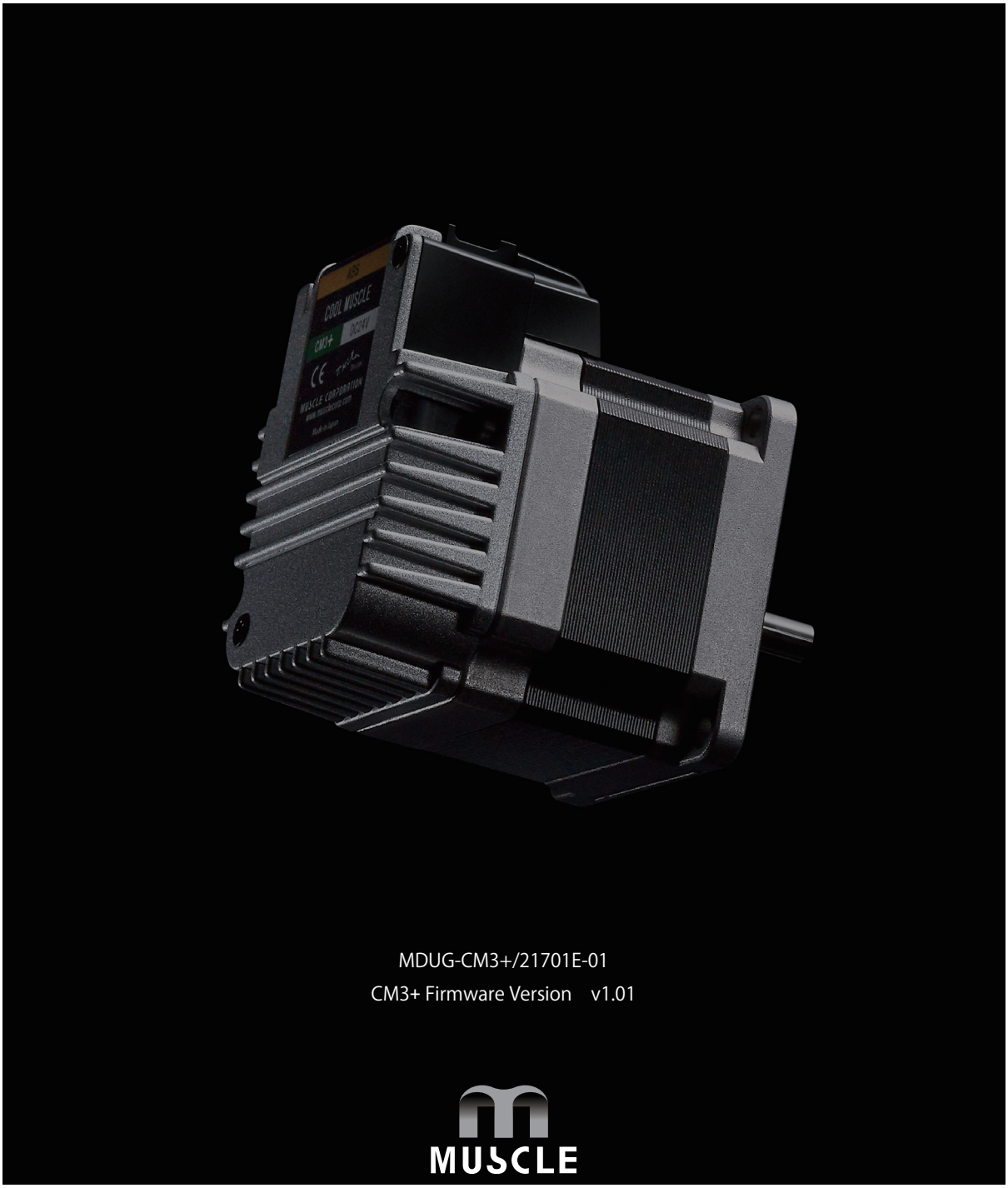
COOL MUSCLE 3+

User's Guide



MDUG-CM3+/21701E-01
CM3+ Firmware Version v1.01

MUSCLE

Table of Contents

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.
- Please notify our sales representative if you have some questions or comments with the contents of this User's Guide.
- The contents of this User's Guide do not guarantee or grant rights to patents, copyright, or any other rights to the intellectual property of MUSCLE CORPORATION or any third party. MUSCLE CORPORATION is not responsible for any problems that may occur concerning the intellectual property rights of third parties resulting from the application of information provided in this User's Guide.
- COOL MUSCLE is a registered trademark of MUSCLE CORPORATION.
- Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and other countries.
- Other company names and product names described in this User's Guide are trademarks or registered trademarks of their respective holders. The trademark notices (TM, ®) are not necessarily appended to company, system, and product names described in this User's Guide.

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 CM3+ while operating.

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

Do not touch CM3+ 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 output 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 output 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 output 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 CM3+ 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 (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, CM3+ 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 (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 rotate output shaft by external force.

Rotating the shaft may cause regenerated voltage within CM3+. This regenerated voltage may damage the driver board.

Do not apply a load exceeding the tolerable load onto the output 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 (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 Product Overview

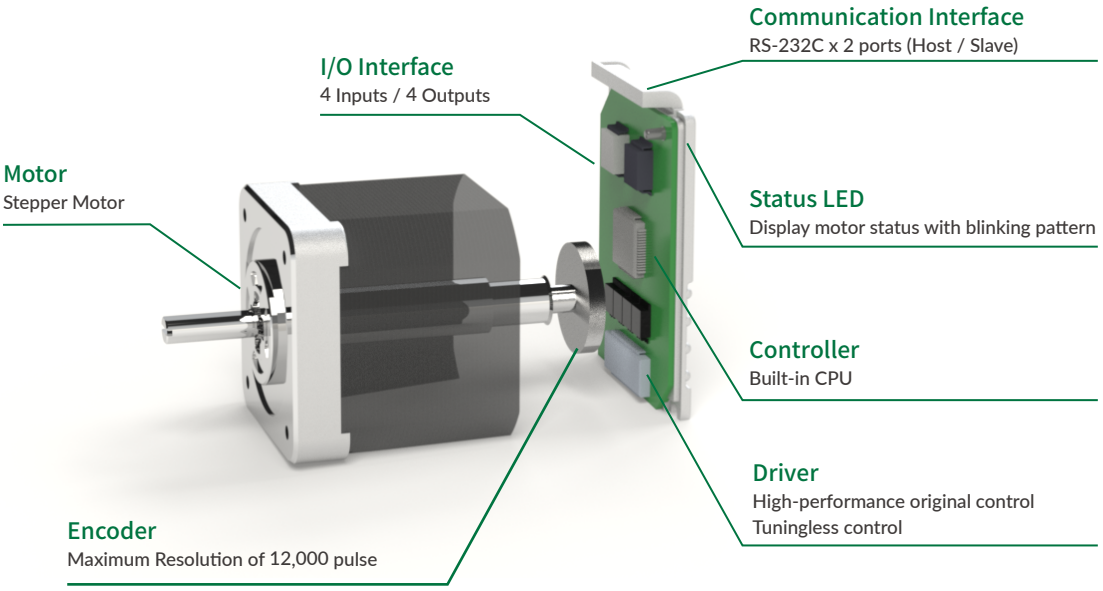
1.1 Overview

The COOL MUSCLE 3 series is designed to provide servo motor equivalent performance with the same ease of use as a stepping motor while maintaining the size of the COOL MUSCLE 1, and is available in two models, COOL MUSCLE 3 and COOL MUSCLE 3+.

COOL MUSCLE 3+ (hereinafter referred to as CM3+) adds new functions to the basic performance of the CM3 and is very easy to use for engineers. It has multi-axis control and PLC functions, making it a more customizable and highly functional motor. With its full range of functions, this model is suitable for those who want to make a full-scale effort from the creation of software.

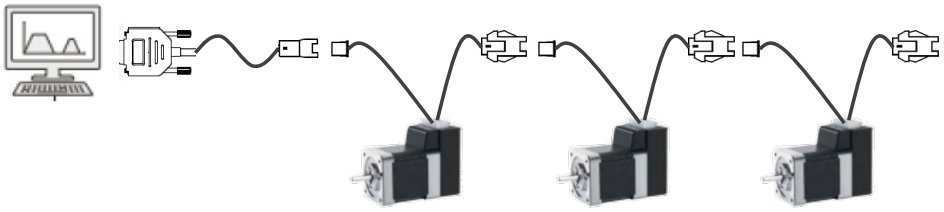
☐ Integrated but Compact Design

Since the motor, encoder, driver, controller, and network functions are integrated, a system can be built without a control panel without the need for a general separate driver or controller. In addition, it is more compact than our conventional CM1 but has more powerful performance.



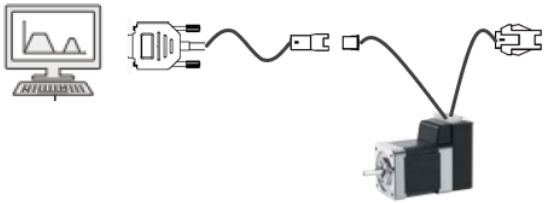
☐ Multi-axis network with reduced wiring

The network configuration uses a daisy chain method. Multi-axis network with up to 15 axes can be constructed simply by connecting the motors with cables. No need to connect to a separate driver or controller. It is possible to start up the device speedily without the trouble of wiring.



☐ Simplest operation

The interface with the host controller uses serial communication, RS232C. If you are in an environment where you can communicate, you do not need any special equipment or software to operate.



☐ Simple program setting / saving

It is possible to set a program that controls the motor and save it in the built-in CPU with only a combination of multiple letters and numbers.

Example)

P=1000	…Set position as 1000
S=100	…Set speed as 100
A=10	…Set Acceleration as 10

This program is called CML (COOL MUSCLE LANGUAGE) and is displayed in ASCII code. You can intuitively execute various operations just by sending and receiving CML. See "Chapter 6 CML (COOL MUSCLE Language)".

☐ Protective function

The following protection functions are installed for safe operation.

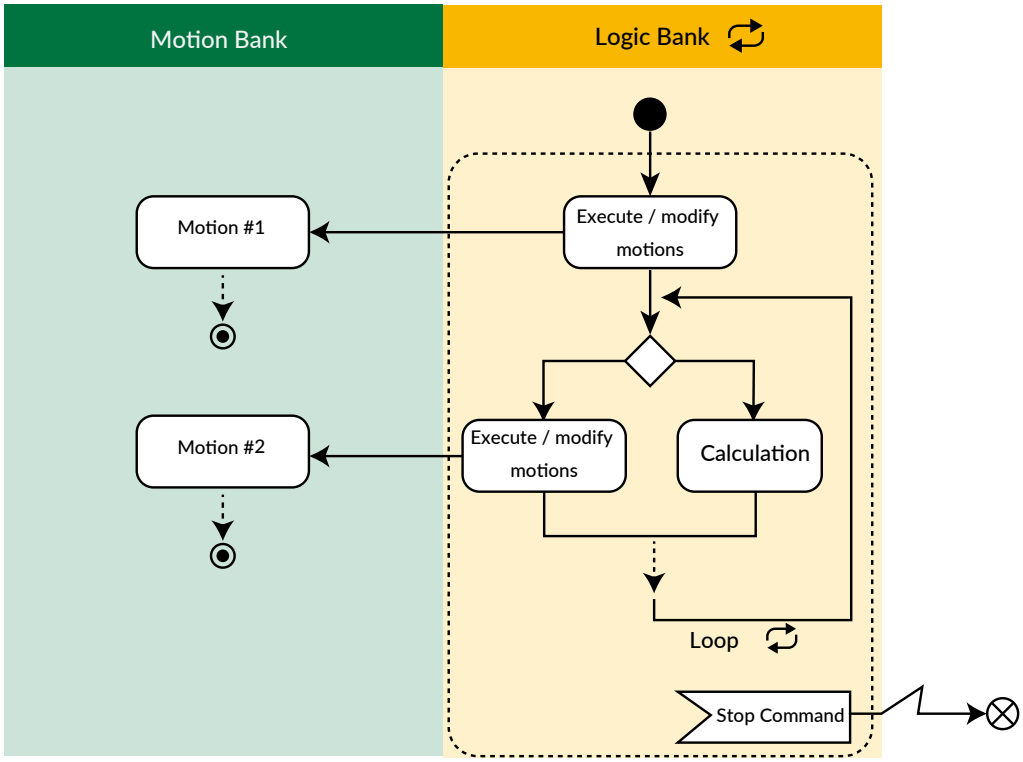
- Soft limit / hard limit function
- Speed override function
- Over current protection function
- Position deviation overflow function
- Over voltage detection function
- Low voltage detection function
- Internal temperature monitor function
- Overload function
- STO (Safe Torque Off) function
- Reverse connection prevention function

☐ Multi-tasking processing

There are two types of CM3+ programs: **Motion Bank**, which describe motion sequences such as positioning, and **Logic Bank**, which describe the entire sequence, and these programs can be executed simultaneously.

CM3+ Multi-tasking processing	
Motion Bank	Logic Bank
Program about motion sequence Run only once (does not repeat automatically)	Program about the whole sequence Executed Cyclically Motion can be executed and changed

While the Motion Bank is executed only once in response to an execution command, the Logic Bank is executed repeatedly in the background until a stop command is issued. This means that data such as input signal ON/OFF, current position of the motor, speed, and torque are periodically monitored, and when conditions are met, changes can be made to the motion in real time through branch processing.

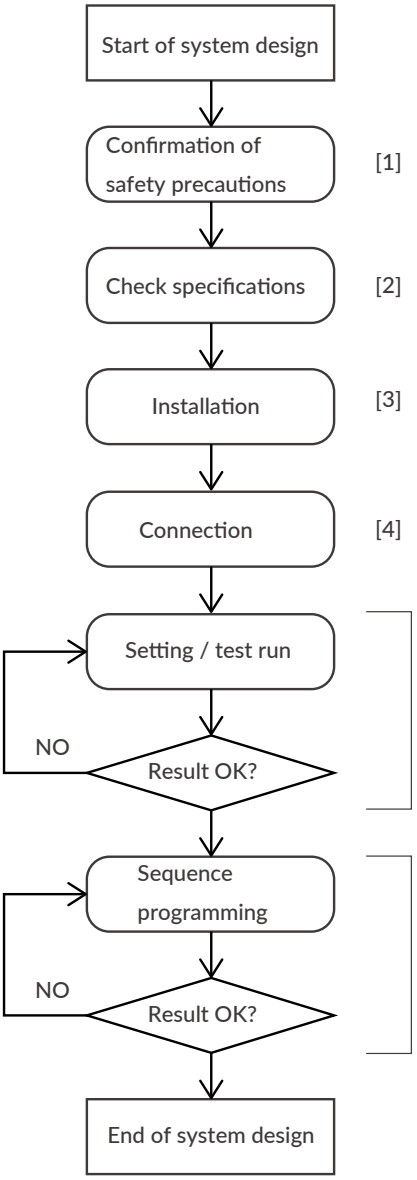


☐ Example of operation using a Logic Bank

Motion Bank only		Motion Bank + Logic Bank
When the home position is far away, the home detection operation is slow and takes a long time.		Starts home detection at high speed and slows down when the sensor before the home sensor turns ON.
Stops when a signal is received during continuous rotation. The sensor must be aligned with the position to be stopped.	➡	Stops after moving an arbitrary distance from the point where the signal is received.
Always position in the same direction with the table mechanism.		Compare clockwise and counterclockwise rotation and rotate to the closer direction.

1.2 Flowchart for Operation

Here, the flow chart shows the flow until CM3+ is operated.
Please be careful and follow the steps below.

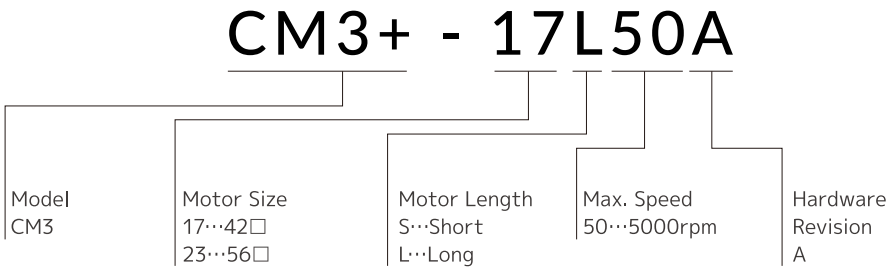


1. Be sure to read the safety precautions before use. See "Instructions for Safety".
2. After confirming the model and characteristics of the CM3+ + to be used, confirm that the environment in which it is used is within the characteristic range. See "Chapter 13 Specifications".
3. Please check the precautions for installation. See "Chapter 3 Installation".
4. Make wiring and connection. Be sure to check the wiring after completing the wiring. See "Chapter 4 Wiring and Connection".
5. Even with multiple axes, be sure to set and check the operation for each single axis. See "Chapter 7 Test Run and Settings".
6. Program the sequence. See "Chapter 8 Program Function"..

Chapter 2 Configuration

2.1 Product Code Scheme

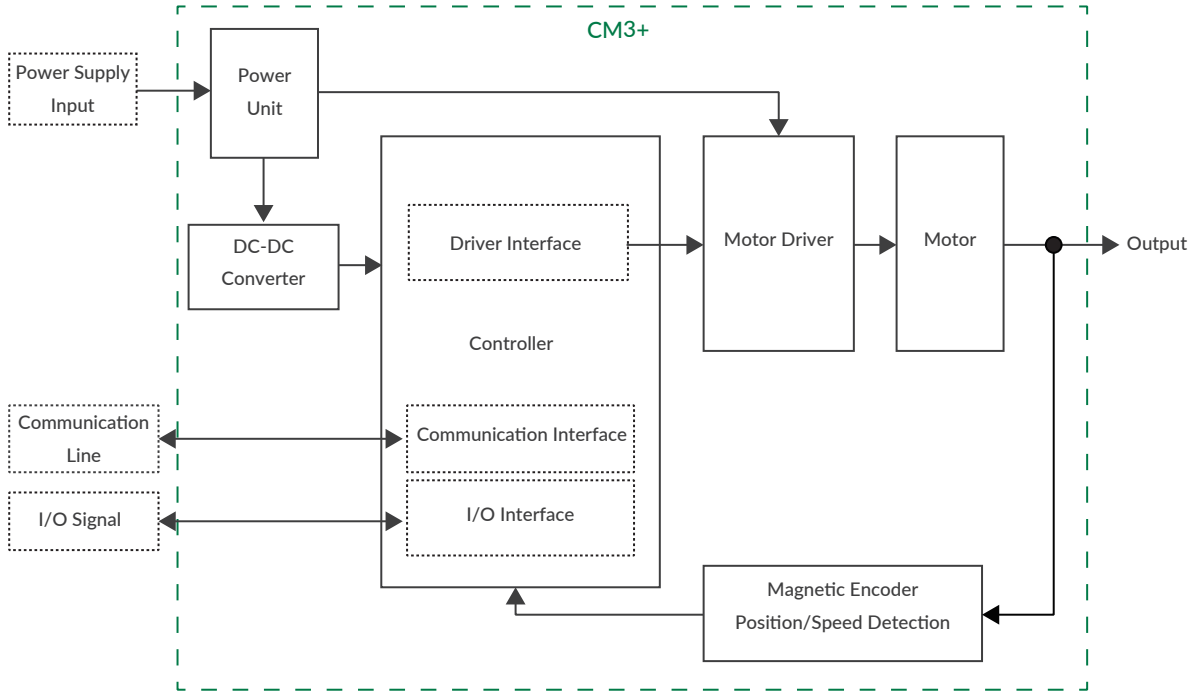
CM3+ product code scheme is described as below.



