Panasonic

No. SX-DSV02125

REFERENCE SPECIFICATIONS

M/S

20bit ϕ35 two-way communication
incremental encoder

MODEL MFE0020BASD

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Motor Company, Panasonic Corporation

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1. Scope

This document is the specification for the encoder that is part of the AC servo system manufactured and delivered by Motor Company, Panasonic Corporation.

2. Applicable Models

Applicable motors of these specifications shall be determined by separate discussions.

3. Functions of encoder

This is an incremental encoder with 20 bit resolution per revolution, and it provides position data, commutation signal status, and fault detection information in the form of serial data per external request.
It does not provide data if the external request is abnormal.

4. Electric specifications

4.1 Connection table

Table. 1 Connection table

Lead wire	Function	Remarks
Red	E5V	DC +5V±5% Positive side of main power supply
Red/White	E0V	Negative side of main power supply
Brown/White	PS	Serial data signals
Brown	／PS	
Green/White	FG	

*The connection may differ depending on the model of your motor.
Refer to the motor specification for the detail.

4.2 The maximum absolute rating

Table. 2 The maximum absolute rating

Item	Specification	Unit
Main supply voltage	5.5	V

4.3 Electrical characteristics

Table. 3 Electrical characteristics

Item	Standard Ta=25℃			Remarks	Unit
	Min.	Typ.	Max.		
Main supply voltage	4.75	5.00	5.25	---	V
Main power consumption	---	70	150	---	mA
Power-ON stand-by time (Note 1)	---	---	500	---	ms
Allowable supply voltage rise time	---	---	50	The supply voltage rise time should be 50 ms or less.	ms

(Note 1): During the Power-ON stand-by time, no external requests will be accepted.
Encoder line driver output will be undefined ("H", "L" or "Hi-z") during
Power-ON stand-by time.

4.3.1 Specifications for one revolution signals

Table. 4 Specifications on revolution signals

Item		Specification	Remarks
Resolution		2^{20}	---
One revolution signals	ABSA	ABSA is 20 bit (i.e. the resolution per revolution) position data that performs cyclic counting and it is reset by the initial Z signal after the Vcc is turned on.	The upper bits represent the count data for signal A and B. The lower 11 bits represent the interpolation data for the Sin/Cos signals. Refer to Fig.1 in detail. Refer to Table.5 for the initial values.
	ABSS	ABSS is 24 bit position data that performs cyclic counting with the position where the Vcc was turned on as the starting point.	The upper bits represent the count data for signals A and B. The lower 11 bits represent the interpolation data for the Sin/Cos signals. Refer to Fig.1 in detail. Refer to Table.5 for the initial values.
Response speed		0～6000 r/min	---
Output code		Pure binary	---
Increasing direction		CCW	When viewing from the end of the motor shaft
Cumulative pitch error		±80″ (±64LSB)	Reference value when PS is "0"
Adjacent pitch error		±40″ (±32LSB)	

