

COOL MUSCLE 3

Direct Type User's Guide



MDUG-CM3/20831E-21
CM3 Firmware Version v1.01



CM3 has three sorts of control types: **Direct type, I/O type, and Pulse type.**

This user's guide is for the CM3 **Direct type** only.

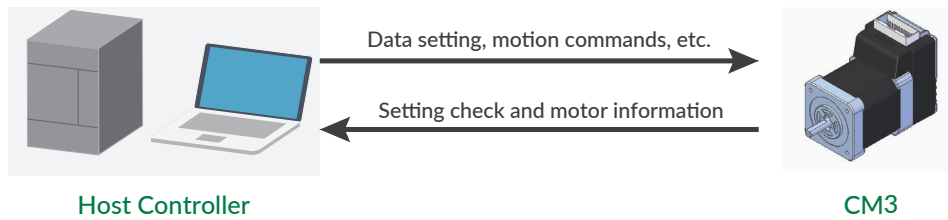
The control type of CM3 can be changed according to the control method.

Type can be changed from the dedicated software "COOL WORKS QUICK" .

- Direct type (Communication type)

Direct type lets you operate CM3 by sending and receiving commands via RS-232C serial communication. Positioning can be done by simple settings as position, speed, acceleration and etc.

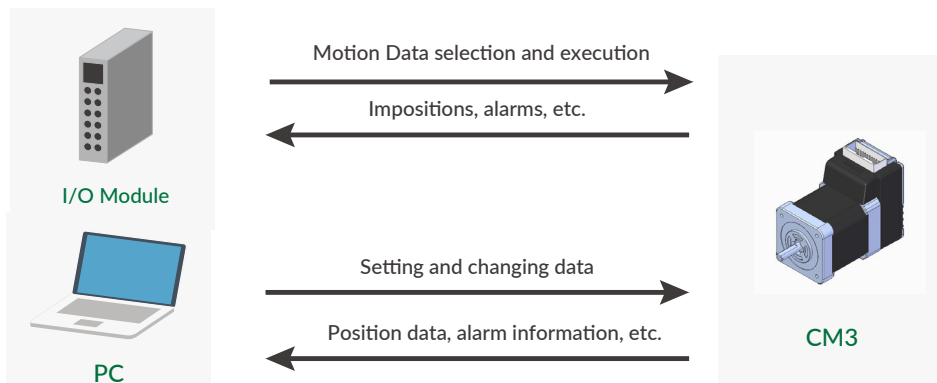
Max 32 point Motion Data can be set and executed.



- I/O type

Max 8 point Motion Data can be set and they can be selected and executed by input signals.

Output signal from I/O port on PLC executes a motion set in CM3' s Motion Data.



- Pulse type

CM3 is controlled by a pulse signal from the PLC.

The ABZ output function allows you to replace an existing system with the CM3.

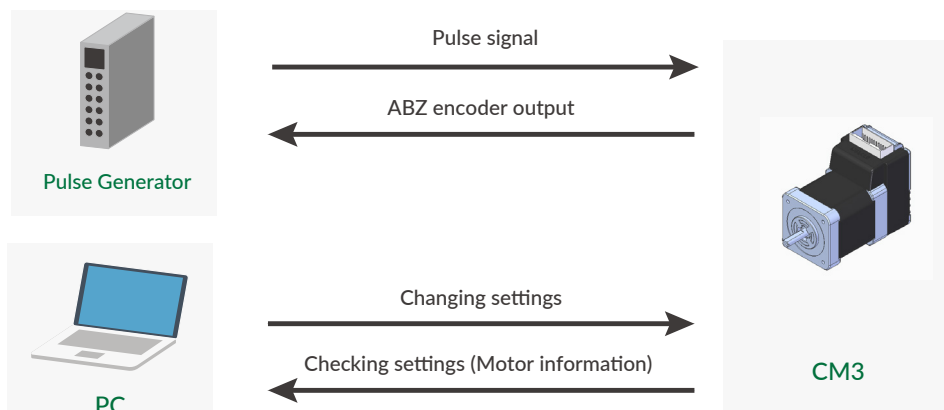


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Before Use

- Before use, read through this User's Guide to ensure proper use.
- In particular, be sure to read "Instructions for Safety" without fail for safety purpose.
- Keep this User's Guide at an easily accessible place so as to be referred anytime as necessary.

- The contents of this User's Guide are subject to change without notice for the improvement in product, specification, or usability of this User's Guide.
- This User's Guide is only intended to provide information about the product and does not guarantee any results from usage of the product. MUSCLE CORPORATION is not responsible for any damages and/or injuries resulting from the implementation in accordance with the contents of this User's Guide.
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- Please refer to the related manuals "COOL WORKS QUICK USER'S MANUAL" for the usage of COOL WORKS QUICK, a communication software for COOL MUSCLE operation.

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Instructions for Safety

Be sure to read before use for safety

To ensure safe use

To ensure the safe and proper use of our products, it is important that you read this User's Guide thoroughly prior to its use. Failure to read, fully understand and implement following instructions and precautions may result in damage to the product, the machine to which it is installed, or operator injury.

About product application



These products are manufactured as a general-purpose part for the application in general industries. They are not designed or manufactured for equipment or systems which affect human life or applications in which faulty operation or failure may result in personal injury or significant damage to property. These products shall not be used in applications which require an extremely high degree of reliability and safety, such as those listed below.

- Medical equipment or system that have a direct affect on human life.
- Applications that directly affect on the safety of people. (For example, the operation and control of aircraft, cars, elevators railroads, etc.)
- Applications in which failure may significantly damage or impact the society and public. (For example, nuclear power, electric power, aerospace, public transportation system, etc.)
- Equipments or systems used under special environmental condition.
- Applications with the same level of importance as those described above.





* When considering the product for use in such special applications, please contact our sales representative. We ask that you employ fail-safe systems when applying these products to the equipment in which any failure on its part can be expected to cause a serious accident or loss.

Safety Precautions


- Please read following precautions in order to ensure safe and proper use of the product and avoid damages on machinery and injuries to the operators and other people.
- This User's Guide should carefully be kept in a convenient place for the operator's easy reference.
- In this User's Guide, safety precautions are classified as either "Warning" or "Caution", indicating the level of hazard seriousness possibly occurred when handling the product incorrectly. The symbols are explained below.

 Warning	Indicates an imminently hazardous situation which, if not handled properly, may result in death or serious injury.
 Caution	Indicates a potentially hazardous situation which, if not handled properly, may result in injury or property damage.


"What must not be done" and "What must be done" are indicated by the following symbols.

 Indicates a prohibited action What must not be done	 Ex. No disassemble
 Indicates a necessary action What must be done	 Ex. Grounding


 **Warning**

- Never touch the rotating part of the motor while operating. 


The failure could result in injuries. Take a measure for safety to keep away contact by personnel.

- Do not touch the motor and driver while power is ON or for some time after power-OFF. 


Temperatures may be high and you may get burnt.

- Do not change the wiring while power is ON. 


Be sure to remove wiring and unplug a connector after power-OFF. The failure could result in electric shocks, runaway or damages.

- Do not give damage to, apply excessive force to, place something heavy upon, or pinch the cable. 


Do not pull the cable by too much power. The failure could result in damages to connection section, or electric shocks.

- Never disassemble, modify, or repair the product. 


Do not open the cover of the product, or disassemble or modify the parts inside. The failure could result in fire, electric shocks, malfunction or injuries

- Do not install the product on or near combustibles. 

Attach the product to noncombustible matter such as metal. The failure could result in fire.


- Do not tamper with water, corrosive gas, inflammable gas, flammable material, or electrically conductive material such as screw or metal piece. 

Do not insert metal pieces into the venting holes of enclosure. The failure could result in fire, electric shocks, or damages.


- Be sure to ground the terminal of the earth wire. 

Securely ground to prevent electric shocks and to stabilize the potential in the control circuit.


 **Caution (Environment)**

- Keep or use the product under the following environmental conditions.
- Operating ambient temperature: 0 to 40°C
 - Storage ambient temperature: -20 to 60°C (non freezing)
 - Ambient humidity : Below 90%RH (non condensing)
 - Vibration / Shock resistance : JIS Z 0232 Level2 / JIS Z 0202 Level3
-  Avoid store or use in such an environment where the product is exposed to oil or water. (It is not waterproof structure.)
- Indoor use only (no direct sunlight). No corrosive gas, inflammable gas, oil mist or dust.


 **Caution (Transportation)**

- The product is precision mechanical equipment. 


Do not drop or give any strong impact to the product. The failure could result in damages or malfunction.

- Do not hold the cables or motor shaft when transporting the product. 

The failure could result in damages or malfunction.


- Do not climb, stand, or put heavy objects on the product. 

The failure could result in damages or malfunction.


- Do not stack in excess of the specified number of products. 

The failure could result in damages or malfunction.


 **Caution (Installation)**

- When installing a pulley or coupling to the machine, do not hammer on the motor shaft. 


The failure could result in damages or malfunction.

- Be sure to fix the product on the machine firmly. 


If fixation is not tight enough, the product may come off while operating.

- Be sure to make precise centering between the motor shaft and the machine. 

Deviation from the center could result in vibration or damages.

- The load inertia moment should be below the recommended load inertia moment ratio of the motor being used. 

If it is too large, desired performance may not be attainable.

- Carefully consider the heat radiation of the product, and make sure to install it in the condition with proper airflow. 

Be sure to avoid interference with the heat radiation of motor and driver.

 **Caution (Wiring)**

Wiring must always be performed properly and reliably.

Ensure that terminal connection or polarity (+, -) is correct.
The failure could result in damages or malfunction.



Carefully consider the cable clamping method, and make sure that bending stress and the stress of the cable's own weight are not applied on the cable connection section.

The failure could result in damages or bursts.



Do not apply a voltage exceeding the specified voltage to the input terminal.

The failure could result in damages or bursts.



Do not modify the connector or terminals on the end of the cable.

The failure could result in damages or bursts.



 **Caution (Operation)**

Provide an external emergency stop circuit to ensure that operation can be stopped, and power switched off immediately.

When a trouble occurs, shut off the power immediately.



Before operation, check the parameter settings to ensure that there are no operation errors. Connect a load to the products after the successful trial-operations.

Improper settings may cause some machines to perform unexpected operation, resulting in damages.



Do not apply a load exceeding the tolerable load onto the motor shaft.

The failure could result in break of the shaft.



Do not turn on or off the power frequently.

The failure could result in degradation of circuit element.



Do not change the parameter settings excessively.

The failure could result in instable or unexpected operation.



 **Caution (Corrective Action)**

If any alarm has occurred, eliminate its causes of the alarm and secure the safety before restarting the operation.

The failure could result in damages or bursts.



When it is assumed that a hazardous condition may take place at the occurrence due to a product fault, use an external holding brake mechanism.

If any alarm has occurs, the motor goes into free-run state.



If any product fault has occurred, shut off the power immediately and do not turn on the power.

The failure could result in damages or bursts.



 **Caution (Maintenance and Inspection)**

Only persons who are trained and qualified to work or on electrical equipment are permitted to maintain or inspect the product.

Incorrect handling or operation could cause electric shocks or damages.



Do not perform a dielectric voltage-withstand test. The failure could result in destruction of circuit element.



MUSCLE CORPORATION is not responsible for any damages resulting from modifications or repairs made to the product.

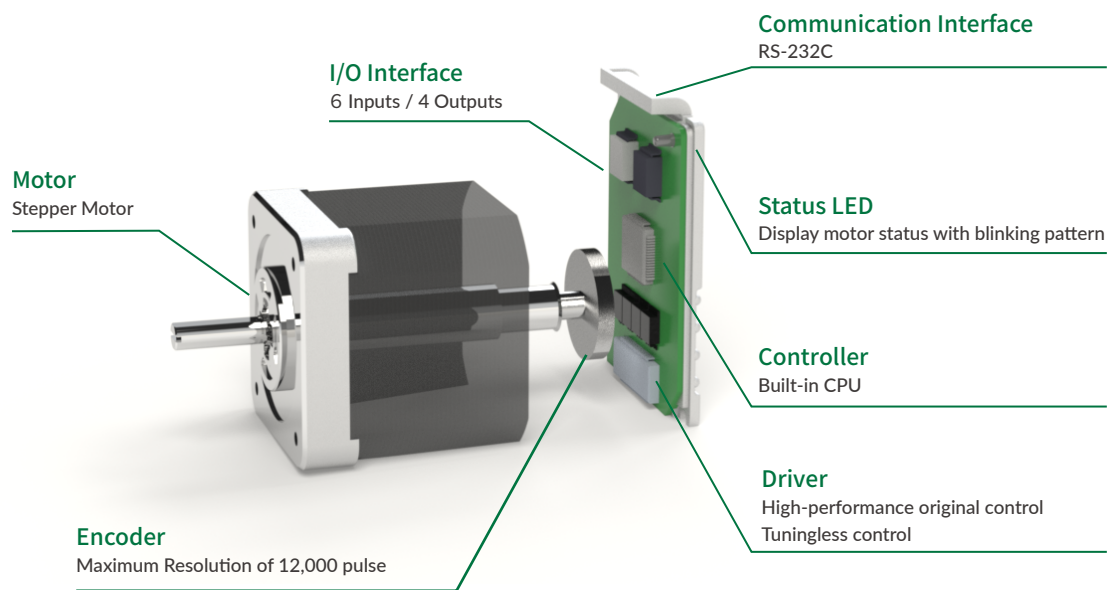
About processing of waste

This product should be treated as an industrial waste when it is disposed.

Chapter 1 Functions and Structure

1.1 Overview

The "CM3" is an integrated AC servo system with a built-in motor, encoder, driver, and controller. The higher torque and speed have been achieved by MUSCLE's unique control technology. With MUSCLE's own programming language "CML" (COOL MUSCLE Language), various motion, such as PTP Motion, torque control and etc. can be executed via RS-232C serial communication. CM3 provides the highest solution.

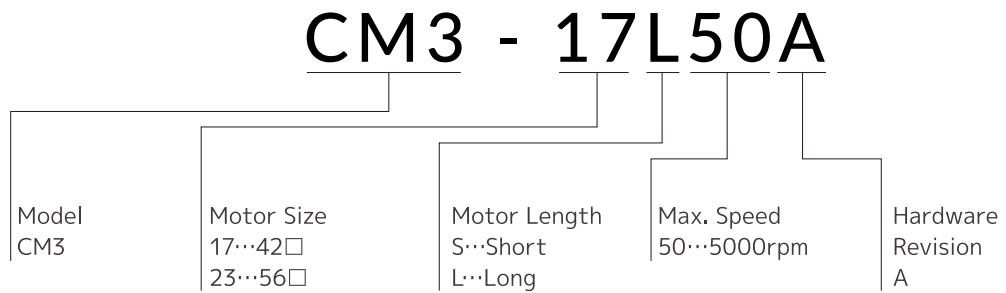


Main Functions of CM3

- PTP Motion
- Continuous Motion
- Push Motion
- Origin Detection
- Software Limit
- STO (Safe Torque Off) Function
- Tuningless Function
- Various Output Functions

1.2 Product Code Scheme

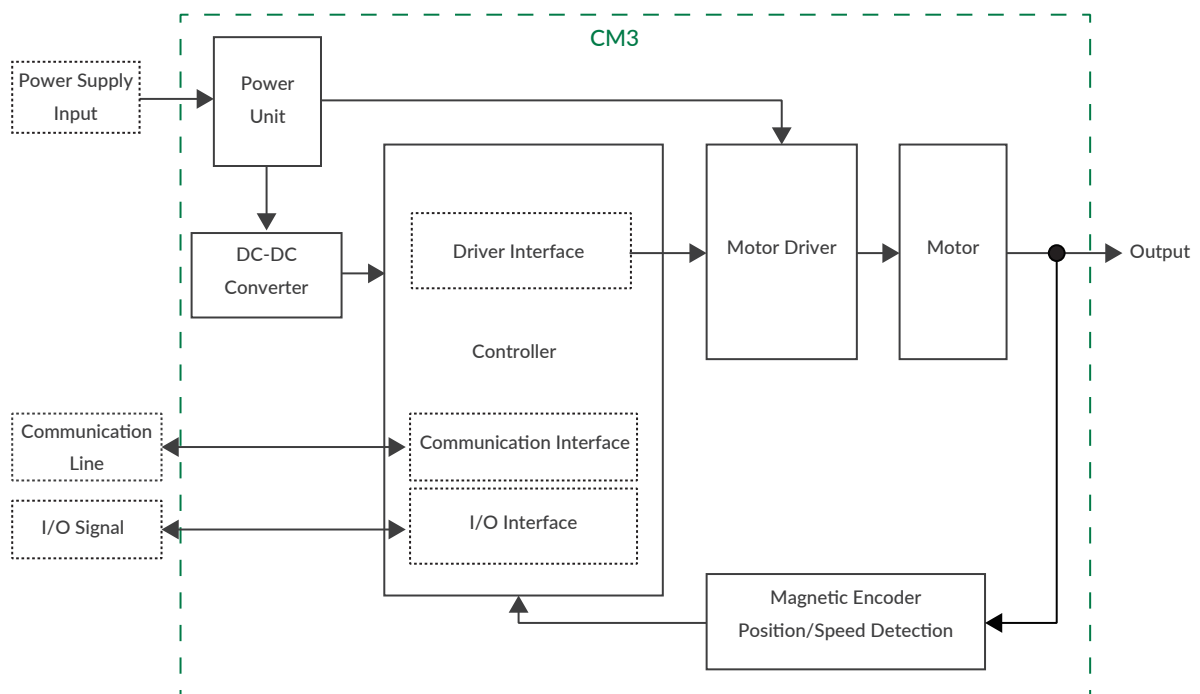
CM3's product code scheme is described as below.



□ Product Name

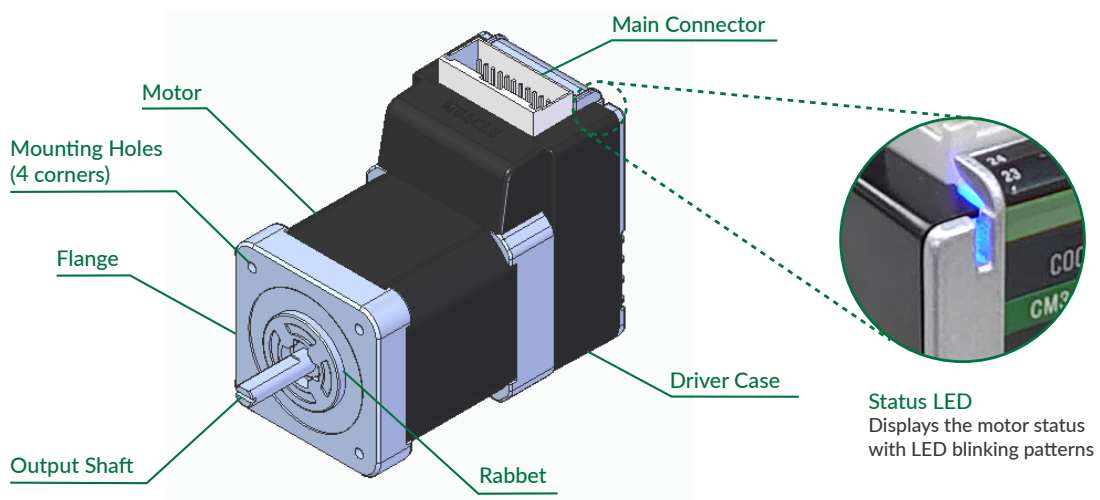
Product Name	Product Code
CM3 42mm Short	CM3-17S50A
CM3 42mm Long	CM3-17L50A
CM3 56mm Short	CM3-23S50A
CM3 56mm Long	CM3-23L50A

1.3 Function Block Diagram



1.4 Parts Description

The names of parts of CM3 are as shown below.



