

Programmable Controller

**MELSEC iQ-F**  
series

MELSEC iQ-F Statistical Analysis  
Function Block Reference

---



# CONTENTS

---

<b>CHAPTER 1 OVERVIEW</b>	<b>2</b>
1.1 Function Block (FB) List.....	2
<b>CHAPTER 2 COEFFICIENT OF DETERMINATION</b>	<b>4</b>
2.1 M+DataStatistics_CoeffDetR2_F (Coefficient of determination calculation).....	5
<b>CHAPTER 3 FB LIBRARY APPLICATION EXAMPLE</b>	<b>8</b>
<b>INSTRUCTION INDEX</b>	<b>12</b>
REVISIONS.....	14

# 1 OVERVIEW

---

## 1.1 Function Block (FB) List

---

The following table lists the FB for performing the statistical analysis.

FB name*1	Description
M+DataStatistics_CoeffDetR2_F	Calculates a coefficient of determination that indicates how close the predictive value is to the actual measurement value.

\*1 Note that this reference does not describe the FB version information which is displayed such as "\_00A" at the end of FB name.



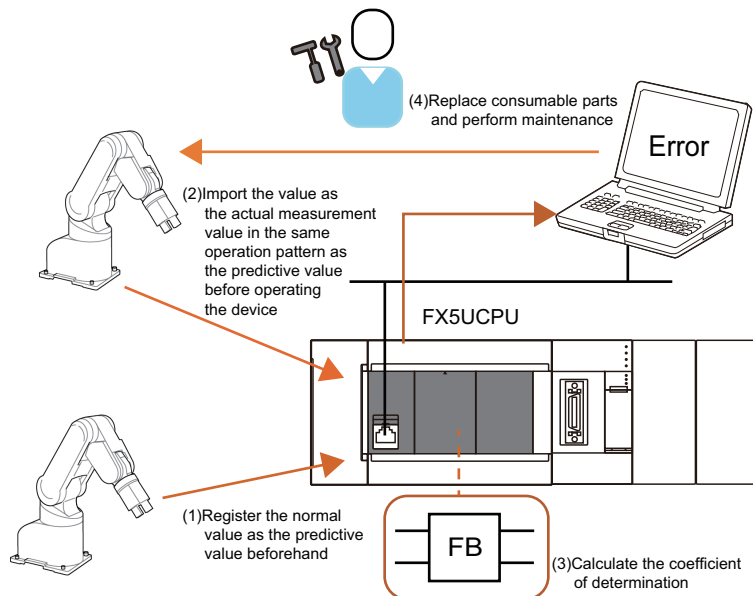
# 2 COEFFICIENT OF DETERMINATION

A coefficient of determination is an index which indicates how close the predictive value is to the actual measurement value. A value from 0 to 1 is calculated, and it indicates that the closer the value approaches 1, the closer two data are.

## Application example

The coefficient of determination is calculated from the change in the value of the current at normal state and the change in the value of the current at present state. The calculated result is used as a guide to replace the consumable parts and perform maintenance.

- (1) Register the change in the value of the current of the device at normal state to the device as the predictive value beforehand.
- (2) Import the change in the value of the current into the device as the actual measurement value in the same operation pattern as the one used when the predictive value is registered before operating the device.
- (3) Calculate the coefficient of determination of the predictive value and actual measurement value in the coefficient of determination calculation FB.
- (4) When the coefficient of determination falls below the set threshold value, it indicates that it is time to replace the consumable parts and perform maintenance.



# 2.1 M+DataStatistics\_CoeffDetR2\_F (Coefficient of determination calculation)

## Name

M+DataStatistics\_CoeffDetR2\_F

## Overview

Item	Description																														
Function overview	Calculates the coefficient of determination from the predictive value and actual measurement value.																														
Symbol	<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 10px auto;"> <p style="text-align: center;">M+DataStatistics_CoeffDetR2_F</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 5%; text-align: right;">(1)</td> <td style="width: 50%;">B : i_bEN</td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 15%; text-align: left;">o_bENO : B</td> <td style="width: 5%; text-align: right;">(5)</td> </tr> <tr> <td>(2)</td> <td>UW : i_uDataPoints</td> <td></td> <td></td> <td>o_bOK : B</td> <td>(6)</td> </tr> <tr> <td>(3)</td> <td>W : i_w500XaxisData</td> <td></td> <td></td> <td>o_bErr : B</td> <td>(7)</td> </tr> <tr> <td>(4)</td> <td>W : i_w500YaxisData</td> <td></td> <td></td> <td>o_uErrId : UW</td> <td>(8)</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>o_eCoeffDetR2 : E</td> <td>(9)</td> </tr> </table> </div>	(1)	B : i_bEN			o_bENO : B	(5)	(2)	UW : i_uDataPoints			o_bOK : B	(6)	(3)	W : i_w500XaxisData			o_bErr : B	(7)	(4)	W : i_w500YaxisData			o_uErrId : UW	(8)					o_eCoeffDetR2 : E	(9)
(1)	B : i_bEN			o_bENO : B	(5)																										
(2)	UW : i_uDataPoints			o_bOK : B	(6)																										
(3)	W : i_w500XaxisData			o_bErr : B	(7)																										
(4)	W : i_w500YaxisData			o_uErrId : UW	(8)																										
				o_eCoeffDetR2 : E	(9)																										

