MITSUBISHI ELECTRIC

Programmable Controller

MELSEC iQ-R series

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

CONTENTS

1 OVERVIEW

The FB library in this manual is for data analysis.

1.1 FB Library List

The following table lists the FB library in this manual.

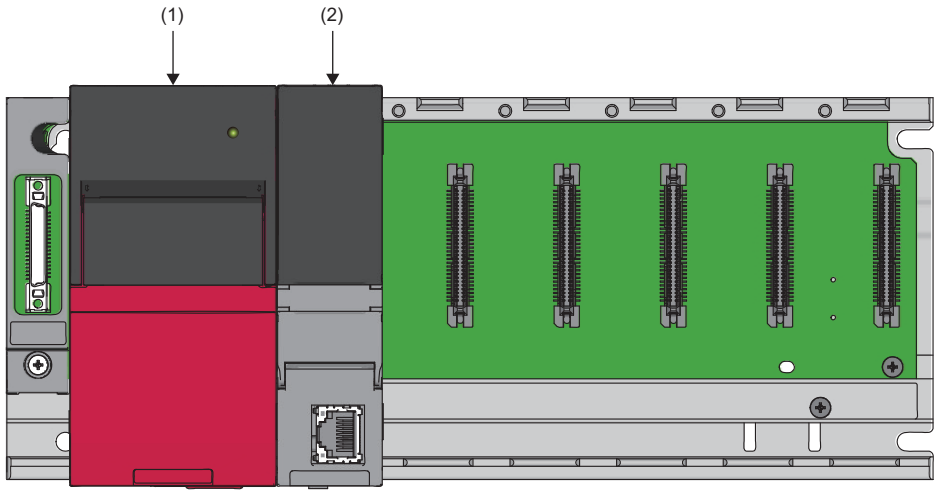
Name	Description
M+DataAnalysis_FFTSpectrum_R	Calculates the FFT spectrum of the specified wave.
M+DataAnalysis_BoundCompareTest_R	Determines if the specified wave is within the specified check value (upper/lower limit value) range.
M+DataAnalysis_Different_R	Calculates the differential operation result of the specified data.
M+DataAnalysis_Integration_R	Calculates the integral operation result of the specified data.

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.

MEMO

2 DETAILS OF THE FB LIBRARY

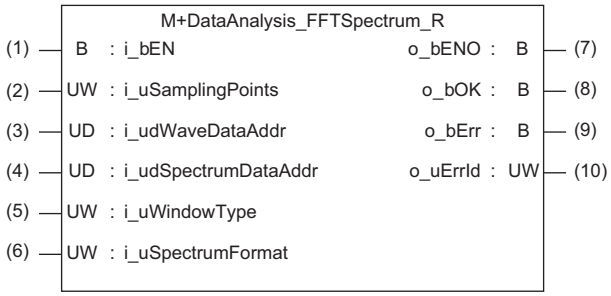
This chapter describes the details of the FB library.

2.1 M+DataAnalysis_FFTSpectrum_R

Name

M+DataAnalysis_FFTSpectrum_R

Overview

Item	Description
Functional overview	Calculates the FFT spectrum of the specified wave.
Symbol	

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_uSamplingPoints	Number of sampling points	Word [unsigned]	6 to 13	Sets the number of sampling points (64 to 8192 points). When the number of sampling points is N, the formula, i_uSamplingPoints = $\log_2 N$, must be satisfied. • i_uSamplingPoints = 6: 64 points • i_uSamplingPoints = 7: 128 points • i_uSamplingPoints = 8: 256 points • i_uSamplingPoints = 9: 512 points • i_uSamplingPoints = 10: 1024 points • i_uSamplingPoints = 11: 2048 points • i_uSamplingPoints = 12: 4096 points • i_uSamplingPoints = 13: 8192 points
(3)	i_udWaveDataAddr	Wave data start address	Double Word [unsigned]	Valid device range*1	Specifies the start address of the file register (ZR) in which wave data to be analyzed is stored.
(4)	i_udSpectrumDataAddr	Output spectrum start address	Double Word [unsigned]	Valid device range*1	Specifies the start address of the file register (ZR) in which analysis results (spectra) are to be stored. Occupies the areas starting from the start device for the number of sampling points.
(5)	i_uWindowType	Window function	Word [unsigned]	0 to 2	Specifies the window function used in the fast Fourier transform (FFT). 0: Not used (do-nothing window) 1: Hanning window 2: Hamming window
(6)	i_uSpectrumFormat	Output spectrum format	Word [unsigned]	0 to 3	Specifies an output spectrum format of the fast Fourier transform (FFT). 0: Power 1: Half amplitude 2: Total amplitude 3: Effective value

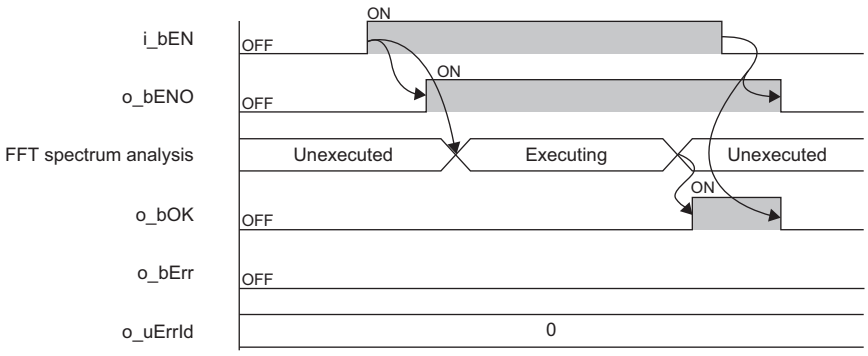
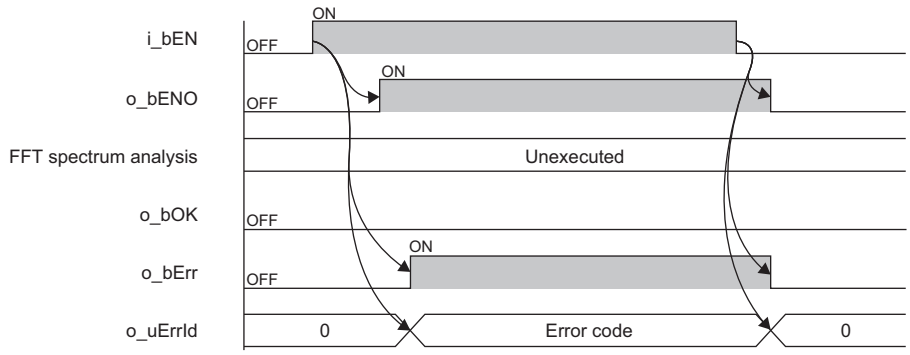
*1 The valid range varies depending on "Device/Label Memory Area Setting" of "CPU Parameter".