☐ Product Name

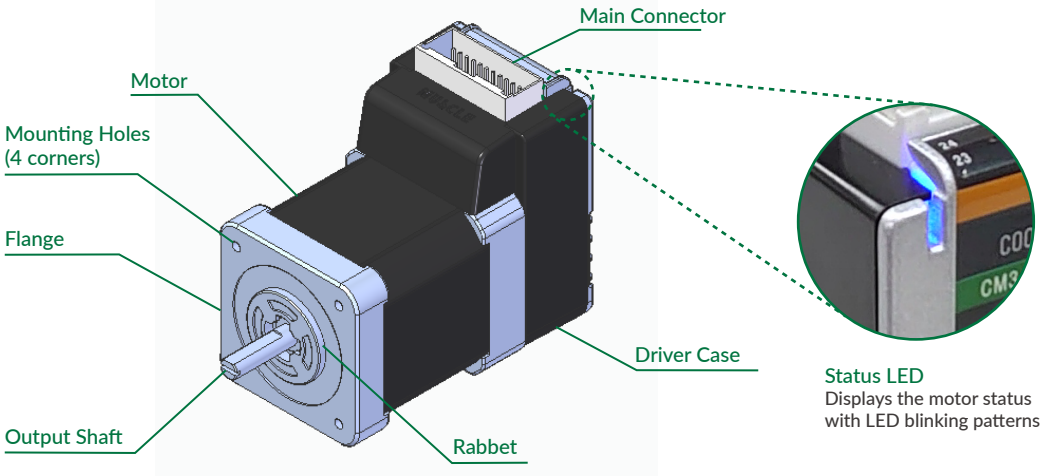
Product Name	Product Code
CM3+ 42 Short	CM3+-17S50A
CM3+ 42 Long	CM3+-17L50A
CM3+ 56 Short	CM3+-23S50A
CM3+ 56 Long	CM3+-23L50A

2.2 Function Block Diagram



2.3 Parts Description

The names of parts of CM3+ are as shown below.



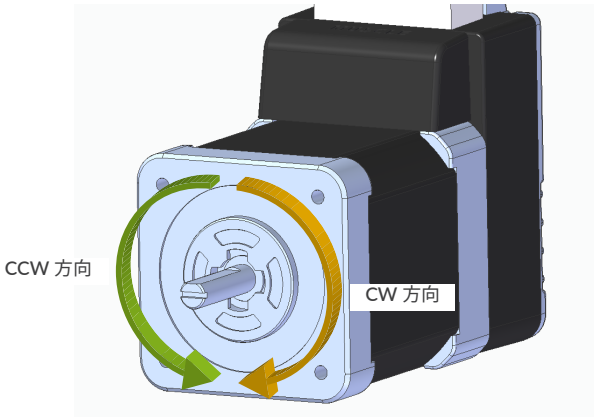
＊ Please refer to "11.8 Status LED" for the status LED blinking pattern.

2.4 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.

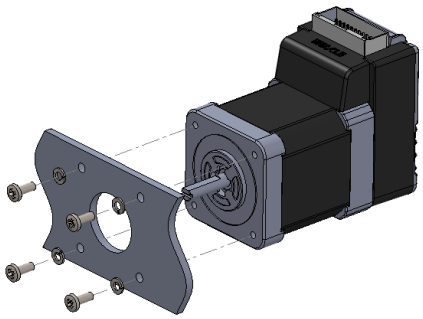
Ref: "10.2 Coordinate Direction（K4）"

Chapter 3 Installation

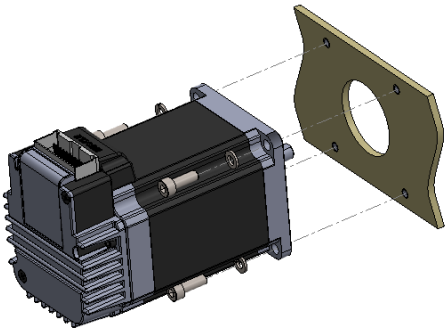
3.1 Mounting to Machinery

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 13 Specifications".)

CM3+-17L50



CM3+-23L50



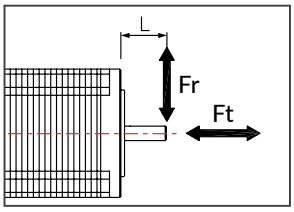
The sizes of mounting bolts are as follows.

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

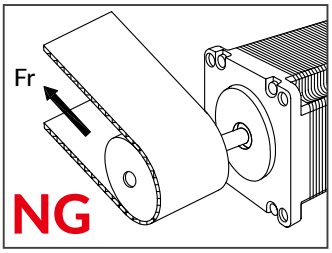
3.2 Load Installation

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 road and thrust load on output shaft do not exceed the allowable values. (Allowable radial load and thrust load of each CM3+ motor size are stated in "Chapter 13 Specifications".)

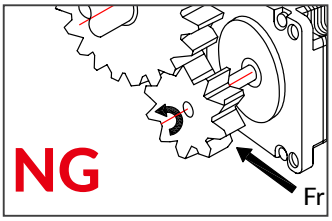
Radial Load (Fr): Perpendicular force applied to the shaft end.
Thrust Load (Ft): Parallel force applied to the shaft end.



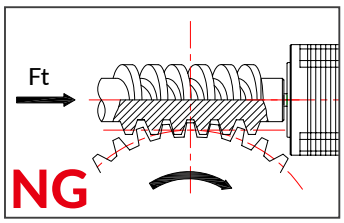
⚠ Mounting a load directly to the output shaft would increase the force and damage the motor.
Consider reviewing the mechanical system so that excessive load is not applied to the output shaft.



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



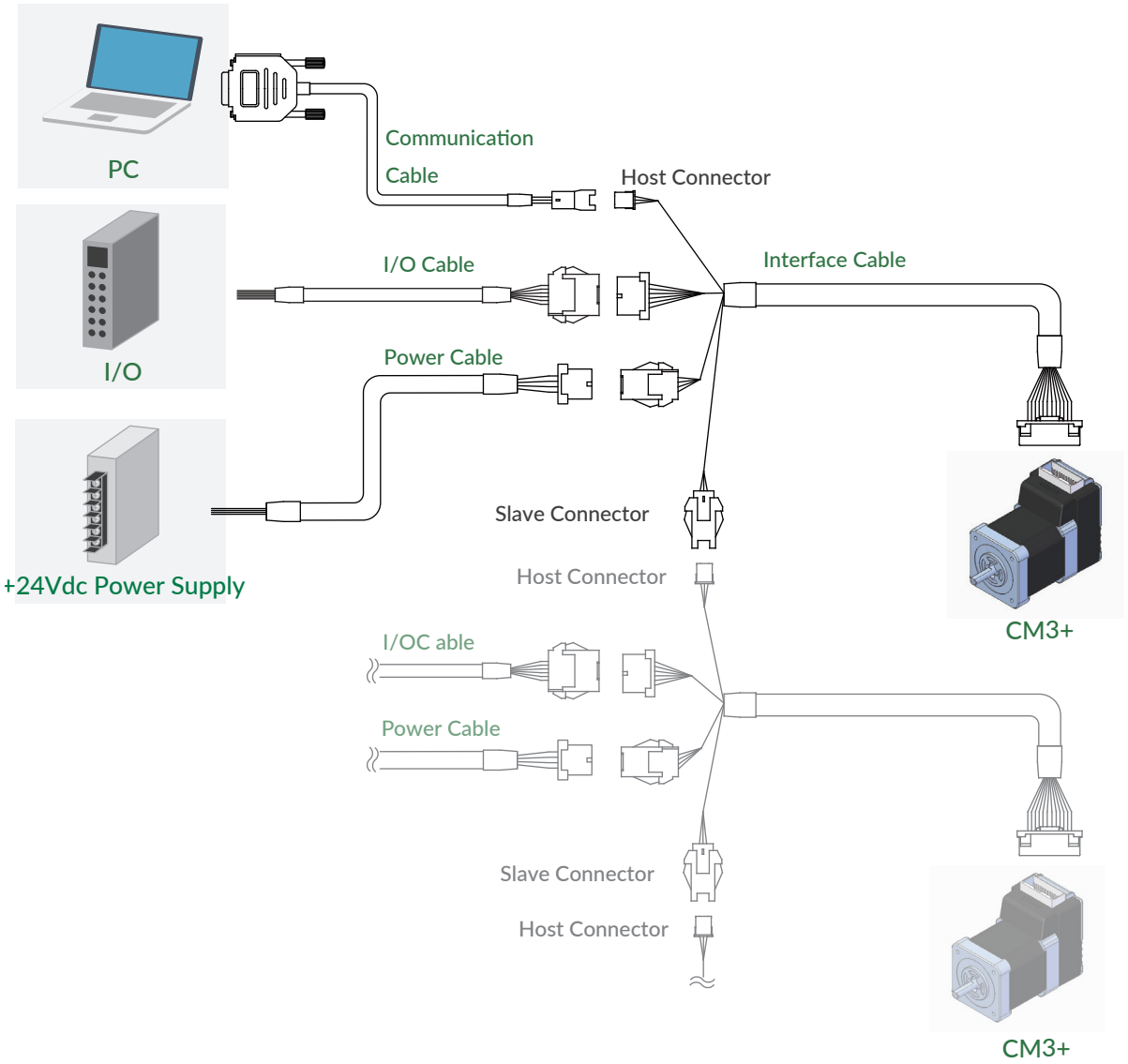
When a worm gear is directly mounted onto output shaft, thrust load (Fr) will be produced and forced to motor shaft. Output shaft will be moved, and it may result in damaging the inside of motor.

Chapter 4 Wiring and Connection

4.1 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.



4.2 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.	名称	機能
2	5V	5V Output
4	D_GND	Digital Ground
6	RXD1	RS232C Receive Data (Slave)
8	TXD1	RS232C Transmit Data (S;ave)
10	OUT3	Output 3
12	OUT1	Output 1
14	D_GND	Digital Ground
16	STO_IN+	STO Input +
18	IN3	General Input 3
20	IN1	General Input 1
22	P-GND	Power Ground
24	POWER	+24Vdc

No.	名称	機能
1	FG	Frame Ground
3	D_GND	Digital Ground
5	RXD0	RS232C Receive Data (Host)
7	TXD0	RS232C Transmit Data (Host)
9	ALARM	Alarm Output
11	OUT2	Output 2
13	STO_IN-	STO Input -
15	IN4	General Input 4
17	IN2	General Input 2
19	IN_COM	IN1 to 4 Common
21	P-GND	Power Ground
23	POWER	+24Vdc

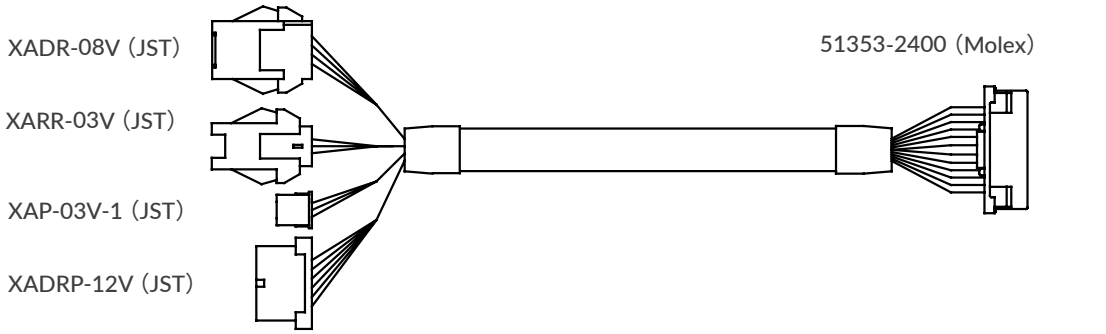
Connector: 55959-2430（Molex）

☐ Interface Cable B（400mm, 1000mm, 2000mm, 3000mm, 5000mm）

Product Number:　CMIFB1-****WR（****: Cable Length）

Wires:　1 - 20 pin … AWG26 UL20276 (80°C / 30V)

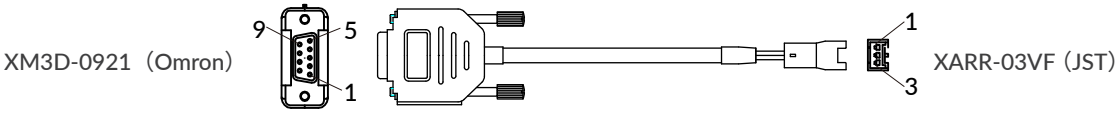
21 - 24 pin … AWG24 UL20276 (80°C / 30V)



☐ 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
GRY	2	TXD	RS232C Transmit Data from PC
ORG	3	RXD	RS232C Receive Data from PC
WHT	5	D_GND	Digital Ground

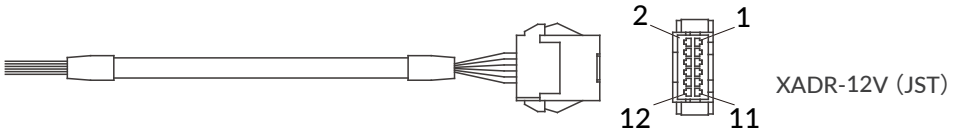
CM3+ side

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 B (1000mm, 3000mm, 5000mm)

Product Number: CMIOB1-****S (****: Cable Length)

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



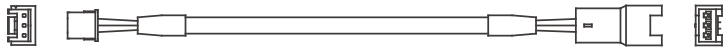
Color	Dot	No.	Name	Function
PPL		1	5V	5V Output
GRN		3	IN2	General Input 2
ORG		5	IN4	General Input 4
BLK		7	OUT1	Output 1
WHT		9	OUT3	Output 3
WHT	-	11	D_GND	Digital Ground

Color	Dot	No.	Name	Function
BLU		2	IN1	General Input 1
YLW		4	IN3	General Input 3
RED		6	IN_COM	IN1 to 4 Common
BRW		8	OUT2	Output 2
GRY		10	ALARM	Alarm Output
WHT		12	N/A	N/A

☐ Daisy Chain Cable A（500mm, 1000mm, 3000mm, 5000mm）

Product Number: CMDCA1-****S (****: Cable Length)

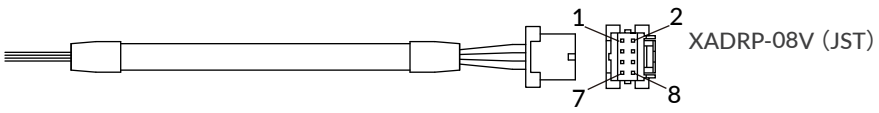
Wires: AWG28 UL758 Style2464（80°C / 300V）



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

Product Number: CMPWA1-****S (****: Cable Length)

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



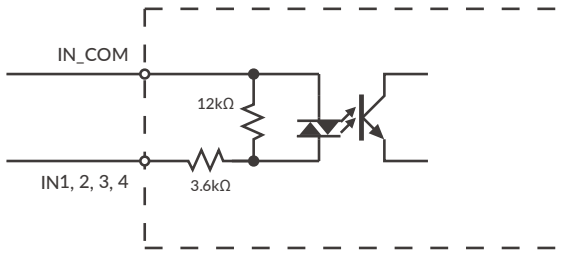
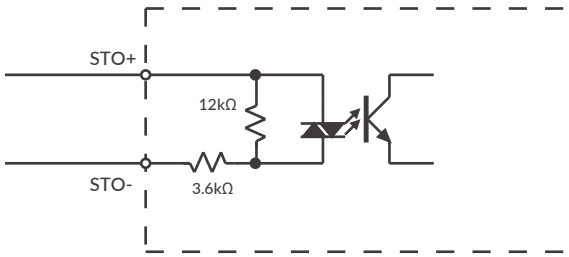
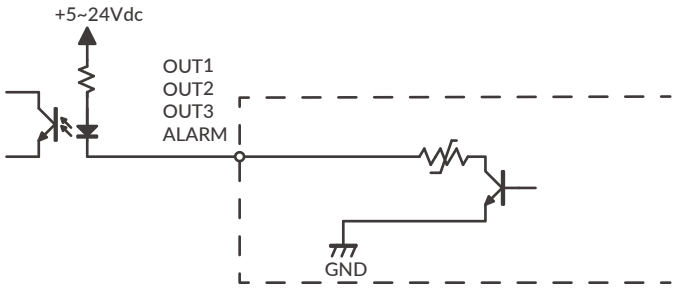
Color	No.	Name	Function
RED	1	POWER	+24Vdc
BLK	3	P-GND	Power Ground
GRY	5	STO_IN+	STO Input +
BRW	7	FG	Frame Ground

Color	No.	Name	Function
GRN	2	POWER	+24Vdc
WHT	4	P-GND	Power Ground
BLU	6	STO_IN-	STO Input -
-	8	N/A	N/A

4.3 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]