## Label

### Input label

No.	Variable name	Name	Data type	Setting range	Description
(1)	i_bEN	Execution command	Bit	ON, OFF	ON: The FB is activated. OFF: The FB is not activated.
(2)	i_uDataPoints	Number of data points	Word [Unsigned]	2 to 500	Specifies the number of data points for each axis.
(3)	i_w500XaxisData	X-axis data	Word [Signed] (0..499)	—	Specifies the start device No. which stores the predictive value.
(4)	i_w500YaxisData	Y-axis data	Word [Signed] (0..499)	—	Specifies the start device No. which stores the actual measurement value.

### Output label

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	When this label is on, it indicates that the coefficient of determination calculation has been completed without error.
(7)	o_bErr	Error completion	Bit	OFF	When this label is on, it indicates that an error has occurred in the FB.
(8)	o_uErrId	Error code	Word [Unsigned]	0	The error code that occurred in the FB is stored.
(9)	o_eCoeffDetR2	Coefficient of determination	Single-precision real number	0	Stores the coefficient of determination value calculated from the predictive value and actual measurement value in single-precision real number.

## Function overview

Item	Description	
Applicable device	Applicable CPU	FX5U CPU, FX5UC CPU
	Applicable engineering tool	GX Works3 Version 1.047Z or later
Programming language	Ladder	
Number of basic steps	405 steps The number of steps in the FB program depends on the CPU module used, input and output definition, and option settings of GX Works3. For the option settings of GX Works3, refer to the <a href="#">GX Works3 Operating Manual</a> .	

Item	Description														
Function description	<p>(1) The number of data points of the predictive value and actual measurement value that calculate the coefficient of determination is set in <code>i_uDataPoints</code> (Number of data points).</p> <p>(2) The predictive value is set in <code>i_w500XaxisData</code> (X-axis data).</p> <p>(3) The actual measurement value is set in <code>i_w500YaxisData</code> (Y-axis data).</p> <p>(4) The coefficient of determination calculation processing is started by turning on <code>i_bEN</code> (Execution command), and the ON state of <code>o_bENO</code> (Execution status) is output. This FB calculates the coefficient of determination by the following expression.</p> <ul style="list-style-type: none"> <li>Covariance calculation When each item is as follows, the covariance of the predictive value and actual measurement value is calculated by the following expression.</li> </ul> <table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>Total number of data</td><td>n</td></tr> <tr><td>The ith data value</td><td><math>X_i, Y_i</math></td></tr> <tr><td>Average of X</td><td><math>\bar{X}</math></td></tr> <tr><td>Average of Y</td><td><math>\bar{Y}</math></td></tr> </table> $\text{Covariance} = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})$ <ul style="list-style-type: none"> <li>Standard deviation calculation When each item is as follows, the standard deviation of the predictive value and actual measurement value is calculated by the following expression. The standard deviation of the actual measurement value is calculated by substituting Y for X in the following table and the expression.</li> </ul> <table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>Total number of data</td><td>n</td></tr> <tr><td>Value of each data</td><td><math>X_i</math></td></tr> <tr><td>Average of data</td><td><math>\bar{X}</math></td></tr> </table> $\text{Standard deviation} = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2}$ <ul style="list-style-type: none"> <li>Coefficient of determination calculation</li> </ul> $\text{Coefficient of determination} = \left( \frac{\text{Covariance of the X-axis data and Y-axis data}}{\text{Standard deviation of the X-axis data} \times \text{Standard deviation of the Y-axis data}} \right)^2$ <p>(5) When the input value is normal, <code>o_bOK</code> (Normal completion) is turned on and <code>o_eCoeffDetR2</code> (Coefficient of determination) is output.</p> <p>(6) When a value out of the range is set in <code>i_uDataPoints</code> (Number of data points), <code>o_bErr</code> (Error completion) turns on and the processing of the FB is interrupted. The error code 100H (hexadecimal) is stored in <code>o_uErrId</code> (Error code). For details of the error code, refer to <a href="#">Page 6 Error code</a>.</p> <p>(7) When the value that cannot calculate the coefficient of determination is stored in <code>i_w500XaxisData</code> (X-axis data) or <code>i_w500YaxisData</code> (Y-axis data), <code>o_bErr</code> (Error completion) turns on and the processing of the FB is interrupted. The error code 101H (hexadecimal) is stored in <code>o_uErrId</code> (Error code). For details of the error code, refer to <a href="#">Page 6 Error code</a>.</p>	Total number of data	n	The ith data value	$X_i, Y_i$	Average of X	$\bar{X}$	Average of Y	$\bar{Y}$	Total number of data	n	Value of each data	$X_i$	Average of data	$\bar{X}$
Total number of data	n														
The ith data value	$X_i, Y_i$														
Average of X	$\bar{X}$														
Average of Y	$\bar{Y}$														
Total number of data	n														
Value of each data	$X_i$														
Average of data	$\bar{X}$														
FB compiling method	Macro type														
FB operation type	Pulsed execution (one scan execution type)														
Restrictions and precautions	<p>(1) This FB does not include error recovery processing. Program the error recovery processing separately in accordance with the required system operation.</p> <p>(2) This FB cannot be used in an interrupt program.</p> <p>(3) Using the FB in a program that is to be executed only once, such as a subroutine program or a FOR-NEXT loop, since <code>i_bEN</code> (Execution command) can no longer be turned off and normal operation cannot be performed, always use the FB in a program that is capable of turning off <code>i_bEN</code> (Execution command).</p>														