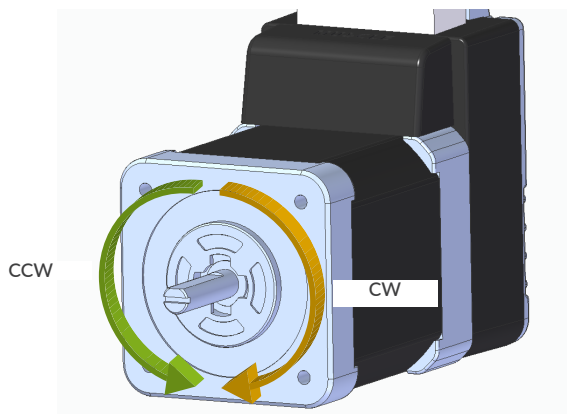
* Please refer to "8.10 Status LED" for the status LED blinking pattern.

1.5 Rotating Direction and Coordinate

Rotating direction and coordination are defined as below.

CW (Clockwise) Direction : Clockwise direction defined as viewed from output shaft side.

CCW (Counterclockwise) Direction : Counterclockwise direction defined as viewed from output shaft side.



Coordinate Direction

By the default setting, CW direction is positive direction and CCW direction is negative direction in coordinate.

Coordinate direction can be reversed by parameter.

Ref: "7.2 Coordinate Direction (K4) "

1.6 Control

Direct type CM3 can be controlled by RS-232C serial communication.

After setting A (Acceleration), S (Speed), P (Position), Motion can be executed by execution command "^".

- Ex. Move to Position 1000 with Acceleration 5, Speed 10.

```
S=10    //Set speed as 10
A=5     //Set acceleration as 5
P=1000  //Set target position as 1000
^       //Execution
```

Max. 32 Motion Data can be created.

Each Motion Data is composed of necessary items for motion such as speed, acceleration, target position, etc.

Motion starts when an execution command is sent after setting data in specified Motion Data.

Refer to "[8.3 Positioning Operation](#)" for details.

1.7 Program Language, COOL MUSCLE Language "CML"

CML is an abbreviation for "COOL MUSCLE Language" (hereafter, CML) to operate/control CM3. CML consists of the following items.

- Parameters

Parameters set the system conditions such as CM3's communication setting, alarm conditions and etc.

- Motion Data

Motion Data set CM3 motion conditions from current position to target position.

- Execution Commands

Execution commands are commands to execute preset content in CM3.

- Query Commands

Query commands read CM3's current status (set value as position, speed etc).

- CM3 Status

Current status (In-position, alarm, warning and etc) of CM3.

Please refer to "[6.5 Query Commands](#)" for Query commands and CM3 status. ".Motor ID" follows all CML but ".Motor ID" is not described in this document due to that CM3 is a single axis controlled device. ".Motor ID" is not necessary when sending CML to CM3 but ".Motor ID" is added in replied data.



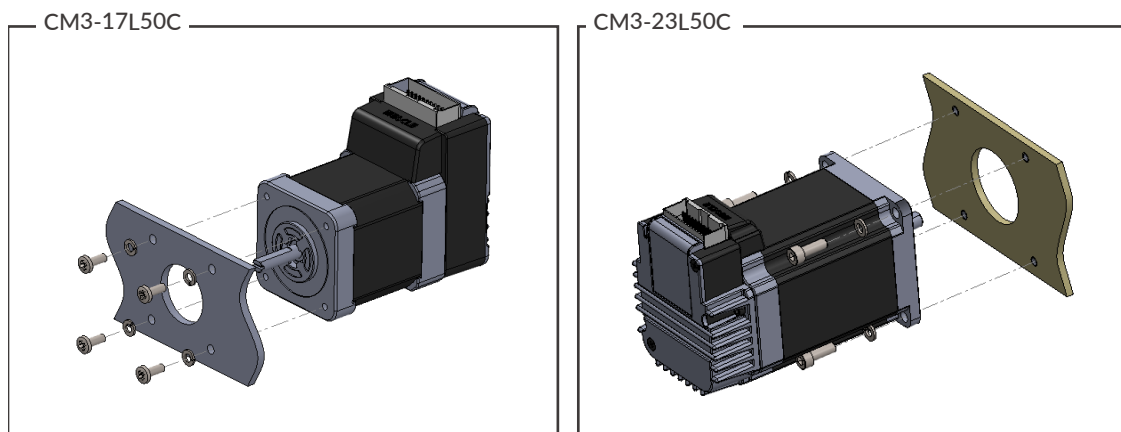
Please use 1 byte character only. CML is not case sensitive.

Chapter 2 Installation

2.1 Mounting to Machinery

CM3 can be mounted either horizontally or vertically. Mount CM3 on the smooth and rigid surface of a metal plate. When installing CM3, insert the rabbet located on the motor's installation surface into the mounting plate's counterbore or through holes then screw it with four bolts through the four mounting holes on CM3's installing surface leaving no gaps between the surface and metal plate.

(Tolerance of rabbet is on "Chapter 10 Specifications".)



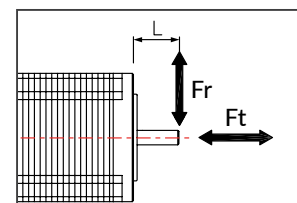
The sizes of mounting bolts are as follows.

Model	Bolt Size	Depth
CM3-17S50 / CM3-17L50	M3	5.0 mm
CM3-23S50 / CM3-23L50	M4	-

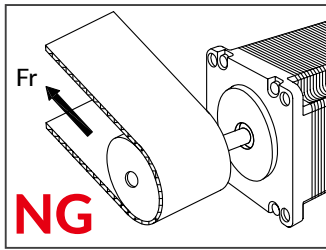
2.2 Mounting to Load

Attach the coupling to the output shaft and adjust so that the load shaft and output shaft are centered. Flexible coupling with torsional rigidity is recommended. Design the machinery and align the assembly to ensure that radial load and thrust load on motor shaft do not exceed the allowable values. (Allowable radial load and thrust load of each CM3 motor size are stated in "Chapter 10 Specifications".)

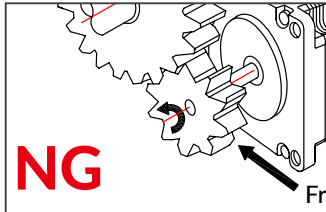
Radial Load (F_r): Perpendicular force applied to the shaft end.
 Thrust Load (F_t): Parallel force applied to the shaft end.



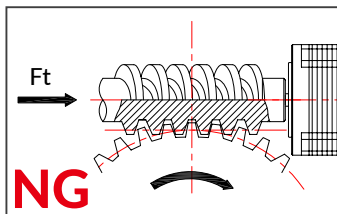
Mounting a load directly to the output shaft would increase the force and damage the motor.
 Consider reviewing the mechanical system so that excessive load is not applied to the output shaft.



When a pulley is directly mounted onto output shaft, radial force (F_r) will be produced by belt tension and may result in damaging bearings in a motor.



When a gear is directly mounted onto output shaft, smaller the dimensions of gear, bigger radial force (F_r) will be produced and may result in damaging bearings in a motor.



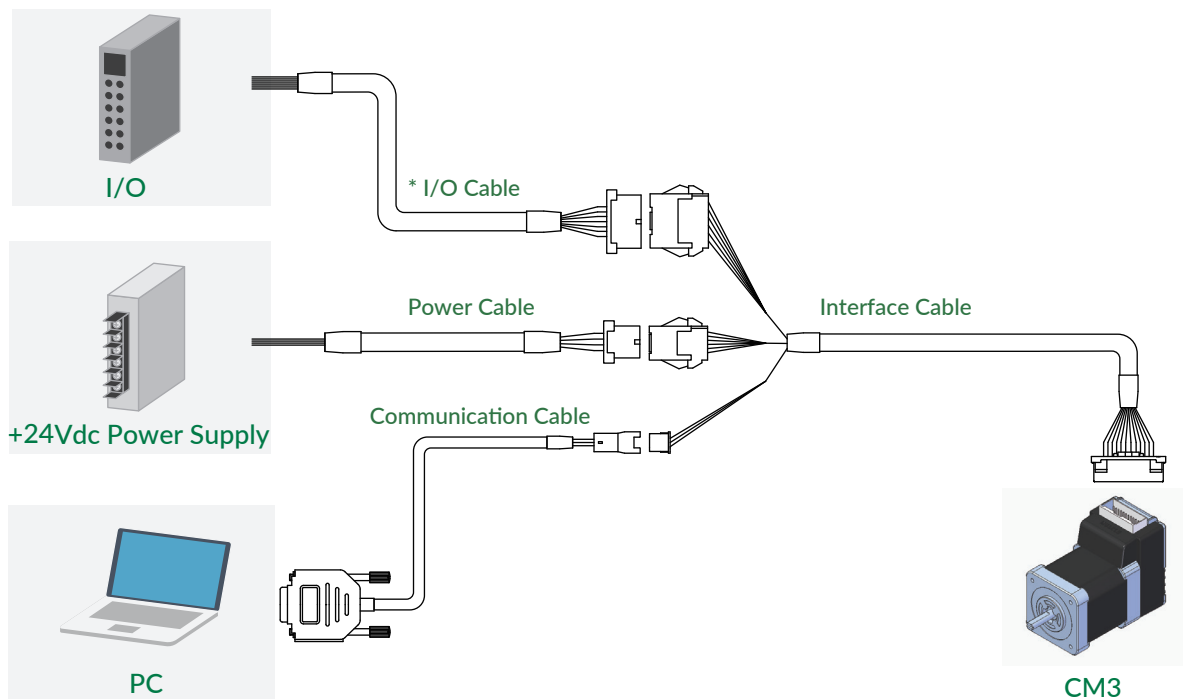
When a worm gear is directly mounted onto output shaft, thrust load (F_t) will be produced and forced to motor shaft. Motor shaft will be moved, and it may result in damaging the inside of motor.

Chapter 3 Wiring and Connection

3.1 Typical Connection Example

Caution about Cabling

- Be sure that the power is off before plugging or unplugging connectors.
- Pay attention for straight insertion and removal of connectors by holding connector's body.
- Be sure there is no stress on connectors.
- Be sure not to pull cables hard or hung CM3 by holding cables. It may result in damaging connectors.



*Required when I/O (input/output) function is used in addition to command control from the host

3.2 Connector Pin Layout and Functions

Pin layout and functions of CM3 cables are described below.

Main Connector

CM3 has a 24-pin connector on the top. The pin layout, names and functions are as follows.

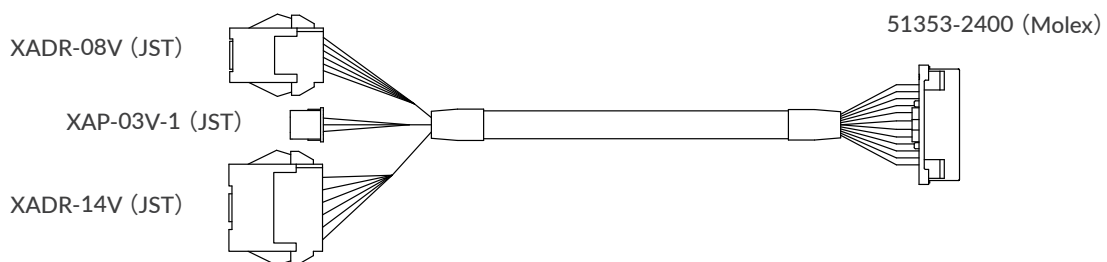
No.	Name	Function	No.	Name	Function
2	D_GND	Digital Ground	1	FG	Frame Ground
4	ALARM	Alarm Output	3	D_GND	Digital Ground
6	OUT3	Output 3 / Z-phase	5	RXD0	RS232C Receive Data
8	OUT2	Output 2 / B-phase	7	TXD0	RS232C Transmit Data
10	OUT1	Output 1 / A-phase	9	STO_IN-	STO Input -
12	STO_IN+	STO Input +	11	IN6+	CW Inching · Jog
14	IN6-	CW Inching · Jog	13	IN5+	CCW Inching · Jog
16	IN5-	CCW Inching · Jog	15	IN_COM	IN1 to 4 Common
18	IN4	Manual Mode	17	IN3	Servo on · off
20	IN2	Limit Sensor	19	IN1	Origin/Limit Sensor
22	P-GND	Power Ground	21	P-GND	Power Ground
24	POWER	+24Vdc	23	POWER	+24Vdc

Connector: 55959-2430 (Molex)

Interface Cable A (400mm, 1000mm, 2000mm, 3000mm, 5000mm)

Product Number: CMIFA1-****WR (****: Cable Length)

Wires: 1 - 20 pin ... AWG26 UL20276 (80°C / 30V)
 21 - 24 pin ... AWG24 UL20276 (80°C / 30V)

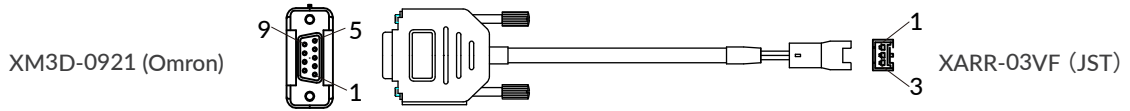


Chapter 3 Wiring and Connection

- Communication Cable A (1000mm, 2000mm, 3000mm, 5000mm)

Product Number: CMRSA1-****W (****: Cable Length)

Wires: AWG26 UL1007 (80°C / 300V)



PC side

Color	No.	Name	Function
ORG	2	RXD	RS232C Receive Data from PC
GRY	3	TXD	RS232C Transmit Data from PC
WHT	5	D_GND	Digital Ground

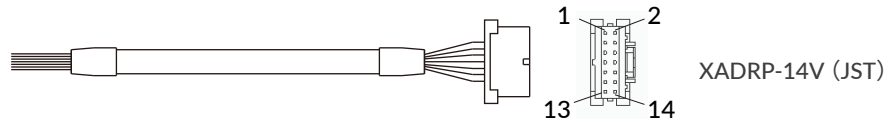
CM3 side

Color	No.	Name	Function
ORG	1	RXD	RS232C Receive Data from CM3
GRY	2	TXD	RS232C Transmit Data from CM3
WHT	3	D_GND	Digital Ground

- I/O Cable A (1000mm, 3000mm, 5000mm)

Product Number: CMIOA1-****S (****: Cable Length)

Wires: AWG28 UL758 Style2464 (80°C / 300V)



Color	Dot	No.	Name	Function
PPL	/	1	IN1	Origin/Limit Sensor
GRN	/	3	IN3	Servo on • off
ORG	/	5	IN5 +	CCW Inching • Jog
BLK	/	7	IN6 +	CW Inching • Jog
WHT	/	9	IN_COM	Input 1 to 4 Common
WHT	-	11	OUT2	Output 2 / B-phase
WHT	- - -	13	ALARM	Alarm Output

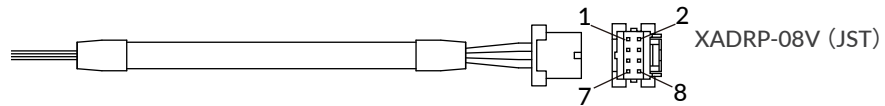
Color	Dot	No.	Name	Function
BLU	/	2	IN2	Limit Sensor
YLW	/	4	IN4	Manual Mode
RED	/	6	IN5 -	CCW Inching • Jog
BRW	/	8	IN6 -	CW Inching • Jog
GRY	/	10	OUT1	Output 1 / A-phase
WHT	- -	12	OUT3	Output 3 / Z-phase
WHT	- - - -	14	D_GND	Digital Ground

Chapter 3 Wiring and Connection

- Power Cable A (1000mm, 3000mm, 5000mm)

Product Number: CM3PWA1-****S (****: Cable Length)

Wires: AWG24 UL758 Style2464 (80°C / 300V)



Color	No.	Name	Function	Color	No.	Name	Function
RED	1	POWER	+24Vdc	GRN	2	POWER	+24Vdc
BLK	3	P-GND	Power Ground	WHT	4	P-GND	Power Ground
GRY	5	STO_IN+	STO Input +	BLU	6	STO_IN-	STO Input -
BRW	7	FG	Frame Ground	-	8	N/A	N/A

3.3 Electrical Specifications

Item		Value
Digital Input	Applied Voltage	0 - 26 [V]
	Low Level Voltage	0.8 [V]
	High Level Voltage	4.2 [V]
Digital Output	Withstanding Voltage	26 [V]
	Max. Continuous Load Current	10 [mA]

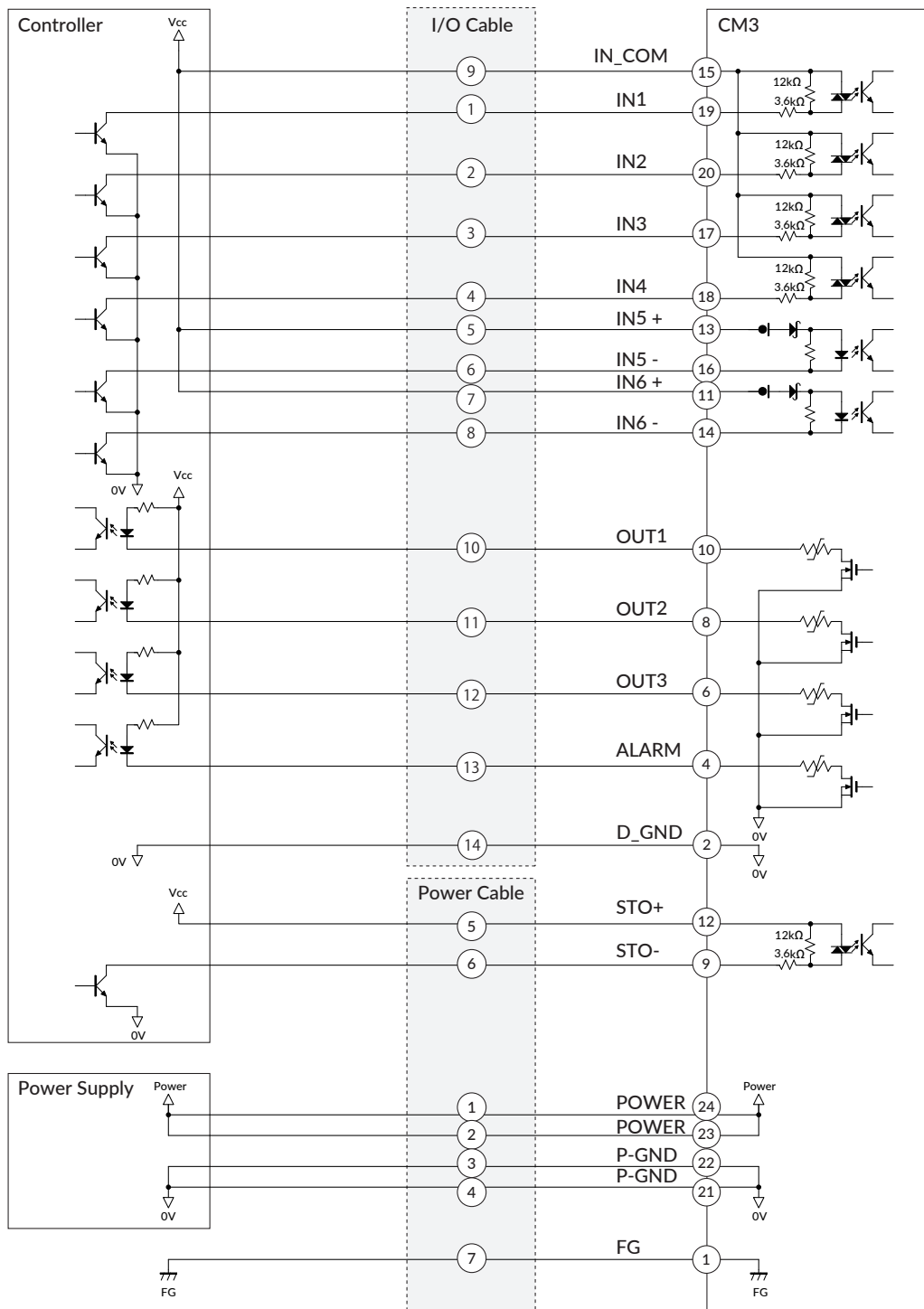
3.4 Input/Output Circuit


Input	IN1, 2, 3, 4 No Polarity	
	IN5, IN6 With Polarity	
	STO No Polarity	
Output	OUT1, 2, 3 ALARM Open-drain	

* When not using the STO function, apply a voltage of 5 to 24V between STO+ and STO-.