■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 FFT spectral analysis has been completed.
(9)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(10)	o_uErrId	Error code	Word [unsigned]	0	The error code of an error occurred in the FB is returned.

FB details

Item	Description	
Relevant devices	CPU module	MELSEC iQ-R series
	Engineering tool	GX Works3 of version 1.015R or later
Language to use	— (The internal program of this FB is not open to the public.)	
Number of steps	16415 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.	
FB dependence	No dependence	
Functional description	(1) As i_bEN (execution command) turns on, this FB calculates the spectrum (magnitude of frequency components) with the fast Fourier transform (FFT). Use this FB to calculate the frequency components of the data (wave data) that contains sampled vibration and sound. (2) The analysis target input wave data of the fast Fourier transform (FFT) is read from the file register (ZR) of the address specified by i_udWaveDataAddr (wave data start address). This FB reads input wave data for the number of points set in i_uSamplingPoints (number of sampling points). (3) Input wave data is read as data in the word [signed] format. (4) Analysis results (spectra) are stored in the file register (ZR) of the address specified by i_udSpectrumDataAddr (output spectrum start address). This FB outputs analysis results (spectra) for the number of points set in i_uSamplingPoints (number of sampling points). (5) Analysis results (spectra) are output as data in the word [signed] format. This FB normalizes and outputs the entire analysis results by setting the maximum value of the analysis results to 32767. (6) Frequency resolution of analysis results (spectra) can be calculated with the following formula. $\text{Frequency resolution} = \frac{1}{\text{Sampling cycle for input wave data [sec]} \times \text{Number of sampling points [point]}}$ [Hz] ■Example When the sampling cycle of the input wave data is 5μs and the number of sampling points is 8192, the frequency resolution is as follows. $\text{Frequency resolution} = \frac{1}{0.000005\ [\text{sec}] \times 8192\ [\text{point}]} \fallingdotseq 24.4$ [Hz] (7) The valid components of analysis results (spectra) are the data of Nyquist frequency (sampling frequency/2) and before, and the number of valid points for analysis results (spectra) is the number of sampling points/2. ■Example When the sampling cycle of the input wave data is 5μs and the number of sampling points is 8192, the maximum value of valid frequency components and the number of valid points are as follows. • Maximum value of valid frequency components: 1 ÷ 0.000005[sec] ÷ 2 = 100000[Hz] • Number of valid points: 8192 ÷ 2 = 4096[point] (8) It takes multiple scans until the fast Fourier transform (FFT) is completed. Thus, do not change the analysis target wave data until the processing is completed. When the fast Fourier transform (FFT) is completed, o_bOK (normal completion) turns on. (9) This FB supports window functions, Not used (do-nothing window), Hanning window, and Hamming window. Set a window function to be used in i_uWindowType (window function). (10)The FB supports output spectrum formats, power, half amplitude, total amplitude, and effective value. Set an output spectrum format to be used in i_uSpectrumFormat (output spectrum format). (11)If a value out of the range is set in i_uSamplingPoints (number of sampling points), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 100H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 7 List of error codes) (12)If a value out of the range is set in i_uWindowType (window function), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 101H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 7 List of error codes) (13)If a value out of the range is set in i_uSpectrumFormat (output spectrum format), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 102H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 7 List of error codes)	

Item		Description
FB compilation method		Subroutine type
FB operation		Pulse execution type (multiple scan execution type)
Timing chart of I/O signals	Normal completion	
	Error completion	
Restrictions and precautions		(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 LZ0. When using an interrupt program, 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 label areas of up to the maximum number of sampling points (8192 points) × 3 words for the fast Fourier transform (FFT) operation. Thus, the label area capacity may be insufficient depending on the CPU module used. When the label area capacity is insufficient, refer to the following and extend the capacity. MELSEC iQ-R CPU Module User's Manual (Application)

Performance value

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

- CPU module: R08CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label			Time required for the processing*1	Maximum scan time	Number of the scans required for the processing
Number of sampling points	Window function	Output spectrum format			
6: 64 points	0: Not used (do-nothing window)	0: Power	1.6ms	0.249ms	9 scans
		1: Half amplitude	1.73ms	0.325ms	
		2: Total amplitude	1.72ms	0.327ms	
		3: Effective value	1.72ms	0.328ms	
	1: Hamming window	0: Power	1.8ms	0.319ms	
		1: Half amplitude	1.9ms	0.32ms	
		2: Total amplitude	1.96ms	0.327ms	
		3: Effective value	1.9ms	0.326ms	
	2: Hanning window	0: Power	1.81ms	0.321ms	
		1: Half amplitude	1.9ms	0.32ms	
		2: Total amplitude	1.93ms	0.32ms	
		3: Effective value	1.91ms	0.319ms	
13: 8192 points	0: Not used (do-nothing window)	0: Power	236ms	12ms	1434 scans
		1: Half amplitude	251ms	24.8ms	
		2: Total amplitude	252ms	25.6ms	
		3: Effective value	252ms	25.6ms	
	1: Hamming window	0: Power	259ms	22.7ms	
		1: Half amplitude	273ms	24.9ms	
		2: Total amplitude	274ms	25.5ms	
		3: Effective value	274ms	25.5ms	
	2: Hanning window	0: Power	260ms	23.7ms	
		1: Half amplitude	274ms	24.8ms	
		2: Total amplitude	275ms	25.5ms	
		3: Effective value	275ms	25.5ms	