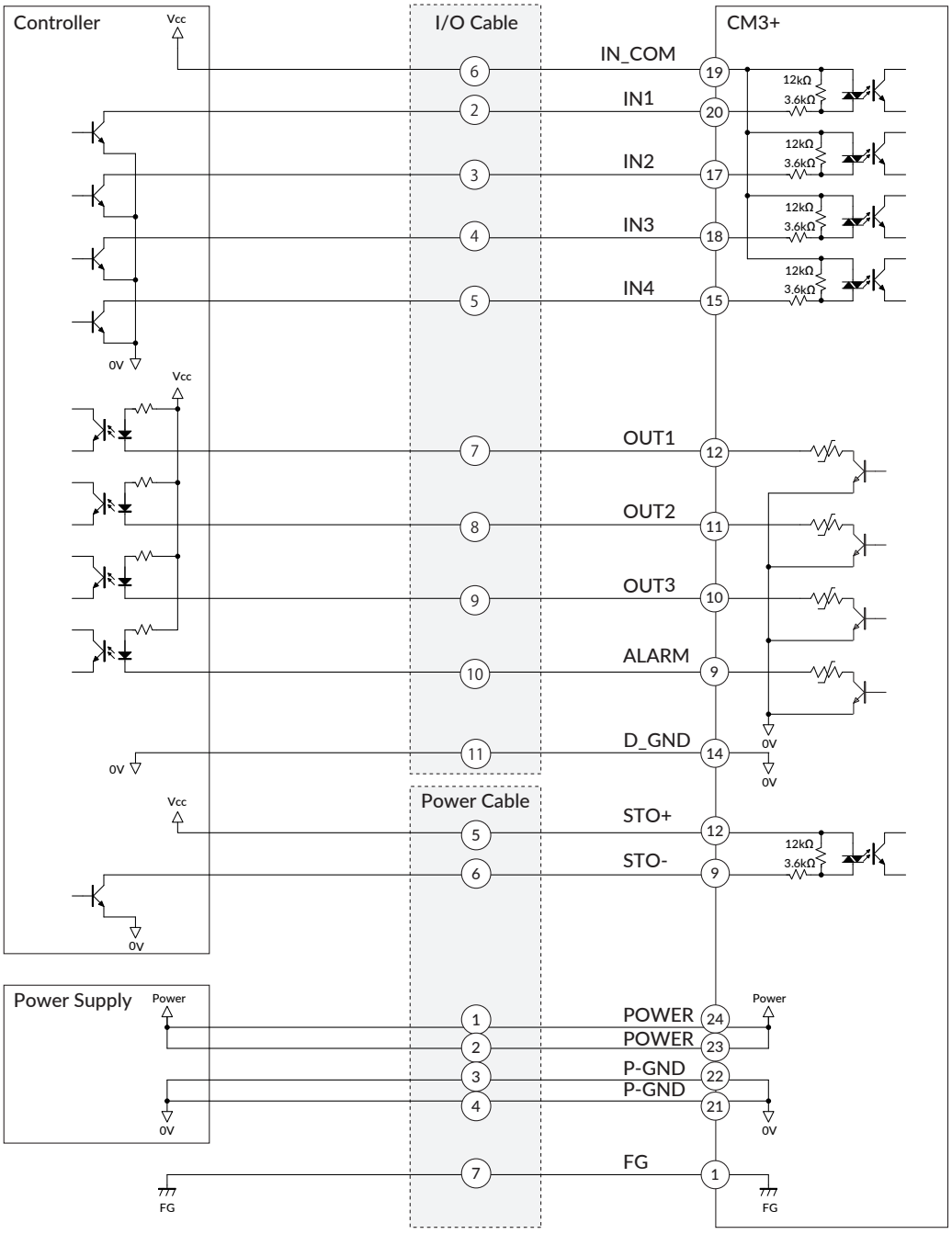
4.4 Input/Output Circuit

<table>
<tr><td rowspan="2">Input</td><td>IN1, 2, 3, 4
No Polarity</td><td> 
</td></tr>
<tr><td>STO
No Polarity</td><td> 
</td></tr>
<tr><td>Output</td><td>OUT1, 2, 3
ALARM
Open-Collector</td><td> 
</td></tr>
</table>

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

4.5 Circuit Connection

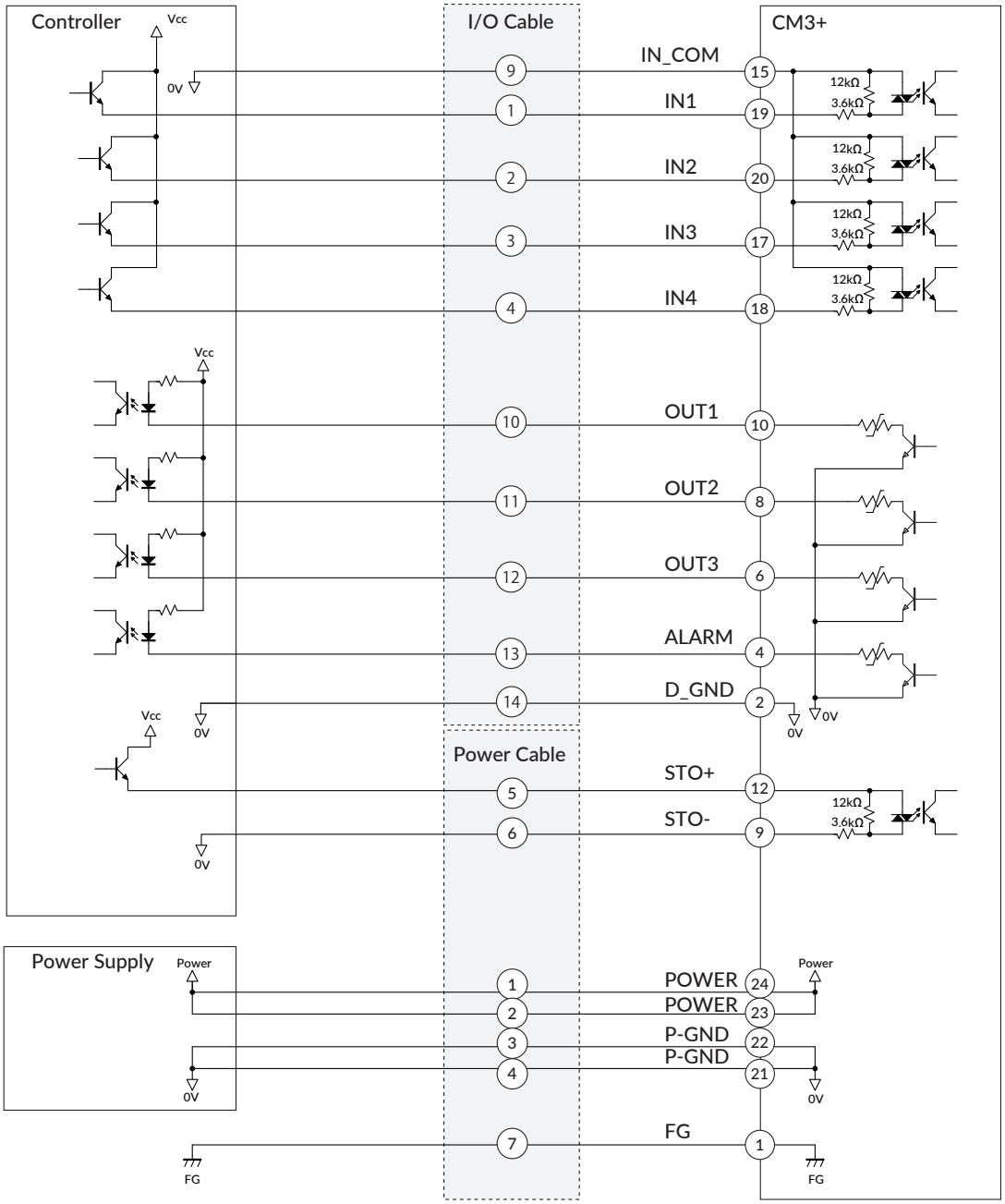
☐ Connection Example with Sink Output Circuit



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.

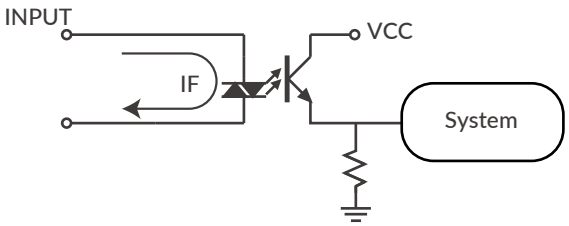
Make sure to ground the FG

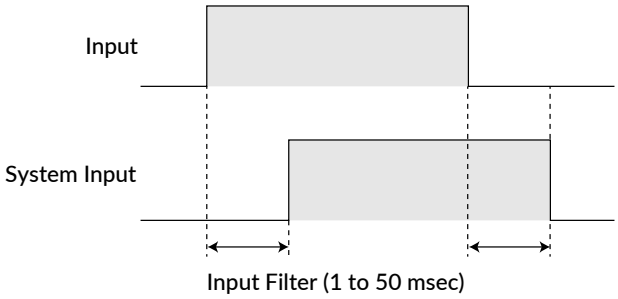
Chapter 5 Input/Output

5.1 Input Signal

5.1.1 Input Filter

CM3+ has 4 digital inputs, IN1 to IN4, do not come 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.

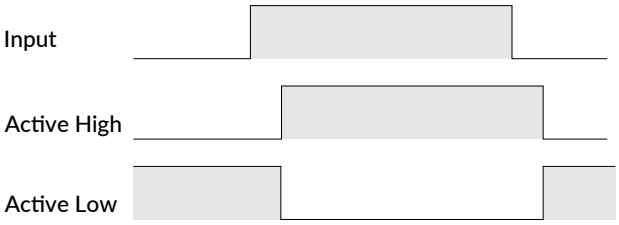




When Input Filter is set, the signal shorter than the set time is not detected as a signal.

5.1.2 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.



5.2 Output Signal

5.2.1 Output function

The output signal is an open collector output of all four points. OUT4 is fixed to the alarm output, and the functions of other Outputs (OUT1 to 3) can be selected by parameters.

5.2.2 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-collector circuit is ON when output condition is true
Active Low:	Gate in open-collector circuit is ON when output condition is false

Refer to "11.4 Output Functions" for further information.

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.

6.2 Operation Mode

CML command can be used in the following two modes.

☐ Direct Mode

CML commands are used to operate the CM3+ directly. This mode is used to run the CM3+ immediately on the spot, to specify the target position each time, for debugging, or to perform interrupt processing (e.g., speed change or forced termination) while the Motion Bank is running.

☐ Bank Mode

CM3+ operates according to pre-defined operating procedures (bank definition commands). These procedures are written in the memory of the CM3+ and can be executed by execution commands or digital signals.

- Motion Bank
  Motion Bank is used to describe a sequence of motions, and is used to repeat a certain motion.
- Logic Bank
  Describes processing linked to input signals and motor status, and is continuously executed in background at fixed times set by parameters. It is used as a simple sequencer or PLC.

6.3 Memory Map

The internal memory of the CM3+ can store various set values.
To read or save the stored set values, specify the memory number following the parameter or command.
The following figure shows the image of the memory occupied by these set values within the set capacity.

☐ Data Definition

Logic Bank				
Direct	Motion Bank			
P0	P1	...	P250	Position Data
S0	S1	...	S250	Speed Data
A0	A1	...	A250	Acceleration Data
M0	M1	...	M8	Torque Data
	T1	...	T15	Timer Data
	V1	...	V15	Variable Data

☐ Bank Definition

B1		
...	Motion Bank	* Up to 500 commands available
B30		
L1		
...	Logic Bank	* Up to 500 commands available
L30		

6.4 CML command list

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
Setting Parameter Ref: 7.3	K**	Motion Environmental Parameters	K1 - K17
		Origin Detection Parameters	K22 - K30
		Gain Adjustment Parameters	K31 - K36
		I/O Parameters	K42 - K60
		Status Parameters	K61 - K66
		Communication Parameters	K71 - K74
		Logic Bank Parameters	K81 - K82
		Monitoring Parameters	K85 - K90

** means number.

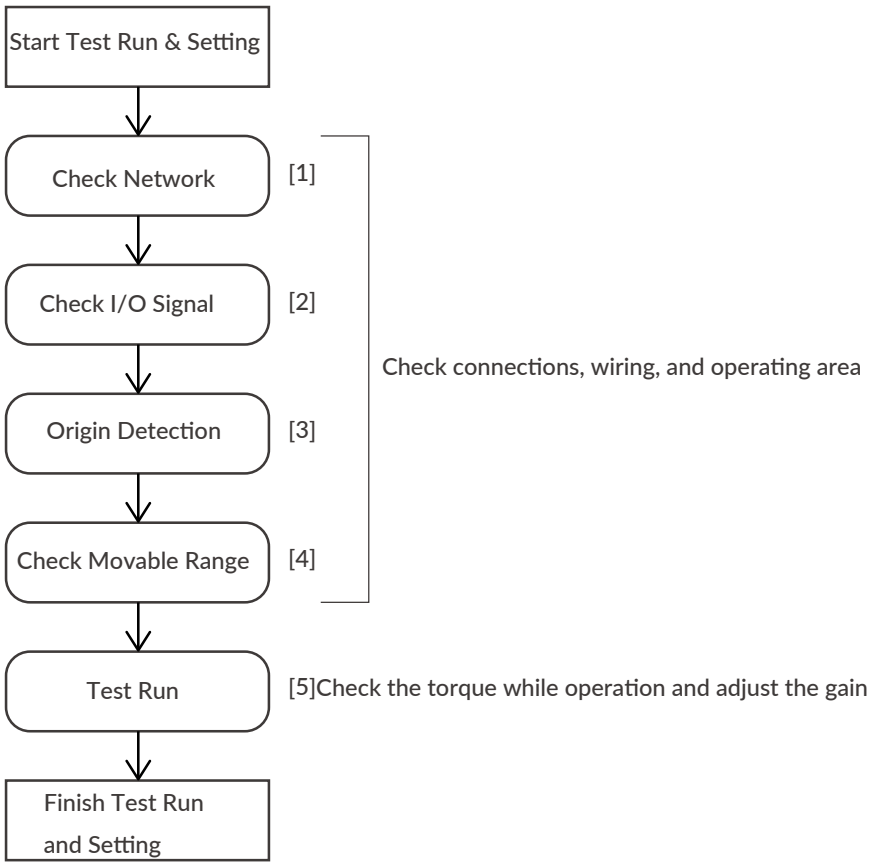
CML Command	Character Code	Function	Others
Execution Commands Ref: 7.2.1	|	Origin Detection execution	
	|1	Move to origin point	
	|2	Set the current position as the origin.	
	^	Direct mode execution	
	[**	Execute the specified Motion Bank.	[1 ~ [30
	$	Save bank data	
	)	Servo Off	
	(1	Alarm canceled	
	(	Servo On	
	O	Output Signal On	O1 ~ O3
	F	Output Signal Off	F1 ~ F3
	]	Stop command	
	#**	Position data acquisition (teaching)	#1~#249
Query Command 7.2.2	?**	Inquiring Current Status	
Motion Command Ref: 8.1	S**	Speed Data	S1 ~ S249
	A**	Acceleration Data	A1 ~ A249
	P**	Position Data	P1 ~ P249
	M**	Torque Data	M1 ~ M7
	Y**	By using it instead of P, the next operation is executed without waiting for the positioning to be completed.	Y1 ~ Y249
	Q**	By using it instead of P, it becomes Push Motion	Q1 ~ Q249
	Z**	By using it instead of P, the next operation is executed without waiting for the Push Motion to be completed.	Z1 ~ Z249
	B**	Start defining Motion Bank	B1 ~ B30
	C**	Call an indicated Motion Bank	C1 ~ C30
	J**	Jump to an indicated Motion Bank	J1 ~ J30
	X**	Repeat	X0 ~ X249
	I**	Conditional branching by input signal	I1 ~ I6
	O**	Output Signal On	O1 ~ O3
	F**	Output Signal Off	F1 ~ F3
	T**	Timer	T0 ~ T8
	W**	Waiting for operation in conditional branch	W1 ~ W8
	V**	Conditional branching, calculation, and data display using general data.	V1 ~ V15
Logic Command Ref: 9.1	L**	Beginning the definition of a Logic Bank	L1 ~ L30
	CL**	Call a specified Logic Bank	CL1 ~ C30
	JL**	Jump to a specified Logic Bank	JL1 ~ J30
	I**	Conditional branching by input signal status	I1 ~ I4
	T**	Timer	T0 ~ T8
	W**	Waits for motion in a conditional branch	T0 ~ T8
	V**	Conditional branching, calculation, and data display of general data	V1.1~V16.1
	END	End of Logic Bank definition	-
	, (comma)	Command linking, merge motion, and simultaneous motion	-
	; (semicolon)	Command linking across multiple lines	-
	: (colon)	Command linking in branching process	-
	Execution command	Use of execute command in Motion Bank	]1、[L、]L、>、<、}、$、\ unavailable

** means number.

CML Command	Character Code	Function	Others
Arithmetic Operators	=	Assigning values	
	+	Addition	
	-	Subtraction	
	*	Multiplication	
	/	Division	
	U1	Sin (Sine)	
	U2	Cos (Cosine)	
	U3	Square root	
Logical Operators	&&	Logical conjunction (AND)	
	||	Logical OR (OR)	
	!!	Negation (NOT)	
Comparison Operators	==	Equal	
	!=	Not equal	
	>	Greater than	
	>=	Greater than or equal to	
	<	Less than	
	<=	Less than or equal to	

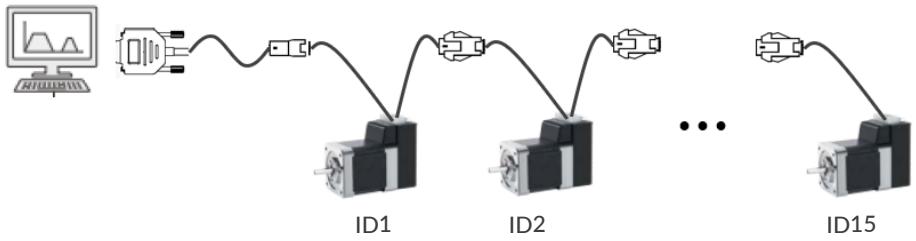
Chapter 7 Test Run and Settings

In this chapter, the flow to the test run is explained. The purpose is to set the appropriate parameters for each axis and make the motion sequence safe and executable by performing a trial run. The below chart shows the procedure of the test run.



7.1 Forming Daisy Chain Network

The CM3+ network uses the Daisy Chain network method in that devices are connected in a row. When forming a network, it is necessary to detect each CM3+ in the network by numbers and the numbers are called motor ID. The motor IDs are automatically assigned when power is supplied (see the figure below). Lower ID closer to a host device. Therefore, when forming a network with multiple axes, the power must be supplied to all CM3+ at the same time.



The default communication specifications for CM3+ + are shown in the table below.

CM3+ + default communication specifications	
Baud rate	38400bps
Data length	8bit
Parity	None
Stop bit	1
Flow control	None

Set the communication on a host device as shown in the above table and confirm a network establishment using terminal software such as TeraTerm. As example, when a 3-axis network is established, the ID number and version information shown in the below figure will be sent to the host device.

If the network is not established, multi-axis control by CML is not possible. Be sure to check the establishment of the network.

＊ If all IDs are not displayed

If the communication settings on the host device are set the same as CM3+, but the ID is not displayed, check the following two points.

1. Is the wiring correct?
2. Is the line feed (LF) deleted on the host device?

7.2 CML Used for Test Run

Once the network is established, you can start to check various things by using the CML such as execution commands, query commands and parameters. The commands shall be sent in the following format.

☐ Runtime format

"CML Command" No.ID *Omitted if No is not required

Execution example: O3.2 // Turn on the output signal 3 of motor ID2

7.2.1 Execution Command

CML	Name	No	Detail
^	Execution of Direct Motion Data		Start motion with data registered for direct execution
]	Stop		Stop
|	Start Origin Detection		Origin detection operation start (according to K21 to K30 set values)
|1	Move to coordinate 0		Move to coordinate 0
|2	Reset current position		Set the current position to coordinate 0
O	Turn on general output	1 ～ 3	Turn on the output specified by No
F	Turn off general- output	1 ～ 3	Turns off the output specified by No
)	Servo off		Turn off the servo
(1	Alarm reset		Reset the alarm
(	Servo on		Turn on servo
$	Save Data		Saves all the data.

7.2.2 Query Command

CML	名称	单位	返信内容		
?	Direct Mode Motion Data	N/A	Displays the definition contents of S0, A0, P0.		Example: To ask direct mode motion data ?.1 S.1=500, A.1=2000, P.1=100000
?50	Output Status	N/A	B0	Output 1	Display Output Status in hexadecimal OUT.1 = Hex value 0: Off / 1: On
			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	
?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 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	Over current Alarm	
			B7	Temperature Alarm	
			B8	Operation Warning	
			B9	Low Voltage Alarm	
			B10	STO Activated	
			B11	Status Warning	
			B12	ABS Alarm	
?999	All Data List	N/A			
?1000	All Motion Bank	N/A			

7.2.3 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

☐ 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]

7.3 Parameter Setting

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

Details of various functions and usage examples are described in Chapter 10.