## Error code

Error code (hexadecimal)	Description	Action
100H	The setting value of <code>i_uDataPoints</code> (Number of data points) is out of the range. The number of data points is not within the range of 2 to 500.	Review and correct the setting of <code>i_uDataPoints</code> (Number of data points) and then execute the FB again.
101H	The value that cannot calculate the coefficient of determination is stored in <code>i_w500XaxisData</code> (X-axis data) or <code>i_w500YaxisData</code> (Y-axis data). The same value is stored in the value of X-axis data or Y-axis data.	Review and correct the setting of <code>i_w500XaxisData</code> (X-axis data) or <code>i_w500YaxisData</code> (Y-axis data) and then execute the FB again.





# 3 FB LIBRARY APPLICATION EXAMPLE

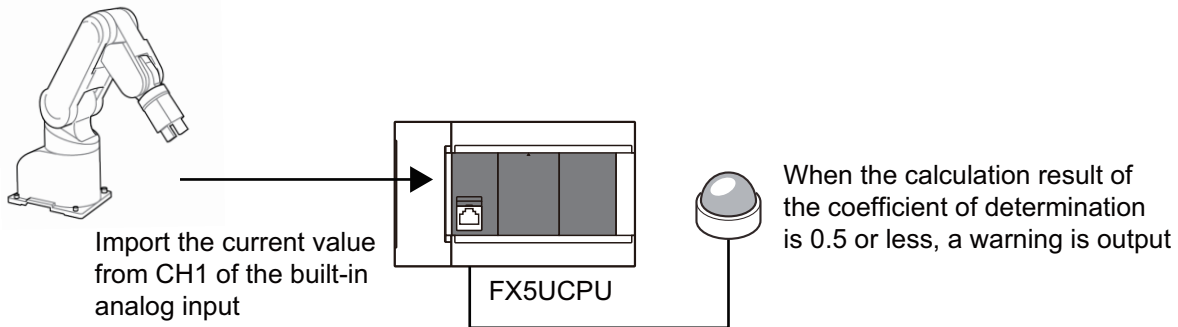
Register the values for the five data points as the predictive values for the device initial values, and calculate the coefficients of determination with the actual measurement values using M+DataStatistics\_CoeffDetR2\_F.

Import the actual measurement values for five points from the FX5U CPU module built-in analog.

Set the threshold value to 0.5. When the coefficient of determination is 0.5 or less, the FB library has an error.

## System configuration example

An FB library application example is described using the following system configuration.



Use the built-in analog input CH1 to import the current value. For details of the settings, refer to the following.

📖 MELSEC iQ-F FX5 User's Manual (Analog Control - CPU module built-in, Expansion adapter)

## Program example

In the program example, perform the following operations assuming that the predictive values are registered for the device initial values.

- Import the current value into the device as the actual measurement value
- Execute the FB for coefficient of determination calculation
- Execute the judgment for the coefficient of determination

### ■ Registering the predictive value for the device initial value

Set the predictive values to D100 to 104, and register them as the device initial values.

For the values to be registered for the device initial values, refer to the following table.

Device	Setting value
D100	20
D101	30
D102	40
D103	50
D104	60

For the registration method of the device initial value, refer to the following.