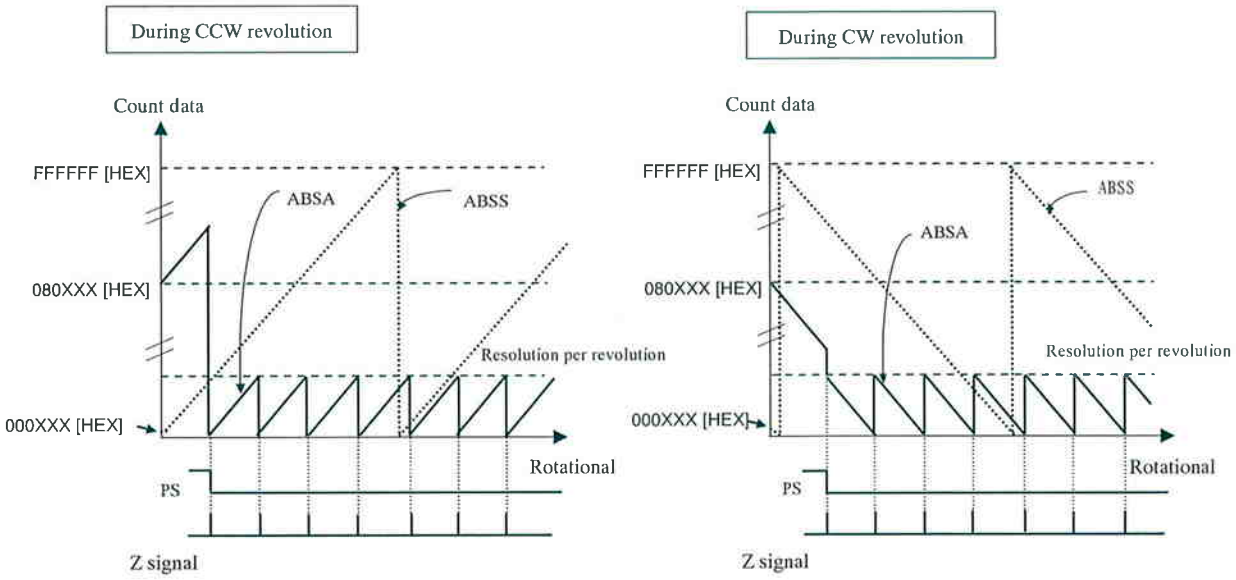


Fig.1 Signal count motion of one revolution

※Refer to Table.5 for initial values of ABSA and ABSS in power supply.

Table. 5 Logic of the internal signals A, B, and Z and initial values of the signals per revolution ABSA and ABSS when the power in turned on.

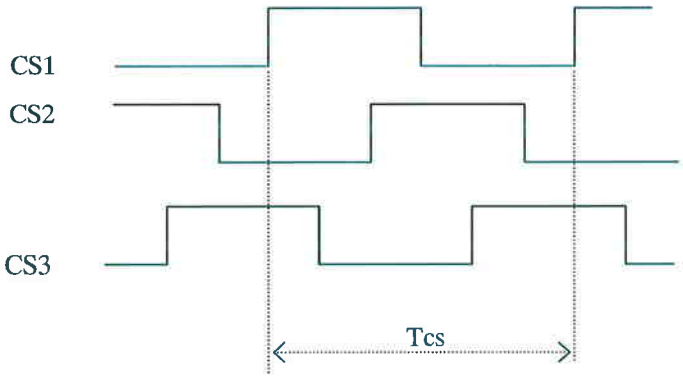
Internal signal	A	H	L	L	H	H	H
	B	L	L	H	H	L	H
	Z	L	L	L	L	H	H
Output data	ABSA	400XXX [HEX]				0FFXXX [HEX]	0FFXXX [HEX]
	ABSS	000XXX [HEX]					

※XXX：12 bit data that includes the 11 bit interpolation data for the Sin/Cos signals when the power is turned on.

4.3.2 Commutation signal specifications

Table. 6 Commutation signal specification

Item	Specification	Remarks
Pulse count	5 P/R	---
Maximum speed	6000r/min	---
Output form	Status information of CS1, CS2, and CS3	---



Tcs : 360degree/5 [TYP]

* During CW revolution as viewed from the motor output shaft.

Fig.2 Waveform of commutation signals

5. Serial Communication

5.1 Outline

Table. 7 Outline of serial communication

Item	Specification		Remarks
Communication code	Binary code		---
Transmitting method	Differential line driver		Subject to RS485
Receiving method	Differential line receiver		Subject to RS485
Transmission data	One revolution data	ABSA	Refer to Table 4 (Specifications on revolution signals).
		ABSS	Refer to Table 4 (Specifications on revolution signals).
	CS signals		Status information of CS1, CS2, and CS3
	Error/Alarm code		(1) Initialized error (2) Count error 1 (3) Count error 2 (4) Z-signal error (5) CS signal error
	Status flag		Preload status
	Encoder ID		ENID1, ENID2
Synchronization system	Base band NRZ		---
Transmission rate	2.5 Mbps		---
Frame format	Details are shown in Sections after 5.2		---