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.
- 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).

7.3.1 Motion Environmental Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
1	Resolution	0	300	ppr	✓	Set the pulse count per revolution. Ref: 10.1
		1	600			
		2	1000			
		3	1200			
		4	2000			
		5	3000			
		6	5000			
		7	6000			
		8	10000			
		9	12000			
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. 10.2
		1	Positive in CCW			
5	In-position Range	1 - 500		Pulse		Set the range for In-position. Ref: 10.3
6	Speed Override	1 - 100		%		Limit the speed by the set proportion. Ref: 10.4
7	Software Limit Setting	0	Disabled	—		Set the enable / disable of the software limit function and the operation when the function is enabled. Ref: 10.5
		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: 10.5
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: 10.5
10	Unit of Software Limit	0	100	Pulse	✓	Set the unit for Software Limit. Ref: 10.5
		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.
		1	Set time (One direction)			
		2	Continuous (Both direction)			
		3	Set time (Both direction)			
12	Push Motion Torque	10 ～ 100		%		Set the torque during pressing operation by command Q or Z in % of the rated torque.
13	Push Motion Holding Time	1 - 30000		msec		Set Push Motion Holding Time. Ref: 8.6.2
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: 10.6
		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: 10.6
16	Deceleration ratio	1 - 500		%		Set the deceleration in % of the A command
17	Creeping Speed	0 - 1000		K2		Set the creeping speed Ref: 10.7

7.3.2 Origin Detection Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
22	Origin Signal Source	0	Stopper Detection	—	✓	Set the origin detection signal source and detection method. The origin sensor can be assigned only to input point 1. (Auto): Automatic origin detection operation starts when the power is turned on. Ref: 11.1
		1	Stopper Detection (Auto)			
		2	Origin Sensor			
		3	Origin Sensor (Auto)			
23	Origin Detection Speed	1 - 32767		pps Set by K2		Set the speed for Origin Detection.
24	Origin Detection Acceleration	1 - 32767		kpps²		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: 11.1.1
29	Single Turn ABS Function	0	Disabled	—	✓	Set Enable / disable the Single Turn ABS function Ref: 10.8
		1	Enabled			
30	Origin Detection Completion	0	Disabled	—	✓	Function will not be operated until origin detection is completed Ref: 10.9
		1	Enabled			

7.3.3 Gain Adjustment Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
31	Tuning	0	PPI	—		Set CM3+ Tuning method. Ref: 11.5
		1	Tuningless			
32	Servo Stiffness	10 - 200				Set Servo Stiffness when Tuningless is selected. Ref: 11.5.1
33	Position P Gain	1 - 5000				Set 3 types of gains when PPI is selected. Ref: 11.5.2
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: 11.5.3

7.3.4 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: 11.3.1
43	Input Logic	1st digit	IN 1	0: Active High 1: Active Low	✓	Set the input logic. Ref: 5.1.2 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 45 46 47	Input 1 Function Input 2 Function Input 3 Function Input 4 Function	0	No Action		✓	Select the function to be assigned to IN1 to IN4. Origin sensor can be assigned only to IN1. Inching / jog can be assigned only to IN3 and IN4. Ref: 11.2
		1	Origin Sensor			
		2	CCW Limit Sensor			
		3	CW Limit Sensor			
		4	Manual Mode			
		5	Servo on・off			
		6	Inching・Jog (CCW)			
		7	Inching・Jog (CW)			
50	Inching・Jog Speed	1 - 32767		pps Set by K2		Set the speed for the Inching and Jog operation. Ref: 11.3.2
51	Inching Distance	1 - 100		Pulse		Set the Inching distance. Ref: 11.3.2
52	Inching・Jog Shift Time	0	No Inching Motion	msec		Set the time to switch Jog from Inching completion. Ref: 11.3.2
		1 - 3000				
53	Output Logic	1st digit	OUT 1	0: Active High 1: Active Low	✓	Set the output logic Ref: 5.2.2 Ex: OUT3 and OUT1 as Active Low K53=101
		2nd digit	OUT 2			
		3rd digit	OUT3			
55 56 57	Output 1 Function Output 2 Function Output 3 Function	0	General Output			Assign functions to Output 1 to 3 Ref: 11.4.2
		1	In-position Output			
		2	Warning Output			
		3	Individual ZONE Output			
		4	ZONE Output			
		5	MOVE Output			
		6	BUSY Output			
		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: 11.4.2
59	ZONE（—）	± 2147483647		Pulse		Set boundary of ZONE Output in the negative direction. Ref: 11.4.2
60	ZONE（+）	± 2147483647		Pulse		Set boundary of ZONE Output in the positive direction. Ref: 11.4.2

7.3.5 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: 10.10
64	Overload Detection Time	100 - 10000		msec		Set the time to output Overload alarm. Ref: 10.11
65	Status LED	0	Enabled			Set enable / disable of the status LED Ref: 11.8
		1	Disabled			
66	Status Report	B0	In-position/Alarm	Ux.1		Set the conditions to automatically report to a host controller. Ref: 10.12
		B1	Input Status	IN.1		
		B2	Output Status	OUT.1		
		B3	No Local Echo	-		
		B4	Comment	-		
		B5	Warning	Ux.1		

7.3.6 Communication Parameters

K	Name	Setting/Range		Unit	Restart	Reference/Remarks
71	Baud Rate for Host communication	0	38.4	kbps		Set the baud rate. Ref: 10.13
		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			
74	Baud Rate for Slave communication	0	38.4	kbps		Sets the communication baud rate between slaves when multiple CM3+ are connected in a daisy chain. Ref: 10.13
		1	9.6			
		2	19.2			
		3	57.6			
		4	115.2			

7.3.7 Logic Bank Parameter

K	Name	Setting/Range	Unit	Restart	Reference/Remarks
81	Logic Bank No. to be executed when power is turned on.	0 ~ 30			Sets the Logic Bank number to be executed when the power is turned on. If set to 0, no Logic Bank will be executed when the power is turned on. Ref: 11.7
82	Logic Bank execution cycle	1 ~ 30000	msec	✓	Sets the execution cycle of the Logic Bank. The Logic Bank will be executed cyclically at the set period. Ref: 11.7

7.3.8 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: 11.7
		1	Target Position	pulse		
		2	Current Position	pulse		
		3	Target Speed	K2 value		
86	CH1 Data	4	Current Speed	K2 value		
		5	Target Torque	% to Max Torque		
		6	Current Torque	% to Max Torque		
87	CH2 Data	7	Load Factor	% to Rated Torque		
		8	Voltage	0.1V		
		9	Temperature	°C		
88	CH3 Data	10	Input Status	—		
		11	Output Status	—		
89	Streaming Interval	1 - 30000		msec		Set time interval to output Streaming Data. Ref: 11.7
90	Streaming Setting	0	Disabled			Set the timing to stream data (cannot be saved) Ref: 11.7
		1	Streaming all the time			
		2	Streaming while operation			

7.4 Checking I/O Connection

The CM3+ has 4 inputs, 3 outputs and 1 STO input. Use CML to check the wiring then check the electrical specifications by measuring devices. Refer to "4.5 Circuit Connection" for connection example.

☐ Confirmation Procedure

1. Turn off the servo

   If the servo is on, send the servo off command ").ID " .
   Send the motor status query command " ?99.ID " and confirm that Ux.ID = 16.

2. Parameter Setting

```
K44.ID=0    // Assigns the "General Input" function to IN1 of the specified motor ID.
K45.ID=0    // Assigns the "General Input" function to IN2 of the specified motor ID.
K46.ID=0    // Assigns the "General Input" function to IN3 of the specified motor ID.
K47.ID=0    // Assigns the "General Input" function to IN4 of the specified motor ID.
K55.ID=0    // Assigns the "General Output" to OUT1 of the specified motor ID.
K56.ID=0    // Assigns the "General Output" to OUT2 of the specified motor ID.
K57.ID=0    // Assigns the "General Output" to OUT3 of the specified motor ID.
```

3. Check the Input Signal

   Turn off all input signals to Input 1 to 4 and STO signal then send the input signal query " ?70.ID ".

```
?70.1       // Send input signal query command
IN.1=0000   // All input signals of ID1 are OFF
```

   Turn on all input signals to Input 1 to 4 and the STO signal then send the input signal query " ?70.ID ".。

```
?70.1       //Send input signal query command
IN.1=006F   // All input signals of ID1 are ON
```

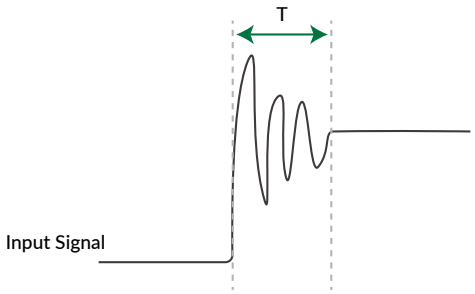
   If you can see the change in the status of input signals, the connection is done correctly.

   ＊ Depending on the connection, the status logic of the input signal may be reversed.

4. Confirmation of Electrical Specifications of Input Signals

   Measure the voltage at the high and low levels of the input signal by measuring devices. Make sure that the specifications in "13.2 Electrical Specifications" are met. Be careful especially when the wiring is long.

   When using switches with mechanical contacts, check chattering and adjust the input filter (K42).



   A signal without chattering is ideal, but if it cannot be removed chattering, measure the chattering period T then set the input filter time as K42 setting value > T [msec].

5. Check the output signal

   To check the wiring of the output, use the CML execution commands " O " and " F ".
   Use this command to check responds from the connected devices.
   Connect not exceeding the maximum rated current.

   Example
   O2.3 // Turn on output 2 of motor ID3
   F1.3 // Turn off output 1 of motor ID3

7.5 Origin Setting

Since the position coordinates of CM3+ are incremental, it is necessary to set the origin (coordinates 0) every time CM3+ is turned on. There are two types of origin signal sources as Stopper and Origin Sensor (* Refer to "11.1 Origin Detection" for origin signal sources). When the origin signal source is not used, it is also possible to set the current position as the origin by using the execution command from the host device. If you do not use the execution command, the position when the power is turned on is 0.

Example: When detecting the origin using the origin signal source
|.1 // CM3+ with ID1 starts the origin detection operation.

Example: When setting the current position to the origin
|2.2 // Set the current position of ID2 as the origin

7.6 Checking Range of Motion

Check the coordinates of the target position by interfering with the machine with other axes, routing the wiring, and so on. CM3+ sets the target position in pulse units. There are two ways to check, one is to use the motion data for direct execution, and the other is to use the jog function of the input function. From here, it becomes the actual operation. Since the area is checked on the hardware side, check with the set speed slowed down as much as possible. Here, the confirmation method using the jog function is shown.

1. Calculate the range of motion (Related Parameter K1: Resolution)

   Calculate the maximum operating area from the machine specifications.

2. Parameter Setting

   ```
   K44.ID=5        // Set Servo On to Motor ID Input 1 function
   K45.ID=4        // Set Manual Mode to Motor ID Input 2 function
   K46.ID=6        // Set Inching・Jog (CCW) to Motor ID Input 3
   K47.ID=7        // Set Inching・Jog (CW) to Motor ID Input 4
   K50.ID=10       // Set 10000ppr to Motor ID Jog speed
   K52.ID=0        // Set No Inching Motion
   ```

   ＊ Please refer to "11.3.2 Manual Mode" for Inching / Jog operation.

3. Origin Detection

   When using an origin sensor as the origin signal source, set Origin Sensor to the Input 1 by K44.
   Use the execution command to turn the servo on and off.

4. Check the Range of Operating

   Operate by Jog operation and check the below 3 points.

   - The current position at the maximum point. Does it match the data calculated in the procedure 1?
     How to check your current position:

     ```
     ?96.ID          // Query command to check the current position
     Px.ID=****      // CM3+ send the current position to the host device
     ```

   - Check for interference with other axes
   - Check the routing of wirings
     Make sure that there is no interference with wiring or machinery, the bending radius of the cable, or the main connector of CM3+ is not under load.

   After confirming the maximum operating area, you can carry the test run more safely by using the Software Limit function by K8 and K9.

7.7 Operation Confirmation

From here, operate CM3+ by sending Execution commands from the host device. Firstly, set position, speed and acceleration for Direct execution then start and stop operation by the following commands.

CML	Name	Detail
^	Execution of Direct Motion Data	Start motion with data registered for direct execution
]	Stop	Stop motion being executed

☐ Points for checking operation

- Tuning (Gain Adjustment Parameters: K31 to K36))
- Torque during task (Monitoring Parameters: K85 to K90)

Refer to "11.5 Tuning" for tuning. Make sure that the torque during the task is within the allowable range. The torque may be differed by installation conditions. Please follow the installation conditions of "Chapter 3 Installation".

Define position, velocity, and acceleration. The definition of each is as follows.

☐ 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 × 100pps = 10000 [pps]

- Unit Conversion to rpm

Speed[rpm] = S Data × Speed Unit [pps] × 60 [sec/min] / Resolution [ppr]

Example: S Data 100（S=100）
Speed Unit 100pps（K2=0）
Resolution 1000ppr（K1=2）

Speed[rpm] = 100 × 100[pps] × 60[sec/min] / 1000[ppr]
= 600 [rpm]

☐ Acceleration

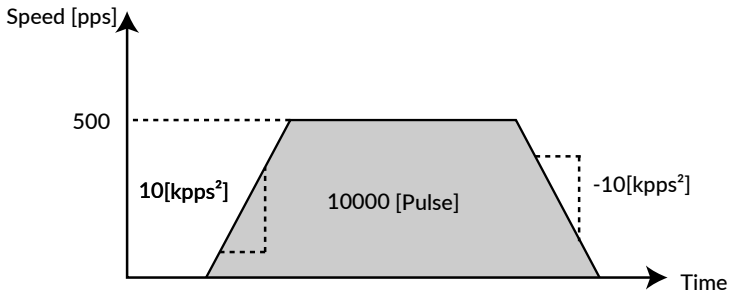
The rate of increase in velocity per second is defined as acceleration. The unit is pps^2 [pulse / sec^2].
The unit of acceleration data "A" is $kpps^2$ (kilo-pulse/sec^2) = 1000 [pps^2]

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 × 100 [pps] / (100 × 1000 pps^2) = 0.5 [sec]

After calculating the trajectory of motion, set the motion data as position, velocity, and acceleration in CM3+.

[Example]
Set 10000 pulse to target position, 5000pps to speed and 10$kpps^2$ to acceleration to the memory 2 of ID2 of CM3+.

```
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 10 kpps² to Acceleration of Motion Data 2
```



The motion will start by the direct mode execution command.

```
^.2             // CM3+ with ID2 starts operation according to the motion data
```

Send stop command to stop CM3+ when it is running.

```
[.2             // Stop the operation of CM3+ + with ID2
```

When CM3+ reaches the target position or is stopped by the stop command, the In-position status Ux.2=8 will be sent to a host device as the same as the positioning is completed.

Chapter 8 Program Function

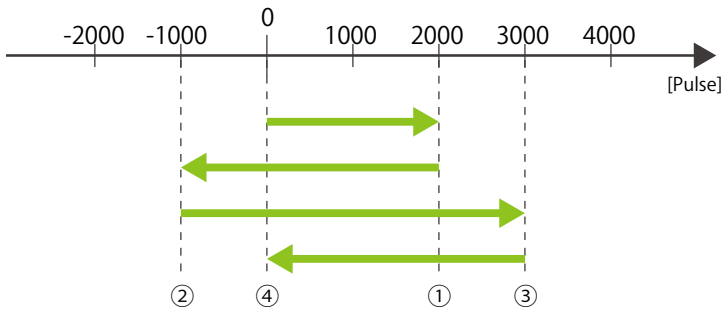
8.1 Program

The sequences specified by motion can be easily created with CM3+. The program is called as “Motion Bank “. There are only three things for the basic operation as setting, command sorting and execution (stop). Command sorting is called as "programming."

- Setting: 250 position data can be set (CML: P0 to P249)
- Sort the commands in the order in which CM3+ shall move
- Execute the program (Execution command: [, Stop command:])

＊ In this chapter, some commands are omitted to make it easier to imagine the Motion Bank function. Please refer to "8.4 Motion Bank Declaration and Modularization" for the correct format and how to send to host device.

The example below shows how to move to four positions from the origin-> ① -> ② -> ③ -> ④ .



1. Point Data Registration

   P1.1 = 20000
   P2.1 = -10000
   P3.1 = 30000
   P4.1 = 0
   //Unit: Pulse

2. Change the order of commands (programming)

   P1.1
   P2.1
   P3.1
   P4.1

   ☐ Send Execution Command

   Change Motion Sequence

   ② -> ① -> ③ -> ④

   ☐ Sorting Commands (Programming)

   P2.1
   P1.1
   P3.1
   P4.1

   ☐ Send Execution Command

8.2 Motion Program

In the previous example, there was only position data. This will not give you the time to the target position. There 250 acceleration and speed data to set task time

You can control the task time by using these two commands.

The basics are the same as setting, command sorting and execution.

In the example, CM3+ moves from the origin position to ① -> ② -> ③ -> ④ .

The speed from the origin to ① is S1.1, the speed from ① to ② is S2.1, the speed from ② to ③ is S3.1, and the speed from ③ to ④ is S4.1. All accelerations are 100 kpps² and set to A1.1.

- Registration of speed / acceleration data

  A1.1= 100

  S1.1 = 100

  S2.1 = 50

  S3.1 = 200

  S4.1 = 300

  //Acceleration unit: kpps², Speed unit: 100 pps [Can be changed by K2]]

- Command Sorting (Program)

  A1.1,S1.1,P1.1

  S2.1,P4.1

  S3.1,P2.1

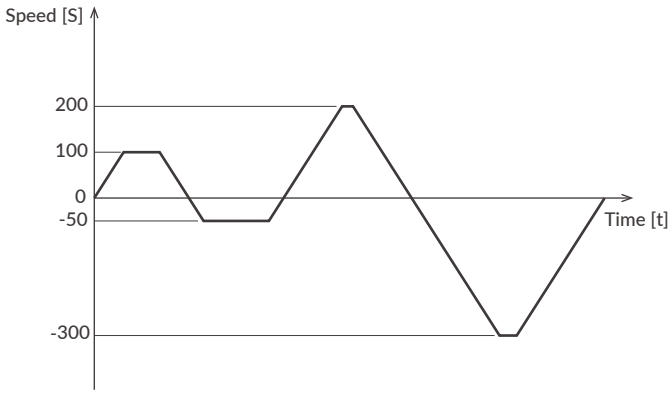
  S4.1,P3.1

  Place commands only if the acceleration / speed are changed.

  If there is no change, it can be omitted.

  Send Execution command

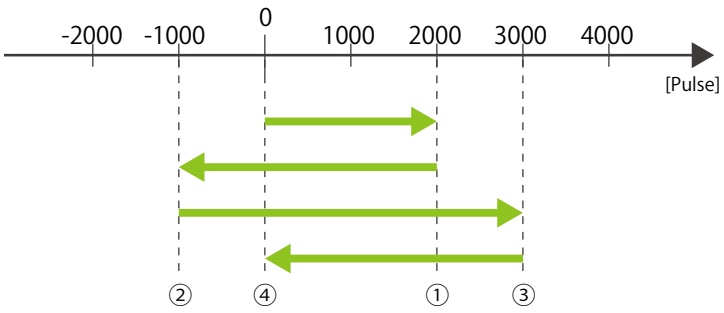
CM3+ will move as the motion trajectory as shown below.



