General Specifications

FA-M3
High-speed Data Acquisition Module

FA-M3

GS 34M06H11-02E

Contents

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General Specifications

FA-M3
F3HA06-1R
High-speed Data Acquisition Module

FA-M3

GS 34M06H11-02E

■ General

The F3HA06-1R is a data acquisition module that is mounted on a base module for the range-free multi-controller FA-M3. It features 6 analog input channels and 3 auxiliary input channels. The auxiliary inputs can also be used for a 1-channel counter.

All channels for analog input operate simultaneously. In addition to fixed-cycle A/D conversion, A/D conversion synchronized with an external signal is also possible.

This module features not only a data acquisition function that stores data in the built-in buffer, but also a filter function, scaling function, and FFT function. The FFT function can be used to analyze acquired data inside the module.

■ Features

● High-speed Conversion, High-speed Response, High Resolution
- This module features simultaneous A/D conversion of 6 channels. It takes 10 µs from sampling to updating digital output values.
- This module has a built-in analog low-pass filter for each analog input. The cutoff frequency of the filter is approximately 40 kHz, and its order is the second-order. This filter reduces the effect of aliasing.
- This module features digital inputs as an auxiliary input. These inputs can be used for applying signals to initiate A/D conversion and start data acquisition, or as counter inputs. The input type is for 5V open collector output. They accept differential input signals and can also receive line driver outputs. The maximum pulse rate of the counter input is 2 Mpps.
- This module uses 16-bit successive approximation ADCs.
● Advanced Functions
- Data acquisition function: This module can store A/D conversion results and counter values in the buffer inside the module. This acquisition process does not rely on the scan cycle of the CPU module, which enables data to be acquired at a high-speed, constant cycle. The shortest acquisition cycle is 5 µs, and the data buffer size is 2M words.
- FFT function: FFT operation can be applied to acquired data. The maximum amount of data is 16,384 points. FFT can also be applied multiple times, and the results can be averaged.
- Filter function: A/D conversion results can be filtered and then stored as data. Filtering is applied based on an A/D conversion cycle, and not an acquisition cycle. This can suppress the aliasing effect even if a longer acquisition cycle is configured.
- Synchronized operation function: A/D conversion can be initiated synchronously with pulses to the auxiliary input or the built-in counter.
- Product-sum operation function: The square of an analog input or the product of two analog inputs is calculated at each A/D conversion and that value is accumulated. This function can be used to calculate the RMS value of alternating voltage input and effective power.

● High Common-mode Voltage between Channels
- Voltages of up to 30 Vrms or DC ±60 V can be applied between channels.

■ Specifications

● Analog Input Specifications

Item	Specification
No. of input channels	6
Absolute maximum rating	Analog input signal: 　±30 V Analog input channel/analog input channel: 　30 Vrms, DC 60 V
Input signal range *1	-10 to 10 V　(-11 to 11 V) (Initial state) 　0 to 10 V　(-0.5 to 10.5 V) 　1 to 5 V　(-0.25 to 5.25 V) 　-5 to 5 V　(-5.5 to 5.5 V) -2.5 to 2.5 V　(-2.75 to 2.75 V)
Input type	Differential voltage input
Common-mode voltage influence between channels (DC)	Approx. -80 dB
Input impedance *2	Differential: Approx. 800 kΩ Common-mode between channels: Approx. 400 kΩ
Overall accuracy	±0.1% of FS (23±2°C), ±0.01% of FS /°C ±0.3% of FS (0 to 55°C)
Resolution *1	-10 to 10 V:　Approx. 1/58,000, Approx. 0.35 mV 　0 to 10 V:　Approx. 1/29,000, Approx. 0.35 mV 　1 to 5 V:　　Approx. 1/23,000, Approx. 0.18 mV 　-5 to 5 V:　　Approx. 1/58,000, Approx. 0.18 mV -2.5 to 2.5 V: Approx. 1/29,000, Approx. 0.18 mV 　(16-bit resolution of ADC)
A/D conversion operation mode	5µs timer mode: Fixed-cycle sampling External signal synchronized mode: 　At a 5µs interval or more *3, response within 0.2 µs or less Counter synchronized mode: 　At a 5µs interval or more *3, response within 0.2 µs or less
Input response time	Maximum of approx. 50 µs (Step input from 0 to 1 V) (Analog circuit's settling time + conversion time + calculation time)
Input bandwidth *4	Approx. 40 kHz (Second-order analog low-pass filter)

*1 You cannot set an input range for individual channels. The range can be set by ADC group, that is, channels 1 and 2, 3 and 4, as well as 5 and 6.
*2 With power supplied to this module.
*3 An allowed interval of signals for initiating A/D conversion by using an external signal or the counter. This module may ignore conversion signals with a shorter interval than this value. Make sure that you avoid setting conversion signal intervals that are below 5 µs.
*4 A frequency at which the amplitude attenuates by 3 dB when a sinusoidal wave with an amplitude of 1 V is input.

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● Auxiliary Input Specifications

Item	Specification
Type and no. of channels of input	Input for 5V open collector output *5 3 channels
Absolute maximum rating	±5.5 V
Rated input voltage	DC 5 V
Rated input current	20 mA
ON voltage/current	DC 3.5 V or more / 12 mA or more
OFF voltage/current	DC 1.5 V or less / 2 mA or less
Common line type	All channels independent

*5   RS-422A-compliant differential input signals can also be applied.