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

List of error codes

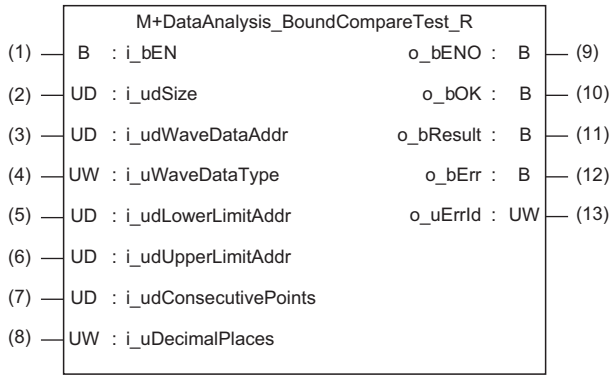
Error code	Description	Action
100H	A value out of the range is set in i_uSamplingPoints (number of sampling points).	Set a value of 6 to 13 in i_uSamplingPoints (number of sampling points). Review and correct the setting and then execute the FB again.
101H	A value out of the range is set in i_uWindowType (window function).	Set a value of 0 to 2 in i_uWindowType (window function). Review and correct the setting and then execute the FB again.
102H	A value out of the range is set in i_uSpectrumFormat (output spectrum format).	Set a value of 0 to 3 in i_uSpectrumFormat (output spectrum format). Review and correct the setting and then execute the FB again.

2.2 M+DataAnalysis_BoundCompareTest_R

Name

M+DataAnalysis_BoundCompareTest_R

Overview

Item	Description
Functional overview	Determines whether the specified wave is within the specified check value (upper/lower limit value) range.
Symbol	

Labels to use

■Input labels

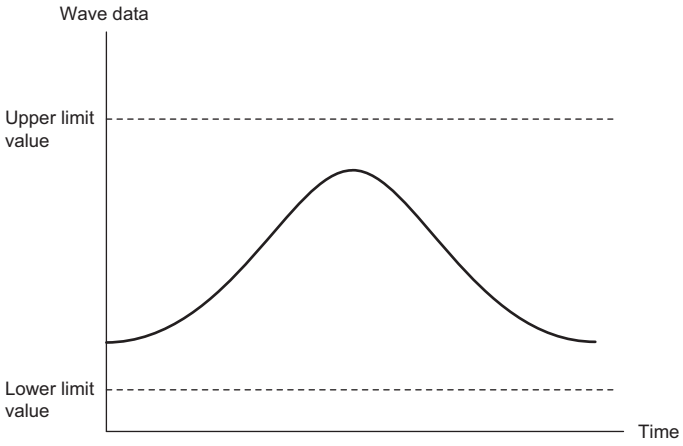
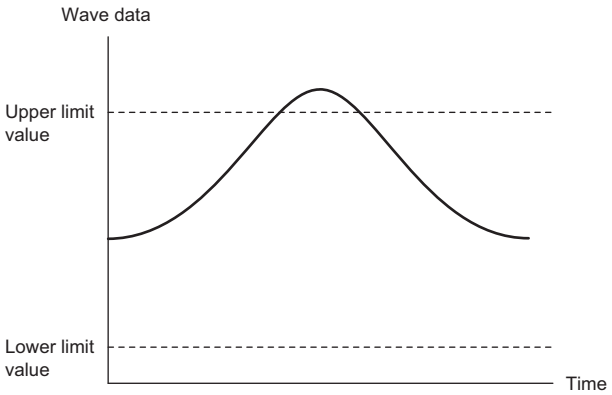
No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_udSize	Number of data points	Double Word [unsigned]	1 to 1000000	Sets the number of data points (1 to 1000000 points).
(3)	i_udWaveDataAddr	Wave data start address	Double Word [unsigned]	Valid device range*1	Specifies the start address of the file register (ZR) where wave data to be calculated is stored.
(4)	i_uWaveDataType	Wave data type selection	Word [unsigned]	0 to 2	Specifies the data type of the wave data to be calculated. 0: Word [signed] 1: Double Word [signed] 2: Single-precision real number
(5)	i_udLowerLimitAddr	Check value (lower limit value) address	Double Word [unsigned]	Valid device range*1	Specifies the address of the file register (ZR) where the check value (lower limit value) is stored.
(6)	i_udUpperLimitAddr	Check value (upper limit value) address	Double Word [unsigned]	Valid device range*1	Specifies the address of the file register (ZR) where the check value (upper limit value) is stored.
(7)	i_udConsecutivePoints	Number of consecutive excess points	Double Word [unsigned]	1 to 100	Specifies the number of consecutive points with which values are recognized as having exceeded or fallen below the reference value.
(8)	i_uDecimalPlaces	Number of significant decimal places	Word [unsigned]	0 to 6	Specifies the number of significant digits after the decimal point when 2: Single-precision real number is set in i_uWaveDataType (wave data type selection). This setting is invalid when a value other than 2: Single-precision real number is set. When the number of significant decimal places is out of the range, the number is handled as four places.

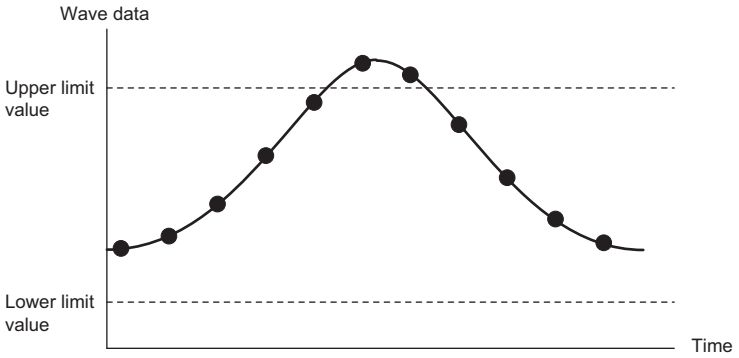
*1 The valid range varies depending on "Device/Label Memory Area Setting" of "CPU Parameter".