The above is the basic Motion Bank programming method.

8.3 Wait Command: T Command

Let's look at the previous operation example again.



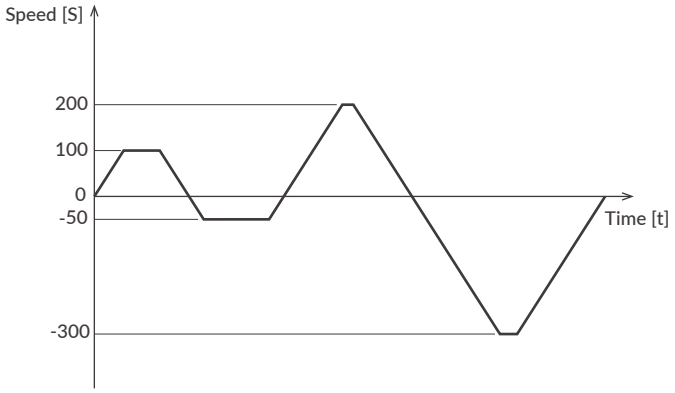
This is an example of moving from the origin to ① -> ② -> ③ -> ④ . Since CM3+ + is a drive device, it will be installed and used in a mechanical device. When moving to ② after reaching ① , the rotation direction of the motor is changed, and it may produce a vibration by backlash or inertia of the mechanical device.
Vibrations are sometimes amplified and accelerate the deterioration of mechanical devices. In such case, set a waiting time to set the vibration settled. Timer commands can also be set and sorted.

☐ Registration of speed / acceleration data

T1.1= 100 //Unit: msec

☐ Command sorting (Program)

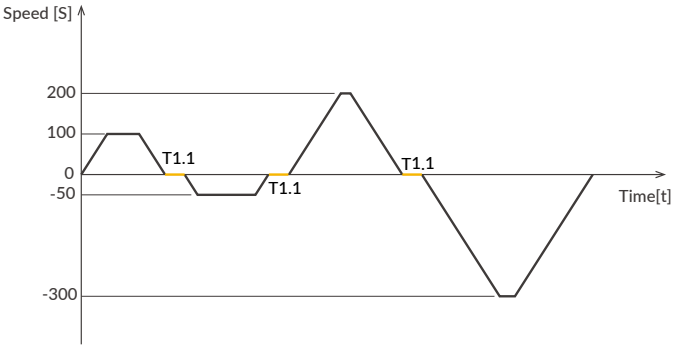
A1.1,S1.1,P1.1
T1.1
S2.1,P4.1
T1.1
S3.1,P2.1
T1.1
S4.1,P3.1



Motion trajctory without Timer command

☐ Send Execution command

As another usage, you can use it when you want to wait for a certain period of time.



Motion trajctory with Timer command

8.4 Motion Bank Declaration and Modularization

As mentioned above, CML consists of four types of commands: execution command, setting command, query command, and program command. Bank command (B) is to start definition of program. Bank command also can be used as a modularization of the sequence. The former example will be as it follows when programming to CM3+:

- Motion Bank declaration

B1.1	Format B1.Motor ID
A1.1,S1.1,P1.1	Set the motion sequence in the Motion Bank 1 of the motor ID.
T1.1	
S2.1,P4.1	
T1.1	
S3.1,P2.1	
T1.1	
S4.1,P3.1	
END.1	END.Motor ID The set the end of the Motion Bank.

As above, the Bank command (B) is used to declare the start of the program, and END is used at the end of program. Up to 500 program commands can be set in Motion Banks. Sequences can be modularized by using Bank commands.

- Modularization

B1.1	
A1.1,S1.1,P1.1	
T1.1	Format: B (No).Motor ID Number is from 1 to 30 Up to 30 sequence operations can be set
P2.1	
T1.1	
P3.1	
B2.1	* When setting Motion Banks, set them in ascending order. When sending a Bank command, Banks which number is larger than the number set by the Bank command will be erased.
A1.1,S1.1,P1.1	
T1.1	
P2.1	
T1.1	Example: If B4.1 is sent when B1.1 to B10.1 are registered, the motion banks after B5.1 will be deleted.
P3.1	
T1.1	
P4.1	
END.1	

- Run / stop modularized Motion Banks

  Modularizing the sequence makes test runs and program management very easy.

  To execute the Motion Bank from the host device, use the following commands.

  Format

  [(Bank No).ID // Execute the Motion Bank specified by No

  ].ID // Pause the currently running Motion Bank

  ]].ID // Complete stop currently running Motion Bank

  In the previous example, when executing the sequence set in Bank 2,

  [2.1 // Execute the sequence set in Bank 2

  When the sequence registered in Bank 2 is completed, the execution of the Motion Bank will be completed.

  ∗ If Bank 1 is executed, Bank 2 will not be executed automatically after Bank 1 is completed.

  To pause or completely stop the operation registered in the Motion Bank during execution, it will be as follows.

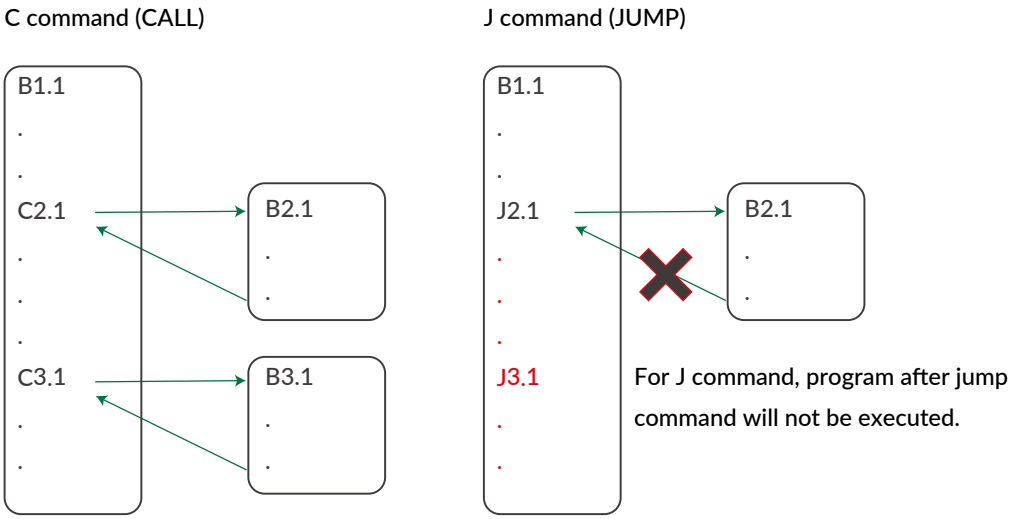
  ].1 // Pause Motion Bank

  [.1 // Resume the paused Motion Bank

  ]].1 // Completely stop the running Motion Bank

  If you send a paused Motion Bank command while the Motion Bank is completely stopped, the Bank No.1 is executed. If the execution command with the Bank number is sent during the pause, the paused Motion Bank will resume regardless of the Bank number.

- Run modular programs in Motion Banks
  You can also run a modular Motion Bank in your program. Motion Bank that number is specified in the programs can be executed by using C command and J command without executing it from a host device.



Both C command and J command can call other program numbers during program is executed. But C command calls a specified Motion Bank then it goes back to an original Motion Bank after executing the called Motion Bank. On the other hand, it does not go back to an original Motion Bank after jumping to a specified Motion Bank by J command and the Motion Bank is completed when the jumped Motion Bank is completed.

It is not possible to call or jump to Motion Bank of another motor ID by using the C command or J command.
An original Motion Bank can not be called in a called Motion Bank from an original Motion Bank.

8.5 Conditional Branching by Input Signal

You can create a conditional branching program that uses all the input signals in Daisy Chain network. The operation can be selected by the status of input signals of the specified motor ID.

Format I [No].ID, [Process 1], [Process 2] // No is 1 to 4

Example 1
I3.2, P2.1, P3.2 // If the signal to Input 3 of motor ID2 is on, move motor ID1 to P2.
If off, move motor ID2 to P3

Example 2
I2.2, C2.1, C4.1 // Call Motion Bank 2 when signal to Input 2 of motor ID2 is on.
If off, call Motion Bank 4

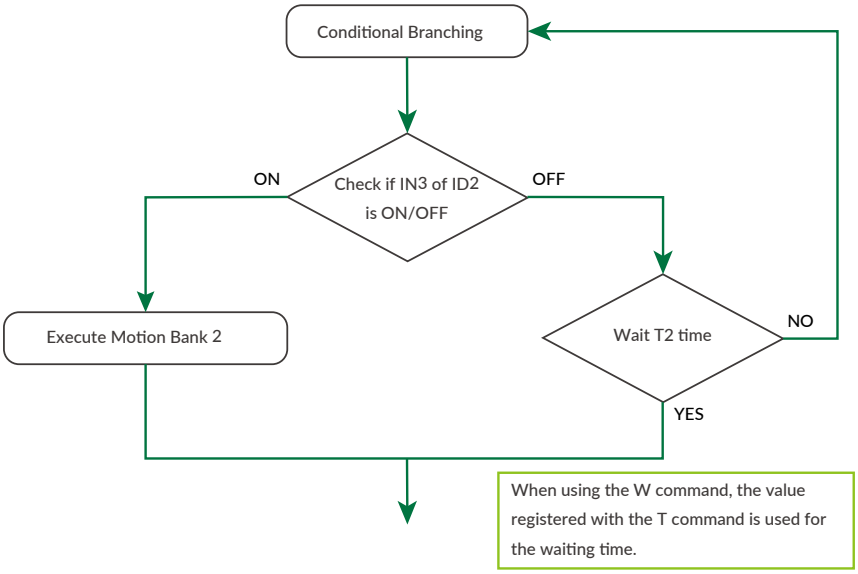
You can monitor the status of input signal for a certain period of time by the following program by using Conditional Branching.

- No action if signal to Input 3 of motor ID2 is off

  Example
  I3.2, C2.1, T0.1 // Call Motion Bank 2 when signal to Input 3 of motor ID2 is on
  If off, no action

- To monitor input signal for a certain period of time

  Example
  I3.2, C2.1, W2.1



In the above example, if T2.1=100 is set, the status of Input 3 of motor ID2 is monitored 100 times in a 1msec cycle. If T command is used instead of W command, Input signal is checked once wait for the time set by T command then execute next process.

8.6 Application Example of Motion Bank

The motion examples shown before are positioning from current position to the next position with specified speed and acceleration. This motion is called PTP (Point To Point) operation. Motions other than PTP operation are also possible by using the program of CM3+.

8.6.1 INC Operation

The data set by P command P usually the absolute position data, it can be used as INC operation from the current position by the following program.

PTP Operation

```
P1.1= 100000        // Pulse

B1.1
A1.1,S1.1,P1.1
END.1
```

INC Operation

```
P1.1= 100000        // Pulse

B1.1
A1.1,S1.1,P1.1+
END.1
```

In the above example, CM3+ moves from current position to the position of 100000 pulse position by executing Motion Bank in PTP operation. In INC operation, when Motion Bank is executed, CM3+ moves 100000 pulses from the current position in the plus coordinate direction. If P1.1=-100000 is set, when Motion Bank is executed, CM3+ moves 100000 pulses in the minus coordinate direction. In the above example, if the Motion Bank is executed 5 times from the origin, the position will be 100000 pulses in PTP operation and 500000 pulses in INC operation.

8.6.2 Push Motion

The Push Motion is a motion that limits the output torque with the set torque for the set time. It can be used for gripping or press-fitting (see "11.2 Push Motion"). When performing Push Motion, use the Q command instead of the P command. At this time, position data set by P command is used as the target position data of Q command.

Push Motion

```
P1.1= 100000        // Pulse

B1.1
A1.1,S1.1,Q1.1      // Q command is used instead of P command
END.1
```

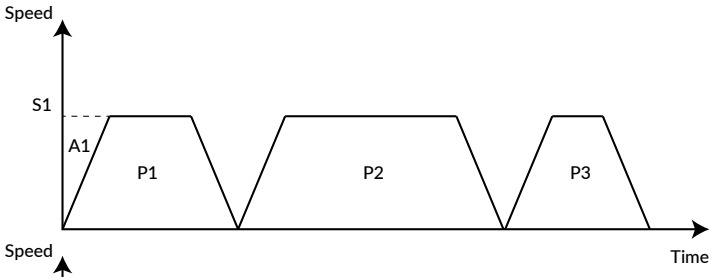
＊ Q1.1+ makes it INC and Push motion.

8.6.3 Merge Motion

The motion moving several target positions without decelerating and stopping is called a Merge motion. In Push Motion explained above, the acceleration / deceleration and speed are limited since the torque in the motion is also limited. Therefore, when moving a long distance, total moving time will be longer than the program. Then extended task time can be shortened by using the Merge Motion.

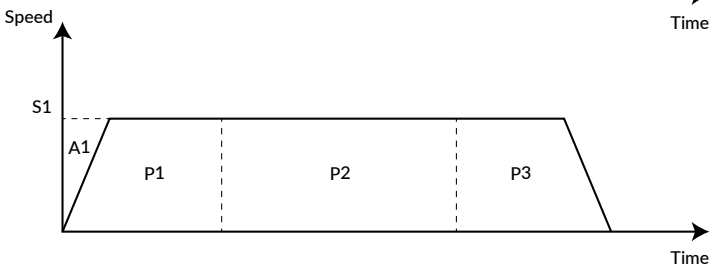
☐ 3-point PTP Motion

B1.1
A1.1,S1.1,P1.1
P2.1
P3.1
END.1



☐ 3-point Merge Motion

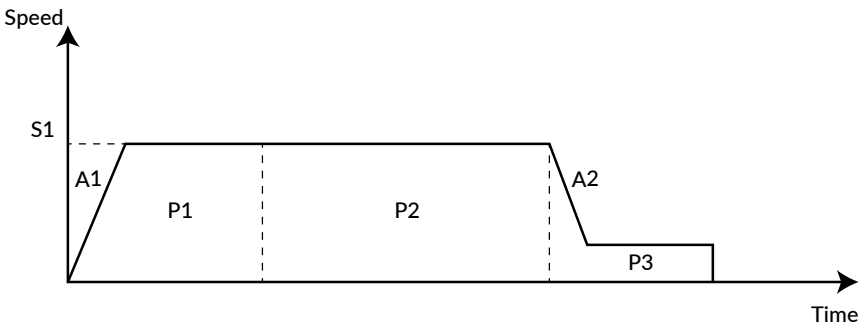
B1.1
A1.1,S1.1,P1.1,P2.1,P3.1
END.1



As shown in the above example, if the P commands (same motor ID) are used in one line, it creates the Merge Motion. The direction of rotation of the motor must be the same in Merge Motion. If not, the motion from where direction is changed will be PTP motion. If A command and S command are used before the position command in Merge Motion, acceleration and speed can be changed as well.

☐ Merge Motion with different speed / acceleration

B1.1
A1.1,S1.1,P1.1,P2.1,A2.1,S2.1,Q3.1
END.1



8.6.4 Looping Process

X command can be used to execute a looping process.

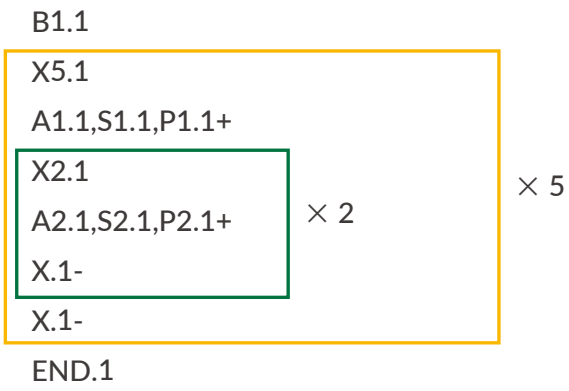
Format: X Number of loops.Motor ID // Looping processing start
X.Motor ID- // End of looping processing

The command line(s) between commands X and X- will be processed for the number of times specified by X command.

Repetitive Processing
B1.1
X5.1
A1.1,S1.1,P1.1+
X.1-
END.1

The INC Motion is repeated 5 times. X command can be used only with the motor ID that the Motion Bank is set. In the example on the right, the ID of the X command must be 1 since the Motion Bank is set in motor ID1.

Looping processing can be performed up to 10 steps.



In the above example, the P1.1+ INC operation will be executed 5 times, and the P2.1+ INC operation will be executed 10 times in total.

8.6.5 Multi-axis sequence motion program

A motion sequence program with multiple axes can be created almost in the same way as the Motion Bank example of single axis motion. The program will be different from starting multiple motors at the same time and in order.

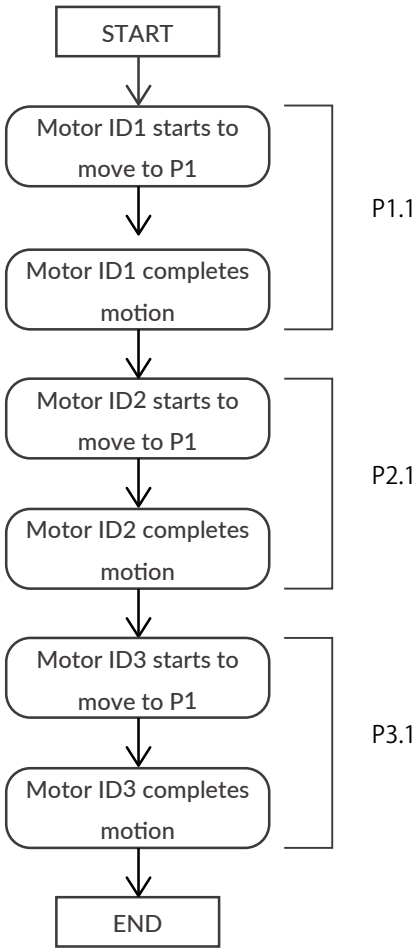
Example 1: Start multiple motors at the same time

```
B1.1
P1.1,P1.2,P1.3
END.1
```

Example 2: Start multiple motors one by one

```
B1.1
P1.1
P1.2
P1.3
END.1
```

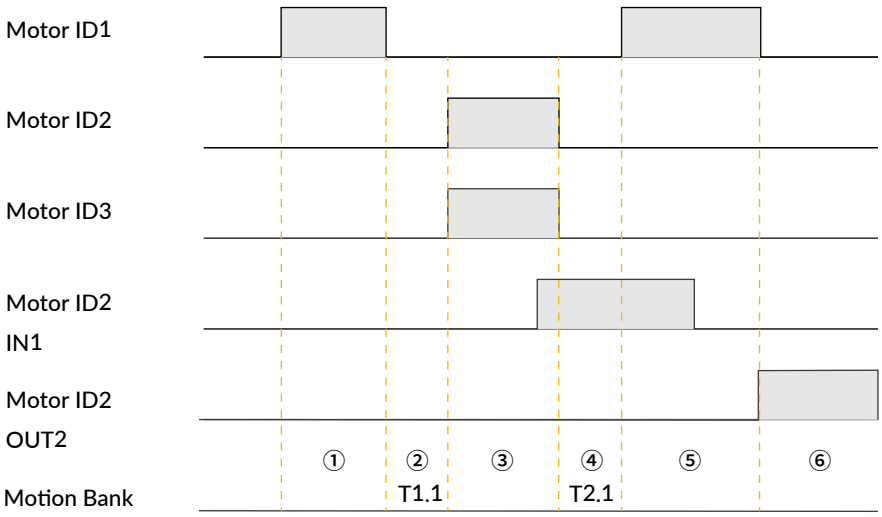
To start multiple motors at the same time, write P commands on the same line. To start them individually, write P commands in different lines. When executing motions in a Motion Bank, all CM3+s on the network must be in In-position status. The flow chart of Example 2 is as follows.