● Counter Specifications

Item	Specification
Channel count	1 (A-phase, B-phase, Z-phase)

Count range	Linear operation:
	  -2,147,483,648 to 2,147,483,647 (32-bit signed)
	Ring operation:
	  0 to 2,147,483,647 (32-bit signed, the maximum value can be specified)

Input pulse rate	0 to 2 Mpps (8 Mpps in the phase A/B mode of four multiplication)
Operation mode	Linear counter, ring counter
Count mode	Phase A/B, travel/direction, addition/subtraction
Multiplication mode	Multiplication by 1, 2, and 4 (Valid only in the phase A/B mode)

● Functional and General Specifications

Item	Specification
A/D conversion frequency division	A frequency division condition for an A/D conversion cycle in the external signal synchronized mode and counter synchronized mode. Can be selected from: No division (0), 2, 4, 8, 16, 32, 64, and 128
A/D conversion interval	A condition for A/D conversion interval measurements. (Measured with a 64-MHz or 1-MHz counter)
Data buffer	Double buffer structure of up to 1M words (Maximum: 2M words)
Data acquisition cycle	Sampling cycle × n, where n is a natural number from 1 to 4,000.
Data acquisition start signal	A combination of a level trigger, external signal, counter match, and output relay

Digital filter	Moving average
	  (Maximum of 2,048 points of data, a power of two) *6
	Low-pass filter
	  (Fourth order, Butterworth/Chebyshev, cutoff frequency range: 400 Hz to 40 kHz) *7
	High-pass filter
	  (Fourth order, Butterworth/Chebyshev, cutoff frequency range: 400 Hz to 40 kHz) *7

Scaling	The upper and lower limits can be set in a range from -30,000 to 30,000.
Auxiliary input filter	Filter for counter input and general-purpose digital input
Product-sum operation function	The function to perform the product-sum operation according to an A/D conversion cycle, ranging from a 1/2 cycle to 32 cycles of an alternating signal. The accumulation count can be specified up to 32,767 times.

Post-data processing	Averaging
	  (A maximum of 512 frames can be averaged)
	FFT
	  (A maximum of 16,384 points, or maximum of 16 frames, can be averaged)

Other acquisition-related functions	Pre-trigger, delay trigger, start index

Isolation	Analog input terminals/internal circuit:
	  Isolated (Isolation provided by capacitive or inductive coupling device, withstanding voltage 500 Vrms, 1 minute), Rated voltage: 30 Vrms
	Analog input channel/analog input channel:
	  Not isolated, Rated voltage: 30 Vrms
	Auxiliary input terminals/internal circuit:
	  Isolated (Isolation provided by photocoupler, withstanding voltage 500 Vrms, 1 minute), Rated voltage: 30 Vrms
	Auxiliary input terminal/auxiliary input terminal:
	  Not isolated
	Analog input terminal/auxiliary input terminal:
	  Isolated (Isolation provided by capacitive or inductive coupling device, withstanding voltage 500 Vrms, 1 minute), Rated voltage: 30 Vrms

Consumption current	420 mA (System-side power source, DC 5 V)
External connection	32-pin spring terminal block
External dimensions *8	28.9(W)×100(H)×83.2(D) mm
Weight	125 g

*6   The maximum value of the total moving average points for all channels is 4,096.

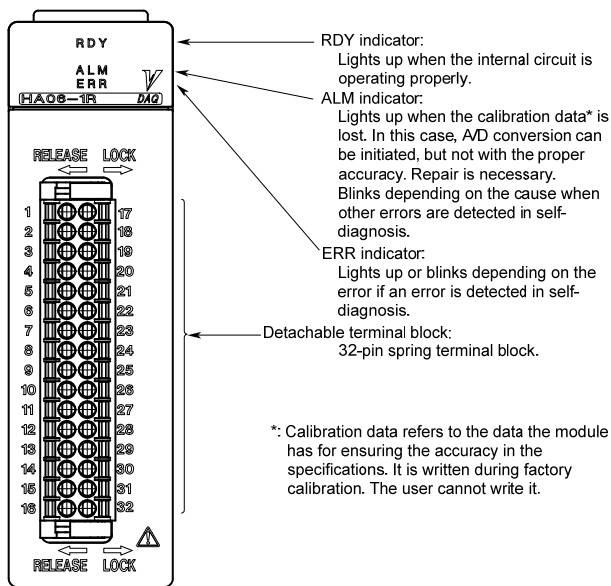*7   There are some limitations on frequencies that you can set.

*8   Dimensions excluding the protrusions (See "External Dimensions Diagram" for details.)
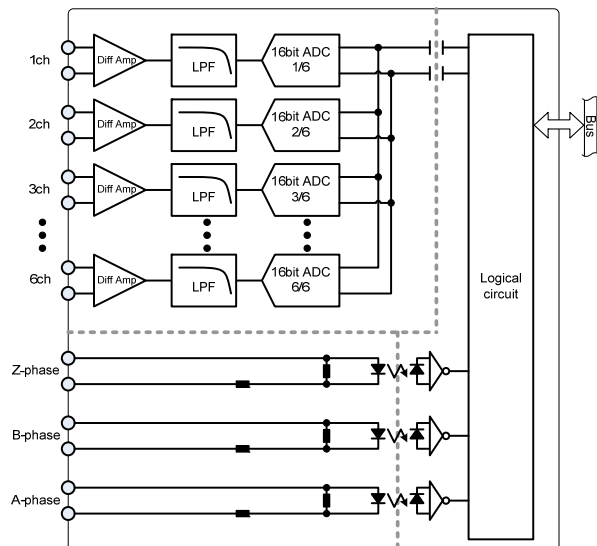
● Environmental Specifications

Item	Specification
Surrounding air temperature range	Operating: 0 to 55°C [9]
	Storage: -20 to 75°C
Surrounding humidity range	Operating: 10 to 90%RH (non-condensing)
	Storage: 10 to 90%RH (non-condensing)
Surrounding atmosphere	Must be free of corrosive gases, flammable gases or heavy dust.