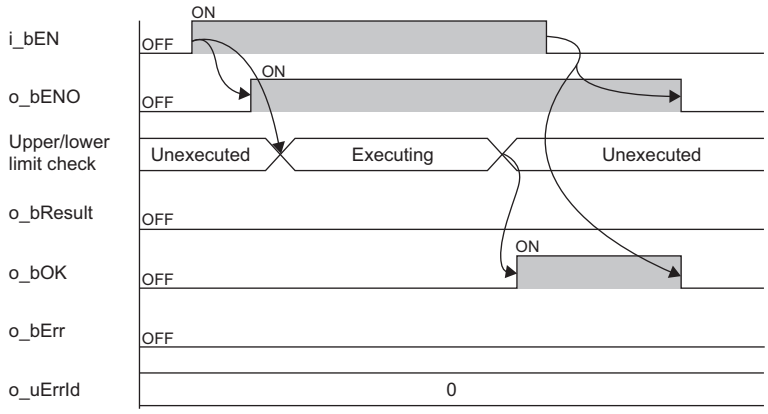
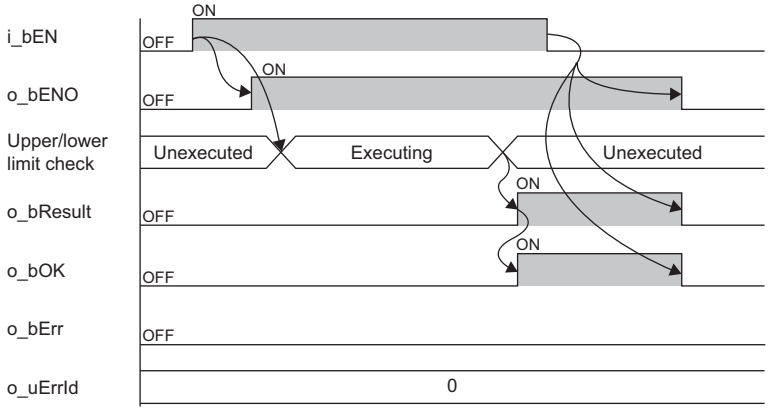
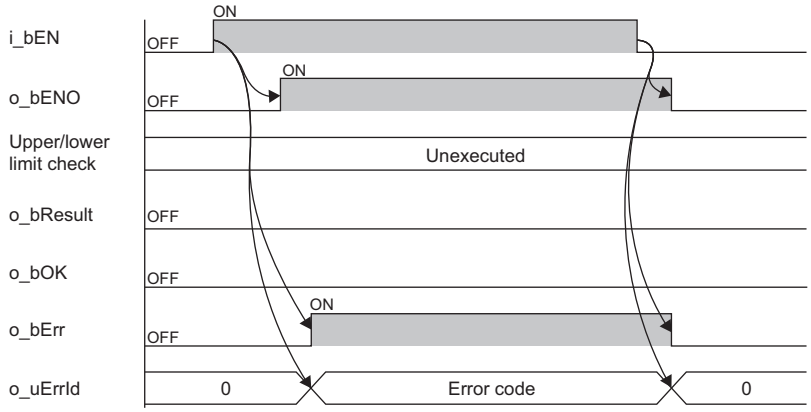
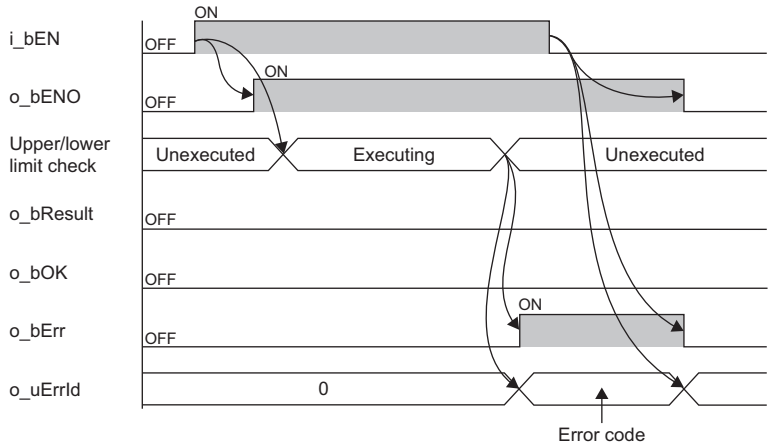
■Output labels

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 upper/lower limit check has been completed.
(11)	o_bResult	Check result	Bit	Off	A check result is stored. Off: Passed On: Failed
(12)	o_bErr	Error completion	Bit	Off	The on state indicates that an error has occurred in the FB.
(13)	o_uErrId	Error code	Word [unsigned]	0	The error code of an error occurred in the FB is returned.

FB details

Item	Description	
Relevant devices	CPU module	MELSEC iQ-R series
	Engineering tool	GX Works3 of version 1.015R or later
Language to use	— (The internal program of this FB is not open to the public.)	
Number of steps	1533 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.	
FB dependence	No dependence	
Functional description	(1) As i_bEN (execution command) turns on, whether the specified wave is within the specified check value (upper/lower limit value) range is determined. • When the specified wave is within the range, o_bResult (check result) turns off (Passed).  • When the specified wave is out of the range, o_bResult (check result) turns on (Failed).  (2) The target wave data for upper/lower limit check is read from the file register (ZR) of the address specified by i_udWaveDataAddr (wave data start address). This FB reads wave data for the number of points set in i_udSize (number of data points). (3) Specify Word [signed], Double Word [signed], or Single-precision real number as the data type of wave data and check value in i_uWaveDataType (wave data type selection).	