The next line will not be executed until all the motions described in the one line of the Motion Bank are in-position and completed.

8.6.6 Before creating a Motion Bank

The function of Motion Bank is to easily perform sequences specified by motion. In order to perform all the sequences of CM3+ on the network, the operation sequence, execution conditions and etc must be put under the considerations. It is recommended to draw flow chart, timing chart or so. By creating these, test runs and change procedures can be performed very smoothly.



Motion Bank from the timing chart will be as follows.

```
B1.1
A1.1,S1.1,P1.1                  // ①  ID1 move
T1.1                            // ②  Wait for T1 after ID 1 complete the motion
A1.2,S1.2,P1.2,A1.3,S1.3,P1.3   // ③  Move IDs 2 and 3 at the same time
I1.2,P2.1,W2.1                  // ④  After ID2 and 3 complete the motion, monitor the Input 1 of ID2
                                       for T2 msec. If ON, ID1 Move. If off, go to next line.
O2.2                            // ⑤  After ID1 complete the motion, turn on Output 2 of ID2.
END.1
```

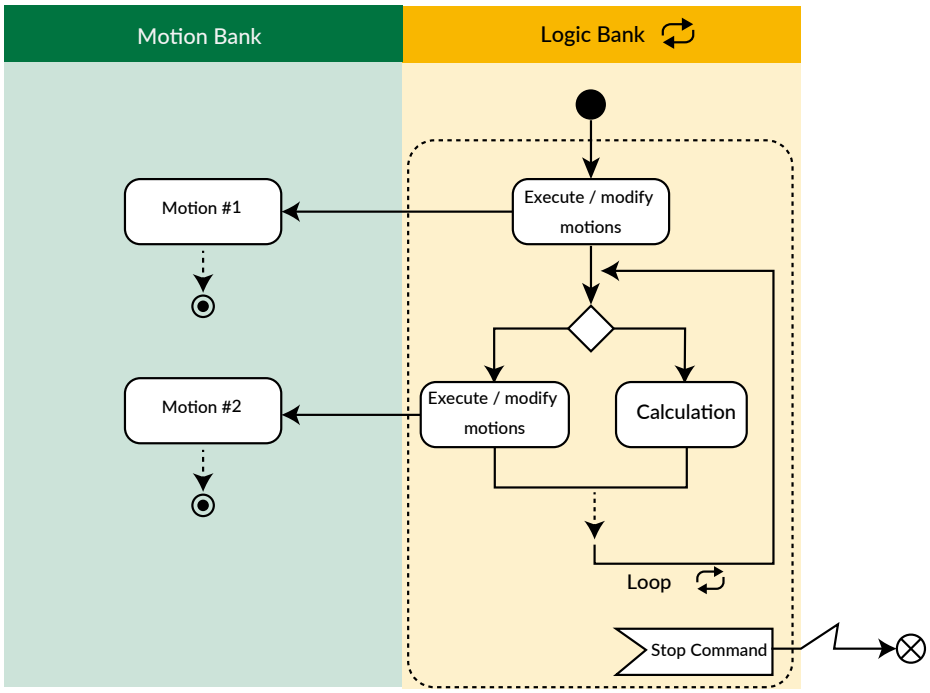
Visual confirmation by drawing charts will help to create programs and do test run.

Chapter 9 Logic Bank Functions

9.1 Logic Bank

Logic Bank does not define the motion itself, but it can handle execution commands within the Logic Bank. Therefore, Direct Mode and Motion Bank can be executed from the Logic Bank. Logic Bank is executed cyclically. In combination with branching commands and comparison operators, CM3+ can constantly monitor input signals from sensors and its own motor information, and perform interrupt processing such as stopping motion in real time or overwriting the speed or target position. In other words, the CM3+ functions like a simple PLC.

☐ Relationship between Motion Bank and Logic Bank



The above diagram shows how the Motion Bank is executed or changed from the Logic Bank, branching and arithmetic processing based on input signals, etc. The Logic Bank loops over and over until it receives a stop command.

☐ What you can do with Logic Bank

Logic Bank can execute Motion, branching, redefine or display values, and override motions.

```
L1.1
V1.1=V2.1          ・・・Assigning values
V1.1=V1.1+V3.1     ・・・Arithmetic operation
V1.1               ・・・Displaying value
V1.1>V3.1,S.1=V4.1,T0.1   ・・・Branching process without any motion
I3.1,]1.1,T0.1     ・・・Branch processing by input signal
END
```

9.2 Execution of Logic Bank

Logic Bank can be executed and stopped with the following commands. Unlike the Motion Bank, once the Logic Bank is executed, it will loop repeatedly in the cycle set by the K82 until the Stop command is sent.

```
[L1.1          // Execute Logic Bank 1
]L             // Stop Logic Bank
```

K81 : Logic Bank No. Execute when Powered ON
Logic banks can be started automatically at power-on without sending an execute command.
Specify the Logic Bank to be automatically executed when power is turned on in K81.

K82 : Logic Bank Execution Cycle Time
Once Logic Bank is executed, it will be executed repeatedly at the cycle set by K80.

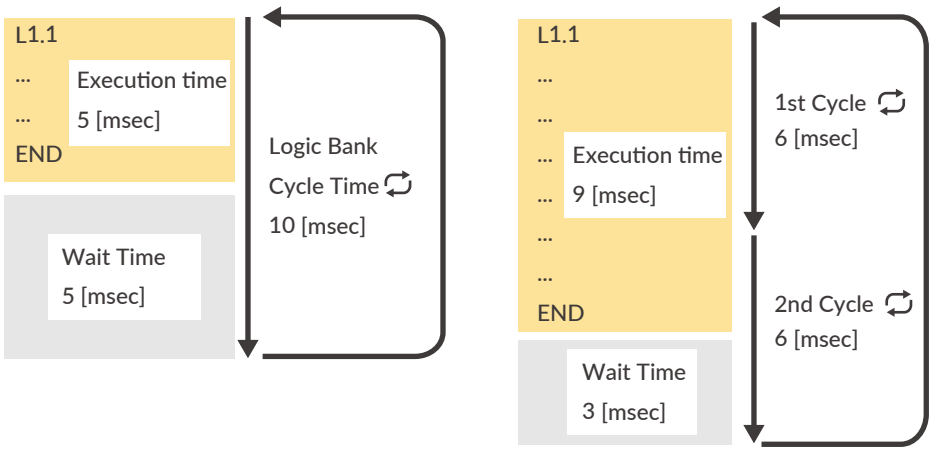
Example:
Sent Data

```
P1.1=1000      // Define 1000 pulses for P1.1

L1.1           // Beginning of Logic Bank 1
P1.1           // Display data of P1.1
END            // END command

[L1.1          // Execute L1.1
```

Received Data

```
P1.1=1000      // Outputs the set value of P1.1 in the cycle set by K82.
P1.1=1000
P1.1=1000
…
```

In a Logic Bank, the processing time per command is 1 msec. If the execution time of the entire Logic Bank is longer than the execution cycle, Logic Bank will be executed in integer multiples of the execution cycle.



9.3 Variable Command (V)

Variable commands (V commands) are commands often used in Logic Banks.
Unlike other commands that are directly related to operation such as position, speed, acceleration, and torque, it can handle motor’ s internal data such as the current position and numerical data for calculation.
Using the numerical values set in the V command and the data inside the motor, it is possible to perform numerical operations, branch processing using comparison operators such as equal and inequality signs and setting values to other commands.

☐ V Command Definition

Numerical values, up to 4 single-byte alphanumeric character strings, and motor internal variables can be specified in the V command. When specifying a character string or a variable inside the motor, enclose it in "(double quotation marks).

Setting Example:
Numerical value [-2147483648 ～ 2147483647]
V3.1=1234 // Set 1234 to variable data 3 of ID1

Alphanumeric [4 digits]
V4.1="ABCD" // Set the character string ABCD to variable data 4 of ID1

☐ Settable motor internal variables

- Px … Current position
- Sx … Current speed
- Ix … Current torque
- Ux … Current motor status
- Pe … Position error
- PT … Target position
- ST … Target speed

V5.1="Px" // Set the current position to variable data 5 of ID1

Example of use in the program:
1）Conditional branching is performed according to the definition value of general data. Conditional branching by combining two general data is also possible by using mathematical and logical operators.

V2.1,?99.1,?98.1 // Execute ?99.1 when V2.1>0, execute ?98.1 otherwise
V2.1==V3.1,?99.1,?98.1 // Execute ?99.1 when V2.1 and V3.1 are equal, otherwise execute ?98.1

2）Perform numerical calculations between each data using mathematical operators.

P2.1=P1.1+V2.1 // Define the addition result of P1.1 and V2.1 in P2.1

3）When this command is used alone, the contents defined in the specified general data are displayed. For example, use it when you want to display an arbitrary message to the host controller.

V4.1 // Display the contents defined in V4.1

9.4 Branching by Input Status

入力点の状態を分岐の条件にすることで、外部からの信号をきっかけにイベントを発生させることができます。

```
L1.1
I2.1,?96.1,T0.1          //Display Px.1 (current position) only while IN2 is ON
END
```

＊ T0.1 means "no action". In the above example, when IN2 is OFF, the program will not execute anything and will move to the next line.

9.5 Execute and Stop Motion Bank

Motion Bank can be started and stopped from Logic Bank.
For example, by combining branching by input points with Motion Bank execution and stopping as shown below, it is possible to execute and stop motions from input points.

```
L1.1
I1.1,[1.1,T0.1           // Execute Motion Bank 1 when IN1 is ON
I2.1,].1,T0.1            // Stop Motion Bank 1 when IN2 is ON
END
```

9.6 Assigning the internal data

By setting the internal data to a V command and assigning it to another V command, the internal data can be treated as a numerical value.

```
V1.1=” Px”        // Set current position in V1.1
V2.1=0            // Use V2.1 for calculation.

L1.1
V2.1=V1.1         // Assign the value of V1.1 (current position) to V2.1
V2.1              // Display the value of V2.1 (current position)
END
```

Point:　To handle the internal data as a numerical value, be sure to assign it to another V command.
If you do not assign it, it will not be recognized as a numerical value.

9.7 Branching by Internal Data

By executing Logic Bank simultaneously with Motion Bank and using the internal data as a condition for branching, you can override the motion from within the Logic Bank without changing the Motion Bank.

Example: Set continuous rotation for the Motion Bank, and automatically change the speed to 10 when the position exceeds 1000 pulses.

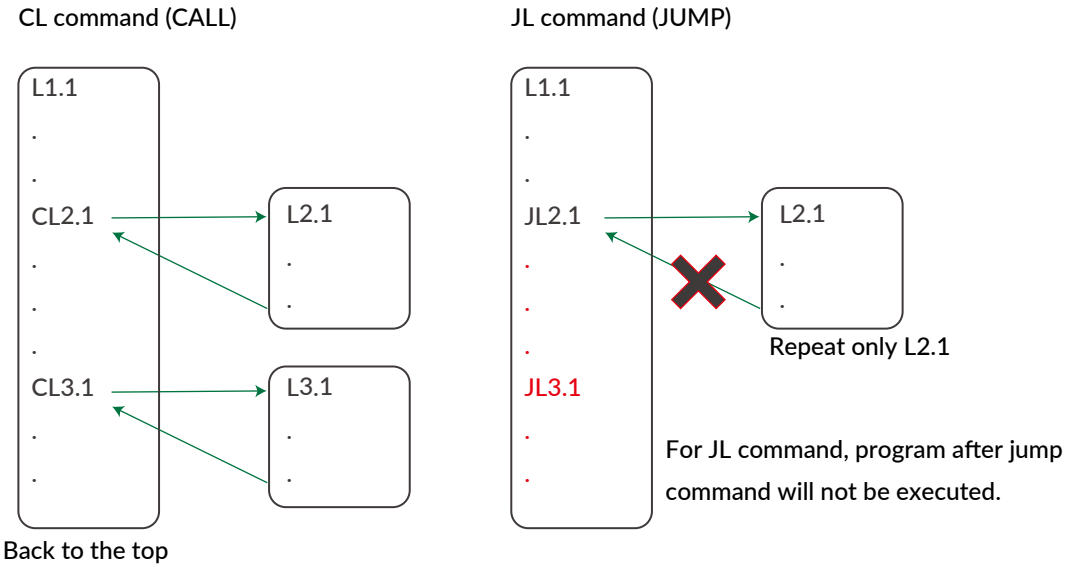
```
Sent Data
P1.1=1000000000          // Define continuous rotation in P1.1
A1.1=100
S1.1=100

B1.1
A1.1,S1.1,P1.1
END

V1.1="Px"                // Set current position to V1.1
V2.1=0                   // Use V2.1 for calculation
V3.1 = 1000              // Define 1000 for comparison in V3.1
V4.1=10                  // Set speed 10 to V4.1

L1.1
V2.1=V1.1                // Assign the value of the current position to V2.1
V2.1>V3.1,S0.1=V4.1,T0.1 // If the current position is greater than 1000 pulses, change the speed to 10.
END

[1.1                     // Execute Motion Bank
[L1.1                    // Execute Logic Bank
```

Point: You can override the target position, velocity, acceleration, and torque by changing P0, S0, A0, and M0 during motion.

9.8 Jump & Call

The Logic Bank can call and jump from the running Logic Bank to other Logic Banks like the Motion Bank. By using the jump and call commands, whole sequence can be separated to routines and modularized in the Logic Banks.

The JC command and JL command can be used to execute the Motion Bank number specified in the program without executing it from the upper level.



Both the CL command and the JL command call other programs, but in the case of the CL command, it returns to the caller after executing the motion sequence of the called Motion Bank number. On the other hand, in the case of the JL command, the motion sequence of the called In the case of the JL command, the program does not return to the read source after executing the motion sequence of the called Motion Bank number.

It is not possible to read out the Motion Bank number of another motor ID using the CL command or the JL command. It is not possible to read out the Motion Bank number of another motor ID using the CL command or JL command.

9.9 Various Conditional Branching

Logic Bank supports various branching operations. Conditions of CM3+ and other devices in the application can be used for branching in CM3+.

9.9.1 Logic Bank Branching

Condition, True to execute, False to execute

☐ Use single input (I command) and single variable (V command)

Example: Jump to L2.1 when input 1 is on, jump to L3.1 when off.
I1.1,JL2.1,JL3.1

Example: V3.1>0 calls L2.1, V3.1<=0 calls L3.1
V3.1,CL2.1,CL3.1

☐ Use logical operators (only available for I command)

Example: Jump to L2,1 when input 1 and input 2 are on at the same time, otherwise jump to L3.1.
I1.1&&I2.1,JL2.1,JL3.1

☐ Use the comparison operator (only available for V command)

Example: If V1.1 is greater than V2.1, run B1.1, otherwise run B2.1
V1.1>V2.1,[1.1,[2.1

9.10 Operator

In the Logic Bank, operators are used to set numerical values and perform conditional branching. Operators include logical operators, comparison operators, and mathematical operators.

9.10.1 Logical Operators

[Operand 1] Logical Operator [Operand 2]

Operator	Function	Example	Description
&&	AND	I1.1 && I3.1	When both input 1 and input 3 are true, execute the true condition. Otherwise, execute False.
||	OR	I1.1 || I3.1	When either input 1 or input 3 is true, execute the true condition. Otherwise, execute False.
!!	NOT	I4.1 && !!(I3.1)	When input 3 is True, False. When input 3 is False, True.

☐ AND

Operand 1	Operand 1	Result
TRUE	TRUE	TRUE
TRUE	FALSE	FALSE
FALSE	TRUE	FALSE
FALSE	FALSE	FALSE

Example: When input 1 and input 2 are turned on, output 1 is turned on.

L1.1
I1.1&&I2.1,O1.1,F1.1
END

☐ OR

Operand 1	Operand 1	Result
TRUE	TRUE	TRUE
TRUE	FALSE	TRUE
FALSE	TRUE	TRUE
FALSE	FALSE	FALSE

Example: When either input 1 or input 2 is turned on, output 1 is turned on.

L1.1
I1.1||I2.1,O1.1,F1.1
END

☐ NOT

Operand	Result
TRUE	FALSE
FALSE	TRUE

Example: When input 1 is ON and input 2 is OFF, output 1 will be ON.

L1.1
I1.1 && !!(I2.1),O1.1,F1.1
END

9.10.2 Comparison Operators

Operator	Function	Example	Description
==	Equal	V1.1 == V2.1	Execute TRUE when the value of V1 is equal to the value of V2.
!=	Not equal to	V1.1 != V2.1	Execute TRUE when the value of V1 is not equal to the value of V2.
>	Greater than	V1.1 > V2.1	When the value of V1 is greater than the value of V2, TRUE is executed.
>=	Greater than or equal to	V1.1 >= V2.1	Execute TRUE when the value of V1 is greater than or equal to the value of V2.
<	Less than	V1.1 < V2.1	Execute TRUE when the value of V1 is less than the value of V2.
<=	Less than or equal to	V1.1 <= V2.1	Execute TRUE when the value of V1 is less than or equal to the value of V2.

Example: Output 1 is ON only when V1.1 (motor status) is 8.

V1.1= "Ux",
V2.1=0
V3.1=8

L1.1
V2.1=V1.1
V1.1 == V3.1,O1.1,F1.1
END

9.10.3 Arithmetic Operators

Operator	Function	Example
=	Set value	P1.1= V1.1
+	Addition	P1.1= P2.1+V1.1
-	Subtraction	P1.1= P2.1-V1.1
*	Multiplication	P1.1= P2.1*V1.1
/	Division	P1.1= P2.1/V1.1
U1	Sine	P1.1= U1(V1.1) U1(θ)=10000 × sin(2 π×θ /36000) θ is the data set in V, etc. (Unit: 0.01 degree)
U2	Cosine	P1.1= U2(V1.1) U2(θ)=10000 × cos(2 π×θ /36000) θ is the data set in V, etc. (Unit: 0.01 degree)
U3	Square root	P1.1= U3(V1.1) $U3(x) = \sqrt{x}$

Chapter 10 Detail of Various Settings

10.1 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=1000000000) is available for all Resolution

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

10.2 Coordinate Direction（K4）

Set which of the CW / CCW directions is positive.

