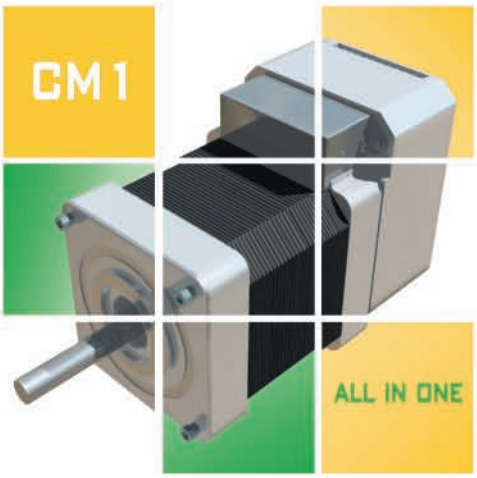
COOL MUSCLE
INTEGRATED SERVO SYSTEM
Driving Innovation In Motion Control Technology
Muscle Corporation
Cool Muscle
Integrated Servo System

CM1 User's Guide

MDUG-CM1/11401E-01



Ver.2.29 / 2.39

Muscle Corporation Inc.

MUSCLE CORPORATION

WARNING

Do not impact the motor.
Impacting motor may cause the driver case and the sensor mounted on the back of the motor to move, resulting in alignment errors.

Do not rotate the shaft of the motor when it is not powered on. Rotating the shaft over 400rpm when the Cool Muscle is not powered on may cause regenerated voltage within the motor. This regenerated voltage may damage the driver board.

Use regulated power supply
Please make sure to use Regulated DC+24V power supply. Sudden spikes that non-regulated power supplies may cause damage to the motor.

Do not use the motor in wet condition
Standard Cool Muscle motors are not environmentally sealed. Using the motor in wet condition may damage the motor.

Use the motor within its specification
Please refer to the spec section of this manual and ensure that the motor is used within these specifications.

Are cables too long?
The recommended length of motor cable is 3m and the power cable is 2m. If a longer cable is required, please follow the instructions in this manual.

Do not connect or disconnect the motor when the motor is powered on. This may cause damage to the motor.

When an alarm occurs, re-start operation after removing its cause. When operation is continued with a cause of alarm, damage to mechanical equipment could occur.

Disclaimer

Before operation of Cool Muscle, it is very important that you read the User Manual thoroughly. The Cool Muscle can cause bodily injury and/or equipment damage if it is misused. Proper safety means and measures should be provided to prevent any misuse and/or improper operations. The user assumes all liabilities for its use. The Cool Muscle shall not be used for mission critical applications without explict written permission from Muscle Corporation.

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ABOUT USER'S GUIDE

Refer to the sections applicable to your Motor Type

- **P** Pulse
- **V** Analog
- **C** Computer

Welcome to the Cool Muscle integrated motor. The Cool Muscle User's Guide provides you with hands-on instructions to help you set up your hardware, set parameters, create / edit command programs and make the most of the Cool Muscle motors.
Since this User's Guide is organized to follow the set up process described in this flow chart.

Flow chart of SECTION

P V C

SECTION 1 About Cool Muscle

The features of Cool Muscle are explained.
The differences between 3 types, P, V and C, of Cool Muscle's interfaces.

P V C

SECTION 2 When You Receive Cool Muscle

When receiving the Cool Muscle, please confirm that there are all components in a package. Then connect Cool Muscle with a PC and confirm the communication.

P V C

SECTION 3 Setting Up Cool Muscle

Please see how to connect Cool Muscle with the attached cables. The other components are shown separatelly.

P V C

SECTION 4 Input and Output

Learn how to cotrol I/O ports and set functions for each I/O port.

SECTION 5 Communication Method

P V C

Communication Method with Cool Muscle is introduced. The outline of special software, Cool Works Lite and the communication method with Hyper Terminal.

SECTION 6 CML Structure

P V C

The composition of special programming language, CML (Cool Muscle Language). The form of parameters and commands and the editing method by a text editor are introduced.