Item	Description
Functional description	(4) The check values are read from the file register (ZR) of the addresses specified by i_udLowerLimitAddr (check value (lower limit value) address) and i_udUpperLimitAddr (check value (upper limit value) address). Set input labels so that the check values stored in the file register (ZR) of the addresses specified by i_udLowerLimitAddr (check value (lower limit value) address) and i_udUpperLimitAddr (check value (upper limit value) address) satisfy the condition of "check value (lower limit value) ≤ check value (upper limit value)". (5) It takes multiple scans until the upper/lower limit check is completed. Thus, do not change the target wave data or check value until the processing is completed. When the upper/lower limit check is completed, o_bOK (normal completion) turns on. (6) For this FB, the number of consecutive points with which values are recognized as having exceeded or fallen below the reference value can be specified. Specify the number of consecutive points in i_udConsecutivePoints (number of consecutive excess points). ■Example When 3 is set in i_udConsecutivePoints (number of consecutive excess points), o_bResult (check result) turns off (Passed) since the upper limit value is consecutively exceeded at only two points in the following figure.  (7) For this FB, the number of significant digits after the decimal point can be specified when 2: Single-precision real number is set in i_uWaveDataType (wave data type selection). Specify the number of significant digits by i_uDecimalPlaces (decimal places). If a value out of the range is set in i_uDecimalPlaces (decimal places), the number of significant decimal places is handled as four places. (8) 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_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 13 List of error codes) (9) If a value out of the range is set in i_uWaveDataType (wave data type selection), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 103H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 13 List of error codes) (10)When a single-precision real number is set in i_uWaveDataType (wave 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. (☞ Page 13 List of error codes) (11)When the check values stored in the file register (ZR) of the addresses specified by i_udLowerLimitAddr (check value (lower limit value) address) and i_udUpperLimitAddr (check value (upper limit value) address) satisfy the condition of "check value (lower limit value) > check value (upper limit value)", o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 202H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 13 List of error codes) (12)If a value out of the range is set in i_udConsecutivePoints (number of consecutive excess points), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 108H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 13 List of error codes)
FB compilation method	Subroutine type
FB operation	Pulse execution type (multiple scan execution type)

Item		Description
Timing chart of I/O signals	Normal completion	• When the specified wave passes the check  • When the specified wave fails the check 
	Error completion	• When an error occurs at startup  • When an error occurs at execution 

Item	Description
Restrictions and precautions	(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 LZ0. When using an interrupt program, 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.

Performance value

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

- CPU module: R120CPU
- File register storage location: Extended SRAM cassette
- FB compilation method: Subroutine type

Input label				Time required for the processing*1	Maximum scan time	Number of the scans required for the processing
Number of data points	Wave data type selection	Number of consecutive excess points	Number of significant decimal places			
8192: 8192 points	0: Word [signed]	1: 1 point	—	8.62ms	1.13ms	9 scans
		100: 100 points	—	8.72ms	1.17ms	
	1: Double Word [signed]	1: 1 point	—	9.23ms	1.18ms	
		100: 100 points	—	9.15ms	1.14ms	
	2: Single-precision real number	1: 1 point	0: 0 place	111ms	13.6ms	
			6: 6 places	107ms	13.2ms	
		100: 100 points	0: 0 place	109ms	13.4ms	
			6: 6 places	107ms	13.2ms	
32768: 32768 points	0: Word [signed]	1: 1 point	—	41.3ms	1.36ms	33 scans
		100: 100 points	—	40.2ms	1.34ms	
	1: Double Word [signed]	1: 1 point	—	47ms	1.57ms	
		100: 100 points	—	46.9ms	1.54ms	
	2: Single-precision real number	1: 1 point	0: 0 place	442ms	13.6ms	
			6: 6 places	434ms	13.4ms	
		100: 100 points	0: 0 place	441ms	13.6ms	
			6: 6 places	434ms	13.4ms	
1000000: 1000000 points	0: Word [signed]	1: 1 point	—	1230ms	1.31ms	1000 scans
		100: 100 points	—	1230ms	1.32ms	
	1: Double Word [signed]	1: 1 point	—	1430ms	1.53ms	
		100: 100 points	—	1430ms	1.53ms	
	2: Single-precision real number	1: 1 point	0: 0 place	13500ms	13.6ms	
			6: 6 places	13300ms	13.4ms	
		100: 100 points	0: 0 place	13500ms	13.6ms	
			6: 6 places	13300ms	13.4ms	

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

List of error codes

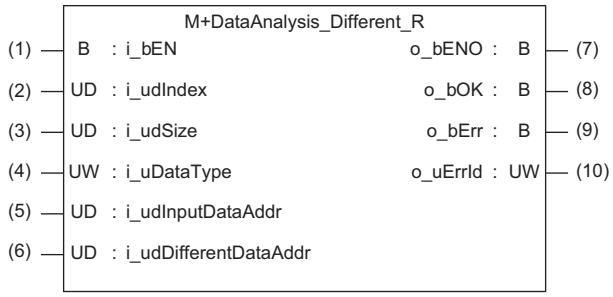
Error code	Description	Action
103H	A value out of the range is set in i_uWaveDataType (wave data type selection).	Set a value of 0 to 2 in i_uWaveDataType (wave data type selection). Review and correct the setting and then execute the FB again.
105H	A value out of the range is set in i_udSize (number of data points).	Set a value of 1 to 1000000 in i_udSize (number of data points). Review and correct the setting and then execute the FB again.
108H	A value out of the range is set in i_udConsecutivePoints (number of consecutive excess points).	Set a value of 1 to 100 in i_udConsecutivePoints (number of consecutive excess points). Review and correct the setting and then execute the FB again.
200H	Although the value set in i_uWaveDataType (wave data type selection) is Single-precision real number, any of the following stored values is not a single-precision real number. • Wave data • Check value (lower limit value) • Check value (upper limit value)	Store the data as a single-precision real number in the file register (ZR). Review and correct the input wave data, check value (lower limit value), and check value (upper limit value), and then execute the FB again.
202H	The check value (lower limit value) is greater than the check value (upper limit value).	Set both the check values so that the check value (lower limit value) is equal to or smaller than the check value (upper limit value). Review and correct the settings and then execute the FB again.