3.5 Circuit Connection

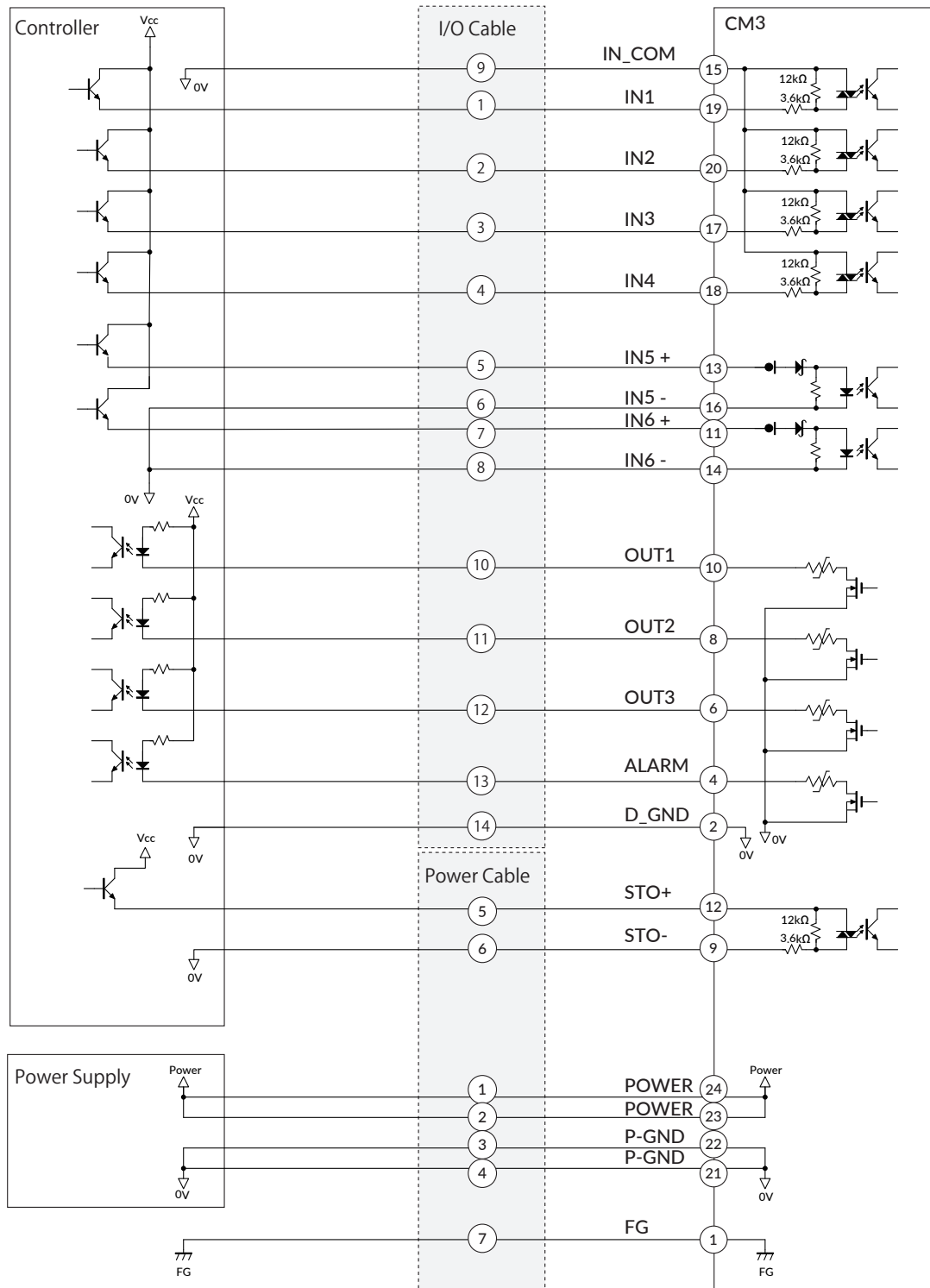
- Connection Example with Sink Output Circuit



 Make sure that the power is OFF while connecting the cables.
Power ON after confirming the wiring is thoroughly correct.

 Make sure to ground the FG

□ Connection Example with Source Output Circuit



Make sure that the power is OFF while connecting the cables.
Power ON after confirming the wiring is thoroughly correct.



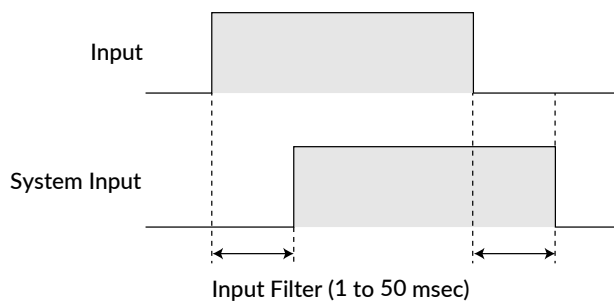
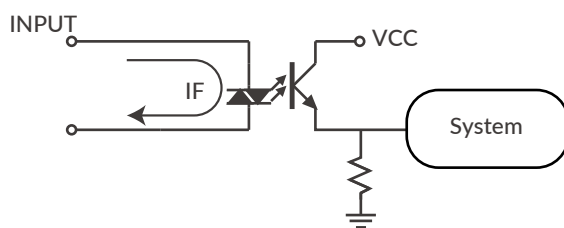
Make sure to ground the FG

Chapter 4 Input/Output

4.1 Input Signal

4.1.1 Input Filter

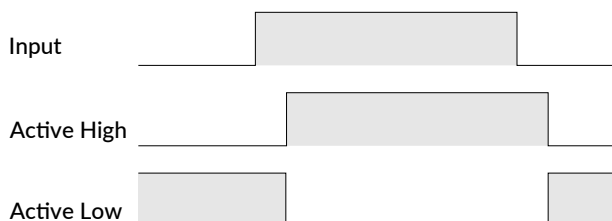
CM3 has 6 Inputs in total, 4 digital inputs, IN1 to IN4, do not come with polarity and 2 digital inputs, IN5 and IN6, with polarity. Filter function (1 to 50 msec) by software is available on all inputs. The filter function by software cannot be removed. The minimum filtering time is 1msec and the detection sequence is shown in the below diagram.



When Input Filter is set, the signal shorter than the set time is not detected as a signal.

4.1.2 Input Logic

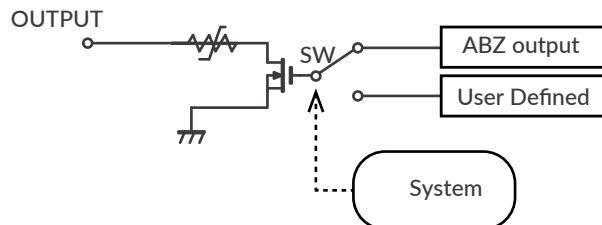
Input signal logic can be set by a parameter. Active High and Active Low settings are as shown in the below diagram. Set it to suit the logic on the controller side.



4.2 Output Signal

4.2.1 Output Function

CM3 has 4 outputs that are an open-drain circuit. OUT4 is fixed for Alarm Output and other Outputs (OUT1 to OUT3) can be set as ABZ Output or General Output by parameters.



4.2.2 Output Logic

When selecting "User Defined" by Output Function parameter, the logic for Output 1 to Output 3 can be switched.

* Output 4 (Alarm output) is fixed as Active Low logic.

Active High: Gate in open-drain circuit is ON when output condition is true

Active Low: Gate in open-drain circuit is ON when output condition is false

Refer to "[8.6 Output Functions](#)" for further information.

Chapter 5 Communication Functions

CM3 can send and receive commands to and from host devices such as PC, PLC, and HMI via RS-232C serial communication. There are the following methods for communication.

- The dedicated software, COOL WORKS QUICK
- Terminal software on Windows such as Tera Term

5.1 Communication Software Overview

☐ COOL WORKS QUICK

COOL WORKS QUICK (hereafter CWQ) is CML compatible utility software, has user-friendly interface and assists easy operation of CM3. With CWQ, you can easily set and save parameters and data, stream data in graph and etc. The latest version of CWQ and its manual are available for free on MUSCLE CORPORATION's website. (<https://musclecorp.com/motion-en>)

☐ Establish communication with CM3

If the following information is displayed when powered on, communication between PC and CM3 is established. If communication is not succeeded, please review the communication conditions.

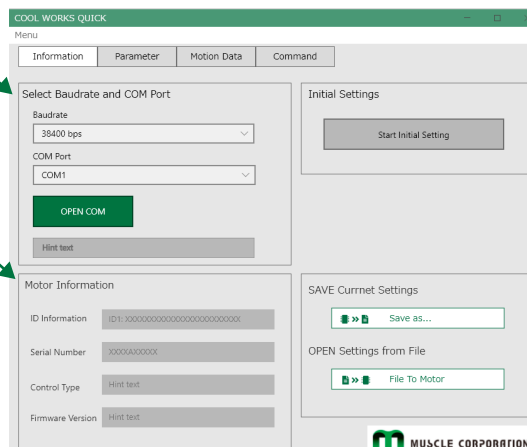
Open COM Port

Start communication with CM3

Motor Information

Once the communication is established, the information below will be shown.

- Motor ID
- Serial Number
- Control Type
- Firmware Version



*The screen is under development

☐ Settings for host devices such as PLC and HMI, and Windows terminal software such as Tera Term.

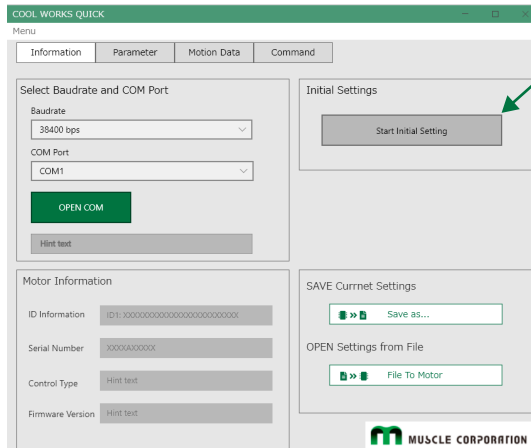
Communication conditions must be set as follows.

Baud rate	38400
Data	8
Parity	NONE
Stop	1
Flow Control	NONE

5.2 Select Control Type

Once communication is established, then select the control type.
The control type can be selected from the initial setup wizard.

1. Click the button below to open the Initial Setup Wizard.



Start Initial Setting Wizard

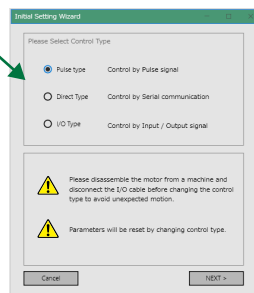
The Initial Wizard allows you to change the control type and default settings.

2. When the Initialization Wizard opens, select a control type.
The pulse type is selected as default. Please select the "Direct type".

Select Control Type

Choose the control type from below items

- Pulse Type
- Direct Type
- I/O Type



*The screen is under development

Chapter 6 CML (COOL MUSCLE Language)

6.1 Overview

The programming language CML via RS-232C serial communication can control CM3.

MUSCLE developed CML based on ASCII code that is the most modern character-encoding schemes used for computer and communication devices. ASCII code chart is as shown in the below table.

□ ASCII Code Chart

		Upper 4-bit (Hex)							
		0	1	2	3	4	5	6	7
Lower 4-bit (Hex)	0	NUL	DLE	(SP)	0	@	P	`	p
	1	SOH	DC1	!	1	A	Q	a	q
	2	STX	DC2	“	2	B	E	b	r
	3	ETX	DC3	#	3	C	S	c	s
	4	EOT	DC4	\$	4	D	T	d	t
	5	ENQ	NAC	%	5	E	U	e	u
	6	ACK	SYN	&	6	F	V	f	v
	7	BEL	ETB	‘	7	G	W	g	w
	8	BS	CAN	(	8	H	X	h	x
	9	HT	EM	)	9	I	Y	i	y
	A	LF	SUB	*	:	J	Z	j	z
	B	VT	ESC	+	;	K	[	k	{
	C	FF	FS	,	<	L	\	l	|
	D	CR	GS	-	=	M	]	m	}
	E	SO	RS	.	>	N	^	n	~
	F	SI	US	/	?	O	_	o	DEL

CML is composed of the combination of the character code above.

CML is composed of parameter, Motion Data, execution command and Query command.

CML and character codes are shown in the below table.

CML Command	Character Code	Function	Others
Parameters Ref: 6.2	K**	Motion Environmental Parameters	K1 - K15
		Origin Detection Parameters	K22 - K30
		Gain Adjustment Parameters	K31 - K36
		I/O Parameters	K42 - K60
		Status Parameters	K61 - K66
		Communication Parameters	K71 - K73
		Monitoring Parameters	K85 - K90

CML Command	Character Code	Function	Others
Motion Data Ref: 6.3	V**	Motion Mode	Motion Data 0 - 31. Motion pattern for Max. 32 positions can be set.
	P**	Position Data	
	S**	Speed Data	
	A**	Acceleration Data	
	D**	Deceleration Ratio Data	
	M**	Torque Limit Data	
	Q**	Push Motion Torque Data	
	ZL**	Individual ZONE (+)	
	ZH**	Individual ZONE (-)	
Execution Commands Ref: 6.4	^**	Motion Data Execution	
	]	Stop, Cancel Warning	
	|	Origin Detection Execution	
	[	Restart	
	(	Servo On, Alarm Reset	
	)	Servo Off	
	#	Teaching	
	\$	Save Parameters & Motion Data	
	O	Output Signal On	
	F	Output Signal Off	
Query Command Ref: 6.5	?**	Current Status	

** = Number

Procedure from setting to operation

- Parameter settings
Set the operating environment such as Resolution and speed unit.
- Motion Data settings
Set Motion Data such as target position, velocity, and acceleration.
- Operation by Execution Commands
After saving the set parameters and Motion Data in CM3, execute the Motion Data.
- Check the Motor Status with a Query Command
Query commands allow to confirm the set data and various information such as the current position, speed, and torque.

CML allows to built a simple system by creating a sequence using execution commands and Query commands on host devices such as PLC, PC, HMI, and microcomputer.

6.2 Parameter Settings

Set parameters such as Resolution, communication settings, and protection function.

Details of various functions and usage examples are described in [Chapter 7](#).

The format for setting/checking using CML parameters is as follows.

Setting Format

K Parameter Number= Value [CRLF]

Confirmation Format

K Parameter Number[CRLF]

Setting Example:

When setting 10000 pulse to the Software Limit in positive coordinate and the Software Limit valid.

K10=100[CRLF] // * The pulse unit of the Software Limit is 100 pulses

K7=1[CRLF]

The above data can be set by sending CML commands to CM3.

Confirming Example:

To confirm whether the Software Limit function is valid.

K7[CRLF] //Send to CM3

K7.1=1[CRLF] //Sent from CM3 to host

* Note

- Please change parameters while CM3 is stopped.
- The changed parameter value is saved by executing the Data Save command (\$).
- Unless the Data Save command is executed, the value saved previously will remain when the power is turned on again.
- For safety reasons, there are some settings that require a power off and on (Restart).

Numbers for Parameter Setting

If B0 to B# is written in the Setting/Range in the next Parameter List, the setting is made in bit units.

Bit	B7	B6	B5	B4	B3	B2	B1	B0
Binary	0	1	0	0	1	1	0	0

The contents set to 1 are valid, and the contents set to 0 are invalid.

When setting parameters, convert the binary number to decimal number before setting.

Example: Binary number: 01001100b ⇒ Decimal number: 76 ⇒ K##.1 = 76[CRLF]

- Separate CML data commands with CR or CRLF.
- The description of CR and CRLF will be omitted in this document.

6.2.1 Motion Environmental Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
1	Resolution	0	300	ppr	✓	Set the pulse count per revolution. The Resolution of ABZ encoder is Max. 3000ppr and the same Resolution as Resolution parameter is applied. When Resolution is set higher than 3000ppr, the Max. 3000ppr is applied to ABZ encoder Resolution. Ref: 7.1
		1	600			
		2	1000			
		3	1200			
		4	2000			
		5	3000			
		6	5000			
		7	6000			
		8	10000			
2	Speed Unit	0	100	pps	✓	Set the speed unit for S command.
		1	10			
		2	1			
3	Servo ON/OFF Setting	0	Servo Off			Set either CM3 starts with Servo on or Servo off when powered on.
		1	Servo On			
4	Coordinate Direction	0	Positive in CW	—	✓	Set the coordinate direction. Ref: 7.2
		1	Positive in CCW			
5	In-position Range	1 - 500		Pulse		Set the range for In-position. Ref: 7.3
6	Speed Override	1 - 100		%		Limit the speed by the set proportion. Ref: 7.4
7	Software Limit Setting	0	Disabled	—		Set the enable / disable of the software limit function and the operation when the function is enabled. Ref: 7.5
		1	Detect before moving			
		2	Detect after moving			
8	Software Limit (+)	0 - Depends on Resolution		Pulse Set by K10		Set the operating limit boundary in the positive direction (Unit set by K10) Ref: 7.5
9	Software Limit (-)	Depends on Resolution - 0		Pulse Set by K10		Set the operating limit boundary in the negative direction (Unit set by K10) Ref: 7.5
10	Unit of Software Limit	0	100	Pulse	✓	Set the unit for Software Limit. Ref: 7.5
		1	10			
		2	1			
11	Push Motion Operation Mode	0	Continuous (One direction)	—		Set the direction and time for Push Motion (); Direction to limit torque. One direction: Torque is limited only in operation direction. Both direction: Torque is limited in both directions. Ref: 8.3.2
		1	Set time (One direction)			
		2	Continuous (Both direction)			
		3	Set time (Both direction)			
13	Push Motion Holding Time	1 - 30000		msec		Set Push Motion Holding Time. Ref: 8.3.2
14	Open Loop Holding Angle	0	Disabled	± 0.1°		Set the angle difference between the target and current position to switch back to closed loop from Open Loop Holding. Ref: 7.6
		1 - 72				
15	Switch Time for Open Loop Holding Mode	10 - 1000		msec		Set the time to switch to Open Loop Holding after positioning is completed. Ref: 7.6

6.2.2 Origin Detection Parameters

K	Name	Setting/Range	Unit	Restart	Reference/Remarks	
22	Origin Signal Source	0	Stopper Detection	—	✓	Set the signal source and method of the Origin Detection. Origin sensor can be assigned only to Input 1. Auto: Origin Detection starts automatically when power is on. Ref: 8.4
		1	Stopper Detection (Auto)			
		2	Origin Sensor			
		3	Origin Sensor (Auto)			
		4	Stopper Detection & Z Phase			
		5	Stopper Detection & Z Phase (Auto)			
		6	Origin Sensor & Z Phase			
		7	Origin Sensor & Z Phase (Auto)			
		8	Z Phase Signal			
		9	Z Phase Signal (Auto)			
23	Origin Detection Speed	1 - 32767	pps Set by K2		Set the speed for Origin Detection.	
24	Origin Detection Acceleration	1 - 32767	kpps ²		Set the acceleration for Origin Detection.	
25	Origin Detection Direction	0	CW	—	✓	Set the direction for Origin Detection.
		1	CCW			
26	Origin Offset Distance	± 32767	pulse		Set offset amount from detected origin to coordinate origin.	
27	Unit of Origin Offset Distance	0	100	pulse	✓	Set the unit when Offset is set.
		1	10			
		2	1			
28	Stopper Detection Torque	10 - 150	%		Set the torque to detect a stopper for Origin Detection by percentage to rated torque. Ref: 8.4.1	
29	Single Turn ABS Function	0	Disabled	—	✓	Set Enable / disable the Single Turn ABS function Ref: 7.7
		1	Enabled			
30	Origin Detection Completion	0	Disabled	—	✓	Function will not be operated until origin detection is completed Ref: 7.8
		1	Enabled			