SECTION 7 Setting Parameters

P V C

Set parameters to make the Cool Muscle suit your specification. Learn how to set the parameters. This section also lists all the parameters available.
(Reference: Appendix2 “Parameter List”)

SECTION 8 Setting Commands

P V C

The details of commands. Operation of Cool Muscle by commands and the programming method are explained.
(Reference: Appendix3 “Command List”)

SECTION 9 Basic CML Program Example

C

Guide for programming by CML commands referring to program examples.
The program for network is also explained.

SECTION 10 Applied CML Program Example

C

Specified program examples with parameter and command settings are shown and the detail of actual motion is explained. Please refer for a further comprehension.

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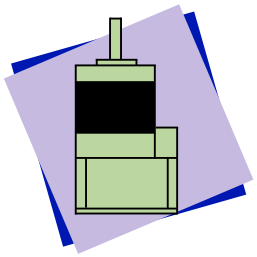


SECTION 1
ABOUT COOL MUSCLE

The Cool Muscle is a fully integrated closed loop vector drive servo system. With an intelligent driver, a 32-bit RISC CPU, a magnetic encoder and power management built onto the motor, the Cool Muscle excels in performance, size and cost.

Supporting a wide variety of communication interfaces including RS-232C, Pulse (CW/CCW and Step/Direction) and Analog Voltage, Cool Muscle can be used not only for new products but also for replacement or upgrading the current system.

The Cool Muscle's high resolution encoder provides you the exceptional resolution of 50,000 pulse/rotation. Combined with vector drive control, the Cool Muscle does not have a mis-step and is an incredibly smooth and quiet motor.

CML (Cool Muscle Language) makes creation of motion programs very simple and can be downloaded directly to the motor.

Cool Muscle Interface

Cool Muscle supports three different interfaces as Pulse, Analog and Computer. Select an interface that will fit your application.

P

PULSE TYPE COOL MUSCLE

P type Cool Muscle can be a replacement for your current pulse driven system and will remove problems as heat generation, mis-step and etc, that are associated with an open loop stepper motor. Further more, Cool Muscle can be a replacement for a Servo Motor and will provide a cost reduction and compactification.

P type Cool Muscle supports both CW/CCW and Pulse/Direction. The type can be selected by the parameter K36.

1: CW/CCW (K36=0)
Apply CW pulse to the input 1
Apply CCW pulse to the input 2

2: Step/Direction (K36=1)
Apply Step pulse to the input 1 (travel distance)
Apply Direction pulse to the input 2 (direction)
When the Direction pulse is high level, CW direction is set.
When the Direction pulse in low level, CCW direction is set.

Note
*The input voltage under DC+3V can not be recongnized as a pulse signal. Please apply pulse signal from DC+5V to DC+24V.
*When using in the Step/Direction mode, please apply a Step pulse only when Cool Muscle is stopping or a few msec after a Direction pulse is applied.

V ANALOG TYPE COOL MUSCLE

V type Cool Muscle can vary speeds or positions in proportion to an input analog voltage level. Set the max speeds or travel distance with ease by parameters. V type Cool Muscle is an ideal solution for constant feed system and valves.

Speed Control (K38=0)
The speed control in both CW and CCW direction in proportion to an input analog voltage level. The max speed at the both direction can be set by the parameter K40.

Position Control (K38=1)
The position control in proportion to an input analog voltage level, referring to DC+4.8V as the max travel distance.
The max travel distance between DC+0.2V and DC+4.8V can be set by the parameter K41.

Speed Control CW (K38=2)
The speed control in CW directon in proportion to an input analog voltage level (from DC+0.2V to DC+4.8V). The max speed in CW

direction can be set by the parameter K40.
Speed Control CCW (K38=3)
The speed control in CCW direction in proportion to an input analog voltage level (from DC+0.2V to DC+4.8V). The max speed in CCW direction can be set by the parameter K40.

Note
The control types above drive the travel distance that is set by K40 or make the acceleration that is set by K41. If the analog voltage is applied when supplying the power to Cool Muscle, it'll interfare the applied input voltage.
Apply the analog voltage that adapts the motion before supplying the power to Cool Muscle.