2.3 M+DataAnalysis_Different_R

Name

M+DataAnalysis_Different_R

Overview

Item	Description
Functional overview	Calculates the differential operation result of the specified data.
Symbol	

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_udIndex	Comparative data index	Double Word [unsigned]	0 to 89999	Specifies how far one area must be away from the other to calculate the difference of input data in these areas.
(3)	i_udSize	Number of data points	Double Word [unsigned]	1 to 90000	Specifies the number of data points (1 to 90000 points).
(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*1	Specifies the start address of the file register (ZR) where the input data is stored.
(6)	i_udDifferentDataAddr	Output data start address	Double Word [unsigned]	Valid device range*1	Specifies the start address of the file register (ZR) where the differential operation result is stored. As the operation results are output as single-precision real numbers (2-word), they are stored in file register within the range of "(number of data points - comparative data index) × 2", starting from the file register (ZR) specified with the output data start address.

*1 The valid range varies depending on "Device/Label Memory Area 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 differential 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_uErrId	Error code	Word [unsigned]	0	The error code of an error occurred in the FB is returned.

FB details

Item	Description	
Relevant devices	CPU module	MELSEC iQ-R series
	Engineering tool	GX Works3 of version 1.015R or later
Language to use	— (The internal program of this FB is not open to the public.)	
Number of steps	444 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.	
FB dependence	No dependence	

Item	Description
Functional description	(1) As i_bEN (execution command) turns on, this FB calculates a differential value of the specified input data values. This FB uses data in file register areas for the number of data points starting from the one specified with the input data start address. The FB calculates the difference between input data values in two areas, one of which is away from the other by the number specified with the comparative data index. And then the FB stores the result in file register areas in order starting from the output data start address. This FB calculates the differential value with the following formula. Differential (i) = $x_{(i + d)} - x_i$ "x_i" stands for i-th input data and "d" for a value of the comparative data index. ■Example The following figure shows an operation example of when values of each input label are as follows. • i_udIndex (comparative data index): 3 • i_udSize (number of data points): 10 • i_udInputDataAddr (input data start address): 0 • i_udDifferentDataAddr (output data start address): 20

No.	Input data	
1	ZR0 (input data start address)	945
2	ZR1	948
3	ZR2	978
4	ZR3	1011
5	ZR4	1035
6	ZR5	1189
7	ZR6	1263
8	ZR7	1304
9	ZR8	1401
10	ZR9	1584

No.	Output data		Operation
1	ZR20 (output data start address)	66	Difference between No.4 and No.1
2	ZR22	87	Difference between No.5 and No.2
3	ZR24	211	Difference between No.6 and No.3
4	ZR26	252	Difference between No.7 and No.4
5	ZR28	269	Difference between No.8 and No.5
6	ZR30	212	Difference between No.9 and No.6
7	ZR32	321	Difference between No.10 and No.7

As the operation results are output as single-precision real numbers (2-word), they are stored in file register areas within the range of "(i_udSize (number of data points) - i_udIndex (comparative data index)) × 2", starting from the file register area (ZR) specified with i_udDifferentDataAddr (output data start address).

(2) Input data targeted for integral operation is read from file register (ZR), starting from the area of the address specified with i_udInputDataAddr (input data start address), for the number of data points specified with i_udSize (number of data points).

(3) The operation result is output as a single-precision real number, and it is stored in file register in the range of "(i_udSize (number of data points) - i_udIndex (comparative data index)) × 2", starting from the file register area (ZR) of the address specified with i_udDifferentDataAddr (output data start address).

(4) It takes multiple scans until the differential operation is completed. Thus, do not change the input data values used for the operation until the processing is completed. When the operation is completed, o_bOK (normal completion) turns on.

(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 of the FB is interrupted. In addition, 105H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 19 List of error codes)

(6) If a value of i_udIndex (comparative data index) is equal to or larger than that of i_udSize (number of data points), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 116H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 19 List of error codes)

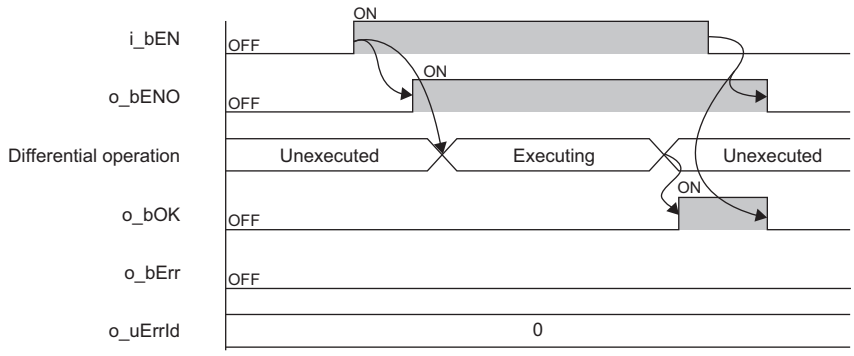
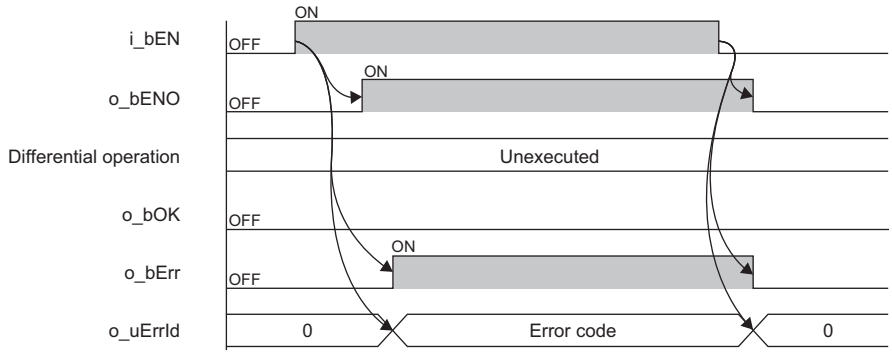
(7) If a value out of the range is set in i_uDataType (input data type selection), o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 103H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 19 List of error codes)