5.2 Frame format

5.2.1 Encoder data acquisition and error reset

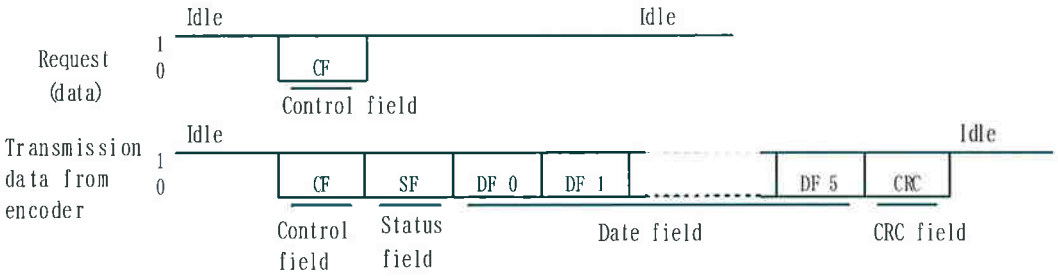


Fig.3 Frame format for the encoder data acquisition

5.3 Detailed description of the fields

5.3.1 Control field (CF)

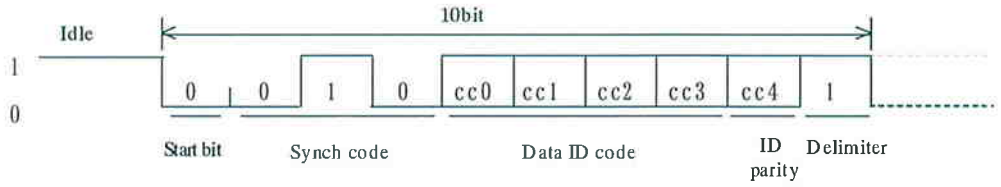


Fig.4 Structure of a control field

① Start bit: Fixed to "0".
② Synch. code: Fixed to "010".
③ Data ID code: Refer to Table.8
④ ID parity: Refer to Table.8
⑤ Delimiter: Fixed to "1"

Table, 8 List of data ID codes

purpose	Data ID	Code description				Parity	The number of request signal frames	The number of data signal frames
		cc0	cc1	cc2	cc3	cc4		
Date acquisition	5	1	0	1	0	0	1	9
	A	0	1	0	1	0	1	9
Reset	B	1	1	0	1	1	1	9
	E	0	1	1	1	1	1	9

Table, 9 Frame structure

purpose	Data ID	Request signal frame structure	Data signal frame structure								
			1	2	3	4	5	6	7	8	9
Data acquisition	5	CF	CF	SF	ABSA0	ABSA1	ABSA2	ABSS0	ABSS1	ABSS2	CRC
	A	CF	CF	SF	ABSA0	ABSA1	ABSA2	ENID1	ENID2	ALMC	CRC
Data acquisition / error reset	B	CF	CF	SF	ABSA0	ABSA1	ABSA2	ABSS0	ABSS1	ABSS2	CRC
	E	CF	CF	SF	ABSA0	ABSA1	ABSA2	ENID1	ENID2	ALMC	CRC

5.3.2 Status field (SF)

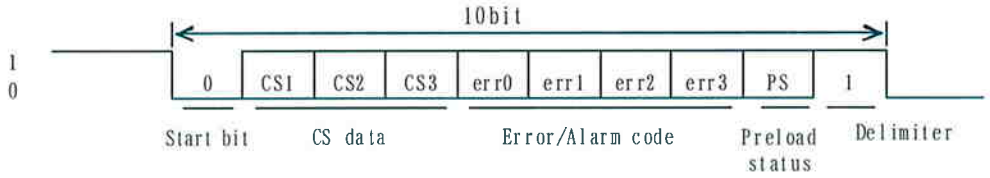


Fig.5 Status field structure

① Start bit: Fixed to "0".
② CS data: Status information data of CS1, CS2, and CS3
③ Error・alarm code: Refer to Table. 10
④ Pre-load Status: Refer to Table. 13
⑤ Delimiter: Fixed to "1".

Table, 10 Structure of error / alarm codes

Output priority when multiple errors occurs simultaneously	Code err3・・・err0	Name of error / alarm
High	0001(1)	Encoder internal initialization error (INIE)
↑	0010(2)	Count error 1 (CE1)
	0011(3)	Count error 2 (CE2)
	0100(4)	Z signal error (ZE)
	0101(5)	CS signal error (CSE)
low	0000(0)	No error / alarm

5.3.3 Data Field (DF0－DF5)

Refer to the table 11 for the relationship between the data ID codes and data fields.

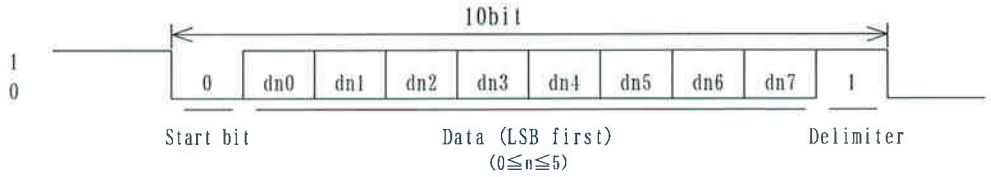


Fig.6 Data field structure

① Start bit: Fixed to "0".
② Data: LSB first data structure
③ Delimiter: Fixed to "1".