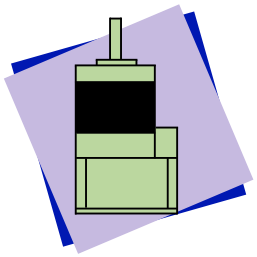
C Computer Type

C-type (computer) is the most powerful Cool Muscle in three (3) interfaces.

Pre-Program
If your application only requires repetitive motion, you can preprogram the motor, eliminating the need for a controller. Preloaded programs can be executed by a switch, PC or PLC.

Direct Command
If your application requires complicated motion or arbitrary motion, you can send command
directly to the Cool Muscle via PC or embedded computers.

Network
The C type Cool Muscles can be daisy chained, providing you with a simple and low cost network solution. There are different ways to network the C type Cool Muscles to suit your needs.



SECTION 2
WHEN YOU RECEIVE COOL MUSCLE

When you receive a Cool Muscle package, please make sure that you have all the components you ordered. You may then proceed to the next step and connect the motor to your PC to make sure that you have proper communications.

Cool Muscle Package

P V C

RS-232C Cable (Y-Cable) is required for all types of Cool Muscle, to set parameters via RS-232C from a PC.

The components that you need to operate the Cool Muscle are listed in the green area in the table below. The components listed in the pink area are the optional components for networking the Cool Muscles.

Components/Interfaces	Pulse Type	Analog Type	Computer Type
Cool Muscle Motor	O	O	O
Motor Cable	O	O	O
RS-232C Cable (Y-Cable)	△	△	△
24V Cool Muscle Power Supply	△	△	△
Manual CD*	O	O	O
Network Card(master set)	△	△	△
Network Card(slave set)	△	△	△
D-sub 9pin network straight cable Male to Female	△	△	△

O = included with the motor
△= optional component
*"Cool Muscle User's Guide", "COOL WORKS LITE USER'S MANUAL", and CoolWorks Lite (Software) are included in this CD.

The CD shall be attached only at the first delivery.

Components

P V C

CM1C1-400S

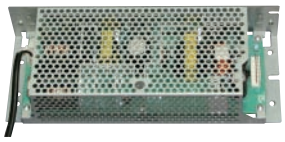
Motor Cable

The Cool Muscle comes with one (1) motor cable. The standard length of the motor cable is 40cm.

CM1C2-2000A

RS-232C Cable (Y-Cable)

A RS-232C Cable is required to connect Cool Muscle to a PC via RS-232C. This cable is required when downloading motor parameters and motion programs to Cool Muscle, or when you wish to control a single motor via RS-232C serial communication.
In addition, a customer can make a RS-232C Cable.
Please refer to AP4-122.

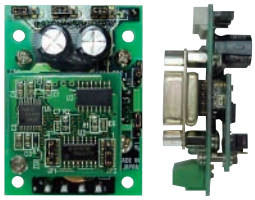


CMPS-XMUS-150-24

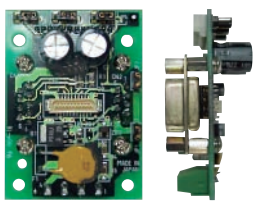
Power Supply

A regulated DC+24V power supply.
Required power supplies may be available from your local distributor.
150W/240W power supply from Muscle is capable for peak current.

C



CM1DC1-MBS
Master Set



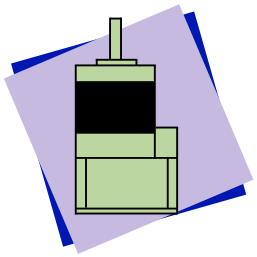
CM1DC1-SBS
Slave Set

Daisy Chain Network Card

Those cards are for the Daisy Chain Network and can be mounted on the back of the motor. The first motor from the upper controller requires a Master Set and the other motors require the Slave Sets.
D-sub 9pin straight cable can be used between those network cards.

Note:
Network cards can not be mounted on CM1-x-11S/L30 motors.

About wiring, please refer to AP4-121.



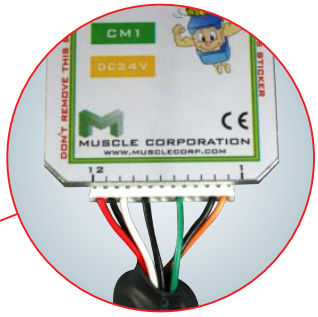
SECTION 3
SETTING UP COOL MUSCLE

How To Connect Cool Muscle

P V C

Using RS-232C Cable

Do not connect or disconnect the motor while it is powered on.