[9]   If using this module as a UL certified product, the upper limit for the surrounding air temperature range is 50°C.

■ Name and Function of Each Part

RDY indicator:
Lights up when the internal circuit is operating properly.
ALM indicator:
Lights up when the calibration data* is lost. In this case, A/D conversion can be initiated, but not with the proper accuracy. Repair is necessary. Blinks depending on the cause when other errors are detected in self-diagnosis.
ERR indicator:
Lights up or blinks depending on the error if an error is detected in self-diagnosis.
Detachable terminal block:
32-pin spring terminal block.

*: Calibration data refers to the data the module has for ensuring the accuracy in the specifications. It is written during factory calibration. The user cannot write it.

■ Internal Circuit Block Diagram

■ External Connections

ANALOG	IN1+	1	17	IN1-	
	IN2+	2	18	IN2-	
	IN3+	3	19	IN3-	
	IN4+	4	20	IN4-	
	IN5+	5	21	IN5-	
	IN6+	6	22	IN6-	
	NC	7	23	NC	
	NC	8	24	NC	
	NC	9	25	NC	
	NC	10	26	NC	
	NC	11	27	NC	
	NC	12	28	NC	
	NC	13	29	NC(AG)	
5V	Z+	14	30	Z-	
	B+	15	31	B-	
	A+	16	32	A-	

TIP

The terminal block used in this module is DFMC 1,5/16-ST-3,5-LR, manufactured by Phoenix Contact.

■ Cable and Crimp-style Terminal

Cable type	Shielded twisted-pair cable
Cable temperature rating	75°C or higher
Cable connection method	Rod terminals are used.

| Examples of crimp-style terminals and compatible wires	Manufacturer	Model	Compatible Wire
	Phoenix Contact	AI 0,34-8 TQ	AWG22 (0.34 mm^2)
		AI 0,5-10 WH	AWG20 (0.5 mm^2)
		AI 0,75-10 GY	AWG18 (0.75 mm^2)
		AI 1-10 RD	AWG18 (1 mm^2)

■ Operating Environment

- The use of this module imposes no restrictions on choosing the sequence CPU module.

■ Model and Suffix Code

Model	Suffix Code	Style Code	Option Code	Notes
F3HA06	-1R	....	....	AI: -10 to 10 V / 0 to 10 V / 1 to 5 V / -5 to 5 V / -2.5 to 2.5 V 6 input channels, 16-bit ADC, 5μs DI: 5 V, 3 input channels

■ External Dimensions Diagram

Unit: mm
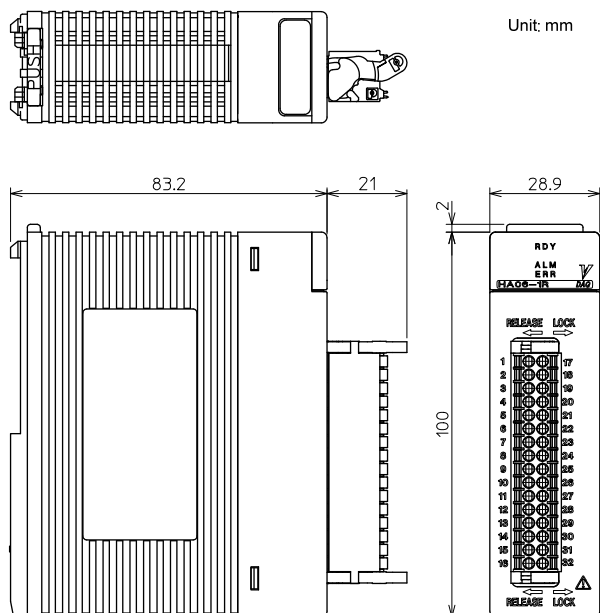
General Specifications

FA-M3
F3HA12-1R
High-speed Data Acquisition Module
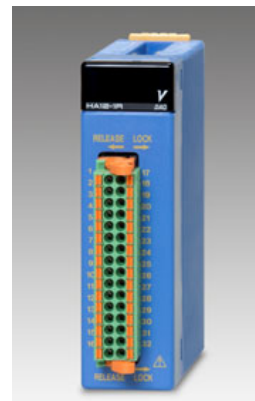
FA-M3

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■ General

The F3HA12-1R is a data acquisition module that is mounted on a base module for the range-free multi-controller FA-M3. It features 12 analog input channels and 3 auxiliary input channels. The auxiliary inputs can also be used for a 1-channel counter.

All channels for analog input operate simultaneously. In addition to fixed-cycle A/D conversion, A/D conversion synchronized with an external signal is also possible.

This module features not only a data acquisition function that stores data in the built-in buffer, but also a filter function, scaling function, and FFT function. The FFT function can be used to analyze acquired data inside the module.