Table. 11 List of data fields

purpose	Data ID	List of data fields					
		DF0	DF1	DF2	DF3	DF4	DF5
Date acquisition	5	ABSA0	ABSA1	ABSA2	ABSS0	ABSS1	ABSS2
	A	ABSA0	ABSA1	ABSA2	ENID1	ENID2	ALMC
Data acquisition / Error reset	B	ABSA0	ABSA1	ABSA2	ABSS0	ABSS1	ABSS2
	E	ABSA0	ABSA1	ABSA2	ENID1	ENID2	ALMC

ABSA0 － ABSA2: Refer to Table 4 (Specification for signals per revolution).
* Of the total 24bits, ABSA0 takes the lower byte, ABSA2 the upper byte.

ABSS0 － ABSS2: Refer to Table 4 (Specification for signals per revolution).
* Of the total 24bits, ABSS0 takes the lower byte, ABSS2 the upper byte.

ENID1: Fixed to "94h"

ENID2: Fixed to "00h"

ALMC: Refer to Table.12

Table. 12 ALMC structure

Bit	$d_7$0	$d_7$1	$d_7$2	$d_7$3	$d_7$4	$d_7$5	$d_7$6	$d_7$7
Designation	Undefined	Fixed to "0"	Fixed to "0"	Count error 1 CE1	Count error 2 CE2	Z signal error ZE	CS signal error CSE	Preload status PS

Note 1: The logic will be "1" if an error occurs or if the initial Z signal is not detected.

Note 2: CE1, CE2, ZE, and CSE will be all "1" if an encoder internal initialization error occurs.
Refer to the section 5.4 for the detail.

Table. 13 Description of status flag functions

Designation	Function		Flag to "L"
Count error CE	The logic "1" will be provided if the data of position per revolution is shifted due to reasons such as malfunction and failure. This works only after the PS logic is turned from "1" to "0".		Reset the error (refer to 5.4) or reset the power.
	CE1	The logic "1" will be provided if the data of position per revolution ABSA is shifted. The detection accuracy is ±0.703°[MAX] The checking frequency is once per revolution.	
	CE2	The logic "1" will be provided if the number of edges of the phases A and B is 11 or lower between the CS signal edges.	
Z signal error ZE	The logic "1" will be provided if the generation of the internal Z signal is stopped. This works only after the PS logic is turned from "1" to "0". The checking frequency is once per revolution.		Reset the error (refer to 5.4) or reset the power.
CS signal error CSE	The logic "1" will be provided if the logic of CS1, CS2 and CS3 are all "1" or all "0".		Reset the error (refer to 5.4) or reset the power.
Preload status PS	The logic "1" will be provided after the power is turned on until the initial Z signal is detected. The logic will be turned to "0" after the initial Z signal is detected. If Z signal is detected when the power is turned on, the logic will be "0" from the beginning. *1		Make maximum of 1 rotation.

*1 This encoder does not turn the preload status to "0" if Z signal is detected within 3.5 degrees immediately after the power is turned on. In this case, the preload status will turn to "0" when the second Z signal is detected.

Immediately stop the servo system if an error occurs, or if the preload status does not turn from "1" to "0" after 2 rotations following the power having turned on, which indicates that the encoder is malfunctioning.

5.3.4 CRC field (CRC)

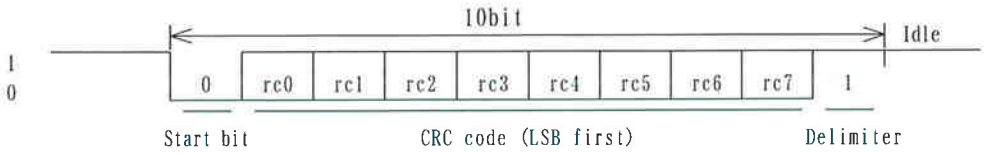


Fig.7 CRC field structure

① Start bit: Fixed to "0".

② CRC code: The code is dependent on the generation formula $G(X) = X^8+1$ (X= rc0－rc7).
The data has the LSB first structure.
The calculation is carried out for all the bits except for the start bit and delimiter in all the fields except for CRC's.

