlation coefficient of cor determination wi fficient of correla	n and a coefficient of determination relation), and a calculated coefficient ith the following formulas. ation (R)
	Coofficient	of		Covarianc	e	
	correlation	(R) = (Standard de	viation of data	of predicted values) × (Sta	andard deviation	n of data of observed values)
	Covarianc	$e = \frac{1}{N} \sum_{i=1}^{N} (x_i - \overline{x})(y_i)$	- <u>y</u> )			
	Standard "N" stan predicte values ( (3) The followir Example The followir • i_udSize • i_uDataT • i_udXaxis • i_udYaxis	<ul> <li>Standard deviation = √(1/N) ∑<sub>i=1</sub><sup>N</sup> (X<sub>i</sub> - x̄)<sup>2</sup></li> <li>"N" stands for the number of data points, "x<sub>i</sub>" for i-th data of predicted values (X-axis), "x̄" for the mean value of data of predicted values (X-axis), "y<sub>i</sub>" for i-th data of observed values (Y-axis), and "y" for the mean value of data of observed values (Y-axis).</li> <li>(3) The following is a calculation example of a coefficient of correlation and a coefficient of determination.</li> <li>■Example</li> <li>The following figures show an operation example of when values of each input label are as follows.</li> <li>i_udSize (number of data points): 5</li> <li>i_uDataType (input data type selection): 0</li> <li>i_udXaxisDataAddr (start address of data of predicted values (X-axis)): 0</li> <li>i_udYaxisDataAddr (start address of data of observed values (Y-axis)): 10</li> </ul>				
	Measured	Data of predicted va	alues (X-axis)	Data of observed value	s (Y-axis)	
	value	File register	Stored value	File register	Stored value	
	1st time	ZR0	20	ZR10	19	-
	2nd time	ZR1	30	ZR11	33	-
	3rd time	ZR2	40	ZR12	38	-
	4th time	ZR3	50	ZR13	49	-
	The mean value of data of predicted values (X-axis): $(20 + 30 + 40 + 50 + 60) \div 5 = 40$ The mean value of data of observed values (Y-axis): $(19 + 33 + 38 + 49 + 65) \div 5 = 40.8$ The following values are obtained by applying the above values to the formulas to calculate standard deviations and a covariance. Standard deviation of predicted values = $\sqrt{\frac{(20 - 40)^2 + (30 - 40)^2 + (40 - 40)^2 + (50 - 40)^2 + (60 - 40)^2}{5}} = 14.142$ Standard deviation of predicted values = $\sqrt{\frac{(19 - 40.8)^2 + (33 - 40.8)^2 + (38 - 40.8)^2 + (49 - 40.8)^2 + (65 - 40.8)^2}{5}} = 15.4713$ Covariance					
	= 216					

Item	Description				
Functional description		The following value is obtained by applying the covariance and the standard deviations to the formula to calculate a coefficient of correlation.			
		$\begin{array}{c} \text{Coefficient of} \\ \text{correlation} \end{array} = \frac{216}{14.142 \times 15.4713} \approx 0.9872 \end{array}$			
		<ul> <li>correlation =</li></ul>			
		i_udYaxisDataAddr (start address of data of observed values (Y-axis)) are overlapped. In such a case, o_bErr (error			
		<ul> <li>(11)When 2 (single-precision real number) is set in i_uDataType (input data type selection) and input data is not a single-precision real number, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 200H is stored in o_uErrld (error code). For the error code, refer to the list of error codes. (C) Page 31 List of error codes. (C) Page 31 List of error codes.</li> <li>(11)When 2 (single-precision real number) is set in i_uDataType (input data type selection) and input data is not a single-precision real number, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 200H is stored in o_uErrld (error code). For the error code, refer to the list of error codes. (C) Page 31 List of error codes)</li> <li>(12)If neither a coefficient of correlation nor a coefficient of determination can be calculated because values stored as data of predicted values or data of observed values are inappropriate, o_bErr (error completion) turns on and the processing of the predicted values or data of observed values are inappropriate, o_bErr (error completion) turns on and the processing of the predicted values or data of observed values are inappropriate, o_bErr (error completion) turns on and the processing of the predicted values or data of observed values are inappropriate.</li> </ul>			
		(SP Page 31 List of error codes)			
FB compilation	n method	Subroutine type			
FB operation		Pulse execution type (multiple scan execution type)			
Timing chart of I/O signals	Normal completion				
		o_bENO     OFF       Calculation of the coefficient of correlation and the coefficient of correlation     Unexecuted       o_bOK     OFF       o_bErr     OFF       o_uErrld     OFF			
	Error				
	completion	i_bEN     OFF       o_bENO     OFF       Calculation of the coefficient of correlation and the coefficient of determination     Unexecuted       o_bOK     OFF       o_bErr     OFF			
		o_uErrId 0 Error code 0			