*Please pay attention to the direction of the connector.

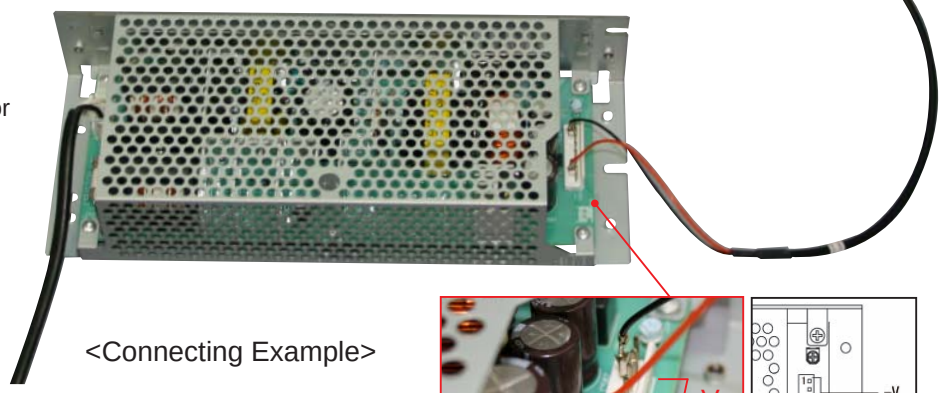
Cool Muscle

RS-232C Cable

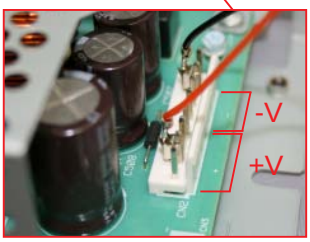
DC+24V power supply

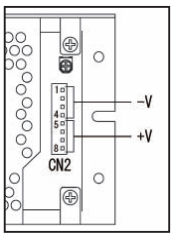
RS-232C Connector

Connect to a RS-232C port on your PC.



<Connecting Example>





C

Using Network Cards

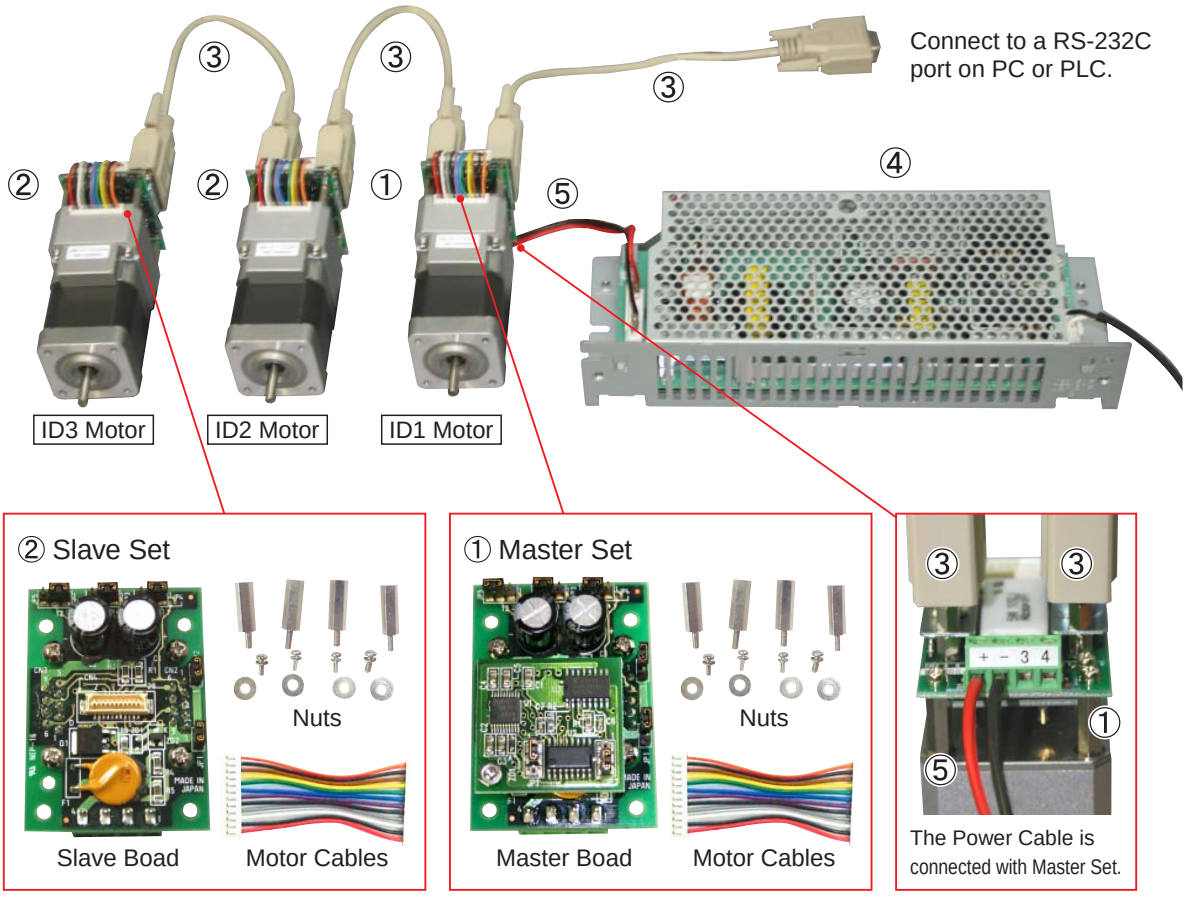
Instead of using a RS-232C Cable, you can use the network card and the interface card to connect the Cool Muscle to a PC.
You need a D-sub 9 pin straight cable.