■ Features

● High-speed Conversion, High-speed Response, High Resolution
- This module features simultaneous A/D conversion of 12 channels. It takes approximately 10 μs from sampling to updating digital output values.
- This module has a built-in analog low-pass filter for each analog input. The cutoff frequency of the filter is approximately 40 kHz, and its order is the second-order. This filter reduces the effect of aliasing.
- This module features digital inputs as an auxiliary input. These inputs can be used for applying signals to initiate A/D conversion and start data acquisition, or as counter inputs. The input type is for 5V open collector output. They accept differential input signals and can also receive line driver outputs. The maximum pulse rate of the counter input is 2 Mpps.
- This module uses 16-bit successive approximation ADCs.
● Advanced Functions
- Data acquisition function: This module can store A/D conversion results and counter values in the buffer inside the module. This acquisition process does not rely on the scan cycle of the CPU module, which enables data to be acquired at a high-speed, constant cycle. The shortest acquisition cycle is 5 μs, and the data buffer size is 2M words.
- FFT function: FFT operation can be applied to acquired data. The maximum amount of data is 16,384 points. FFT can also be applied multiple times, and the results can be averaged.
- Filter function: A/D conversion results can be filtered and then stored as data. Filtering is applied based on an A/D conversion cycle, and not an acquisition cycle. This can suppress the aliasing effect even if a longer acquisition cycle is configured.
- Synchronized operation function: A/D conversion can be initiated synchronously with pulses to the auxiliary input or the built-in counter.
- Product-sum operation function: The square of an analog input or the product of two analog inputs is calculated at each A/D conversion and that value is accumulated. This function can be used to calculate the RMS value of alternating voltage input and effective power.
● High Common-mode Voltage between Channels
- Voltages of up to 30 Vrms or DC ±60 V can be applied between channels.

■ Specifications

● Analog Input Specifications

Item	Specification
No. of input channels	12
Absolute maximum rating	Analog input signal: ±30 V Analog input channel/analog input channel: 30 Vrms, DC 60 V
Input signal range *1	-10 to 10 V (-11 to 11 V) (Initial state) 0 to 10 V (-0.5 to 10.5 V) 1 to 5 V (-0.25 to 5.25 V) -5 to 5 V (-5.5 to 5.5 V) -2.5 to 2.5 V (-2.75 to 2.75 V)
Input type	Differential voltage input
Common-mode voltage influence between channels (DC)	Approx. -80 dB
Input impedance *2	Differential: Approx. 800 kΩ Common-mode between channels: Approx. 400 kΩ
Overall accuracy	±0.1% of FS (23±2°C), ±0.01% of FS /°C ±0.3% of FS (0 to 55°C)
Resolution *1	-10 to 10 V: Approx. 1/58,000, Approx. 0.35 mV 0 to 10 V: Approx. 1/29,000, Approx. 0.35 mV 1 to 5 V: Approx. 1/23,000, Approx. 0.18 mV -5 to 5 V: Approx. 1/58,000, Approx. 0.18 mV -2.5 to 2.5 V: Approx. 1/29,000, Approx. 0.18 mV (16-bit resolution of ADC)
A/D conversion operation mode	5μs timer mode: Fixed-cycle sampling External signal synchronized mode: At a 5μs interval or more *3, response within 0.2 μs or less Counter synchronized mode: At a 5μs interval or more *3, response within 0.2 μs or less
Input response time	Maximum of approx. 50 μs (Step input from 0 to 1 V) (Analog circuit's settling time + conversion time + calculation time)
Input bandwidth *4	Approx. 40 kHz (Second-order analog low-pass filter)

*1   You cannot set an input range for individual channels. The range can be set by ADC group, that is, channels 1 and 2, 3 and 4, 5 and 6, 7 and 8, 9 and 10, as well as 11 and 12.
*2   With power supplied to this module.
*3   An allowed interval of signals for initiating A/D conversion by using an external signal or the counter. This module may ignore conversion signals with a shorter interval than this value. Make sure that you avoid setting conversion signal intervals that are below 5 μs.
*4   A frequency at which the amplitude attenuates by 3 dB when a sinusoidal wave with an amplitude of 1 V is input.

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● Auxiliary Input Specifications

Item	Specification
Type and no. of channels of input	Input for 5V open collector output *5 3 channels
Absolute maximum rating	±5.5 V
Rated input voltage	DC 5 V
Rated input current	20 mA
ON voltage/current	DC 3.5 V or more / 12 mA or more
OFF voltage/current	DC 1.5 V or less / 2 mA or less
Common line type	All channels independent

*5   RS-422A-compliant differential input signals can also be applied.

● Counter Specifications

Item	Specification
Channel count	1 (A-phase, B-phase, Z-phase)

Count range	Linear operation:
	  -2,147,483,648 to 2,147,483,647 (32-bit signed)
	Ring operation:
	  0 to 2,147,483,647 (32-bit signed, the maximum value can be specified)

Input pulse rate	0 to 2 Mpps (8 Mpps in the phase A/B mode of four multiplication)
Operation mode	Linear counter, ring counter
Count mode	Phase A/B, travel/direction, addition/subtraction
Multiplication mode	Multiplication by 1, 2, and 4 (Valid only in the phase A/B mode)

● Functional and General Specifications

Item	Specification
A/D conversion frequency division	A frequency division condition for an A/D conversion cycle in the external signal synchronized mode and counter synchronized mode. Can be selected from: No division (0), 2, 4, 8, 16, 32, 64, and 128
A/D conversion interval	A condition for A/D conversion interval measurements. (Measured with a 64-MHz or 1-MHz counter)
Data buffer	Double buffer structure of up to 1M words (Maximum: 2M words)
Data acquisition cycle	Sampling cycle × n, where n is a natural number from 1 to 4,000.
Data acquisition start signal	A combination of a level trigger, external signal, counter match, and output relay