Coordinate Direction	
0: Set CW direction as the positive	1: Set CCW direction as the positive
P=100: 100 pulses in CW	P=100: 100 pulses in CCW
P=-100: 100 pulses in CCW	P=-100: 100 pulses in CW

-100（CCW） 0 （CW）100 -100（CW） 0 （CCW）100

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

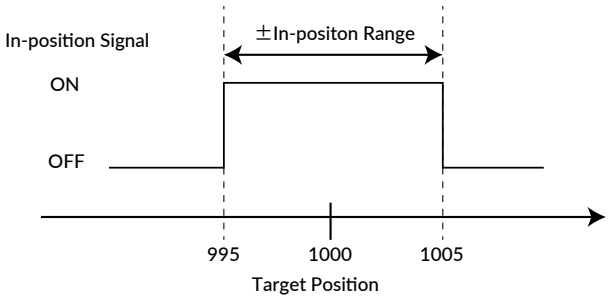
＊ When 10^9 is set to the target position (P=1000000000), the motion will be the continuous motion.
For continuous motion, rotation direction is set only by S command.
Regardless of the coordinate direction (K4) setting, when the S command has a positive value,
the output shaft rotates in the CW direction, and when it has a negative value, it rotates in the CCW direction.

10.3 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: "11.4.2 Other Output Functions").

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.



10.4 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) × Speed Override (K6) / 100

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

10.5 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:

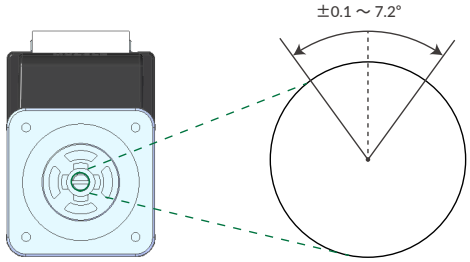
K8=100 // Set 10000 pulse to Software Limit（+）

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

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

10.6 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.



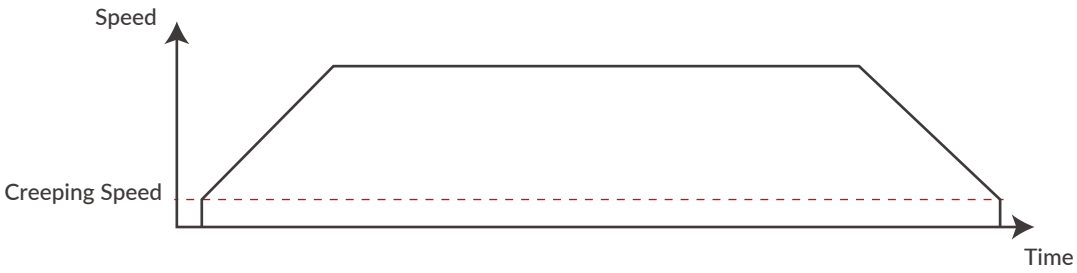
Example:

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

10.7 Creeping Speed（K17）

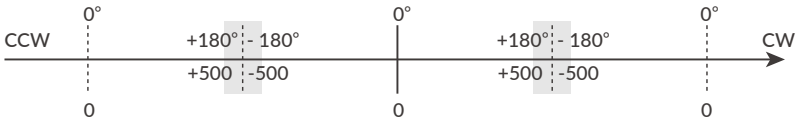
Set the creeping speed at the start and completion of the operation from 0 to 1000 (unit: K2 setting value). The creeping speed is the initial speed at which the operation actually starts and the final speed at the end of the operation. By changing the creeping speed, you can adjust the response time of the motor and increase the tact time, but if you increase the set value too much, vibration may occur or operation may not be possible.



10.8 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 ± 180° 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.

K1=5 //1000 ppr
K4=0 // CW +



☐ 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: "11.1 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 ° 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.

10.9 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.

10.10 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

10.11 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

10.12 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

10.13 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 11 Various Functions

11.1 Origin Detection

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

K22	Content
0	Stopper Detection
1	Stopper Detection (Auto)
2	Origin Sensor *
3	Origin Sensor (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
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）
- Origin Set Completion Output（K55、K56、K57）

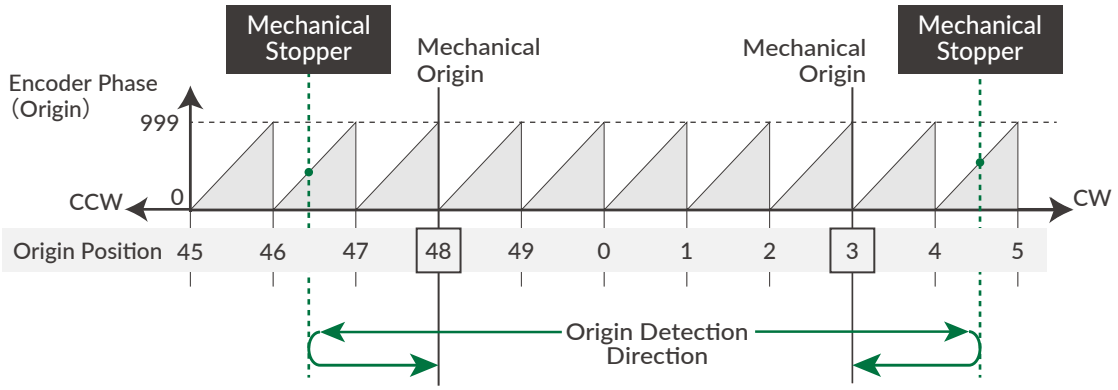
11.1.1 Stopper Detection

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.



- 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.

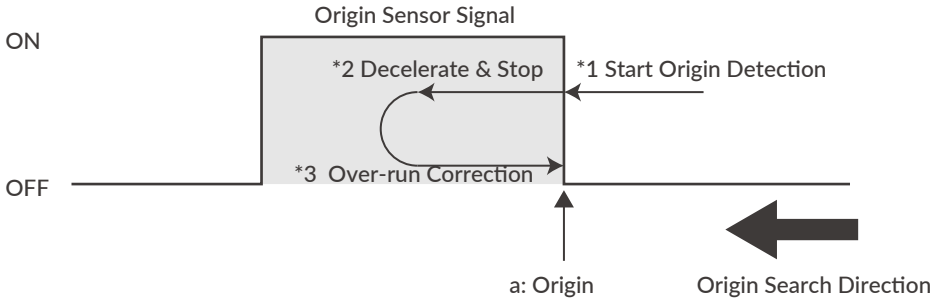
11.1.2 Origin Sensor

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).

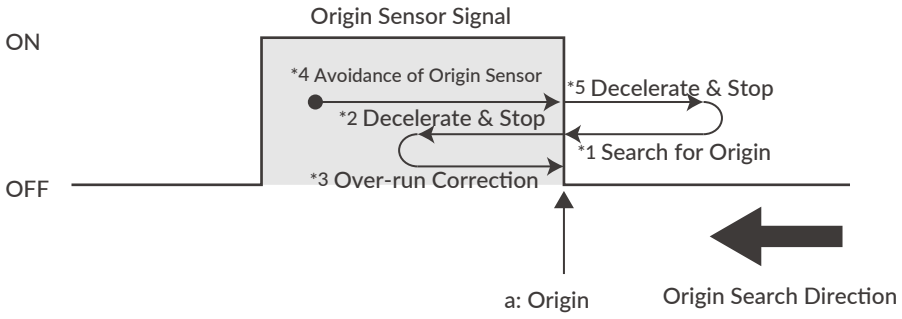
Depending on the status of origin sensor signal when Origin Detection starts, there are following differences in the Origin Detection operation.

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



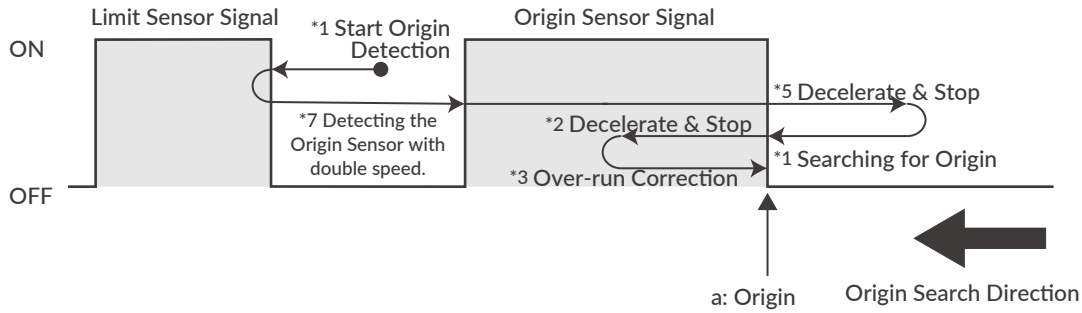
① Start origin detection
② Decelerate from rising edge (a) of origin sensor (Point a) (*2)
③ Move to Point a again (*3)
Complete origin detection

☐ 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 (*5).
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

11.2 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, use Q command instead of P command for target position and set the Push Motion Operation Mode (K11), Push Motion Torque (K12) and Push Motion Holding Time (K13).

☐ PTP / INC Push Motion

PTP (absolute position) Push Motion and INC (relative position) Push Motion are available for Push Motion.

PTP Push Motion: Starts the Push Motion from the current position toward the set absolute position.
PTP Push Motion can be operated by using Q command instead of P command.

INC Push Motion: Starts the Push Motion with the target position at the distance from the current position.
INC Push Motion can be operated by using Q+ command instead of P+ command.

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. 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 Waring, WARN.1=1 is replied.

☐ 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 Motion 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 does not 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 Torque（K12）

Set the torque for the Push Motion. (Unit: percentage of rated torque)

☐ Push Motion Holding Time（K13）

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

Parameter Example:

K11=1 // Set Push Motion Operation Mode as One-direction and Set Time.
K12=40 // Set 40% of rated torque to Push Motion Torque
K13=3000 // Set Push Motion Holding Time as 3000 msec

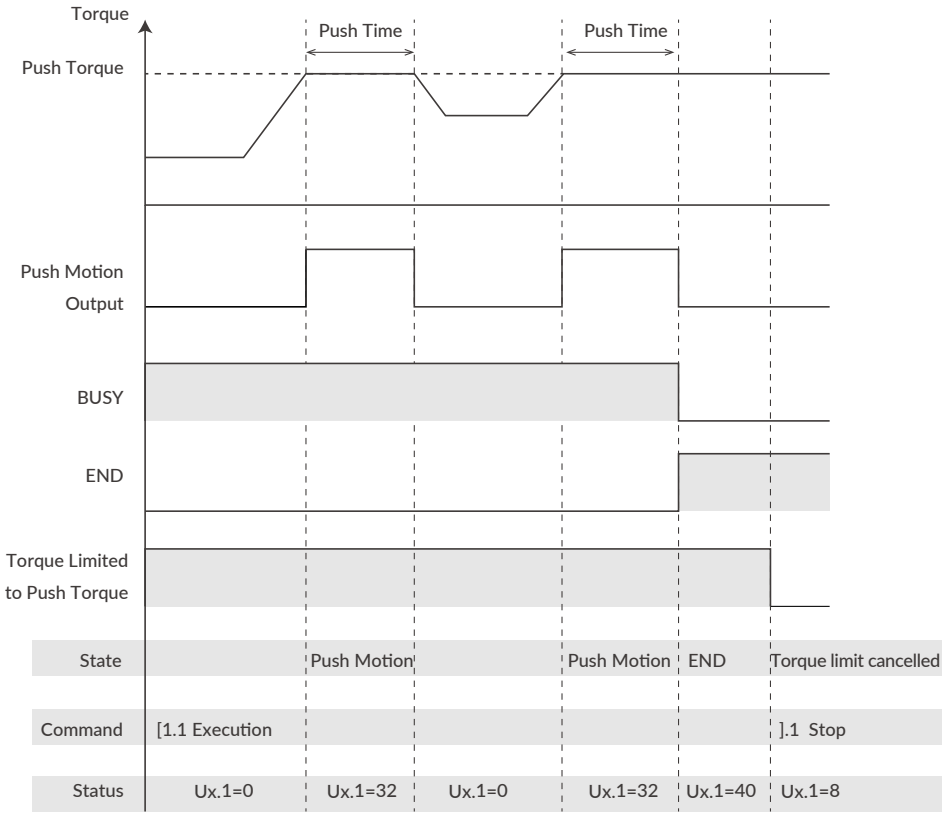
P2=10000 // Set Target Position 2 as 10000 pulses
S2=20 // Set Speed 2 as 20 (Unit: K2)
A2=50 // Set Acceleration 2 as 50 kpps²

Program Example:

B1.1 // Motion Bank 1 starts
A2.1,S2.1,Q2.1 // Push Motion by using Q2 instead of P2
END

[1.1 // Execute Motion Bank 2

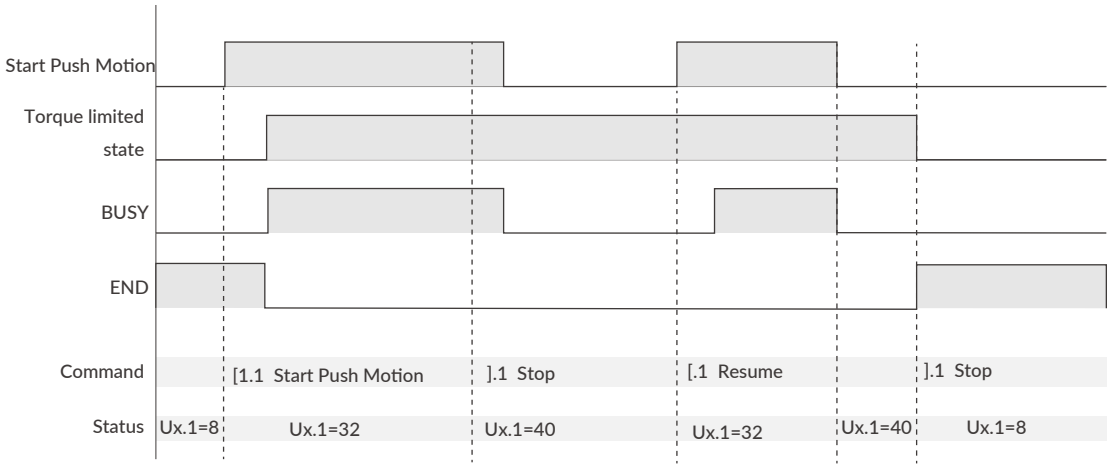
CM3+ goes into Push Motion when CM3+'s torque reaches 40% of the rated torque and the status goes into Push Motion status (Ux.1=32). Push Motion is completed (Ux.1=40) when the total time of Push Motion goes up to 3000 msec.



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 Waring, WARN.1=1 is replied.

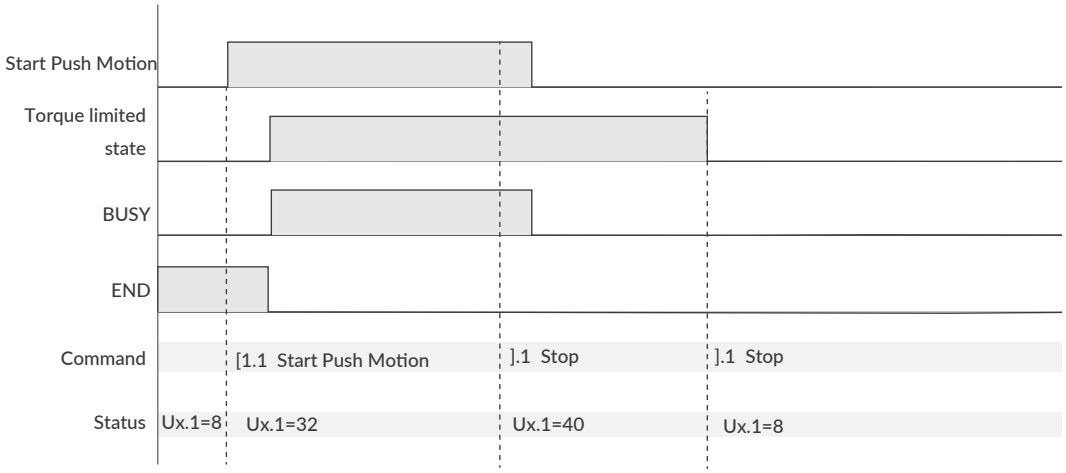
☐ To Resume Push Motion

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.

11.3 Input Functions

CM3+ + has 4 inputs, and the functions of inputs 1 to 4 are set with K44 to K47.

- Function and description of each inputs

K44/K45/ K46/K47	Function	Description
0	General Input	Set when using the I command
1	Origin Sensor	Available for IN1 only
2	Limit Sensor (CCW)	Limit Sensor in CCW direction
3	Limit Sensor (CW)	Limit Sensor in CW direction
4	Manual Mode	Switch to Manual Mode.
5	Servo ON/OFF	Toggle Servo on / Servo off. Alarm can be reset when the servo is turned on.
6	CCW Inching・Jog	Only available for IN3 and IN4. Inching/Jog in the CCW direction in Manual Mode.
7	CW Inching・Jog	Only available for IN3 and IN4. Inching/Jog in the CW direction in Manual Mode.

11.3.1 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:

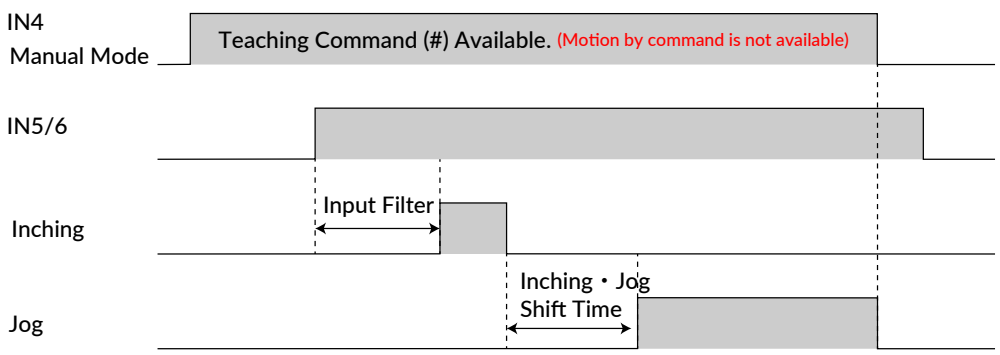
K42=5 //Set the filtering time for the input signal to 5 msec

11.3.2 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
          K46=6         // Assign Inching / Jog (CCW) to Input 3
          K47=7         //Assign Inching / Jog (CW) to Input 4
          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 IN3 (IN4) is turned on, CM3+ move 100 pulses in the CW (CCW) direction as Inching. If IN3 (IN4) 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.

11.3.3 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).

11.3.4 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.

11.4 Output Functions

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

This section explains about each output functions. Refer to timing chart for the timings.

11.4.1 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 "11.8 Status LED" or reply ("7.2.2 Query Command") to Query command (?99).

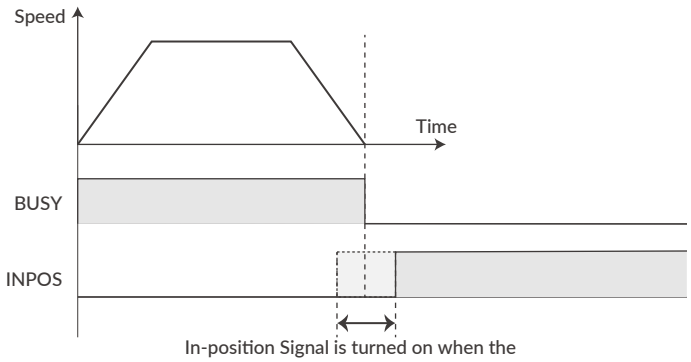
11.4.2 Other Output Functions

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	N/A	N/A
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 (±) 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.