(8) If an overflow occurs during the differential operation, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 203H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 19 List of error codes)

(9) 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_uErrId (error code) in one scan. For the error code, refer to the list of error codes. (☞ Page 19 List of error codes)

(10)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. (☞ Page 19 List of error codes)

FB compilation method	Subroutine type
FB operation	Pulse execution type (multiple scan execution type)

Item		Description
Timing chart of I/O signals	Normal completion	
	Error completion	
Restrictions and precautions		(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 registers LZ0, LZ1, and LZ2. Set the long index (LZ) to three points or greater in "Index Register Setting" of "CPU Parameter". (MELSEC iQ-R CPU Module User's Manual (Application)) When using interrupt programs, do not use the corresponding index registers. (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) This FB requires input data to be stored in the file register. In addition, the FB outputs operation result data in the file register (ZR). Refer to the following examples and set the file register capacity. For how to set the file register capacity, 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) × 3) - (i_udIndex (comparative data index) × 2)" for the file register (ZR). ■When 2 is set in i_uDataType (input data type selection) Set the capacity of "(i_udSize (number of data points) × 4) - (i_udIndex (comparative data index) × 2)" for the file register (ZR). (7) This FB checks the input data values before the differential 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 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_uErrId (error code). (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_uErrId (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_uErrId (error code).

Performance value

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

- CPU module: R08CPU
- File register storage location: CPU built-in memory
- FB compilation method: Subroutine type

Input label			Time required for the processing*1	Maximum scan time	Number of the scans required for the processing
Number of data points	Input data type	Comparative data index			
100 points	0: Word [signed]	99	Cannot be measured	0.159ms	1 scan
		50	4.193ms	0.156ms	50 scans
		0	8.455ms	0.152ms	100 scans
	2: Single-precision real number	99	Cannot be measured	0.157ms	1 scan
		50	4.199ms	0.158ms	50 scans
		0	8.459ms	0.157ms	100 scans
32768 points	0: Word [signed]	32767	Cannot be measured	0.156ms	1 scan
		16383	1404.858ms	0.159ms	16385 scans
		0	2798.199ms	0.152ms	32768 scans
	2: Single-precision real number	32767	Cannot be measured	0.15ms	1 scan
		16383	1408.626ms	0.152ms	16385 scans
		0	2800.049ms	0.16ms	32768 scans
90000 points	0: Word [signed]	89999	Cannot be measured	0.154ms	1 scan
		45000	3845.068ms	0.153ms	45000 scans
		0	7684.673ms	0.158ms	90000 scans
	2: Single-precision real number	89999	Cannot be measured	0.156ms	1 scan
		45000	3849.393	0.157ms	45000 scans
		0	7691.146	0.159ms	90000 scans

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

List of error codes

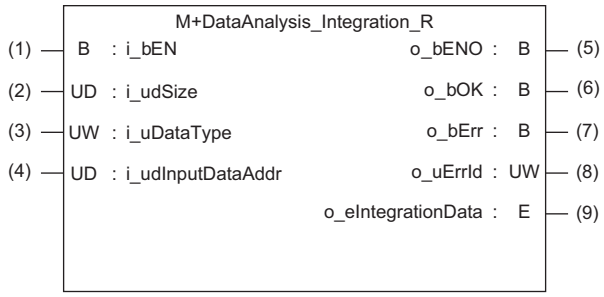
Error code	Description	Action
103H	A value out of the range is set in i_uDataType (input data type selection).	Set 0 or 2 in i_uDataType (input data type selection). Review and correct the setting and then execute the FB again.
105H	A value out of the range is set in i_udSize (number of data points).	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.
116H	A value out of the range is set in i_udIndex (comparative data index).	Set a value that satisfies the following conditions in i_udIndex (comparative data index). • i_udIndex (comparative data index) ≥ 0 • i_udIndex (comparative data index) < 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.

2.4 M+DataAnalysis_Integration_R

Name

M+DataAnalysis_Integration_R

Overview

Item	Description
Functional overview	Calculates the integral operation result of the specified data.
Symbol	

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	Specifies the number of data points (1 to 90000 points).
(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*1	Specifies the start address of the file register (ZR) where the input data is stored.

*1 The valid range varies depending on "Device/Label Memory Area 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 an integral 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_uErrId	Error code	Word [unsigned]	0	The error code of an error occurred in the FB is returned.
(9)	o_eIntegrationData	Output data	Single-precision real number	0	The integral operation result is stored.

FB details

Item	Description	
Relevant devices	CPU module	MELSEC iQ-R series
	Engineering tool	GX Works3 of version 1.015R or later
Language to use	— (The internal program of this FB is not open to the public.)	
Number of steps	290 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.	
FB dependence	No dependence	
Functional description	(1) As i_bEN (execution command) turns on, this FB calculates an integral value of the specified input data values. This FB integrates input data values for the number of data points from the input data start address, and outputs an operation result. This FB calculates the integral value with the following formula. $\text{Integral} = \sum_{i=S}^{(S+D-1)} (x_i)$ "x_i" stands for i-th input data, "S" for input data start address, and "D" for a value of number of data points. ■Example The following figure shows an operation example of when values of each input label are as follows. • i_udSize (number of data points): 7 • i_udInputDataAddr (input data start address): 0 • i_uDataType (input data type selection): 0 (Word [signed])	

No.	Input data	
0	ZR0 (input data start address)	10
1	ZR1	20
2	ZR2	30
3	ZR3	40
4	ZR4	50
5	ZR5	60
6	ZR6	70
7	ZR7	80
8	ZR8	90
9	ZR9	100

The operation result of the following formula is output in o_eIntegrationData (output data).

$$\sum_{i=0}^{(7-1)} (x_i) = x_0 + x_1 + x_2 + x_3 + x_4 + x_5 + x_6$$
$$= 10 + 20 + 30 + 40 + 50 + 60 + 70$$
$$= 280$$