6.2.3 Gain Adjustment Parameters

K	Name	Setting/Range	Unit	Restart	Reference/Remarks
31	Tuning	0	PPI	—	Set CM3's Tuning method. Ref: 8.7
		1	Tuningless		
32	Servo Stiffness	10 - 200			Set Servo Stiffness when Tuningless is selected. Ref: 8.7.1
33	Position P Gain	1 - 5000			Set 3 types of gains when PPI is selected. Ref: 8.7.2
34	Speed P Gain	50 - 5000			
35	Speed I Gain	0 - 5000			
36	S-Curve Gain	0 - 1024			Set S-Curve Gain for positioning operation. Ref: 8.7.3

6.2.4 I/O Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
42	Input Filter	1 - 50		msec	✓	Set the filtering time for input signal. Ref: 8.5.1
43	Input Logic	1st digit	IN 1	0: Active High 1: Active Low	✓	Set the input logic. Ref: 4.1.2 Ex: IN1, IN3, and IN5 as Active Low K43=010101
		2nd digit	IN 2			
		3rd digit	IN 3			
		4th digit	IN 4			
		5th digit	IN 5			
		6th digit	IN 6			
44	Input 1 Function	0	No Action		✓	Assign functions to Input 1 & 2. Functions of Input 3 to 6 are fixed. Ref: 8.5
45	Input 2 Function	1	Origin Sensor (only for IN1)			
		2	CCW Limit Sensor			
		3	CW Limit Sensor			
50	Inching · Jog Speed	1 - 32767		pps Set by K2		Set the speed for the Inching and Jog operation. Ref: 8.5.2
51	Inching Distance	1 - 100		Pulse		Set the Inching distance. Ref: 8.5.2
52	Inching · Jog Shift Time	0	No Inching Motion	msec		Set the time to switch Jog from Inching completion. Ref: 8.5.2
		1 - 3000				
53	Output Logic	1st digit	OUT 1	0: Active High 1: Active Low	✓	Set the output logic Ref: 4.2.2 Ex: OUT3 and OUT1 as Active Low K53=101
		2nd digit	OUT 2			
		3rd digit	OUT3			
54	Output Function	0	ABZ Encoder Output		✓	Select the function to be assigned to outputs 1 to 3 from "ABZ Encoder Output" and "User Defined". Ref: 8.6
		1	User Defined			
55	Output 1 Function	0	General Output			Assign functions to Output 1 to 3 when "User Defined" is selected. Ref: 8.6.3
		1	In-position Output			
		2	Warning Output			
56	Output 2 Function	3	Individual ZONE Output			
		4	ZONE Output			
		5	MOVE Output			
		6	BUSY Output			
57	Output 3 Function	7	END Output			
		8	Servo On Output			
		9	Push Motion Output			
		10	Origin Set Completion Output			
58	MOVE Output Threshold	0 - 2147483648		pps Set by K2		Set the speed threshold to output MOVE Output signal. Ref: 8.6.3
59	ZONE (−)	± 2147483647		Pulse		Set boundary of ZONE Output in the negative direction. Ref: 8.6.3
60	ZONE (+)	± 2147483647		Pulse		Set boundary of ZONE Output in the positive direction. Ref: 8.6.3

6.2.5 Status Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
61	Temperature Warning Threshold	0 - 100		°C		Set the threshold to output a temperature warning.
62	Load Warning Threshold	0 - 100		%		Set a threshold to output a load warning as a percentage of the maximum torque.
63	Position Error Overflow Threshold	1 - 32767		1000 pulse		Set Position Error Overflow Threshold between current and target position. Ref: 7.9
64	Overload Detection Time	100 - 10000		msec		Set the time to output Overload alarm. Ref: 7.10
65	Status LED	0	Enabled			Set enable / disable of the status LED Ref: 8.10
		1	Disabled			
66	Status Report	B0	In-position/Alarm	Ux.1		Set the conditions to automatically report to a host controller. Ref: 7.11
		B1	Input Status	IN.1		
		B2	Output Status	OUT.1		
		B3	No Local Echo	-		
		B4	Comment	-		
		B5	Warning	Ux.1		
		B6	N/A			
		B7	N/A			

6.2.6 Communication Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
71	Baud Rate	0	38.4	kbps		Set the baud rate. Ref: 7.12
		1	9.6			
		2	19.2			
		3	57.6			
		4	115.2			
72	Parity	0	None			Set the parity when transferring data.
		1	Even			
		2	Odd			
73	Delimiter	0	CR			Set the delimiter type at the end of replied data from CM3
		1	CRLF			

6.2.7 Monitoring Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
85	CH0 Data	0	Disabled	—		Output data can be set up to 4 channels. Ref: 8.9
		1	Target Position	pulse		
		2	Current Position	pulse		
86	CH1 Data	3	Target Speed	K2 value		
		4	Current Speed	K2 value		
		5	Target Torque	% to Max Torque		
87	CH2 Data	6	Current Torque	% to Max Torque		
		7	Load Factor	% to Rated Torque		
		8	Voltage	0.1V		
88	CH3 Data	9	Temperature	°C		
		10	Input Status	—		
		11	Output Status	—		
89	Streaming Interval	1 - 30000		msec		Set time interval to output Streaming Data. Ref: 8.9
90	Streaming Setting	0	Disabled			Set the timing to stream data (cannot be saved) Ref: 8.9
		1	Streaming all the time			
		2	Streaming while operation			

6.3 Motion Data

By setting specific Motion Data such as speed, acceleration, and target position, the CM3 can perform the desired positioning operation. CM3 supports normal positioning, relative positioning, and push motion. First, let's set the data as follows.

```

V0=0           // Set PTP Motion to Motion Mode
S0=100        // Set speed to 100
A0=50         // Set acceleration to 50
M0=70         // Set 70% for maximum torque
P0=10000     // Set 1000 pulses as the target position
^0           // Execution

```

When the motion is executed, CM3 moves toward the target position 10000 [pulse] at the set speed and acceleration. When the positioning is completed, CM3 sends the status Ux.1=8 indicating the in-position

Up to 32 Motion Data can be set from 0 to 31. Each Motion Data consists of the items listed below.

Command	No.	Name	Setting/Range	Unit	
V	0 - 31	Motion Mode	0	PTP Motion	—
			1	INC Motion	
			2	PTP Push Motion	
			3	INC Push Motion	
P		Position Data	Depends on Resolution (Ref: 7.1)		pulse
S		Speed Data	± 200000 (Ref: 7.1)		Set by K2
A		Acceleration	1 - 32767		kpps ²
D		Deceleration Ratio	1 - 150		% of A command
M		Torque Limit	0 - 100		% of Max. Torque
Q		Push Motion Torque	10 - 100		% of Rated Torque
ZL	Individual ZONE (—)	Depends on Resolution (Ref: 7.1)		pulse	
ZH	Individual ZONE (+)	Depends on Resolution (Ref: 7.1)		pulse	

6.3.1 Definition of position, speed and acceleration

Position

Define a unit of angle that positioning can be executed as 1 pulse.

Number of pulses per rotation of output shaft is called Resolution and its unit is ppr (pulse per revolution)

1000 is set to Resolution as default setting and the Resolution can be set from 300 to 12000ppr by parameter.

Speed

Define the number of pulse to move per second as 1pps. The unit of speed is set as 100pps and it is selected from 100pps, 10pps or 1pps by parameter.

Example: When K2=0 (100pps) and S=100

$$S.1 = 100 \times 100\text{pps} = 10000 \text{ [pps]}$$

• Unit Conversion to rpm

$$\text{Speed[rpm]} = S \text{ Data} \times \text{Speed Unit [pps]} \times 60 \text{ [sec/min]} / \text{Resolution [ppr]}$$

Example: S Data 100 (S=100)

Speed Unit 100pps (K2=0)

Resolution 1000ppr (K1=2)

$$\begin{aligned} \text{Speed[rpm]} &= 100 \times 100\text{[pps]} \times 60\text{[sec/min]} / 1000\text{[ppr]} \\ &= 600 \text{ [rpm]} \end{aligned}$$

□ Acceleration

The rate of increase in velocity per second is defined as acceleration. The unit is pps² [pulse / sec²].
 The unit of acceleration data "A" is kpps² (kilo-pulse/sec²) = 1000 [pps²]

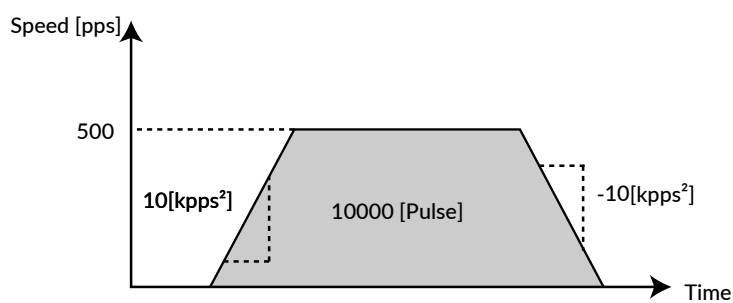
Example: Speed Unit: 100pps (K2=0)
 Speed Data: 500 (S=500)
 Acceleration Data: 100 (A=100)
 Acceleration time to reach target speed is
 Acceleration Time [sec] = $500 \times 100 \text{ [pps]} / (100 \times 1000 \text{ pps}^2) = 0.5 \text{ [sec]}$

• Setting Format

"CML command" Motion Data No.= Value

Example: Set 10000 pulse to Position, 5000 pps to Speed and 10kpps² to Acceleration of Motion Data 2.

```
V2.1=0 //Set PTP Motion to Motion Type of Motion Data 2
P2.1=10000 //Set 10000 pulse to Position of Motion Data 2
S2.1=50 //Set 5000 pps to Speed of Motion Data 2 (Unit set by K2)
A2.1=10 //Set 10Kpps 2 to Acceleration of Motion Data 2
D2.1=100 //Set 100% to Deceleration of Motion Data 2
```



• Confirmation Format

"CML command" Motion Data No.1 *".1" is displayed for replied data

Example: Confirm the speed set in Motion Data 2

```
S2.1 //Confirm the Speed Data set in Motion Data 2
S2.1= 50 //Reply to host from CM3
```

6.3.2 Commands

 Motion Mode Setting (V command)

Choose a motion mode from the below list.

V	Contents	Detail
0	PTP Motion	Absolute positioning motion to the target position set by the P command with reference to the origin
1	INC Motion	Incremental positioning motion to move the distance set by the P command from the current position
2	PTP Push Motion	PTP Motion with the limited torque by Q command
3	INC Push Motion	INC Motion with the limited torque by Q command

Example:

```
V0=0          // Set the motion mode of Motion Data 0 to PTP Motion
V3=1          // Set the motion mode of Motion Data 3 to INC Motion
```

 Position Setting (P command)

Set the target position with respect to the origin for PTP Motion, and set the relative motion distance from the current position for INC Motion.

```
Example: P1=1000          // Set 1000 pulses as the target position of Motion Data 1
          P10=1000000000 // Set continuous motion for Motion Data 10
```

- * When 10^9 is set to the target position (P=1000000000), the motion will be the continuous motion.
For continuous motion, rotation direction is set only by S command.
Regardless of the coordinate direction (K4) setting, when the S command has a positive value, the output shaft rotates in the CW direction, and when it has a negative value, it rotates in the CCW direction.
- * The settable range of position data depends on the Resolution.
Please refer to ["7.1 Resolution \(K1\)"](#) for details.
- * If the current position exceeds the settable range of coordinates due to INC Motion or continuous operation, executing PTP Motion from that position may move in an unexpected direction. Be sure to reset the current position if the coordinate range is exceeded.

 Speed Setting (S command)

Set the target speed of the motion as a positive value. If the acceleration is small with respect to the distance traveled, deceleration will start before the set value is reached. The unit is selected from 100pps, 10pps, and 1pps according to the speed unit parameter (K2).

Ex 1:

```
S1=100          // Set 100 (unit: K2) as the target speed of Motion Data 1
```

Ex 2:

```
P10=1000000000 // Set continuous operation for Motion Data 10
S10=-100       // Set 100 (unit: K2) as the continuous motion speed of Motion Data 10 in the CCW .
```

* Set a negative value for speed data only for continuous operation in the CCW direction.

Acceleration Setting (A command)

Sets the acceleration of motion.

Example:

```
A0=100          // Set 100 kpps2 as the acceleration of Motion Data 0
```

Deceleration Setting (D command)

Set the deceleration as a ratio to the acceleration.

Example:

```
A20=100          // Set 100 kpps2 as the acceleration of Motion Data 20  
D20=50           // Set the deceleration of Motion Data 20 to 50% of the A20
```

Torque Limit Setting (M command)

The output torque during motion can be limited by the ratio to the maximum torque.

Example:

```
M25=80           // Limit the output torque in Motion Data 25 to 80% of the maximum torque
```

Push Motion Torque Setting (Q command)

Set the torque for the push motion as a ratio to the rated torque when push motion is set by the Motion Mode.
Please refer to "[8.3.2 Push Motion](#)" for details.

Example:

```
Q9=50            // Set the torque for push motion of Motion Data 9 to 50% of the rated torque
```

Individual Zone (−) (ZL command)

Sets the negative boundary point of the individual zone output.

Please refer to "[7.1 Resolution \(K1\)](#)" for settable value range of the position data.

Please refer to "[8.6.3 Other Output Functions](#)" for the details.

Example:

```
ZL6=5000        // Set 5000 pulses for Individual Zone (−)
```

Individual Zone (+) (ZH command)

Sets the positive boundary point of the individual zone output.

Please refer to "[7.1 Resolution \(K1\)](#)" for settable value range of the position data.

Please refer to "[8.6.3 Other Output Functions](#)" for the details.

Example:

```
ZH6=10000       //Set 10000 pulses for Individual Zone (+)
```

6.4 Execution Commands

Execution commands trigger action to CM3 such as to execute/stop motion, cancel alarms and etc..

By using the execution command and Query command together, it is possible to create a sequence operation on the host side.

Execution Format

"CML command" No *Number can be omitted when it is not required

Example: ^28 // Execute Motion Data 28

CML	Name	No	Contents
^	Motion Data Execution	0 - 31	Execute the Motion Data by specified No.
]	Stop • Cancel Alarm	—	][CRLF]: Pause motion. INC and push motion can be resumed.][CRLF][CRLF]: Complete stop of motion and cancellation of warning.
[	Restart	—	Resume paused motion
|0	Origin Detection	—	Start Origin Detection (Set by K21 to K30) Ref: 8.4
|1	Move to Position 0	—	Move to position 0
|2	Reset Current Position	—	Reset the current position to 0.
\$	Data Save	—	Save data *Make sure the motor is not running before sending the command.
)	Servo OFF	—	Servo off
(0	Servo ON	—	Servo on (available only after alarm reset)
(1	Alarm Reset	—	Reset an alarm
#	Teaching	0 - 31	Capture current position to specified position memory (available only during Manual Mode) Ref: 8.5.2
O	Output Signal On	1 - 3	Turn on the specified output Ref: 8.6.3
F	Output Signal Off	1 - 3	Turn off the specified output Ref: 8.6.3

6.5 Query Commands

Query commands read the set data and current status of CM3.

6.5.1 Status Query Commands

CML	Name	Unit	Replied Contents		
?0 - ?31	Motion Data	N/A	Display specified Motion Data		
?50	Output Status	N/A	B0	Output 1	Display Output Status in hexadecimal OUT.1 = Hex value 0: Off / 1: On Not available when set to ABZ encoder output.
			B1	Output 2	
			B2	Output 3	
			B3	Output 4	
?70	Input Status	N/A	B0	Input 1	Display Input Status in hexadecimal IN.1=Hex value 0: Off / 1: On Please reduce the acceleration for B7.
			B1	Input 2	
			B2	Input 3	
			B3	Input 4	
			B4	Input 5	
			B5	Input 6	
			B6	STO Signal	
			B7	Over Current Signal	
			B8	N/A	
			B9	N/A	
			B10	Input 5 Jog operation signal	
B11	Input 6 Jog operation signal				
?71	Temperature in Driver Case	°C	Temp.1=Value		
?72	Power Voltage	0.1V	CVSEN.1=Value		
?79	Load Factor	%	PWR.1=Value	Display percentage of rated torque	
?85	Version Information	N/A	Display CM3 Version Information		
?90	List of Parameters	N/A	Display the list of all K parameters		
?95	Position Deviation	Pulse	Pe.1=Value		
?96	Current Position	Pulse	Px.1=Value		
?97	Current Speed	Set by K2	Sx.1=Value		
?98	Current Torque	%	Ix.1=Value	Display percentage of the Max. torque	
?99	Motor Status	N/A	B0	Position Error Overflow	Display Motor Status in decimal Ux.1=Decimal Value The contents of the operation warning and status warning can be checked by "?199."
			B1	Overvoltage Alarm	
			B2	Overload Alarm	
			B3	In-position	
			B4	Servo off	
			B5	Push Motion	
			B6	Overcurrent Alarm	
			B7	Temperature Alarm	
			B8	Operation Warning	
			B9	Low Voltage Alarm	
			B10	STO Activated	
			B11	Status Warning	
B12	ABS Alarm				
?1000	List of Motion Data	N/A	Display the list of all Motion Data		

6.5.2 Warning Query Command

Warning information can be checked with the Warning Query Command. Since the warning is a state before the alarm, the motor will not be Servo off. Utilizing warnings will help preventive maintenance of CM3.

CML	Name	Unit	Contents		Category	Cause
?199	Warning WARN.1=Value	N/A	B0	Push Motion Warning	Operation	Reach the target position during Push Motion
			B1	Software Limit Warning	Operation	Execution command to the target position set over the software limit is sent
			B2	Limit Sensor Warning	Operation	Limit sensor is on
			B3	Manual Mode	Operation	Execution Command is sent in Manual Mode
			B4	N/A	N/A	N/A
			B5	Execution Warning	Operation	An operation command is sent when operation cannot be performed
			B6	Temperature Warning	Status	Temperature inside of driver case exceeds the set value of K61
			B7	Over Load Warning	Status	The load exceeds the set value of K62

The replied data is shown as B0 to B# are set by bit.

Ex. When B6, B3, and B2 are ON

Bit	B7	B6	B5	B4	B3	B2	B1	B0
Binary	0	1	0	0	1	1	0	0

Binary : 0100 1100

Decimal : $2^6 + 2^3 + 2^2 = 64 + 8 + 4 = 76$

Hex : $76 = 16 \times 4 + 12 = 4C$

Chapter 7 Detail of Various Settings

7.1 Resolution (K1)

Set the Resolution of the motor in pulse per rotation. The maximum and minimum value of the position (P command) for each Resolution is as shown in the below table.

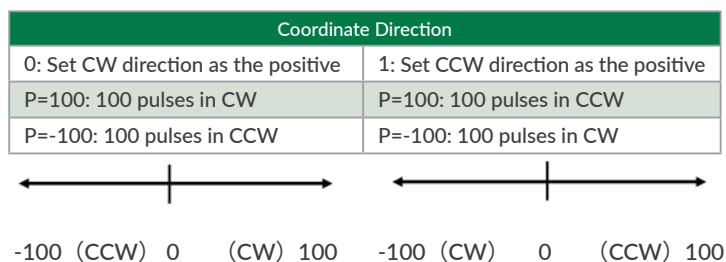
Value	Resolution	Maximum value in the negative direction	Maximum value in the positive direction	Speed data value at 5000 rpm for 100 pps speed unit
0	300	-12,884,901	12,884,901	250
1	600	-25,769,803	25,769,803	500
2	1000	-42,949,672	42,949,672	833
3	1200	-51,539,607	51,539,607	1000
4	2000	-85,899,345	85,899,345	1667
5	3000	-128,849,018	128,849,018	2500
6	5000	-214,748,364	214,748,364	4167
7	6000	-257,698,037	257,698,037	5000
8	10000	-429,496,729	429,496,729	8333
9	12000	-515,396,075	515,396,075	10000

* Continuous position (P=100000000) is available for all Resolution

Example: K1=2 // Set 1000 to the Resolution per rotation

7.2 Coordinate Direction (K4)

Set which of the CW / CCW directions is positive.