☐ ZONE / MOVE Output

- 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.

11.5 Tuning

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

11.5.1 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.

11.5.2 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.

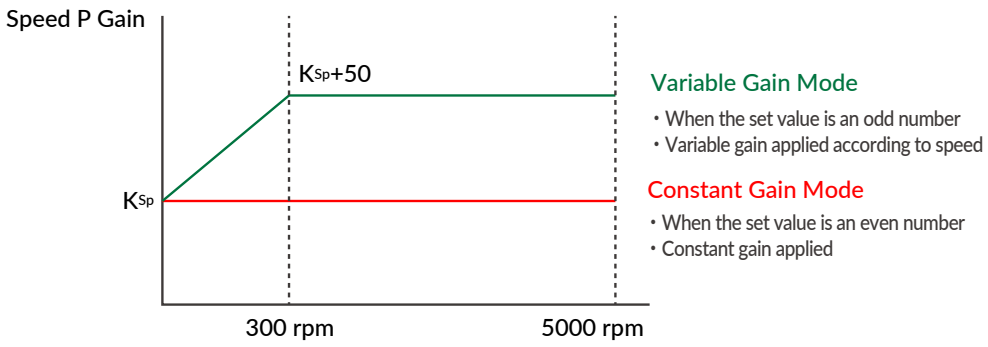
Follow the steps below to adjust CM3+'s Position P gain, Speed P gain, and Speed I gain values. An adjustment with CM3+ mounted in a machine and running a motor is necessary to find the optimum values.
Adjustment steps are as it shown in below.

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.

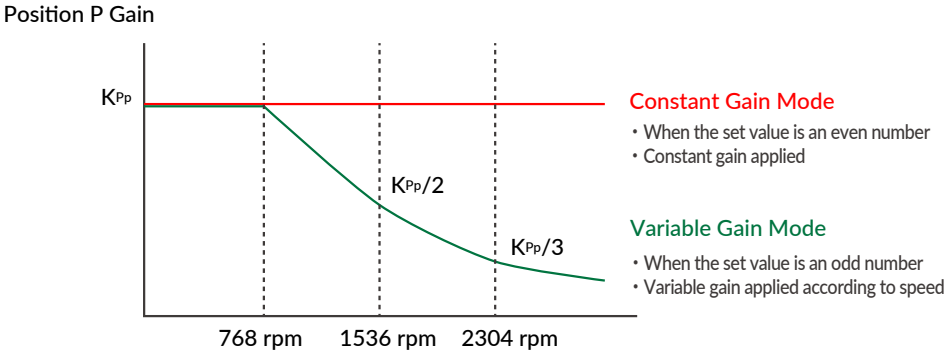


For variable gain mode, this gain setting value applies to when the speed is 0 rpm. When Speed is between 0rpm and 300rpm, Speed P gain value increases in proportion. The conclusive gain value is setting gain value plus 50.

∗ 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.

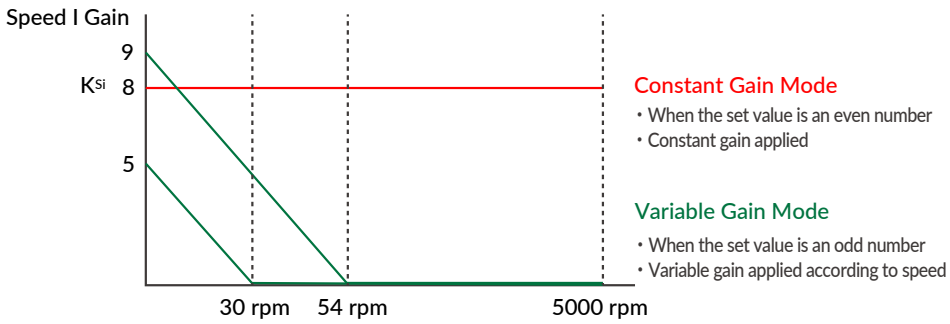


In the variable gain mode, the set value is the gain applied during low speed operation. The gain starts decreasing after the speed exceeds 768 rpm, and at 2304 rpm it becomes one-third of the set value.
For example, if you set K33=101, 100 will be applied at speeds below 768 rpm, then at 3000 rpm, 25 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.

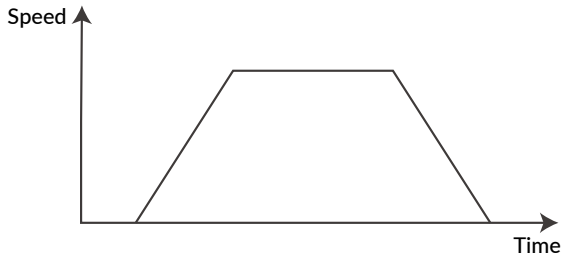
The optimal values can be set by following the above steps.

11.5.3 S-Curve Gain

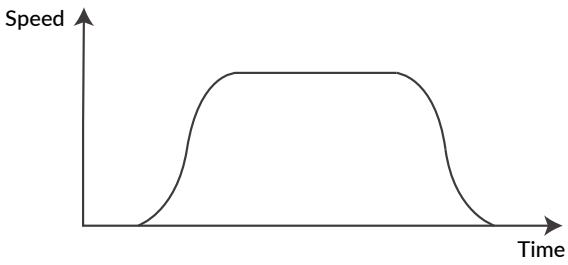
The s-curve gain (K36) is the parameter to change the trapezoidal motion to S-shape. K36 can be set from 0 to 1024, and the higher the K36, the more the motion is S-shape. By enabling the S-curve gain, it helps to soften the impact when starting and stopping, and to reduce overshoot.

Example:

K36=0 //Trapezoidal Motion



K36=1024 //S-Curve Motion



11.6 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.

11.7 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 the default value of "K90=-1" whuch means "Disable" 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
```

11.8 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	■						
Overload Alarm	Alternate	■	■					
Over Current Alarm	Alternate	■		■				
Over Temperature Alarm	Alternate	■			■			
Over Voltage Alarm	Alternate	■				■		
Low Voltage Alarm	Alternate	■					■	
Position Error Overflow Alarm	Flashing	■						
ABS Alarm	Alternate	■						■
Servo Off	Lighting		■					
Push Motion Warning	Flashing							■
Limit Sensor	Alternate			■				■
Software Limit	Alternate					■		■
Manual Mode Warning	Lighting							■
Operation Warning	Alternate						■	■
Overload Warning	Alternate		■					■
Temperature Warning	Alternate				■			■
Servo On	Lighting					■		
BUSY*	Lighting			■				
Push Motion	Flashing			■				
In The Manual Mode	Alternate					■	■	

* LED lighting for BUSY means motion is being executed. It may not match the BUSY output during operation (Ux.1=0). Please confirm the exact status by communication.

Chapter 12 Maintenance and Inspection

12.1 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	• 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	• Is there any loose point at tighten points? • Are terminals intact not damaged?

12.2 Troubleshooting

Please check the following items before inquiring.

12.2.1 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 4 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 "7.1 Forming Daisy Chain Network" 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.

12.2.2 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.

12.2.3 Motion

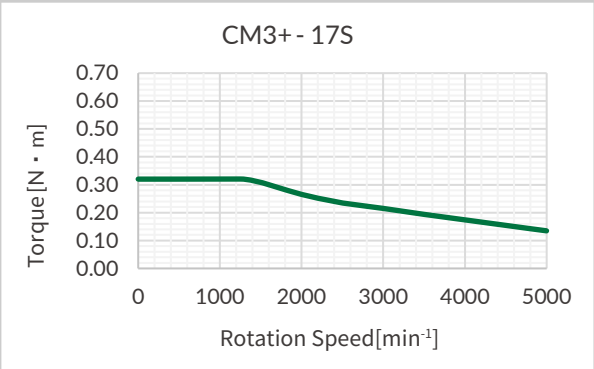
Symptom	Check	How to solve
Inaccurate origin	Is the origin search speed too high?	Decrease the Origin search speed at the point close to origin.

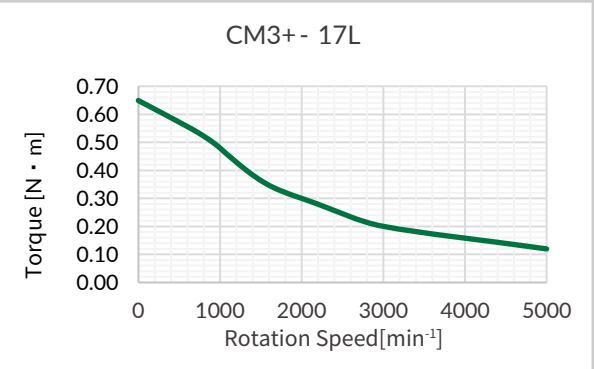
Chapter 13 Specifications

13.1 Basic Specifications

☐ CM3+-17S/L

Items		CM3+-17S50*	CM3+-17L50*
Input voltage		+24Vdc ± 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 MΩ 500Vdc	
Insulation Strength	Coil-Frame	500V (1mA leak current)	
	Coils	500V (1mA leak current)	
I/O	Input	Digital Input：4	
	Output	Digital Output: 4 (Including 1 error output)	
	STO	1	
Communication port		2 Ports for Host and Slave. 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	

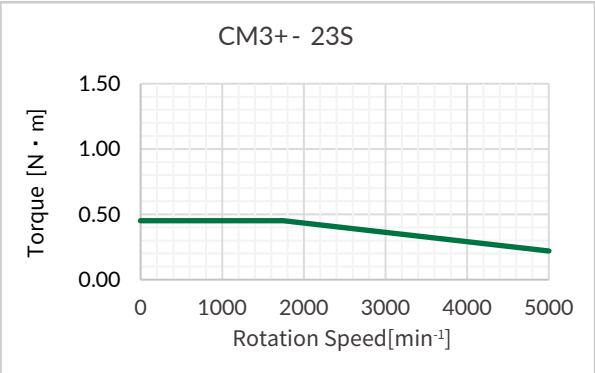


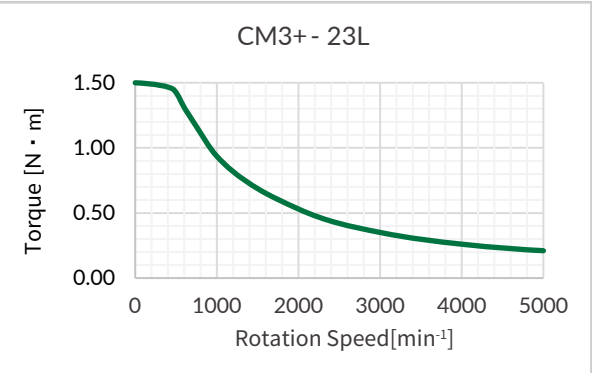


＊ Specifications are subject to change without notice.

☐ CM3+-23S/L

Items		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・m2]	0.36 × 10-4 [kg・m2]
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：4	
	Output	Digital Output: 4 (Including 1 error output)	
	STO	1	
Communication port		2 Ports for Host and Slave. 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	





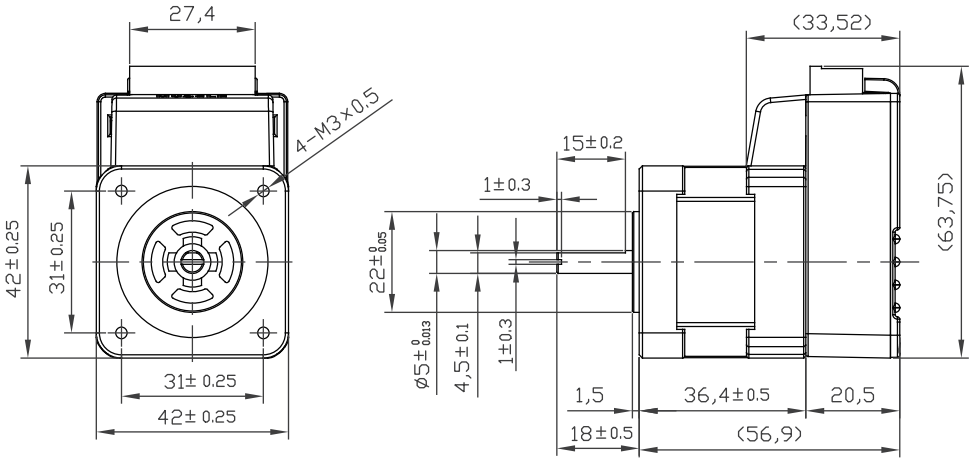
＊ Specifications are subject to change without notice.

13.2 Electrical Specifications

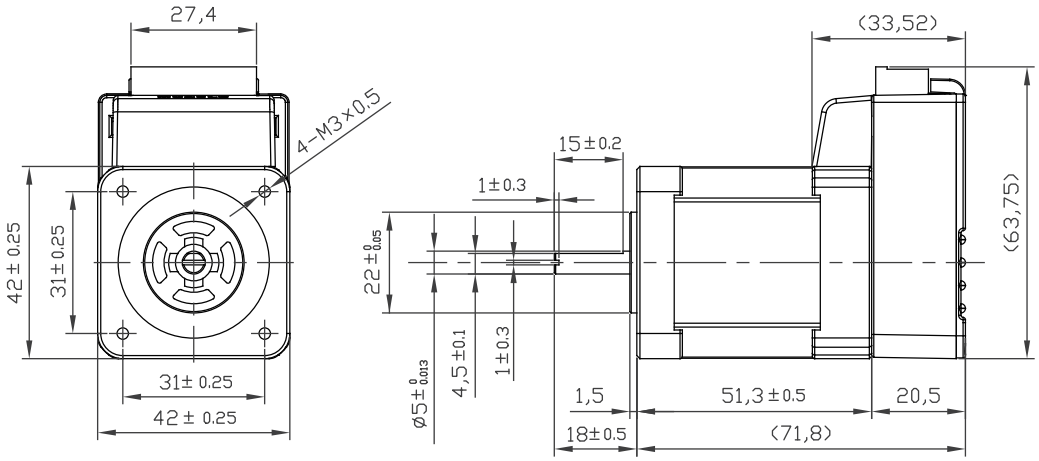
Item		Value
Digital Input	Applied Voltage	0 - 26 [V]
	Low Level Voltage	0.8 [V]
	High Level Voltage	4.2 [V]
Digital Output	Withstanding Voltage	26 [V]
	Max. Continuous Load Current	10mA
Communication	Baud Rate	9.6 - 115.2 [kbps]

13.3 Dimensions

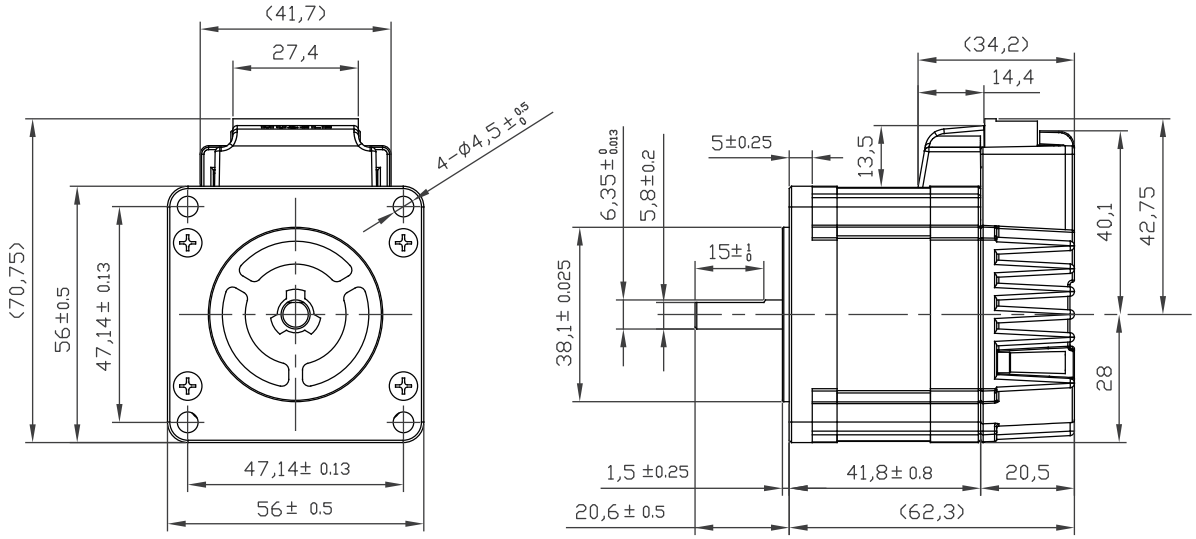
☐ CM3+-17S



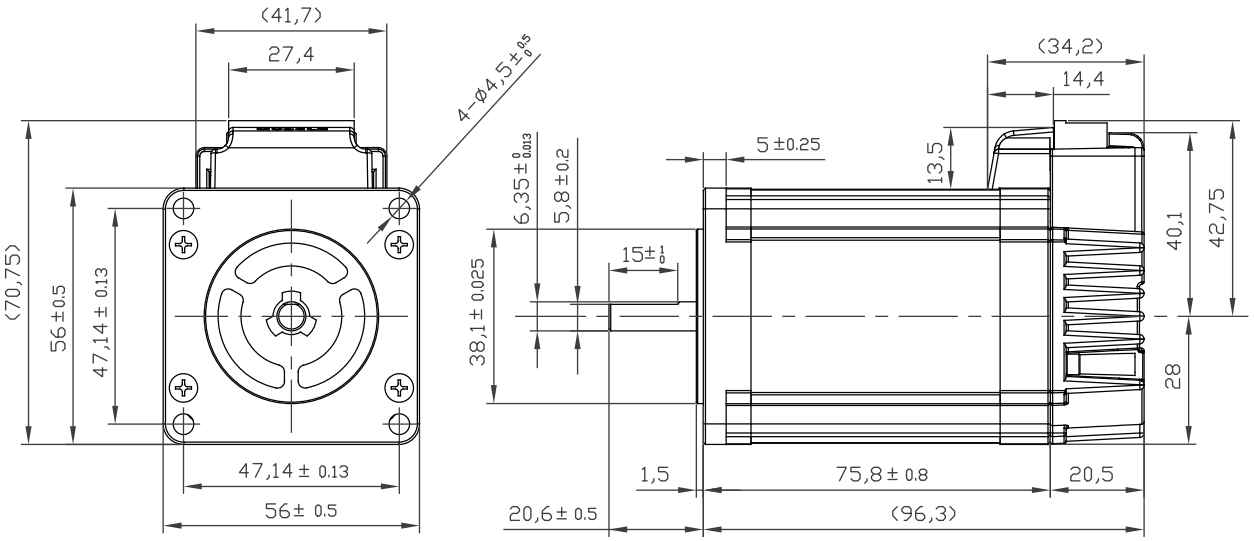
☐ CM3+-17L



☐ CM3+-23S



☐ CM3+-23L



Appendix ASCII Chord Table

☐ ASCII Code Table

		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.

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
March 2021	MDUG-CM3+/21301E-01			New Document
July 2021	MDUG-CM3+/21701E-01			Added description about Logic Banks