Digital filter	Moving average
	  (Maximum of 2,048 points of data, a power of two) *6
	Low-pass filter
	  (Fourth order, Butterworth/Chebyshev, cutoff frequency range: 400 Hz to 40 kHz) *7
	High-pass filter
	  (Fourth order, Butterworth/Chebyshev, cutoff frequency range: 400 Hz to 40 kHz) *7

Scaling	The upper and lower limits can be set in a range from -30,000 to 30,000.
Auxiliary input filter	Filter for counter input and general-purpose digital input
Product-sum operation function	The function to perform the product-sum operation according to an A/D conversion cycle, ranging from a 1/2 cycle to 32 cycles of an alternating signal. The accumulation count can be specified up to 32,767 times.

Post-data processing	Averaging
	  (A maximum of 512 frames can be averaged)
	FFT
	  (A maximum of 16,384 points, or maximum of 16 frames, can be averaged)

Other acquisition-related functions	Pre-trigger, delay trigger, start index

Isolation	Analog input terminals/internal circuit:
	  Isolated (Isolation provided by capacitive or inductive coupling device, withstanding voltage 500 Vrms, 1 minute), Rated voltage: 30 Vrms
	Analog input channel/analog input channel:
	  Not isolated, Rated voltage: 30 Vrms
	Auxiliary input terminals/internal circuit:
	  Isolated (Isolation provided by photocoupler, withstanding voltage 500 Vrms, 1 minute), Rated voltage: 30 Vrms
	Auxiliary input terminal/auxiliary input terminal:
	  Not isolated
	Analog input terminal/auxiliary input terminal:
	  Isolated (Isolation provided by capacitive or inductive coupling device, withstanding voltage 500 Vrms, 1 minute), Rated voltage: 30 Vrms

Consumption current	570 mA (System-side power source, DC 5 V)
External connection	32-pin spring terminal block
External dimensions *8	28.9(W)×100(H)×83.2(D) mm
Weight	125 g

*6   The maximum value of the total moving average points for all channels is 4,096.

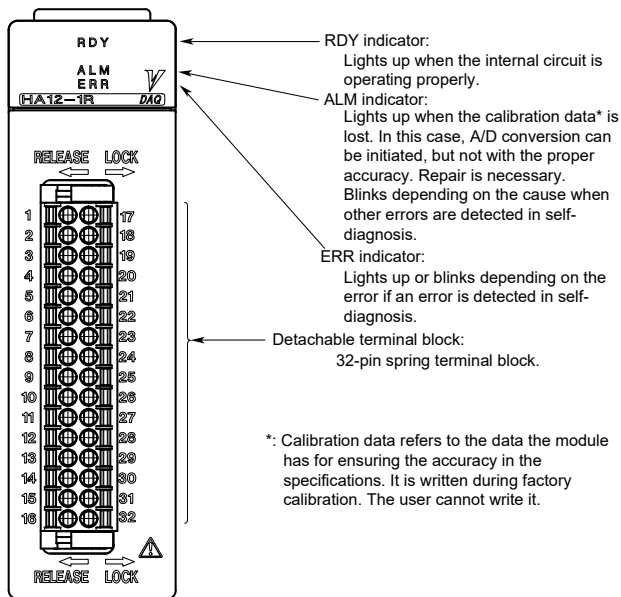*7   There are some limitations on frequencies that you can set.

*8   Dimensions excluding the protrusions (See "External Dimensions Diagram" for details.)

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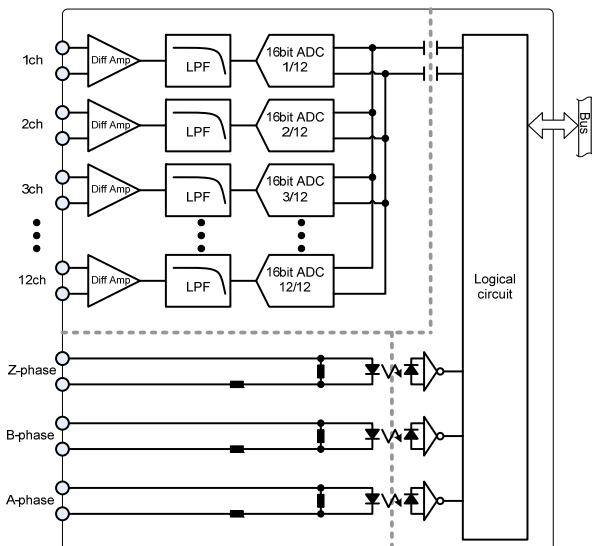● Environmental Specifications

Item	Specification
Surrounding air temperature range	Operating: 0 to 55°C *9
	Storage: -20 to 75°C
Surrounding humidity range	Operating: 10 to 90%RH (non-condensing)
	Storage: 10 to 90%RH (non-condensing)
Surrounding atmosphere	Must be free of corrosive gases, flammable gases or heavy dust.

*9   If using this module as a UL certified product, the upper limit for the surrounding air temperature range is 50°C.

■ Name and Function of Each Part

RDY indicator:
    Lights up when the internal circuit is operating properly.