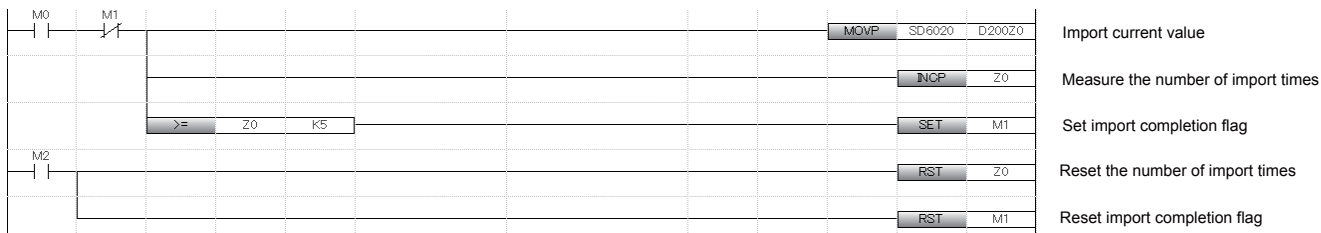
📖 MELSEC iQ-F FX5 User's Manual (Application)

### ■Importing the current value as the actual measurement value

Import the current into D200 to 204 as the actual measurement values from the FX5U CPU module built-in analog CH1.

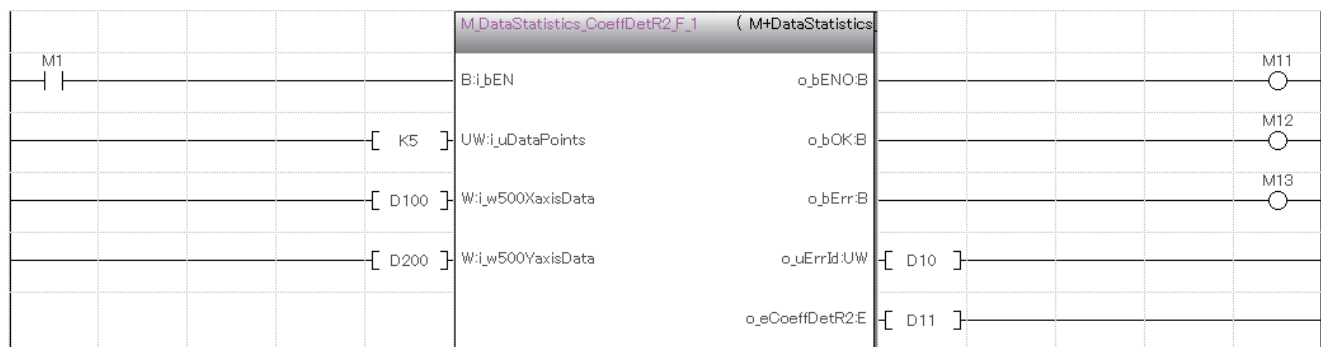
For the setting method to import the current from the built-in analog input, refer to the following.

📖MELSEC iQ-F FX5 User's Manual (Analog Control - CPU module built-in, Expansion adapter)



### ■Coefficient of determination calculation program

After importing the current value has been completed, the FB for coefficient of determination calculation is executed, and the calculation results of the coefficient of determination are stored in D11 and 12.



### ■Judgment for the coefficient of determination

Whether the coefficient of determination calculated in the FB for coefficient of determination calculation is 0.5 (threshold value) or less is judged.



<Coefficient of determination calculation example>

- Normal judgment

When the combinations of the predictive values and actual measurement values are as shown in the following table, the coefficient of determination becomes 0.974599, which is equal to or larger than 0.5 (threshold value), and is judged as normal.

Predictive value	Actual measurement value
20	19
30	33
40	38
50	49
60	65

- Abnormal judgment

When the combinations of the predictive values and actual measurement values are as shown in the following table, the coefficient of determination becomes 0.465249, which is equal to or less than 0.5 (threshold value), and is judged as abnormal.

Predictive value	Actual measurement value
20	29
30	13
40	36
50	57
60	42

# MEMO

---

# INSTRUCTION INDEX

---

## M

---

M+DataStatistics_CoeffDetR2_F .....	5
-------------------------------------	---

# MEMO

---

# REVISIONS

---

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

Revision date	*Manual number	Description
November 2018	SH(NA)-082093ENG-A	First edition

Japanese manual number: SH-082090-A

---

This manual confers no industrial property rights of any other kind, nor does it confer any patent licenses. Mitsubishi Electric Corporation cannot be held responsible for any problems involving industrial property rights which may occur as a result of using the contents noted in this manual.

---

© 2018 MITSUBISHI ELECTRIC CORPORATION





Manual number: SH(NA)-082093ENG-A(1811)

## **mitsubishi electric corporation**

HEAD OFFICE : TOKYO BUILDING, 2-7-3 MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN  
NAGOYA WORKS : 1-14, YADA-MINAMI 5-CHOME, HIGASHI-KU, NAGOYA, JAPAN

When exported from Japan, this manual does not require application to the  
Ministry of Economy, Trade and Industry for service transaction permission.

Specifications subject to change without notice.