Example: K4=1 // Set CCW direction as the positive direction

* When 10° is set to the target position (P=100000000), the motion will be the continuous motion.

For continuous motion, rotation direction is set only by S command.

Regardless of the coordinate direction (K4) setting, when the S command has a positive value,

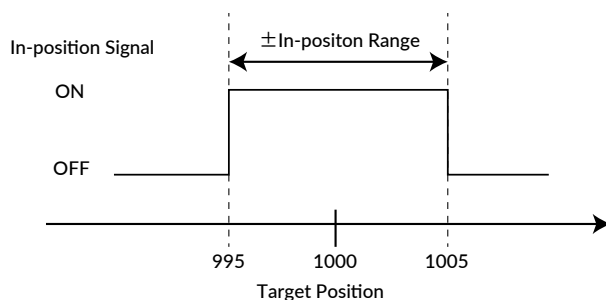
the output shaft rotates in the CW direction, and when it has a negative value, it rotates in the CCW direction.

7.3 In-position (K5)

This parameter sets the range for In-position in the pulse unit. In-position is detected when the current position is within the set range against the target position. When stopping the motor by a stop command, the stopped position is recognized as the target position, therefore In-position is detected within the set range against the current position. When recognized as In-position, In-position signal is ON and the motor status goes in Ux.1=8. In-position signal can be output by assigning an output function (Ref: 8.6.3).

Example: K5=5 // Set in-position range as ± 5 pulses

In-position signals will be sent out between 995 and 1005, when the target position is 1000.



7.4 Speed Override (K6)

The speed override can change the actual operating speed uniformly to the ratio to the set speed. In order to ensure the safety of the device, please set the speed override before trying the required speed. Without changing the value of the S command, you can test the motion at the speed that the speed override is applied. Gradually increase the ratio and check if there is any problem with the set S command data.

Operation Speed = Set Speed (S) \times Speed Override (K6) / 100

Example: K6=50 // A speed of 50% of the value of the S command is applied to the every motion

7.5 Software Limit (K7 • K8 • K9 • K10)

Please use the software limit function to prevent accidents when executing a set Motion Data. This function sets enable/disable of the limit of motion range, and how motor behaves when the function is enabled.

Software Limit Setting (K7)

0	Disable	Disable the Software Limit
1	Enable (no motion)	Enable the Software Limit. If the motion to the outside of the Software Limit range is executed, the motor won't start moving, and Operation Warning (Ux.1=256) will be output.
2	Enable (move to software limit)	Enable the Software Limit. If the motion to the outside of the Software Limit range is executed, the motor moves to the boundary of the Software Limit range, and Operation Warning (Ux.1=256) will be output.

※ Software Limit does not work for Continuous Motion.

Example: K7=1 // Set Software Limit as Enabled (no motion)

The motor does not start operating and output Ux.1=256 (Operation Warning) when it receives a command to execute the operation to the target position that exceeds the Software Limit set value. Then, WARN.1=2 (Software Limit Warning) is replied to the Query ?199 (Warning Information).

【Software Limit Setting Range and Unit】

From 0 position, set the positive operation boundary value to K8 Software Limit (+) and negative operation boundary value to K9 Software Limit (−) with the set unit by K10. The set ranges are different by the unit as shown in the below table.

Software Limit Setting Range		Unit (K10)	
Positive (K8)	Negative (K9)		
0 to 9,999,999	-9,999,999 to 0	0	100 pulse
0 to 99,999,999	-99,999,999 to 0	1	10 pulse
0 to 999,999,999	-999,999,999 to 0	2	1 pulse

Example:

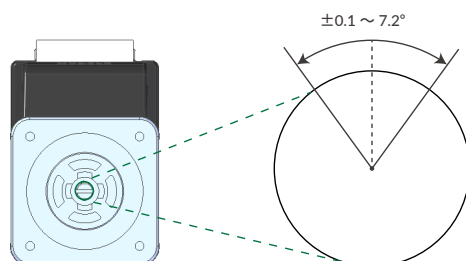
K8=100 // Set 10000 pulse to Software Limit (+)

K9=-150 // Set -15000 pulse to Software Limit (−)

K10=0 // Set 100 pulse to the Unit of Software Limit

7.6 Open Loop Holding (K14 • K15)

The Open Loop Holding is a function to automatically switch from closed loop control to open loop control if there is no operation command for the set time by K15 parameter after positioning is completed. In Open Loop Holding mode, hunting inherent to the servo motor can be suppressed. If the difference between the current position and the target position becomes larger than the K14 set value (± 0.1 to 7.2 degree) due to external force, the motor goes back in closed loop and returns to the previous target position.



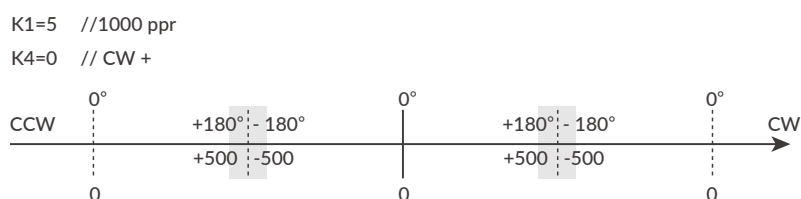
Example:

K14=10 // If the shaft is moved 1 degree by external force, it goes back in the closed loop then goes back to previous target position

K15=500 // When there is no positioning command for 500msec after positioning is completed, CM3 goes in Open Loop Holding

7.7 Single Turn ABS Function (K29)

The Single Turn ABS function is a function that memorizes the position of the origin even after the power is turned off and can hold the position within $\pm 180^\circ$ with respect to the origin even after the power is turned off. In applications such as turntables, the time to return to origin can be omitted. However, as shown in the figure below, if the stop position after the power is turned off is around 180 degrees from the origin, it will be an indefinite area, so when the power is turned off, stop as close to the origin as possible.



□ Steps to enable the Single Turn ABS Function

K29=1 // Enable Single Turn ABS Function

\$ // Send Data Save command

Turn off / on the power

ABS Alarm is ON (Ux.1=4096)

(1 // Reset Alarm (Ux.1=16)

(//Servo ON (Ux.1=8)

| // Complete the Origin Detection.

* The origin is cleared when the origin signal source or origin detection direction is changed.

Follow the above procedure again to set the origin. (Ref: "8.4 Origin Detection")

Position value after turning on the power again

The current position when the power is turned on again is always -180° to $+180^\circ$ with respect to the origin. For example, for 1000 Resolution (K1=3), the current position after power on is a value from -500 to +500.

* Even if the output shaft rotates multiple times after the power is turned off, the position after the power is turned on again is converted into the range from -500 to +500.

Ex 1: If the power is turned on again at the position of $Px.1 = 600$, the current position will be $Px.1 = -400$.

Ex 2: If the power is turned on again at the position of $Px.1 = 2300$, the current position will be $Px.1 = 300$.

Ex 3: If the power is turned on again at the position of $Px.1 = -1600$, the current position will be $Px.1 = 400$.

7.8 Origin Detection Completion (K30)

When the origin detection completion confirmation is enabled (K30=1) and the power is turned on again, only the origin detection operation is accepted until the origin detection is completed. If the execution command is issued when the origin detection is not completed, CM3 will not operate and $Ux.1=264$ (8: In-position + 256: Operation warning) will be output. When confirmed by the Query command ?199 (warning information), $WARN.1=32$ (operation warning) will be returned.

7.9 Position Error Overflow Threshold (K63)

Settable range: 1 to 32767

Unit: 1000 pulses

An error ($Ux.1=1$) is output when the deviation between the current position and the target position exceeds the set value then stop with Servo off.

Example: $K63=50$ // Set Position Error Overflow Threshold as 50000 pulses

7.10 Overload Detection Time (K64)

Settable range: 100 to 10000

Unit: msec

Set the time until the overload alarm is output.

If the overload state continues for the set time (msec), an overload alarm ($Ux.1 = 4$) is output, and the servo is turned off.

Example:

$K64=3000$ //When overload condition continues more than 3000 msec (3 sec),
the motor goes into an overload alarm status and stops with Servo off

7.11 Status Report (K66)

Set the conditions to automatically report to a host controller.

When combining each condition, set the total value of each numerical value.

Ex 1: K66=13

$2^0 = 1$: Automatically report to a host when in-position and alarm occur.

$2^2 = 4$: Automatically report to a host when output status changes.

$2^3 = 8$: No local echo

When 3 functions are combined, the value of K66 shall be $1+4+8=13$ by addition.

Ex 2: K66=38

$2^1 = 2$: Automatically report to a host when input status changes.

$2^2 = 4$: Automatically report to a host when output status changes.

$2^5 = 32$: Automatically report to a host when warning occur.

When 3 functions are combined, the value of K66 shall be $2+4+32=38$ by addition.

Status Report	Bit	Ex1	Ex2
No Report	0		
In-position / Alarm	B0	$2^0 = 1$	
Input Status	B1		$2^1 = 2$
Output Status	B2	$2^2 = 4$	$2^2 = 4$
No Local Echo	B3	$2^3 = 8$	
Comment	B4		
Warning	B5		$2^5 = 32$
K66 Value		13	38

- Comment example

error.01.1: Value Out of Range!!

When a value outside the Motion Data setting range is entered

7.12 Baud Rate (K71)

Set the baud rate for the communication to a host controller.

When this parameter is changed, the host baud rate needs to be changed to match the changed baud rate.



The set baud rate might not be available on some PCs and host instruments.

Please enter a proper value that matches their specifications.



CM3's communication buffer could be overflowed by a delay of communication data processing when a lot of data are transferred to CM3 and over-written, then unexpected motion is possibly produced.

Example: K71=1 //Set 9.6 kbps as the baud rate.

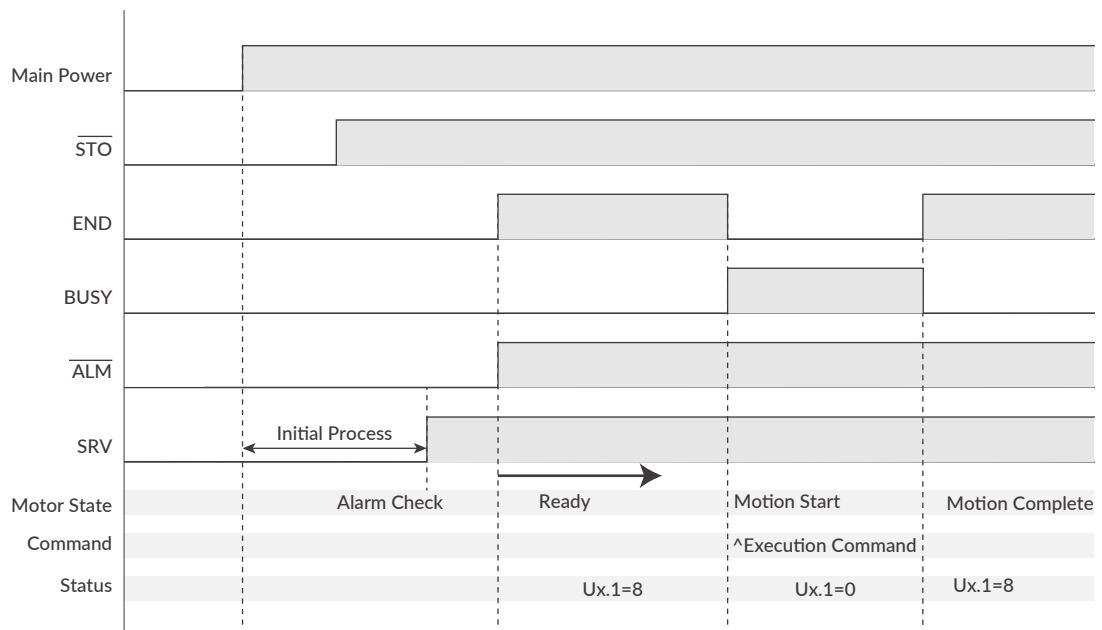
Chapter 8 Various Functions

See the legend below for the sequences in Chapter 8.

INPOS	: In-position	Ux.1=8	} Access via communication or Output by signal
ALM	: Alarm output	Ux.1=Alarm No.	
BUSY	: During operation	Ux.1=0	
STO	: STO	Ux.1=1024	
SRV	: Servo status	Ux.1=16	
END	: End	-----	Only output signal

8.1 Sequence When Power is On

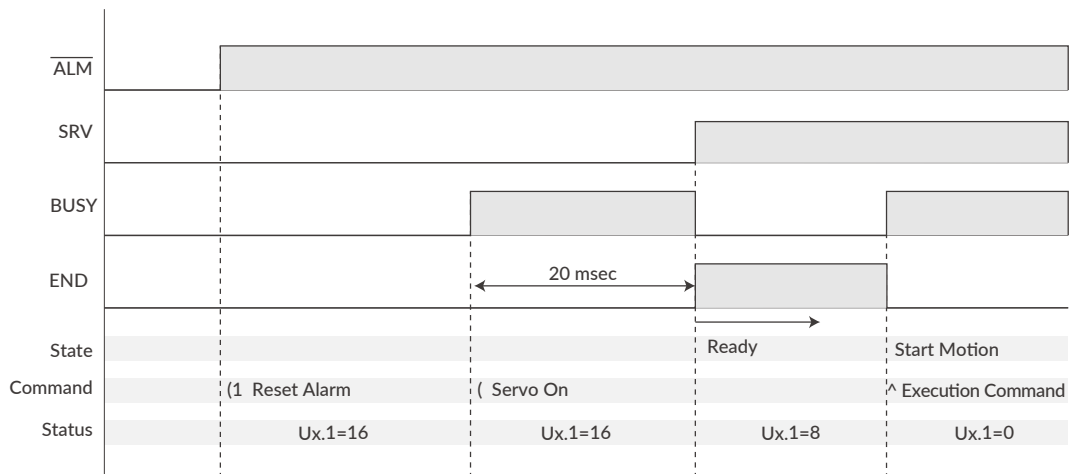
The sequence below describes from when the main power is turned on until CM3 is ready to accept commands. This sequence is only for initial servo state is "Servo on".



When the main power is turned on, the system checks that the STO function is off, then the servo is on. Next, the system checks the alarm status. When there are no alarms, the ALM and END outputs are turned off. Finally, CM3 is ready to accept the execution command.

8.2 Sequence to Reset Alarm

The sequences shown below is for resetting alarm.



In case of alarm status, remove the cause of alarm and reset alarm. Then send Servo On command after alarm reset and checking status. 20msec after Servo on, CM3 will be ready to accept execution commands.

* If using an external brake, release the brake within this 20 msec.

8.3 Positioning Operation

Motion Data is composed of elements necessary for operation, such as speed, acceleration, target position, and torque. Motion Data can be registered and saved in CM3, and positioning operation can be performed by specifying the Motion Data number and sending an execution command. Absolute positioning (PTP Motion), relative positioning (INC Motion), and push motion are available.

* PTP Motion means PTP (ABS directive), and INC Motion means PTP (INC directive).

8.3.1 Normal Positioning

PTP Motion Example

Set the below data to Motion Data 1.

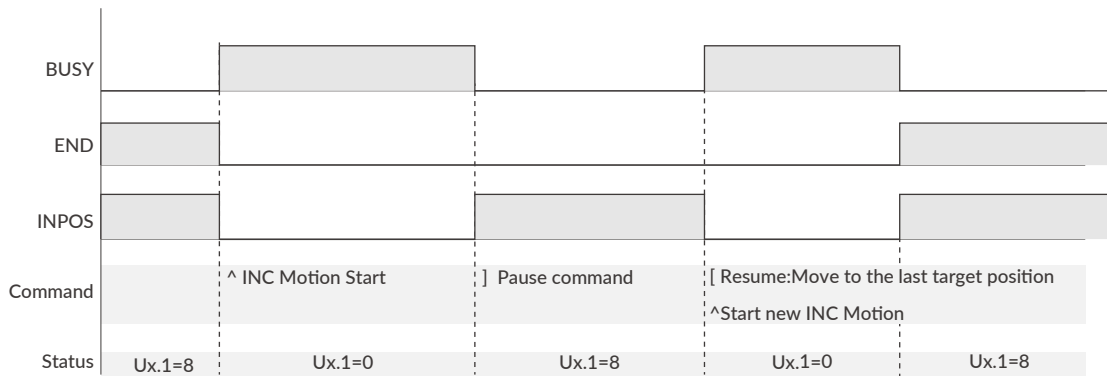
```
V1=0           //Set PTP Motion to Motion Mode
P1=10000      //Set 10000 pulse to Position
S1=100        //Set 100 (Unit: K2) to Speed
A1=100        //Set 100 kpps2 to Acceleration
^1            //Execute Motion Data 1
```

□ INC Motion Example

Set the below data to Motion Data 1.

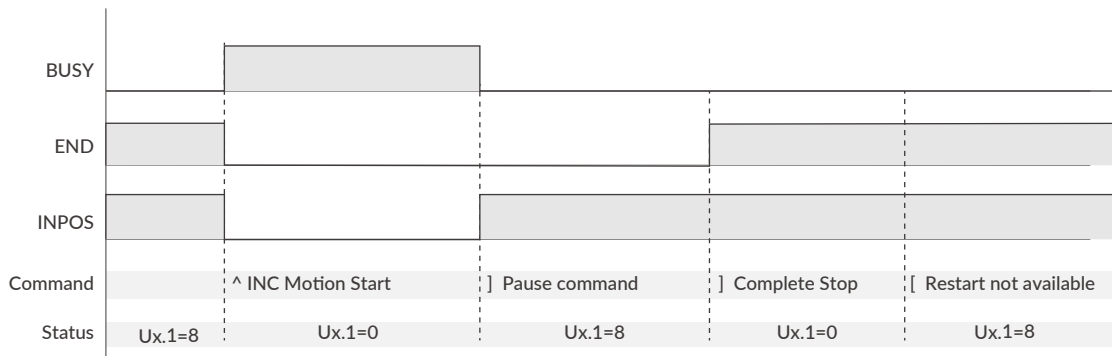
```
V1=1          // Set INC Motion to Motion Mode
P1=10000     // Set 10000 pulse to position
S1=100       // Set 100 (Unit: K2) to Speed
A1=100       // Set 100 kpps2 to Acceleration
^1           // Execute Motion Data 1
```

• Sequence when Pause command is sent during INC Motion



When Pause command (]) is sent during INC Motion, CM3 stops and In-position is detected. With re-start command, CM3 goes to the former target position and the motion will be completed.

• Sequence when stop command is sent during INC Motion



When Pause command (]) is sent during INC Motion, CM3 stops and In-position is detected. CM3 becomes stop = END status by sending Pause command again and will not move even if restart command is sent.

8.3.2 Push Motion

The Push Motion is an operation that limits the output torque with the set torque for the set time. It can be used for gripping and press-fitting workpieces.

To execute the Push Motion, set the Motion Mode (V command), Push Torque (Q command), Push Motion Operation Mode (K11), and Push Motion Holding Time (K13).

PTP / INC Push Motion

Push Motion is available by setting the Motion Mode to PTP Push Motion (V=2) or INC Push Motion (V=3). The target position for Push Motion can be set to either PTP (absolute position) or INC (relative position).

- PTP Push Motion:
Starts the Push Motion from the current position toward the set absolute position.
- INC Push Motion:
Starts the Push Motion with the target position at the distance set from the current position.

In either case, set the target position so that it is several revolutions ahead of the object to be pushed. If the target position is too small, positioning may be completed before the workpiece is detected, or sufficient torque may not be generated.