③ Delimiter: Fixed to "1".

<Example of CRC calculation>

Table 14 shows examples of the encoder data (CF－DF3) and CRC data values.

Table. 14 CRC calculation examples

Field name	CF	SF	DF0	DF1	DF2	DF3	CRC
Encoder transmission data (LSB first)	01001100	00001000	10000000	00010100	00001101	00010000	11001101

5.4 Error reset

To reset an error flag, transmit data IDB or data IDE to the encoder.
As soon as the encoder receives the data IDB or data IDE, it will return the data as shown in the table 9 and reset the error flag at the same time.
If the encoder malfunction is not resolved, the error flag will be provided again.
If all the flags of CE1, CE2, ZE, and CSE are turned to "1" and they are not reset by the reset command, there is an encoder internal initialization error. It requires repairing or exchanging with a new one.

6. Detection of date acquisition frame

6.1 Detection of the start of a frame

In Control Field(CF),regarding the first logic "0" after Idle if the subsequent 3 bits match with Synch. Code, it is " Frame start ".

In case the 3 bits do not match with Synch Code, frame detection will be executed again.

In 3μsec (TYP) after receiving delimiter signal of request frame, Encoder will start data transmission.

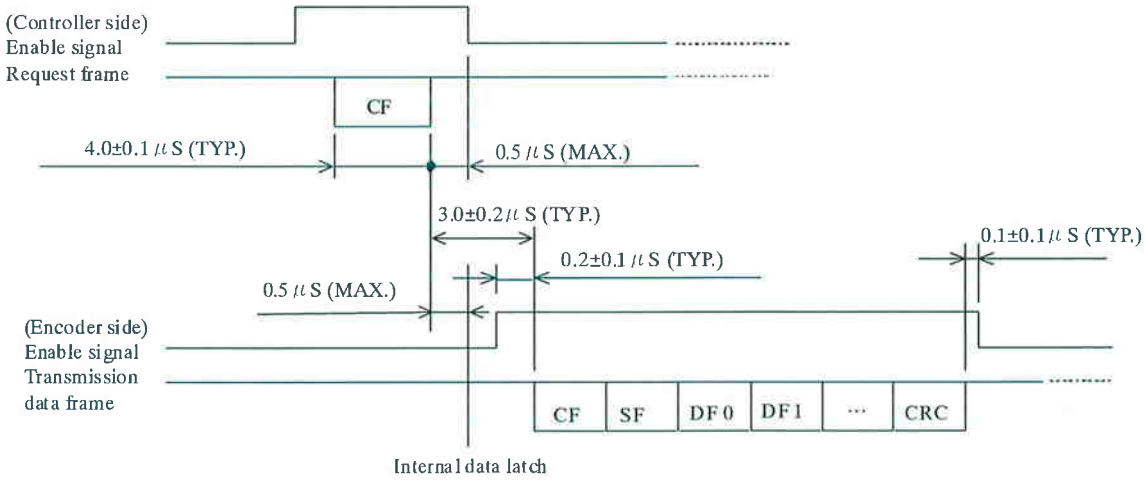


Fig.8 Frame detection

6.2 End of frame

After detecting frame start , if there is no start bit after delimiter, it will be regarded as frame end.

Therefore ,there is no particular field indicating frame end.

6.3 Idling

Space between frames is idle. Output logic on sender side is fixed to "1" .

6.4 Conditions to disregard requests

In case of condition shown in Table.15, requests will be invalid.

In this event, no data transmission from encoder will be made.

Table. 15 Conditions to disregard requests

No.	Condition
1	Logic of synch. code is abnormal.
2	Data ID code is not 5, A, B, or E.
3	Logic of parity is abnormal.
4	Logic of delimiter is abnormal.

7. Precautions for transmitting a request

Table. 16 Precautions for transmitting a request

Function	Data ID	Description
Data acquisition	5 , A	Transmit a data ID code (as shown in Table.8) to encoder based on table 11(List of data fields).
Error reset	B , E	Transmit a data ID code (as shown in Table.8) to encoder based on table 11(List of data fields). It will reset the error flag.

※The encoder has RS485 receiver IC mounted, use a driver IC in conformity to RS485(equivalent to ADM485) for the code transmission.