ALM indicator:
    Lights up when the calibration data* is lost. In this case, A/D conversion can be initiated, but not with the proper accuracy. Repair is necessary. Blinks depending on the cause when other errors are detected in self-diagnosis.

ERR indicator:
    Lights up or blinks depending on the error if an error is detected in self-diagnosis.

Detachable terminal block:
    32-pin spring terminal block.

*: Calibration data refers to the data the module has for ensuring the accuracy in the specifications. It is written during factory calibration. The user cannot write it.

■ Internal Circuit Block Diagram

■ External Connections

F3HA12-1R Terminal allocation

IN1+	1	17	IN1-
IN2+	2	18	IN2-
IN3+	3	19	IN3-
IN4+	4	20	IN4-
IN5+	5	21	IN5-
IN6+	6	22	IN6-
IN7+	7	23	IN7-
IN8+	8	24	IN8-
IN9+	9	25	IN9-
IN10+	10	26	IN10-
IN11+	11	27	IN11-
IN12+	12	28	IN12-
NC	13	29	NC(AG)
Z+	14	30	Z-
B+	15	31	B-
A+	16	32	A-

ANALOG: IN1+ through IN12+
5V: Z+, B+, A+

TIP

The terminal block used in this module is DFMC 1,5/16-ST-3,5-LR, manufactured by Phoenix Contact.

■ Cable and Crimp-style Terminal

Cable type	Shielded twisted-pair cable
Cable temperature rating	75°C or higher
Cable connection method	Rod terminals are used.

| Examples of crimp-style terminals and compatible wires	Manufacturer	Model	Compatible Wire
	Phoenix Contact	AI 0,34-8 TQ	AWG22 (0.34 mm^2)
		AI 0,5-10 WH	AWG20 (0.5 mm^2)
		AI 0,75-10 GY	AWG18 (0.75 mm^2)
		AI 1-10 RD	AWG18 (1 mm^2)

■ Operating Environment

-    The use of this module imposes no restrictions on choosing the sequence CPU module.

■ Model and Suffix Code

Model	Suffix Code	Style Code	Option Code	Notes
F3HA12	-1R	········	········	AI: -10 to 10 V / 0 to 10 V / 1 to 5 V / -5 to 5 V / -2.5 to 2.5 V 12 input channels, 16-bit ADC, 5μs DI: 5 V, 3 input channels

■ External Dimensions Diagram

Unit: mm
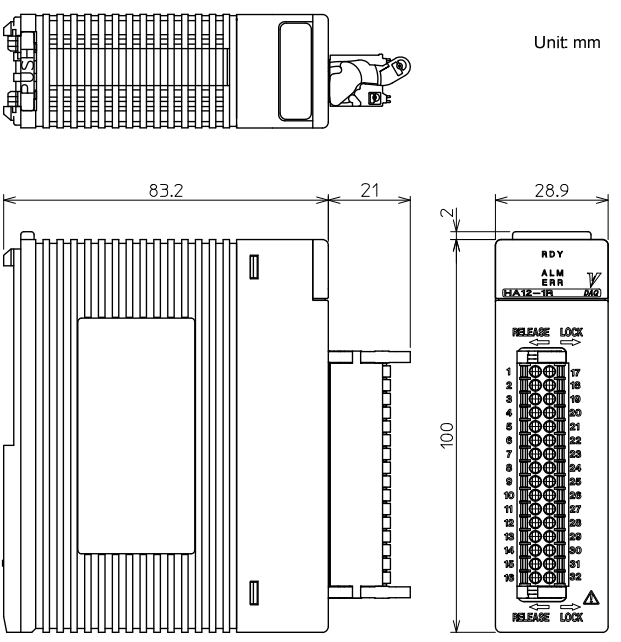
Glossary

This section explains the terms related to the specifications of the high-speed data acquisition module F3HA06-1R and F3HA12-1R.

Numeric

5μs timer mode
An operation mode in which A/D conversion is initiated at a fixed cycle with the internal timer. The conversion cycle of this mode is 5 μs in this module.

A

A/D conversion interval measurement
A function to measure the A/D conversion interval using the internal clock. This function is used to record the information, such as A/D conversion intervals and change rates of a measurement target. Such information is lost after data acquisition in the external signal synchronized mode or counter synchronized mode.

Absolute maximum rating
Stresses exceeding the absolute maximum rating may cause permanent damage to this module, even if being applied for a fairly short time. The damage can occur on a range basis, a channel basis, or a module basis. Symptoms caused by this damage include performance deterioration such as offset error and gain error, or complete malfunction such as the inability to perform input.

Acquisition cycle
A cycle at which A/D conversion results are thinned out to the internal data buffer. With this setting, the cycle of the acquisition can be extended to the range from 2 to 4000 times longer.

Acquisition number
A number that indicates the timing of A/D conversion. This timing is as counted in order from the beginning of acquired data.

Analog input overall accuracy
Indicates the amount of errors included in the digital output. This is indicated by the ratio to the input signal range (full scale).

Auxiliary input filter
A function to reduce the impact of electro-magnetically coupled noise in the pulse output from an encoder or other device.

Auxiliary input terminal
An input terminal that is used to receive the pulse output from an encoder or other device. Those pulses are used as A/D conversion signals or inputs to the counter.

Averaging
A function to reduce variance in the acquired data. This function averages the data in the same timing or same position, starting from the trigger timing or position. Instead of averaging adjacent data items, this function uses data items acquired multiple times and averages them in the same timing starting from the trigger timing. This can reduce random variance such as electro-magnetically coupled noise in the conversion result without affecting the rising speed of waveforms.