Push Torque (Unit: % to rated torque)

Set the torque for Push Motion with Q command .

Push Motion Operation Mode (K11)

Select the direction to limit Torque and the finite (set time) / continuous Push Motion Holding time.

K11	Push Torque Direction	Push Time
0	One-direction	Continuous
1	One-direction	Set time
2	Both-direction	Continuous
3	Both-direction	Set time

- Push Torque Direction
 - One direction: The Push Torque is effective only in the operation direction. This can be used to grip a rigid workpiece.
 - Both direction: The Push Torque is effective in both directions. This can be used to grip an elastic workpiece or only detect a workpiece.
- Push Motion Time
 - Continuous: Regardless of the Push Motion Holding Time (K13), the Push Motion doesn't stop until the stop command is sent.
 - Set Time: When the total Push Time reaches the Push Motion Holding Time (K13), the Push Motion is completed.

Push Motion Holding Time (K13)

Set the time to continue the Push Motion. (Unit: msec)

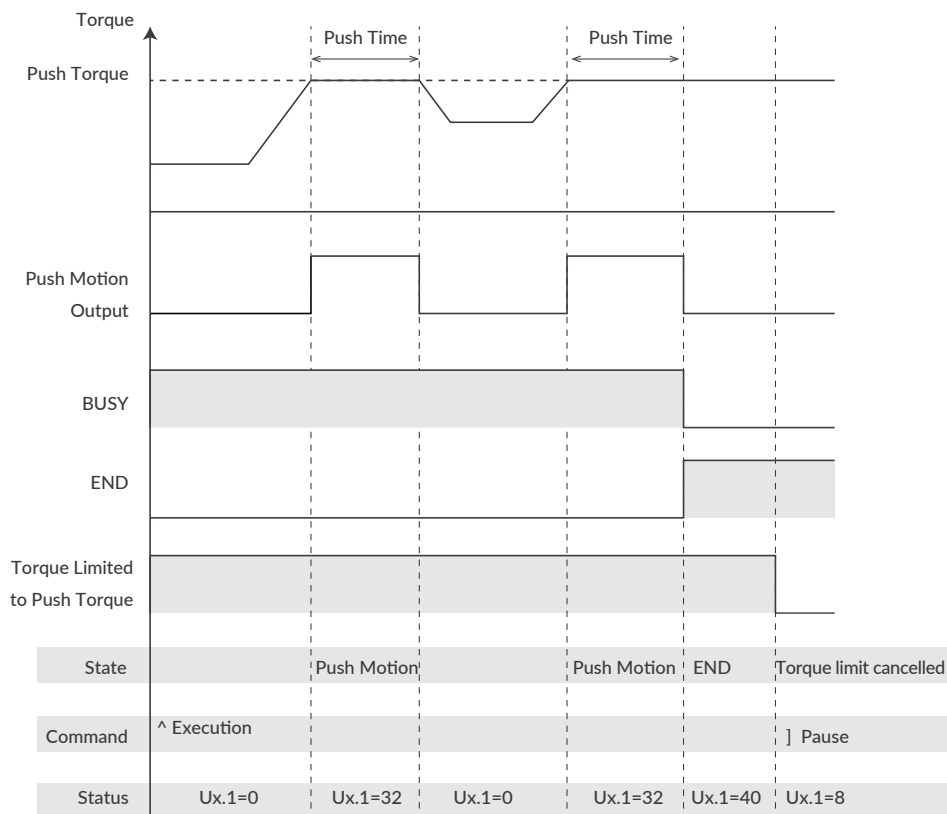
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Example:

```

K11=1          // Set Push Motion Operation Mode as One-direction and Set Time.
K13=3000      // Set Push Motion Holding Time as 3000 msec
V2=2          // Set Operation Mode 2 as PTP Push Motion
P2=10000     // Set Target Position 2 as 10000 pulses
S2=20        // Set Speed 2 as 20 (Unit: K2)
A2=50        // Set Acceleration 2 as 50 kpps2
Q2=30        // Set Push Torque 2 as 30% of Rated Torque
^2           // Execute Motion Data 2
  
```

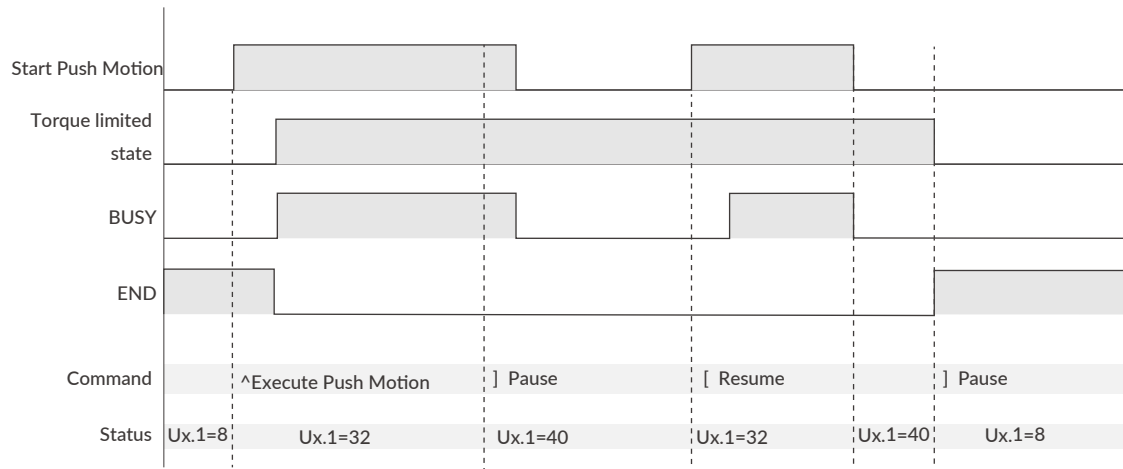
CM3 starts moving to 10000 pulse position by set acceleration and speed. CM3 goes into Push Motion when CM3's torque reaches 30% of the rated torque and the status goes into Push Motion status (Ux.1=32). Push Motion is completed when the total time of Push Motion goes up to 3000 msec. After the completion of Push Motion, torque remains at set torque by the Push Motion Torque and the status becomes Ux.1=40 (=32+8). The set torque remains until Pause command is sent or the next Motion Data is executed.



If the object to be pushed cannot be detected during the Push Motion and reach the set target position, Ux.1=296, which is the total of the Operation Warning Ux.1=256, Push Motion Ux.1=32, and in-position Ux.1=8 will be output. Sending the warning information Query command ?199, the Push Motion Warning, WARN.1=1 is replied.

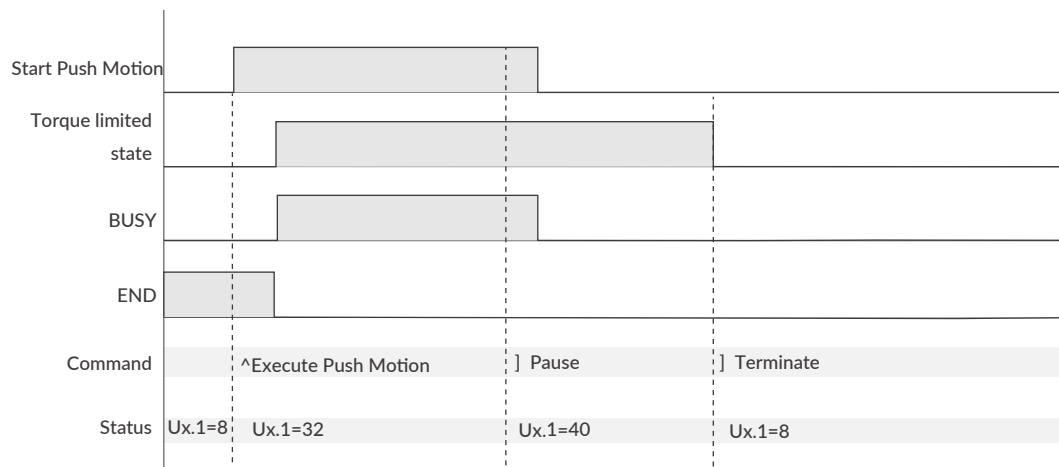
To Resume Push Motion

If Pause command is sent during the Push Motion, motion will be paused but the Push Motion Holding Time will not be cleared. Paused Push Motion will be resumed when re-start command is sent.



To Execute Next Motion

If Pause command is sent twice during Push Motion, Push Motion will be terminated and torque limit is canceled.



Signal output is valid only when the function is assigned to output by Output Function Selection.

8.4 Origin Detection

Origin Detection can be selected from Stopper Detection, Origin Sensor, Z Phase Signal and combination as shown in the below table.

K22	Content
0	Stopper Detection
1	Stopper Detection (Auto)
2	Origin Sensor *
3	Origin Sensor (Auto) *
4	Stopper Detection + Z Phase Signal
5	Stopper Detection + Z Phase Signal (Auto)
6	Origin Sensor + Z Phase Signal *
7	Origin Sensor + Z Phase Signal (Auto) *
8	Z Phase Signal
9	Z Phase Signal (Auto)

* Valid only when origin sensor is assigned to Input 1

Category of Origin Detection

Stopper Detection : Origin Detection using a mechanical stopper

Origin Sensor : Origin Detection using a origin sensor

Z Phase Signal : Origin Detection using a Z phase signal of CM3

Auto : Origin Detection starts automatically when the power is turned on.

Set the following parameters as needed to perform origin detection:

Settings for Origin Detection Motion

- Origin Detection Speed (K23)
- Origin Detection Acceleration (K24)
- Origin Detection Direction (K25)

Settings for Offset

- Origin Offset Distance (K26)
- Origin Offset Distance Unit (K27)

Settings for Stopper Detection

- Stopper Detection Torque (K28)

Setting for Origin Sensor

- Input 1 Function (K44)

Settings for Origin Detection Completion

- Origin Detection Completion (K30)
- Output Function (User Defined) (K54)
- Origin Set Completion Output (K55、K56、K57)

8.4.1 Stopper Detection

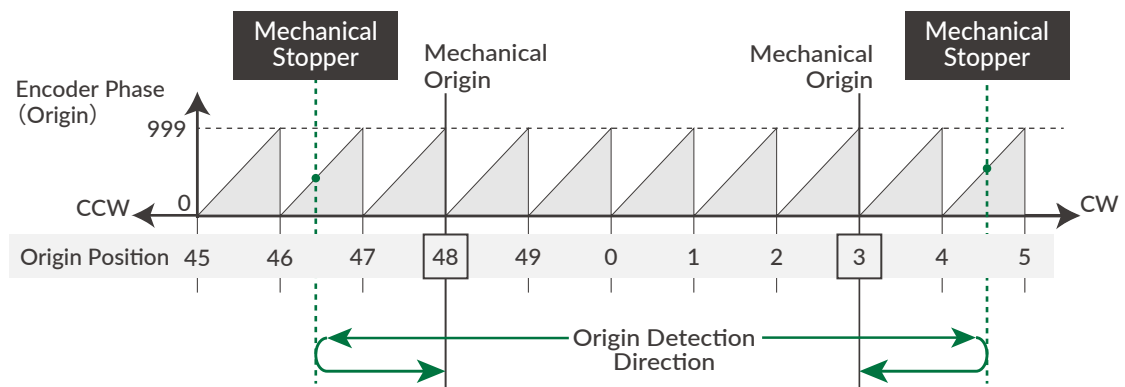
If the device to which the CM3 is installed has a mechanical stopper, the origin search is available using the stopper as the origin signal source.

There are 50 origin positions (mechanical origins) per rotation when using Origin Detection Stopper Detection. Encoder phase shifts from 0 to 999 linearly between each origin position.

When Origin Detection is started, CM3 starts rotating in the set direction to detect stopper. A stopper detection will be completed when the motor torque reaches the Stopper Detection Torque and the speed becomes 1/16 of the Origin Detection Speed.

Then displays the encoder phase information (Origin=0 to 999).

After stopper detection, Origin Detection is completed at the encoder phase 0 point that is 1 cycle before detected phase by stopper. Phase 0 is not related to Z phase.



- Set the threshold of the torque to detect a stopper for Origin Detection by percentage to Max. Torque.
- When the Stopper Detection Torque is set too low, Origin is mis-detected by detecting torque reaching the threshold.
- When Origin Offset is set, the position moves the set offset distance from the detected mechanical origin is the coordinate origin.
- For the stable origin search, adjust an attachment as a coupling for the encoder phase value indicated in "Origin=***" to be between 200 to 800.

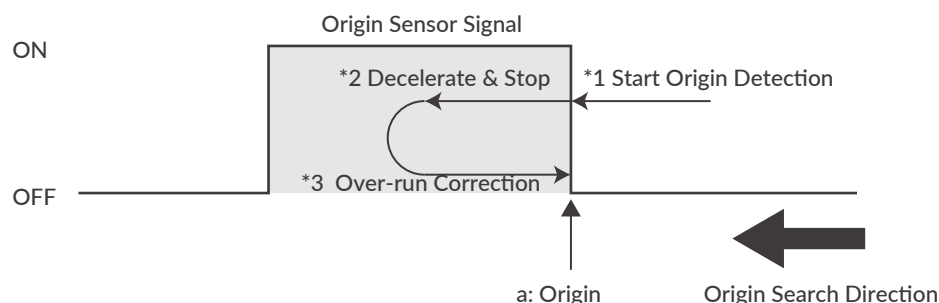
8.4.2 Origin Sensor

Origin Sensor signal can be assigned only to IN1. Sensor signal detection circuit is hysteresis circuit to minimize the noise influence. Rising edge of origin sensor in Origin Detection Direction is detected as mechanical origin.

* If the origin detection is executed when the origin sensor is not assigned to Input 1, Ux.1=264 which is the total of the operation warning Ux.1 = 256 and in-position Ux.1 = 8 is output, and WARN.1=32 (operation warning) is output when the warning Query command ?199 is sent. When selecting the Input 1 function of K44, be sure to select the origin sensor (K44=1) or the limit sensor in the origin detection direction (K44=2: CCW limit sensor, K44=3: CW limit sensor).

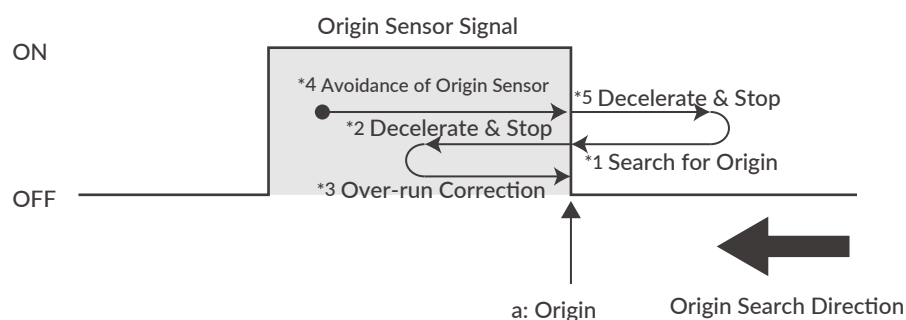
Depending on the status of origin sensor signal when Origin Detection starts, there are following differences in the Origin Detection operation.

- When an origin sensor signal is OFF when Origin Detection is executed



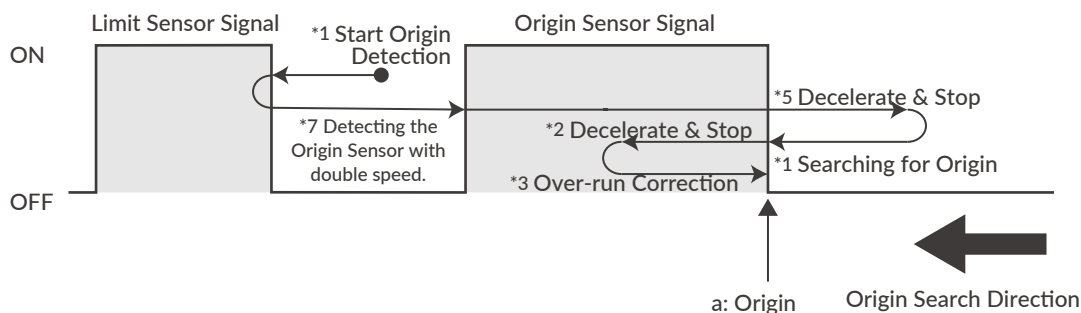
- ① Start origin detection
 - ② Decelerate from rising edge (a) of origin sensor (Point a) (*2)
 - ③ Move to Point a again (*3)
- Complete origin detection

- When an origin sensor signal is ON when Origin Detection is executed



- ① Running in the opposite to the origin detection direction to get out from the origin sensor
 - ② After passing the point a and detecting a sensor signal off in the figure, start to decelerate (*2).
 - ③ The same motion as “When an origin sensor signal is OFF” in the previous paragraph will be executed.
 - ④ Starting origin detection
 - ⑤ Decelerate from rising edge of origin sensor (point a) (*2)
 - ⑥ Move to Point a again (*3)
- Complete origin detection

□ Simultaneous use of limit sensor and origin sensor



- ① Start Origin Detection.
- ② When the limit sensor signal in the origin detection direction is detected, start moving in the opposite direction at twice the origin detection speed.
- ③ Detect the origin sensor signal (*7).
- ④ After detecting the origin sensor signal, then the same motion as "When an origin sensor signal is ON" in the previous paragraph will be executed.
- ⑤ To move out of sensor signal, move in the opposite direction from origin detection direction.
- ⑥ After passing the point a in the figure, start to decelerate after detecting a sensor signal off (*5)
- ⑦ The same motion as "When an origin sensor signal is OFF" in the previous paragraph will be executed.
- ⑧ After starting origin detection, decelerate from rising edge of origin sensor (Point a) (*2)
- ⑨ Move to Point a again (*3)
Complete origin detection

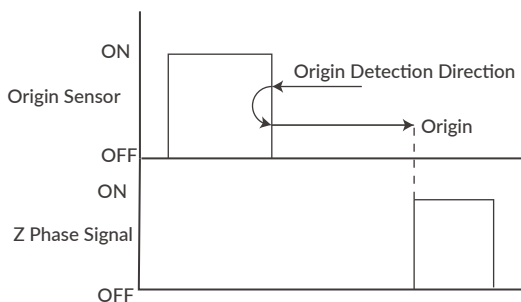
8.4.3 Z Phase Signal

The Z-phase signal is output once per rotation based on the internal encoder information. Origin Detection using Z-phase signals can always have the same origin in one rotation of the output shaft, so it is possible to omit the sensor in applications such as rotary tables.

* Origin Offset is ignored when using Z Phase Signal.

□ Simultaneous use of Origin Sensor/Stopper Detection and Z Phase Signal.

It is possible to detect an origin by a combination with Stopper Detection / Origin Sensor and the Z Phase signal. After detecting an origin by Stopper Detection / Origin Sensor, CM3 moves to the opposite direction of Origin Detection Direction and set the first Z Phase Signal as a coordinate origin.



8.5 Input Functions

CM3 has 6 inputs. The functions of Input 1 and Input 2 are set with K44 and K45.

The functions of inputs 3 to 6 are fixed.

- Function and description of each inputs

Input	Function	Description
1	Limit • Origin Sensor	Select origin sensor (1) or CCW (2) / CW (3) in the direction of limit sensor with K44
2	Limit Sensor	Select CCW (2) / CW (3) in the limit sensor direction with K45
3	Servo on / Alarm Reset	Toggle Servo on / Servo off. Alarm can be reset when the servo is turned on.
4	Manual Mode	Switch to Manual Mode.
5	CCW Inching • Jog	Inching/Jog in the CCW direction in Manual Mode.
6	CW Inching • Jog	Inching/Jog in the CW direction in Manual Mode.

8.5.1 Input Filter

Set the filter time for the input signal with K42 between 1 and 50 msec. The higher the number, the longer the filter time and the slower the response to the input. Signals shorter than the set value will not be recognized as input signals.