Item	Description
Restrictions and precautions	<ol> <li>This FB does not include the error recovery processing. Prepare the error recovery processing separately to suit the user's system and the expected operation.</li> <li>The FB cannot be used in an interrupt program.</li> <li>Using the FB in a program that is to be executed only once, such as a subroutine program or a FOR-NEXT loop, has a problem that i_bEN (execution command) can no longer be turned off and normal operation is not possible; Always use the FB in a program that is capable of turning off the execution command.</li> <li>The FB requires the configuration of the ladder for every input label.</li> <li>Change "Memory/Device Setting" of "CPU Parameter" so that the memory capacity required to use this FB is secured. If "Memory/Device Setting" is not changed, an error may occur on GX Works3.</li> <li>This FB checks the input data values before the operation execution to calculate a coefficient of correlation and a coefficient of determination to prevent an overflow from occurring during the operation. If a possibility of an overflow is detected at this check, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code). For the operation with the single-precision real number, an error may occur depending on the combination of input data values. Even after the input data values are checked, the instruction execution fault (operation error) may occur at the operation error occurs, o_bErr (error completion) turns on and 203H is stored in o_uErrld (error code).</li> <li>If 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module due to an error outside FB while i_bEN (execution command) of this FB is on, o_bErr (error completion) turns on and the processing of "CPU Parameter" is set to stop the processing after an operatior "RAS Setting" of "CPU Parameter" is set to stop the processing after an operation error outside FB while i_bEN (execution command) of this FB is on, o_bErr (error completion) turns on and the pro</li></ol>

The following table lists the performance values of this FB under the following conditions.

- CPU module: R120CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label		Time required for the	Maximum scan time	Number of the scans required for the processing	
Number of data points	Input data type	processing <sup>^1</sup>			
2 points	0: Word [signed]	0.162ms	0.221ms	2 scans	
	2: Single-precision real number	0.151ms	0.223ms		
45000 points	0: Word [signed]	607.000ms	0.999ms	1125 scans	
	2: Single-precision real number	659.000ms	0.996ms		
90000 points	0: Word [signed]	1220.000ms	0.999ms	2250 scans	
	2: Single-precision real number	1320.000ms	0.999ms		

\*1 The time required from start to end of the processing

List of error codes				
Error code	Description	Action		
103H	A value out of the range is set in i_uDataType (input data type selection).	Review and correct the setting and then execute the FB again. Set 0 or 2 in i_uDataType (input data type selection).		
105H	A value out of the range is set in i_udSize (number of data points).	Set a value of 2 to 90000 in i_udSize (number of data points). Review and correct the setting and then execute the FB again.		
11DH	Some areas of input data and output data are overlapped.	<ul> <li>Review the following settings so that the input data areas and the output data areas are not overlapped.</li> <li>i_udSize (number of data points)</li> <li>i_udXaxisDataAddr (start address of data of predicted values (X-axis))</li> <li>i_udYaxisDataAddr (start address of data of observed values (Y-axis))</li> <li>Review and correct the settings and then execute the FB again.</li> </ul>		
200H	Although the value set in i_uDataType (input data type selection) is Single-precision real number, the stored input data is not a single- precision real number.	Store the input data as a single-precision real number in the file register (ZR). Review and correct the input data and then execute the FB again.		
203H	An overflow has occurred in the FB during the operation.	Review and correct the input data stored and then execute the FB again. When 3403H is stored in the special register SD0 (Latest self- diagnostic error code) of the CPU module, refer to the MELSEC iQ-R CPU Module User's Manual (Application).		
204H	The processing of the FB has been interrupted due to an overflow in an operation other than that of this FB.	An overflow has occurred in the operation other than that of this FB, and 3403H is stored in the special register SD0 (Latest self-diagnostic error code) of the CPU module. Refer to the MELSEC iQ-R CPU Module User's Manual (Application).		
205H	i_bEN (execution command) has been turned off during the processing.	Do not turn off i_bEN (execution command) until o_bOK (normal completion) or o_bErr (error completion) turns on.		
210H	Neither a coefficient of correlation nor a coefficient of determination can be calculated since the values stored either as data of predicted values (X-axis) or as data of observed values (Y- axis) are all the same.	Check that either data of predicted values or data of observed values stored in the file register are not all the same values, then execute the FB again.		

## **INSTRUCTION INDEX**

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## **REVISIONS**

*The manual number is given on the bottom left of the back cover.			
Revision date	*Manual number	Description	
May 2017	BCN-P5999-0835-A	First edition	
January 2018	BCN-P5999-0835-B	<ul> <li>Additional FB</li> <li>M+DataStatistics_FrequencyDistribution_R</li> <li>Added or modified parts</li> <li>Section 1.1, 2.4</li> </ul>	
June 2018	BCN-P5999-0835-C	■Added or modified parts Section 2.1, 2.2, 2.3	
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