B

Butterworth filter
A filter without gain ripple in the passband and stopband. On the other hand, changes in attenuation characteristics are relatively moderate around the cutoff frequency.

C

Chebyshev filter
A filter with changes in attenuation characteristics relatively sharp around the cutoff frequency. On the other hand, the filter has the disadvantage that it causes gain ripple in the passband. The gain ripple in the passband of the Chebyshev filter in this module is 0.05 dB.

Common-mode voltage
Electric potential from the ground of the FA-M3 or e-RT3 system. The common-mode voltage applicable to an analog input terminal and auxiliary input terminal in this module is AC 30 V (rms) and AC 42 V (peak), as well as DC 60 V.

Common-mode voltage between channels
Electric potential difference between the negative-side terminals in two or more channels. If there is an electric potential difference between channels, use the maximum difference as the common-mode voltage between channels. The allowable common-mode voltage between channels in this module is AC 30 V (rms) and AC 42 V (peak), as well as DC 60 V.

Common-mode voltage influence between channels
A value that indicates how much a measured value is influenced by electric potential difference, if any such difference exists between the negative-side terminals in two or more channels. When the common-mode voltage between channels in this module is applied in direct current, its influence is -80 dB.

Continued data processing
A data processing that is applied to A/D converted values before data acquisition. This processing operates synchronously with A/D conversion. This module supports the filter function, scaling function, and product-sum operation function.

Counter count mode
A mode to specify how to count the pulses that are input to an auxiliary input terminal. This mode supports the phase A/B mode, CW/CCW pulse mode, and travel/direction mode.

Counter match trigger
A trigger setting with which acquisition is started by change in the signal input to an auxiliary input terminal. Acquisition is started according to the value of signal change counted by the counter inside the module.

Counter operation mode
A mode to specify the behavior when the counter increases/decreases beyond the counter maximum/minimum value. When the above-mentioned condition occurs, the linear counter notifies an error and stops count operation. On the other hand, when the ring counter increases exceeding the maximum value, the value returns to "0" and the counter continues counting up. When this counter counts down from "0", the value changes to the maximum value, from which the counter continues counting down.

Counter synchronized mode
An operation mode in which A/D conversion is initiated as synchronized with external signals that are input to the auxiliary input terminals. Signal changes are counted by the counter inside the module and A/D conversion is initiated as synchronized with those signal changes.

Cutoff frequency
A parameter that is used to set a bandwidth for the low-pass filter and high-pass filter. When a signal at the specified frequency is input, the output amplitude attenuates by 3 dB.

D

Data buffer
A memory that is used to store the A/D conversion results. This memory cannot be accessed directly from the CPU module. Therefore, the acquired data stored in the data buffer is read via the "transferred data 1" to "transferred data 2048" input/output data registers, which are a data area that is readable/writable from both MCUs of the CPU module and this module.

Delay trigger
A parameter that is used to set the timing to start data acquisition. If you need to delay the acquisition start, use this parameter to specify the amount of time after the trigger condition to start acquisition is met.

Differential voltage input
A format of voltage input from a connected device. In this format, the electric potential between two connection points is measured based on the electric potential connected to the input terminal on the negative side. The module allows electric potential difference between input terminals on the negative side between channels.

Disable trigger
A function to disable triggers.

Disable Z-phase
A function to disable the counter preset function. This function is used to tentatively disable the preset conditions repeatedly satisfied by auxiliary input.

E

Edge (trigger function)
One of the trigger conditions specifying the data acquisition start. When a trigger source is set on the edge side, the module determines that the trigger condition is met only at the timing when a signal changes to the specified conditions.

External signal synchronized mode
An operation mode in which A/D conversion is initiated as synchronized with external signals that are input to an auxiliary input terminal. In this mode, A/D conversion is initiated at the timing when the external signal changes from OFF to ON.

External trigger
A trigger setting with which acquisition is started by a change in the signal input to an auxiliary input terminal. Acquisition starts when the signal changes.

F

FFT (Fast Fourier Transform)
A function to transform time domain data into frequency domain data. The target can be selected from the voltage input applied to the analog input terminal. The data is output at the same scale as the analog input. The value that can be specified for the frame length is a power of two from 512 to 16384 points.

FFT averaging
A function to average the results of FFT operation repeated the specified number of times. This function is used to reduce variance found in the FFT results that are based on the acquired data.

Filter (digital filter)
A digital filter is one of the continued data processing functions and is used to remove unnecessary signals from the input signals applied to the analog input terminal. In this module, this function is applied to data after A/D conversion. The following options can be selected: multi-sampling, moving average, low-pass filter, and high-pass filter. Selectable filters are limited depending on the operation mode.

Forced acquisition start

A method for starting acquisition by using an output relay of "forced acquisition start (Y35)". When this output relay is set, acquisition starts.

Frame length

Indicates the number of a set of data used for post-data processing out of the acquired data. This indicates the number of acquired data items used per averaging process and the number of data items subject to FFT operation.

Frequency division setting

A function that is available in the external signal synchronized mode and counter synchronized mode. This function specifies the cycle to initiate A/D conversion. This function is used when the pulse rate from an encoder or other device is shorter than the A/D conversion cycle of this module.