Example:

K42=5 //Set the filtering time for the input signal to 5 msec

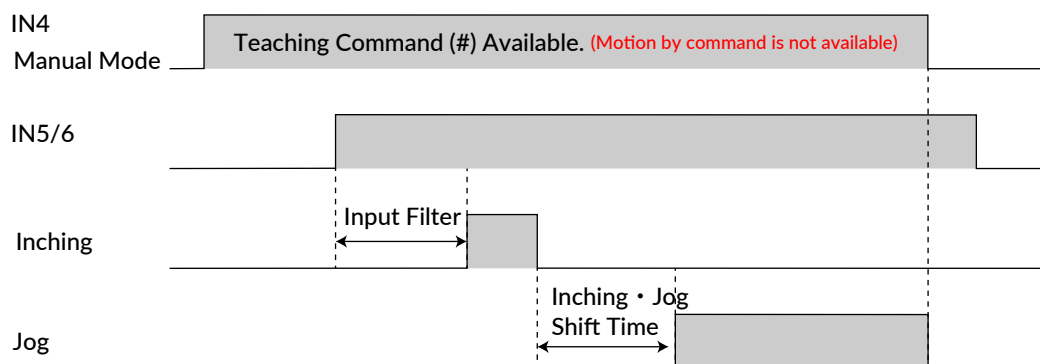
8.5.2 Manual Mode

By turning on Input 4, CM3 go into the Manual Mode. In this mode, Input 5 and 6 allow Inching and Jog motion. The execution command is not available in the Manual Mode.

- Inching • Jog

Inching and Jog are possible by input signals. IN5 is for CCW direction, and IN6 is for CW direction. When an input signal coming in, CM3 move the Inching Distance of K51 (1 to 100 pulses) at the speed set by K50 (1 to 32767 [unit: K2]).

After that, the motion will switch to the Jog after the Inching • Jog Shift Time set by K52 (1 to 3000 msec). If the applied input signal is shorter than K52, only Inching motion will be executed.




```

Example: K2=0           // Set speed unit as 100 pps
        K50=50         // Set Inching / Jog Speed as 50 x [100 pps]=5000 pps
        K51=100        // Set Inching Distance as 100 pulses
        K52=1000       // Set Inching Shifting time as 1000 msec
    
```

When IN5 (IN6) is turned on, CM3 move 100 pulses in the CW (CCW) direction as Inching. If IN5 (IN6) is continuously turned on for 1000 [msec] or more even after the operation is completed, the motion will switch to the Jog operation and continue rotating at a speed of 5000 [pps].

Jog

Set the speed for Jog by Inching · Jog Speed parameter when signal is applied.

```

Example: K2=0           // Set Speed Unit as 100 pps
        K50=100        // Set Inching · Jog Speed as 10000 pps
        K52=0           // Only Jog will start
    
```

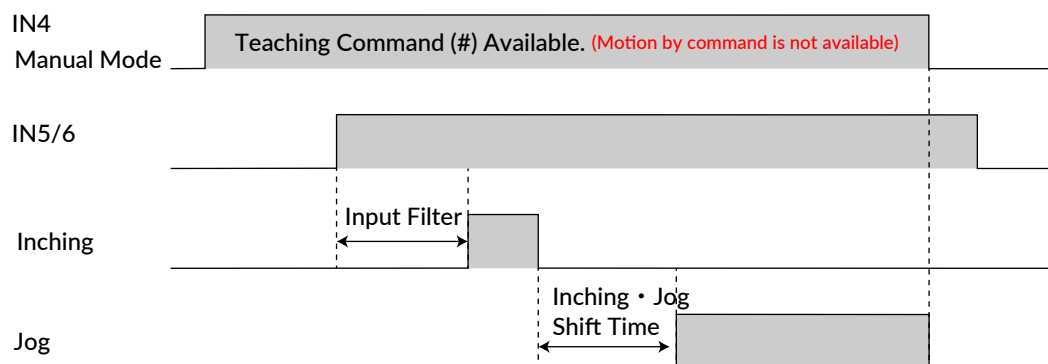
Jog motion is executed in the direction of CCW by a signal to IN5 and to CW by a signal to IN6. CM3 keep rotating at a speed of 10000pps while the input is ON.

- * If K52=0 is set, only Jog operation is enabled.
- Refer to "Inching · Jog Shift Time" for details.

Teaching

Teaching function is to capture current position to position data. During Manual Mode is on, move CM3 to specific position by Inching / Jog by signal to Input 5 and 6 then set the position to Motion Data by # command.

Sequence of Teaching Mode



```

Example: #19           // Capture current position into Motion Data 19 (P19)
    
```

- * In Manual Mode, the Software Limit function is disabled.

8.5.3 Servo On/Servo Off

IN3 can toggles the Servo on (alarm reset) and Servo off. When the signal is turned on, the alarm is reset and the servo is turned on at the same time, and the status of Ux.1=8 (in position) is replied. When the signal turns off, the servo turns off, and CM3 replies the status of Ux.1=16 (Servo off).

8.5.4 Limit Sensor

The function of the limit sensor can be set for Input 1 and Input 2.

```
Example: K44=2 // Set CCW direction limit sensor to Input 1
        K45=3 //Set CW direction limit sensor to Input 2
```

When the limit sensor turns on, CM3 sends Operation Warning (Ux.1=256) and the motor stops at the deceleration set in the Motion Data. Limit sensor warning (WARN.1=4) is returned with the Warning Information Query command ?199. After stopping, CM3 can only move in the opposite direction of the limit sensor.

8.6 Output Functions

CM3 has 4 outputs. Functions can be assigned to Output 1 -3 though Output 4 is fixed to ALARM output.

Either ABZ Encoder Output or User Defined can be selected as functions for Output 1-3. It is recommended that ABZ Encoder Output is selected for a host controller to control CM3 and User Defined is selected for CM3 to output its status.

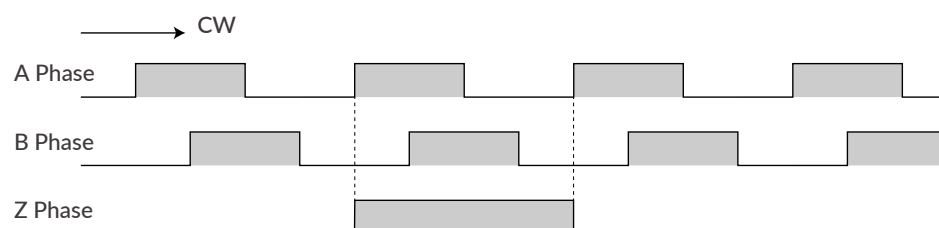
Each output function can be set by Output Function parameter. This section explains about each output functions. Refer to timing chart for the timings.

8.6.1 Alarm Output

Alarm output function is assigned to Output 4. CM3 goes in Servo Off when an alarm occurs to protect CM3. Alarm information can be confirmed by "8.10 Status LED" or reply ("6.5 Query Commands") to Query command (?99). Refer to "8.2 Sequence to Reset Alarm" for the sequence to cancel an alarm.

8.6.2 ABZ Encoder Output

When the output function is set to "ABZ encoder output" (K54=0), OUT1 to 3 are assigned to the ABZ phase encoder output function. The Z phase is output once per rotation, and the relationship between the AB phase and the Z phase is as follows.



Related parameters: Resolution (K1), Output Function (K54)

The Resolution of the ABZ output is fixed at 3000 ppr when the Resolution parameter is set to 3000 ppr or higher. If the Resolution parameter is less than 3000 ppr, the Resolution of the ABZ encoder output will be the same as the Resolution parameter.

8.6.3 Other Output Functions

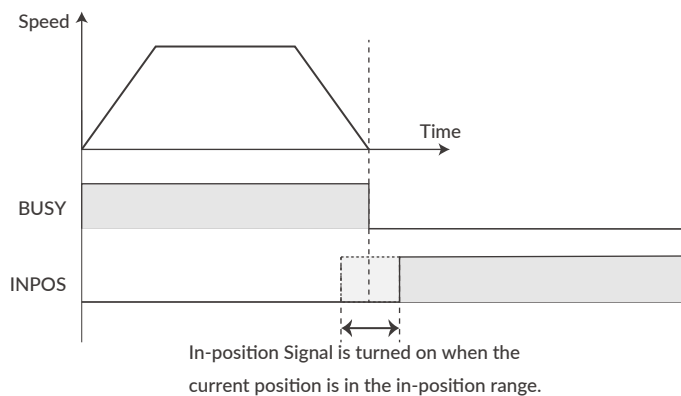
By selecting "User defined" for output function (K54 = 1), 3 out of 11 kinds of output function can be assigned to output 1, 2, and 3. Select the function of output 1 by K55, output 2 by K56, and output 3 by K57.

K55/K56/K57	Function	Output Contents
0	General Output	Turn outputs on / off by command
1	In-position Output	Output in the In-position range
2	Warning Output	Output in the Operation and Status Warning state
3	Individual ZONE Output	Output in the ZONE set by Motion Data
4	ZONE Output	Output in the ZONE set by parameters
5	MOVE Output	Output when speed exceeds MOVE Output Threshold
6	BUSY Output	Output during motion
7	END Output	Output when operation is completed
8	Servo On	Output when Servo On
9	Push Motion Output	Output when torque exceeds the set value during Push Motion
10	Origin Set Completion Output	Output when origin is set

Positioning Status Output (In-position, BUSY, END)

CM3 goes into In-position status and output signal from Output that In-position Output is assigned when the current position goes into the In-position range (\pm) set by In-position Range parameter (K5).

When END Output is assigned, turn output on when the operation set in Motion Data is completed. When the operation is paused, In-position Output is turned on but END Output is not turned on.



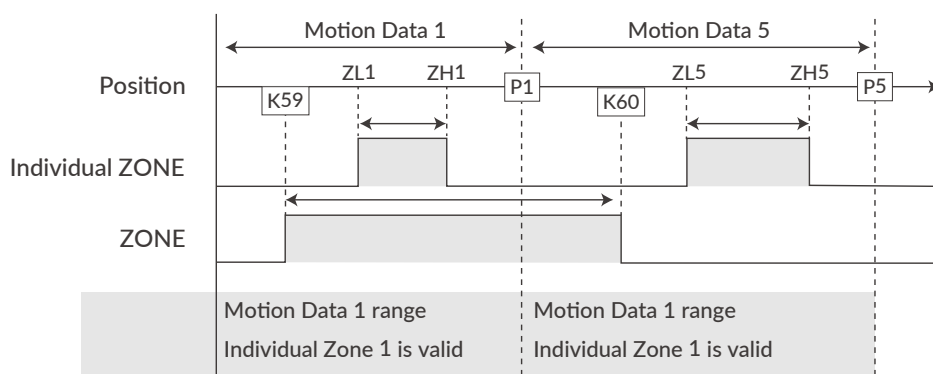
□ Individual ZONE / ZONE / MOVE Output

- Individual ZONE Output

Output is turned on when CM3's current position goes in the zone set by Individual ZONE (-) (ZL) and Individual ZONE (+) (ZH) in each Motion Data. The Individual ZONE Output is valid from Motion Data execution and signal is on until the next Motion Data positioning is executed.

- ZONE Output

Output is turned on when CM3's current position goes in the set zone. ZONE Output range is set by ZONE (-) (K59) and ZONE (+) (K60) and this function is valid for all operation.



- MOVE Output

The output turns on when the speed set by the MOVE Output Threshold (K58) is exceeded.

All output signals are valid only when the output function is assigned to the output point.

8.7 Tuning

The servo Tuning method can be selected from Tuningless or PPI control with the Tuning parameter (K31).

8.7.1 Tuningless (K31=1)

When selecting Tuningless by Tuning parameter, CM3 is automatically optimized by the changes of load, motion and etc. from low to high speed range. When some adjustment of trackability is necessary, it can be adjusted by Servo Stiffness parameter. The higher the Servo Stiffness value, the higher the trackability but setting it too high will cause the motor's vibration.

8.7.2 PPI (K31=0)

In case of fixed load and operation, PPI Control can be selected by Tuning parameter. When selecting PPI Control, the Position P gain, Speed P gain, and Speed I gain are valid. These gains can be separately set by parameters and are to match your machinery and CM3 servo motor. Without the gain adjustment, it may cause CM3 a vibration, too sensitive condition and some noise.

Follow the steps below to adjust CM3's Position P gain, Speed P gain, and Speed I gain values. An adjustment with CM3 mounted in a machine and running a motor is necessary to find the optimum values.

Adjustment steps are as it shown in below.

① Initial Setting

Set parameters as it follows.

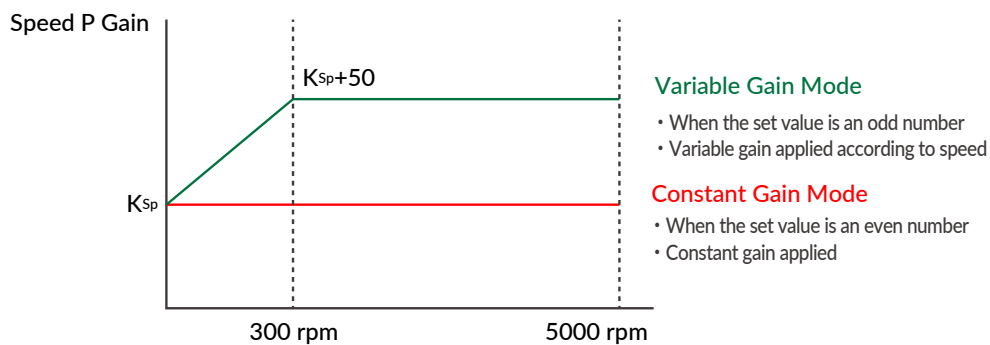
Position P gain=100

Speed P gain=150

Speed I gain=1

② Speed P Gain (K34)

First, in order to optimize the Speed P Gain, increase the K34 value so that high-frequency vibration does not occur during CM3 operation. If the value of this parameter is too large, high frequency vibration may occur, but it is more stable to set K34 as high as possible.



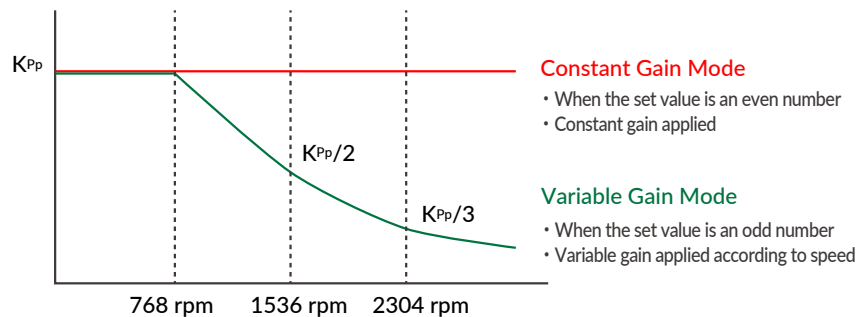
For variable gain mode, this gain setting value applies to when the speed is 0 rpm. When Speed is between 0rpm and 300rpm, Speed P gain value increases in proportion. The conclusive gain value is setting gain value plus 50.

* If the gain value is even, the Constant Gain Mode is set, and if the gain value is odd, the Variable Gain Mode will be set.

③ Position P Gain (K33)

After setting the optimum value of Speed P Gain, search for the optimum value of Position P Gain while operating CM3. Increasing the value of Position P Gain will reduce the position error. In other words, the positioning time will be shorter, but if the value of Position P Gain is too large, vibrations may occur. The higher the value as much as possible, the more stable the motion will be.

Position P Gain



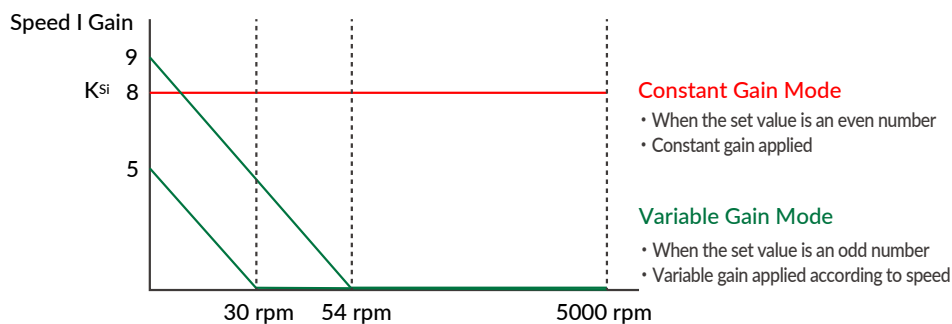
In the variable gain mode, the set value is the gain applied during low speed operation. The gain starts decreasing after the speed exceeds 768 rpm, and at 2304 rpm it becomes one-third of the set value.

For example, if you set K33=101, 100 will be applied at speeds below 768 rpm, then at 3000 rpm, 25 will be applied.

* If the gain value is even, the Constant Gain Mode is set, and if the gain value is odd, the Variable Gain Mode will be set.

④ Speed I Gain (K35)

After setting the optimum value of Position P Gain, increase the value of Speed I Gain. Find the optimum value while operating CM3. Speed I Gain is a parameter for slowly correcting the position error when the position error is not sufficiently reduced even if the Position P Gain is adjusted. If the value of Speed I Gain is excessively high, a large vibration might occur.



In variable gain mode, Speed I Gain decreases with increasing speed. When K35 = 5, Speed I Gain becomes 0 above 30 rpm, and when K35 = 9, it becomes 0 above 54 rpm.

* If the gain value is even, the Constant Gain Mode is set, and if the gain value is odd, the Variable Gain Mode will be set.

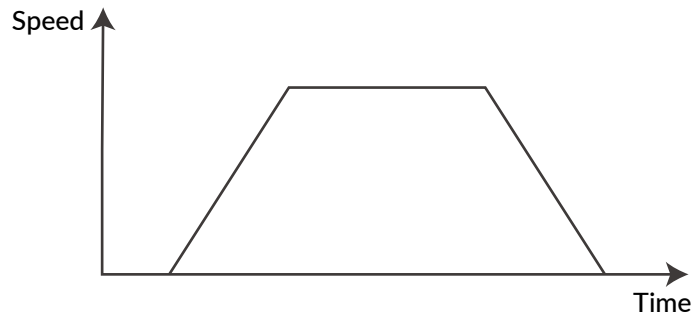
The optimal values can be set by following the above steps.

8.7.3 S-Curve Gain

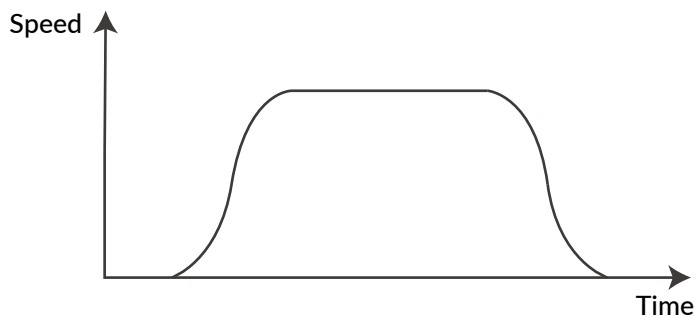
The s-curve gain (K36) is the parameter to change the trapezoidal motion to S-shape. K36 can be set from 0 to 1024, and the higher the K36, the more the motion is S-shape. By enabling the S-curve gain, it helps to soften the impact when starting and stopping, and to reduce overshoot.