8. Example of the transmitting/receiving circuit configuration

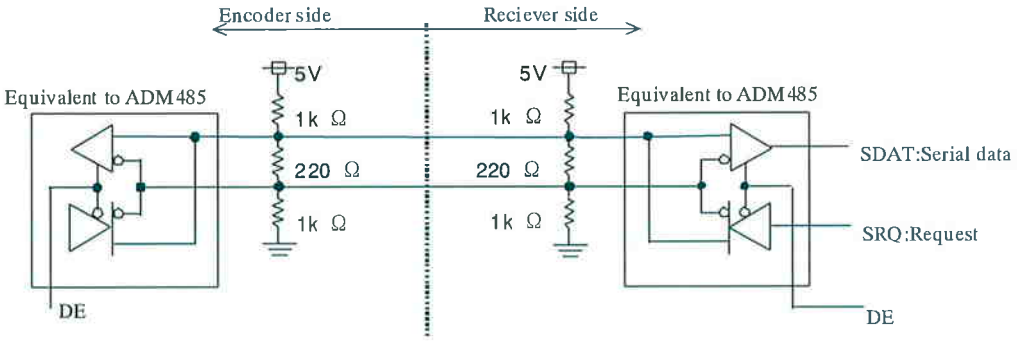


Fig.9 Example of the transmitting/receiving circuit configuration

Do not send request signals to the encoder while it is sending data. It may destroy the encoder I/O. The encoder is normally in the receiving mode.

9. Environmental conditions (Reference; refer to the motor specification for the environmetal conditions for the encoder assembled with the motor)

9.1 Temperature

- Encoder operating temperature range :-10°C－+85°C (Ambient temperature)
  (Note that the LED surface temperature should be 85℃ or less.)
- Storage temperature range :-20°C－+65°C (with the motor assembled)

Operating the encoder outside the operating temperature range may affect the life of the encoder components such as the LED and cause malfunction. Ensure to always operate it within the specified range.

9.2 Humidity

- The humidity should be 85%RH or less in the operating temperature range(no condensation is allowed).

< Reference information>

●Life of the encoder

- Electrical life (LED life): 30,000 hours at minimum
  This encoder is designed to meet the specification with half the amount of LED light. Thus the electrical life is the time it takes for the LED to reduce its amount of light by half with the normal operation at the supply voltage of 5V.

10. Warranty period

Refer to the motor specification for the period and scope of the warranty.

11. Special instructions

(1) If you need any items not specified in this document agreed upon or plan to use the device outside of the specifications, please inform the manufacturer in advance.

(2) Partial modifications such as changes to components of the device may be made to improve the performance and other reasons within the range where this specification is met.

(3) Please be aware that you will be required to verify the complete equipment's conformance to standards and regulations.

(4) In case of a failure, a resolution shall be developed and implemented based on mutual consultation according to this specification.

(5) The device does not have protectors attached as shipped. Add in the complete equipment the overcurrent protection device, ground fault interrupter, overtemperature prevention device, emergency stop device and other protective devices to provide appropriate protection.

(6) Wiring conditions (grounding method, cable lengths, shielding of signal wires) and other conditions may affect the noise immunity. Please verify the noise immunity with your complete equipment.

(7) Do not transmit request signals to the encoder while it is transmitting data. It may destroy the encoder I/O.

(8) The device should never be used in locations where it is exposed to fluids such as water and machining oil, and to foreign matters such as oil mist and chips. Also never use it in atmosphere of corrosive gases (e.g. H_2S, SO_2, NO_2, Cl_2) and flammable gases, and in the proximity of flammable materials.

(9) We have been putting maximum effort to ensure the quality of this product. But since the possibility of the occurrence of the product's abnormal behavior not in accordance with the setting still exists due to the unexpectedly strong exogenous noise (including radiation and the like), the application of static electricity, or the rare event such as abnormality in the input power source, the wiring, and the parts. You are to give considerations to secure safety in the operable range in the operating place as well as fail-safe designing.

(10) The device is designed for general industrial applications. It is not intended for the use for equipment that involves human lives or is used in special environments, such as nuclear power controls, aerospace instruments, transportation facilities, medical machinery, various safety devices, and equipment that requires cleanliness.

(11) Do not conduct pressure tests with the device.

12. Points to keep in mind when using the motor

(1) Prior to using the motor, consult the motor specification.

(2) Ensure all the connections are made correctly when connecting the lead wires of the motor and encoder.