G

Gate (trigger function)

One of the trigger conditions specifying the data acquisition start. When a trigger source is set on the gate side, the module compares the input status with the specified conditions for trigger judgment, regardless of whether a signal changes or not. Essentially, the gate is used to specify the conditions to enable the trigger.

H

Hardware range

A hardware input signal range. The following two types are available: -10 to 10 V range and -5 to 5 V range. The input signal range of this module has the five types ranging from -10 to 10 V range to -2.5 to 2.5 V range. This module selects a hardware input signal range, according to the specified input signal range.

High-pass filter

A filter with characteristics that allows high-frequency signals to pass and blocks low-frequency signals. This filter is used with a cutoff frequency specified. When a signal at the frequency specified with a cutoff frequency is input, the output amplitude attenuates by 3 dB.

I

Index number

A value used for the start index function. Notifies the timing when the trigger condition is met using the number (acquisition number) that indicates the timing of A/D conversion as counted in order from the beginning of acquired data.

Input bandwidth

A frequency at which the amplitude of the input signal attenuates by 3 dB. This module is equipped with an analog low-pass filter prior to each A/D converter in the input circuit. The amplitude attenuates due to an effect of the low-pass filter. This low-pass filter is a second-order Butterworth filter and the cutoff frequency is approximately 40 kHz.

Input/output data register

A memory area on this module. This area is used to send/receive data between this module and the CPU module.

Input range

The input range is a voltage range that can be input, with an additional over range of ±5% (which may vary depending on the range) of the input signal range. In specification descriptions in this document, the input range is enclosed in parentheses when used with the input signal range. When a voltage out of the input range is applied, the digital output value is limited within the input range.

Input response time

A period of time required to reflect a change in the voltage applied to the analog input terminal onto the input/output data register (immediately updated data) in this module. The time is composed of delay in the analog filter (settling time), A/D conversion time, and the time required for continued data processing.

Input signal range

The input signal range is a nominal input voltage range. When using the scaling function, you should specify the digital output values corresponding to the upper and lower limits of this input range. In contrast to this nominal input range, the "input range" indicates an input voltage range that can be actually input.

L

Level trigger

A trigger setting with which acquisition is started by a change in the signal input to an analog input terminal. Acquisition is started according to the value of the signal converted by the A/D converter in the module.

Low-pass filter

A filter with characteristics that allows low-frequency signals to pass and blocks high-frequency signals. This filter is used with a cutoff frequency specified. When a signal at the frequency specified with a cutoff frequency is input, the output amplitude attenuates by 3 dB.

M

Mode register

A memory area on this module. This area is used to specify the operation of this module.

Moving average

A function to reduce variance in the acquired data. This function calculates and outputs the average of the specified number of the latest A/D conversion results.

Multiplication mode

A mode to specify how to count the pulses that are input to an auxiliary input terminal. Applicable only to outputs from an encoder with the phase A/B mode.

Multi-sampling

A function that is available in the external signal synchronized mode and counter synchronized mode. A single A/D conversion signal initiates A/D conversion multiple times and the A/D conversion results are averaged and output. The cycle of A/D conversion initiated multiple times in this process is 5 µs. This function is used to reduce variance in conversion when the cycle of A/D conversion signals from external inputs is longer than the A/D conversion cycle of this module.

O

Operation mode

A mode to specify what A/D conversion is synchronized with in this module. The following three types of operation modes are provided: 5µs timer mode, external signal synchronized mode, and counter synchronized mode.

P

Page number

A number that is used to specify the data to be read from the acquired data in the data buffer. This module manages acquired data by separating the data in units of 2048 words from the beginning of acquired data. A group of data separated in units of 2048 words makes up a page. Data is read in units of pages.

Post-data processing
A data processing that is applied to the acquired data after acquisition is completed. This module is equipped with the averaging function and FFT function.

Preset
A function to set the count value of the counter function to the specified value. This function is executed according to the auxiliary input and output relay.

Pre-trigger
If this parameter is specified for the acquisition start condition, the module also acquires the specified number of data points for the period up to the time when the trigger condition is met. The range that can be specified is from "0" (disabled) to "the number of acquisition points subtracted by 1".

Product-sum operation function
A function that can be used to calculate the RMS value of alternating voltage input and effective power. Accumulation of the product of the alternating voltage input applied to one or two inputs is executed at each A/D conversion. The accumulation period can be specified within the range from 1/2 cycle to 32 cycles of an alternating signal.

R

Resolution
A voltage value that is equivalent to 1 LSB in A/D converters. In other words, a nominal minimum value of detectable voltage. More specifically, it is calculated by dividing the difference between the upper and lower limits of the input voltage range by the difference between the corresponding A/D conversion results for the upper and lower limits of the input voltage range. The minimum value of actually detectable voltage is affected by the scaling function settings.

S

Scale lower limit
Specifies a digital value for the applied lower limit voltage in the input voltage range.

Scale upper limit
Specifies a digital value for the applied upper limit voltage in the input voltage range.

Scaling
A function to get the desired conversion results of the input voltage range. When using this function, you should specify the scale upper limit and scale lower limit.

Start index
If the trigger condition is met multiple times during a single data acquisition, this function records the second timing the trigger condition is met and any thereafter. This function notifies the timings using the number (acquisition number) that indicates the timing of A/D conversion as counted in order from the beginning of acquired data.

T

Trigger
A trigger is used to specify the conditions to start acquisition in data acquisition.

Trigger filter
A function to prevent starting acquisition with the edge in the reverse direction when a level trigger is used under an environment with a lot of electromagnetic noise.