Example:

K36=0 //Trapezoidal Motion



K36=1024 //S-Curve Motion

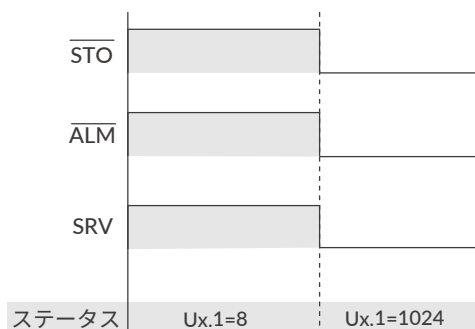


8.8 STO Function

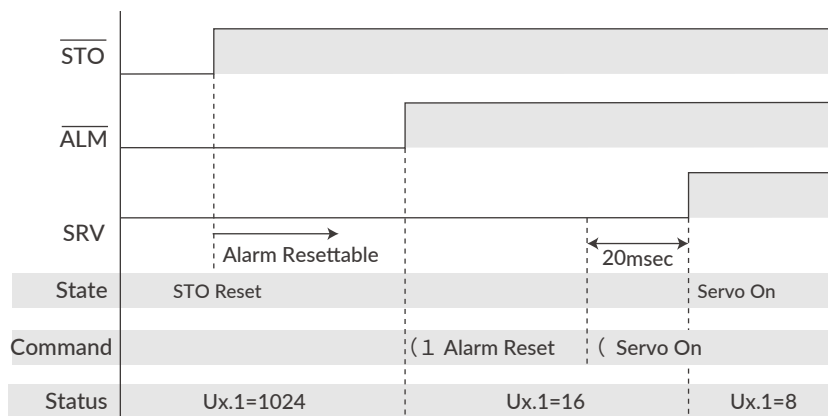
CM3 is equipped with the STO (Safe Torque Off) function, which is one of the safety functions defined in the international standard IEC61800-5-2. STO is a function that cuts off only the power supply to the motor. When the STO function is activated, the stopped state of the motor is not controlled and the servo is turned off.

If a voltage is applied between STO + and STO-, the STO stays disabled and CM3 is ready to operate. When the voltage is cut off, the STO is activated and goes in an STO (Ux.1=1024) status. When voltage is applied again between STO + and STO-, STO is canceled and the alarm can be canceled.

Sequence for STO



Recovery sequence from STO state



8.9 Streaming Data

The Streaming Data function is a function that periodically outputs data such as the current position, speed, and torque. Up to 4 types of data from CH0 to CH3 can be sent at the same time.

Output Format: 01,[CH0],[CH1],[CH2],[CH3]

Streaming Data Selection (K85 to K88)

The data that can be set for CH0 (K85), CH1 (K86), CH2 (K87), and CH3 (K88) are as follows.

K85/K86/K87/K88	Output Data	Unit	K85/K86/K87/K88	Output Data	Unit
0	Disabled	—	6	Current Torque	% of Max. Torque
1	Target Position	Pulse	7	Load Factor	% of Rated Torque
2	Current Position	Pulse	8	Voltage	0.1V
3	Target Speed	K2	9	Temperature	°C
4	Current Speed	K2	10	Input Status	—
5	Target Torque	% of Max. Torque	11	Output Status	—

Streaming Interval (K89)

The data output interval is set with the Streaming Interval parameter (K89). Setting the Streaming Interval to 5 msec or less can cause the interval to become unstable.

Streaming Setting (K90)

Set the streaming on / off and the timing when it is on by the Streaming Setting (K90). The K90 will always return to "Disable" (K90 = 0) when the power is turned on again.

K90	Name	Details
0	Disabled	No Data Streaming
1	Streaming all the time	Stream data all the time. To stop the streaming, set K90=0.
2	Streaming while operation	Stream data only when the motor is running. Otherwise, no data streamed.

• Streaming Data Example :

[Sent Data]

```

K85=1 // Set Target Position for CH0
K86=2 // Set Current Position for CH1
K87=4 // Set Current Speed for CH2
K88=6 // Set Current Torque for CH3
K89=100 // Set Streaming Interval as 100msec
K90=2 // Set Streaming Setting as "2: Streaming while operation"
^ //Execution Command

```

[Received Data]

```

0 msec: 01,0,0,0,0
100 msec: 01,495,494,10200,4
200 msec: 01,1495,1495,10080,2
300 msec: 01,2494,2495,9960,3
400 msec: 01,3495,3496,10200,3
500 msec: 01,4494,4495,10200,1

```

8.10 Status LED

The status of CM3 is indicated by the status LED of 7 colors (blue, green, red, magenta, cyan, yellow, white). The flashing pattern of the status LED for each status is as follows. If multiple statuses occur at the same time, the status of the first row of the table has a higher priority.

Status	Pattern	Red	Magenta	Green	Cyan	Blue	White	Yellow
STO	Lighting	Red						
Overload Alarm	Alternate	Red	Magenta					
Over Current Alarm	Alternate	Red		Green				
Over Temperature Alarm	Alternate	Red			Cyan			
Over Voltage Alarm	Alternate	Red				Blue		
Low Voltage Alarm	Alternate	Red					White	
Position Error Overflow Alarm	Flashing	Red						
ABS Alarm	Alternate	Red						Yellow
Servo Off	Lighting		Magenta					
Push Motion Warning	Flashing							Yellow
Limit Sensor	Alternate			Green				Yellow
Software Limit	Alternate					Blue		Yellow
Manual Mode Warning	Lighting							Yellow
Operation Warning	Alternate						White	Yellow
Overload Warning	Alternate		Magenta					Yellow
Temperature Warning	Alternate				Cyan			Yellow
Servo On	Lighting					Blue		
BUSY	Lighting			Green				
Push Motion	Flashing			Green				
In The Manual Mode	Alternate					Blue	White	

Chapter 9 Maintenance and Inspection

9.1 Maintenance

It is important to have regular maintenance for CM3 to ensure it is operating safely.

Check Up Items

Type	Cycles	Inspection items
Daily inspection	Daily	<ul style="list-style-type: none"> • Are there dust, foreign objects around the motor? • Is there any abnormal vibration, noise or smell? • Are the cables not damaged? • Is there any loose connection or misalignment with other devices? • Is the main circuit voltage normal?
Periodical inspection	Annually	<ul style="list-style-type: none"> • Is there any loose point at tighten points? • Are terminals intact not damaged?

9.2 Troubleshooting

Please check the following items before inquiring.

9.2.1 Communications

Symptom	Check	How to solve
There is no response in the software window or can not operate a motor	Is the cabling between devices connected properly?	Please see " Chapter 3 Wiring and Connection " and make sure all cables are connected properly. Confirm the state of the contact of the connector pins and the state of the harnesses. (Has not the disconnection occurred?)
	Are the communication settings set correctly when using communication software?	Once change CM3 baud rate, baud rate of communication software must be changed. Read " Chapter 5 Communication Functions " and create a new communication connection from the beginning.
	Is a set value corresponding to the rewritten baud rate?	Please set the same baud rate of the communication software to the value of CM3.
	Are there multiple communication software running?	If there is other software using COM ports, it may cause interference. Please close the software.

9.2.2 Motor

Symptom	Check	How to solve
Noise and vibrations	Are the machine and the motor resonating?	Adjust the gain or speed of CM3.
	Damage to bearing?	Check the noise and vibrations with no load applied to the motor. If there is noise and vibrations, replacement or repair is required.
Overheat	Is operating temperature within specification?	Do not use outside the specification.
	Check the mounting part on the machine.	Make sure there are no loose or slippery places in the machine.
	Is the load inertia within the allowable range.	Make sure that it is within the specification.
	Is bearing not damaged?	Turn the power off and rotate the shaft. If there is a noise, then replacement or repair is required.
Does not rotate	Is the power ON?	Turn the power ON.
	Check cable connection	Connect the cables properly. Confirm whether the state of the contact of the connector pins and the state of the harnesses.
	Is the load within the allowable range?	Use it within the allowable load.
	Is the CM3 Servo off?	Servo on the CM3.
	Is the motor in an alarm state?	Remove the cause of alarm and reset an alarm.
	Has the STO been activated?	When STO is activated, CM3 power circuit is cut off. Apply the voltage to STO input.

9.2.3 Motion

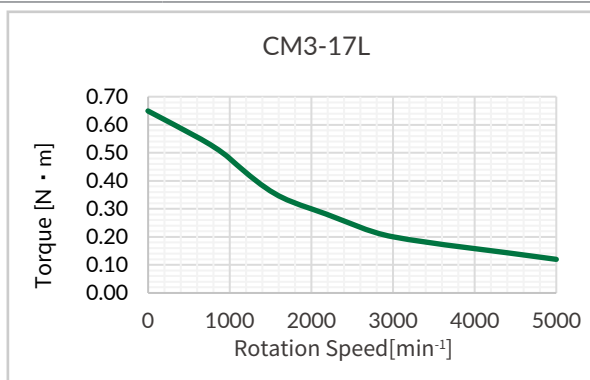
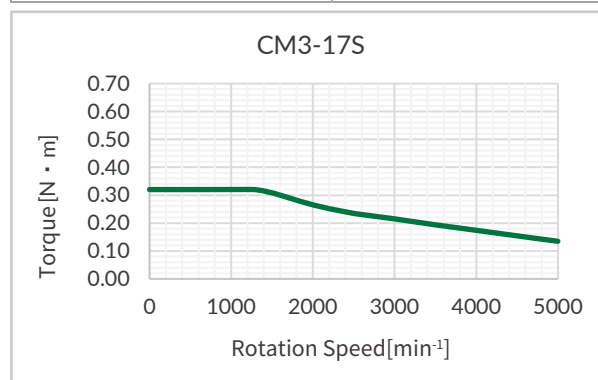
Symptom	Check	How to solve
Inaccurate origin	Is the origin search speed too high?	Decrease the Origin search speed at the point close to origin.

Chapter 10 Specifications

10.1 Basic Specifications

CM3-17S/L

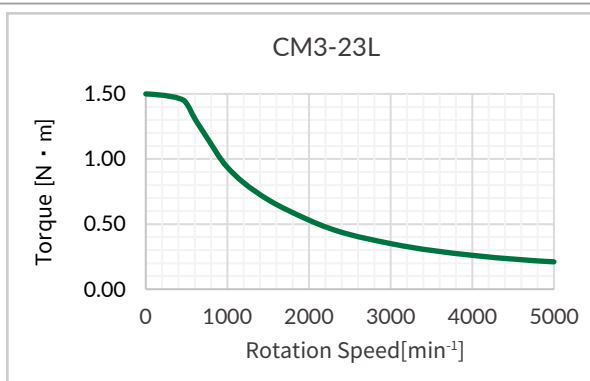
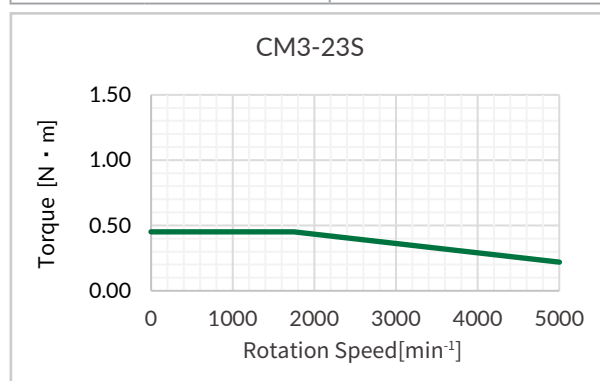
Items		CM3-17S50*	CM3-17L50*
Input voltage		+24Vdc \pm 10%	
Input current / peak current		3.5 [A] / 4.8 [A]	4 [A] / 5 [A]
CM3 output		60 [W]	60 [W]
Maximum rotation speed		5000 [min ⁻¹]	
Rated torque		0.25 [N · m]	0.52 [N · m]
Maximum torque		0.32 [N · m]	0.65 [N · m]
Rotor moment of inertia		0.036×10^{-4} [kg · m ²]	0.074×10^{-4} [kg · m ²]
Allowable load moment of inertia		Less than 10 times the Rotor Inertia	
Allowable radial load (shaft end)		37 [N]	32 [N]
Allowable thrust load		10 [N]	10 [N]
Speed / position detector		Incremental Magnetic Encoder	
Resolution		Selectable from 300 to 12000 [pulse/rotation]	
Control method		Closed-loop vector control	
Heat resistant class		B	
Insulation resistance		100 M Ω 500Vdc	
Insulation Strength	Coil-Frame	500V (1mA leak current)	
	Coils	500V (1mA leak current)	
I/O	Input	Digital Input : 6	
	Output	Digital Output: 4 (Including 1 error output)	
	STO	1	
Communication port		RS-232C	
Cooling method		Natural cooling	
Mass		295 [g]	435 [g]
Operation / storage temperature		0°C to 40°C (No freezing) / -20°C to 60°C (No freezing)	
Operation / storage humidity		5 to 95%RH (No condensation) / 20 to 90%RH (No condensation)	
Atmosphere		Do not use in explosive, flammable gas, corrosive atmosphere, dust, water, oil fumes, water vapor, radiation, or direct sunlight.	
Vibration resistance / shock		JIS Z0232 Level 2 / JIS Z0202 Level 3	



* Specifications are subject to change without notice.

□ CM3-23S/L

項目		CM3-23S50*	CM3-23L50*
Input voltage		+24Vdc ± 10%	
Input current / peak current		4[A] / 5[A]	5[A] / 6[A]
CM3 output		80 [W]	100 [W]
Maximum rotation speed		5000 [min ⁻¹]	
Rated torque		0.30 [N · m]	1.05 [N · m]
Maximum torque		0.45 [N · m]	1.50 [N · m]
Rotor moment of inertia		0.1×10^{-4} [kg · m ²]	0.36×10^{-4} [kg · m ²]
Allowable load moment of inertia		Less than 10 times the Rotor Inertia	
Allowable radial load (shaft end)		77[N]	70[N]
Allowable thrust load		15[N]	15[N]
Speed / position detector		Incremental Magnetic Encoder	
Resolution		Selectable from 300 to 12000 [pulse/rotation]	
Control method		Closed-loop vector control	
Heat resistant class		B	
Insulation resistance		100 MΩ 500Vdc	
Insulation Strength	Coil-Frame	500V (1mA leak current)	
	Coils	500V (1mA leak current)	
I/O	Input	Digital Input : 6	
	Output	Digital Output: 4 (Including 1 error output)	
	STO	1	
Communication port		RS-232C	
Cooling method		Natural cooling	
Mass		525 [g]	1050 [g]
Operation / storage temperature		0°C to 40°C (No freezing) / -20°C to 60°C (No freezing)	
Operation / storage humidity		5 to 95%RH (No condensation) / 20 to 90%RH (No condensation)	
Atmosphere		Do not use in explosive, flammable gas, corrosive atmosphere, dust, water, oil fumes, water vapor, radiation, or direct sunlight.	
Vibration resistance / shock		JIS Z0232 Level 2 / JIS Z0202 Level 3	



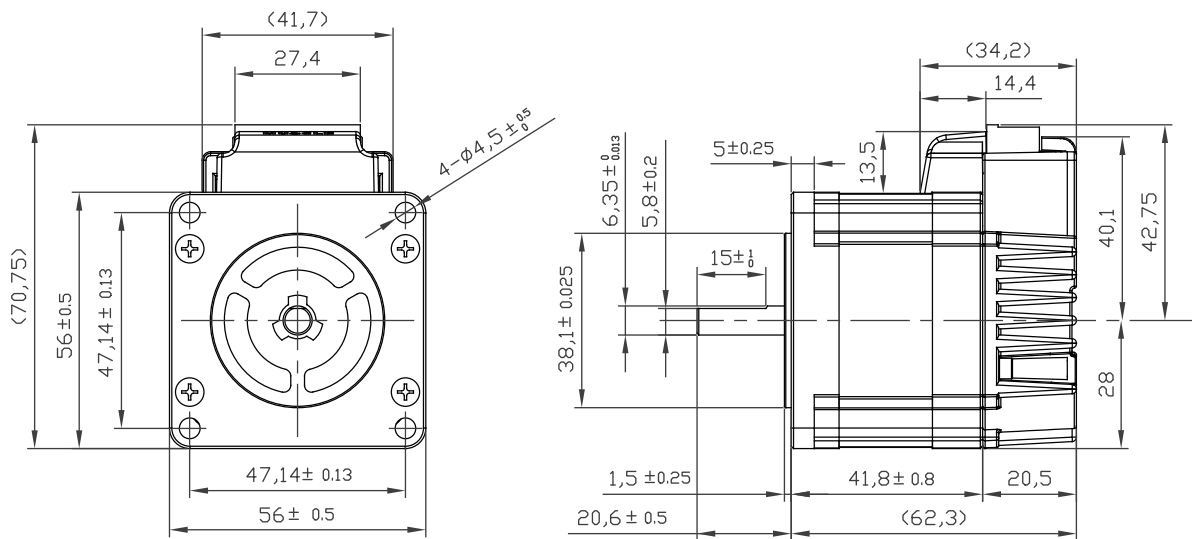
* Specifications are subject to change without notice.

10.2 Electrical Specifications

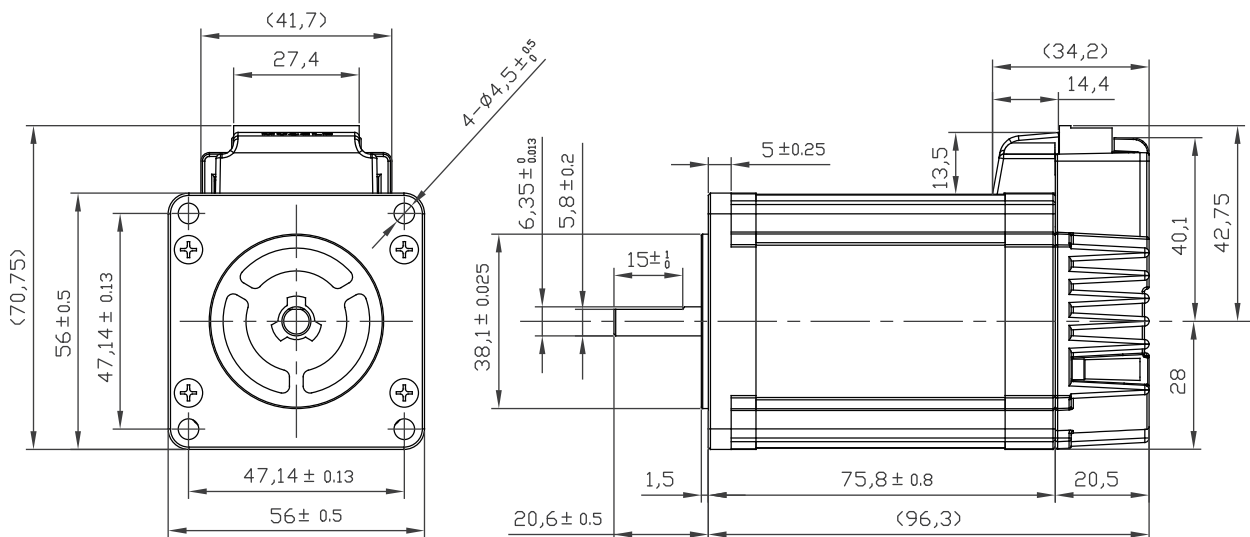
Item		Value
Digital Input	Applied Voltage	0 - 26 [V]
	Low Level Voltage	0.8 [V]
	High Level Voltage	4.2 [V]
Digital Output	Withstanding Voltage	50 [V]
	Max. Continuous Load Current	10mA
Communication	Baud Rate	9.6 - 115.2 [kbps]

Chapter 10 Specifications

□ CM3-23S



□ CM3-23L



Appendix Conformance

CE Marking

CM3 is a component that is intended to be incorporated into machines and equipment for industrial use. When CM3 is built into machines or equipment, it must be established that the machine or equipment fulfills the requirements of the EU Directives.

RoHS Directive

CM3 is conformed to RoHS directive.

EMC Directive

The EMC Directive applies not to CM3 alone but to machines and equipment incorporating CM3. CM3 is conformed to EMC directive.

The conditions of installation, wiring and grounding may be different to the above example, when CM3 is incorporated in machinery or equipment. Therefore, the conformity assessment is required to the machinery or equipment, with CM3 is incorporated, as a whole, in order to meet the EMC Directive.

(The whole machinery or equipment, incorporating CM3, is subjected to the EMC Directive, rather than CM3 alone.)

Revision History

※ User's Guide No. is described in the cover of this manual.

Revised Data	User's Guide No.	Page	Object	Revised Item
August 2020	MDUG-CM3/20831E-21			New Document