■Example
The following figure shows an operation example of when values of each input label are as follows.
• i_udSize (number of data points): 7
• i_udInputDataAddr (input data start address): 10
• i_uDataType (input data type selection): 2 (Single-precision real number)

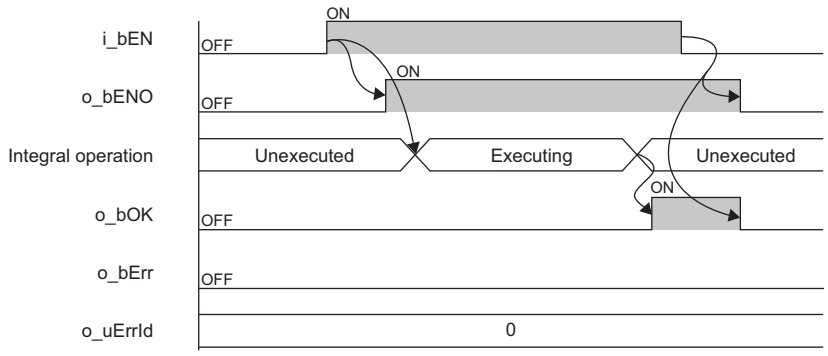
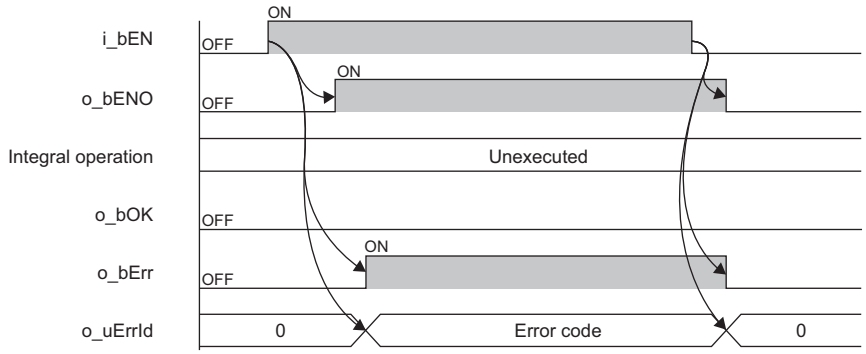
Item	Description
Functional description	

No.	Input data	
0	ZR10 (input data start address)	1.1
	ZR11	
1	ZR12	1.2
	ZR13	
2	ZR14	1.3
	ZR15	
3	ZR16	1.4
	ZR17	
4	ZR18	1.5
	ZR19	
5	ZR20	1.6
	ZR21	
6	ZR22	1.7
	ZR23	

$$\sum_{i=0}^{(7-1)}(x_i) = x_0 + x_1 + x_2 + x_3 + x_4 + x_5 + x_6$$
$$= 1.1 + 1.2 + 1.3 + 1.4 + 1.5 + 1.6 + 1.7$$
$$= 9.8$$

(2) Input data targeted for integral operation is read from file register (ZR), starting from the area of the address specified with i_udInputDataAddr (input data start address), for the number of data points specified with i_udSize (number of data points).
(3) The operation result is output to o_eIntegrationData (output data) as a single-precision real number.
(4) It takes multiple scans until the integral operation is completed. Thus, do not change the input data values used for the operation until the processing is completed. When the operation is completed, o_bOK (normal completion) turns on.
(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 of the FB is interrupted. In addition, 105H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 24 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_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 24 List of error codes)
(7) If an overflow occurs during the integral operation, o_bErr (error completion) turns on and the processing of the FB is interrupted. In addition, 203H is stored in o_uErrId (error code). For the error code, refer to the list of error codes. (☞ Page 24 List of error codes)
(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_uErrId (error code) in one scan. For the error code, refer to the list of error codes. (☞ Page 24 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. (☞ Page 24 List of error codes)

FB compilation method	Subroutine type
FB operation	Pulse execution type (multiple scan execution type)

Item		Description
Timing chart of I/O signals	Normal completion	
	Error completion	
Restrictions and precautions		(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 LZ0. When using an interrupt program, 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) This FB requires input data to be stored in the file register. Refer to the following examples and set the file register capacity. For how to set the file register capacity, 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). ■When 2 is set in i_uDataType (input data type selection) Set the capacity of "i_udSize (number of data points) × 2" for the file register (ZR). (7) This FB checks the input data values before the integral 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 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_uErrId (error code). (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_uErrId (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_uErrId (error code).

Performance value

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

- CPU module R120CPU
- File register storage location: Extended SRAM cassette
- FB compilation method Subroutine type

Input label		Time required for the processing*1	Maximum scan time	Number of the scans required for the processing
Number of data points	Input data type			
100 points	0: Word [signed]	12.000ms	0.214ms	99 scans
	2: Single-precision real number	11.900ms	0.219ms	
45000 points	0: Word [signed]	5230.000ms	0.242ms	44999 scans
	2: Single-precision real number	5240.000ms	0.236ms	
90000 points	0: Word [signed]	10500.000ms	0.244ms	89999 scans
	2: Single-precision real number	10500.000ms	0.245ms	

*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.

MEMO

INSTRUCTION INDEX

M

MEMO

REVISIONS

*The manual number is given on the bottom left of the back cover.

Revision date	*Manual number	Description
December 2015	BCN-P5999-0623-A	First edition
June 2017	BCN-P5999-0623-B	■Additional FBs M+DataAnalysis_BoundCompareTest_R, M+DataAnalysis_Different_R, M+DataAnalysis_Integration_R ■Added or modified parts Section 1.1, 2.1, 2.2, 2.3, 2.4
June 2018	BCN-P5999-0623-C	■Added or modified parts Function block library name, Section 2.1, 2.2, 2.3, 2.4
March 2024	BCN-P5999-0623-D	■Added or modified part Section 2.4

Japanese manual number: BCN-P5999-0622-E

BCN-P5999-0623-D(2403)

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