You can network multiple motors by using network cards.
Network Cards are required for Daisy Chain operation. Connect a Master Set to an ID1 Cool Muscle (closest Cool Muscle to an upper controller) and Slave Set to an ID2 and later Cool Muscles.

What Do I Need to Create a Daisy Chain?

① Master Set (CM1DC1-MBS)
② Slave Set (CM1DC1-SBS)
③ D-sub 9 pin Straight Cables (CM1DC1-SSC-1800)
④ CD+24V Power Supply (CMPS-XMUS-150/240)
⑤ Power Cable (Not Attached)

<Connecting Example>



Attachment of Network card

CM1- ∗ -11S30 / 11L30

Network card can not be mounted on a back of driver case. Place it separately from Cool Muscle.

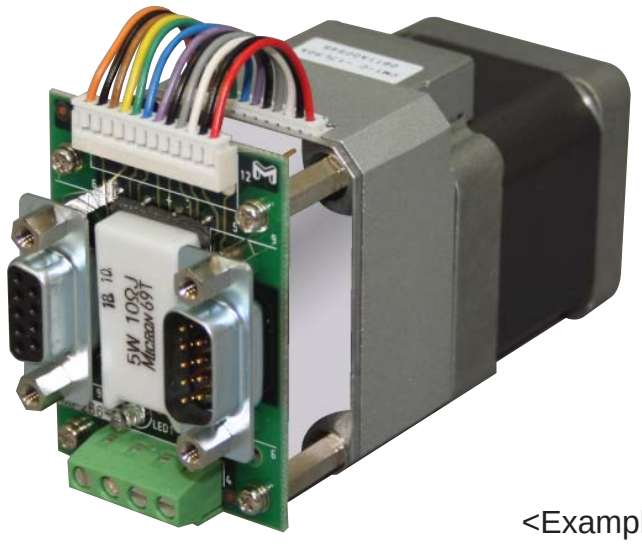
* Do not loosen the screws on a driver case. Nuts may fall down in a driver case and it may cause an internal short circuit.

CM1- ∗ -17S30 / 17L30, **CM1-** ∗ -23S30 / 23L20

Network card can be mounted on a back of driver case and placed separately as well.

* Do not open a lid of driver case. Failure may be induced.

* Cool Muscle will be exempt the warranty if a lid of driver case is opened or whole sticker is removed.



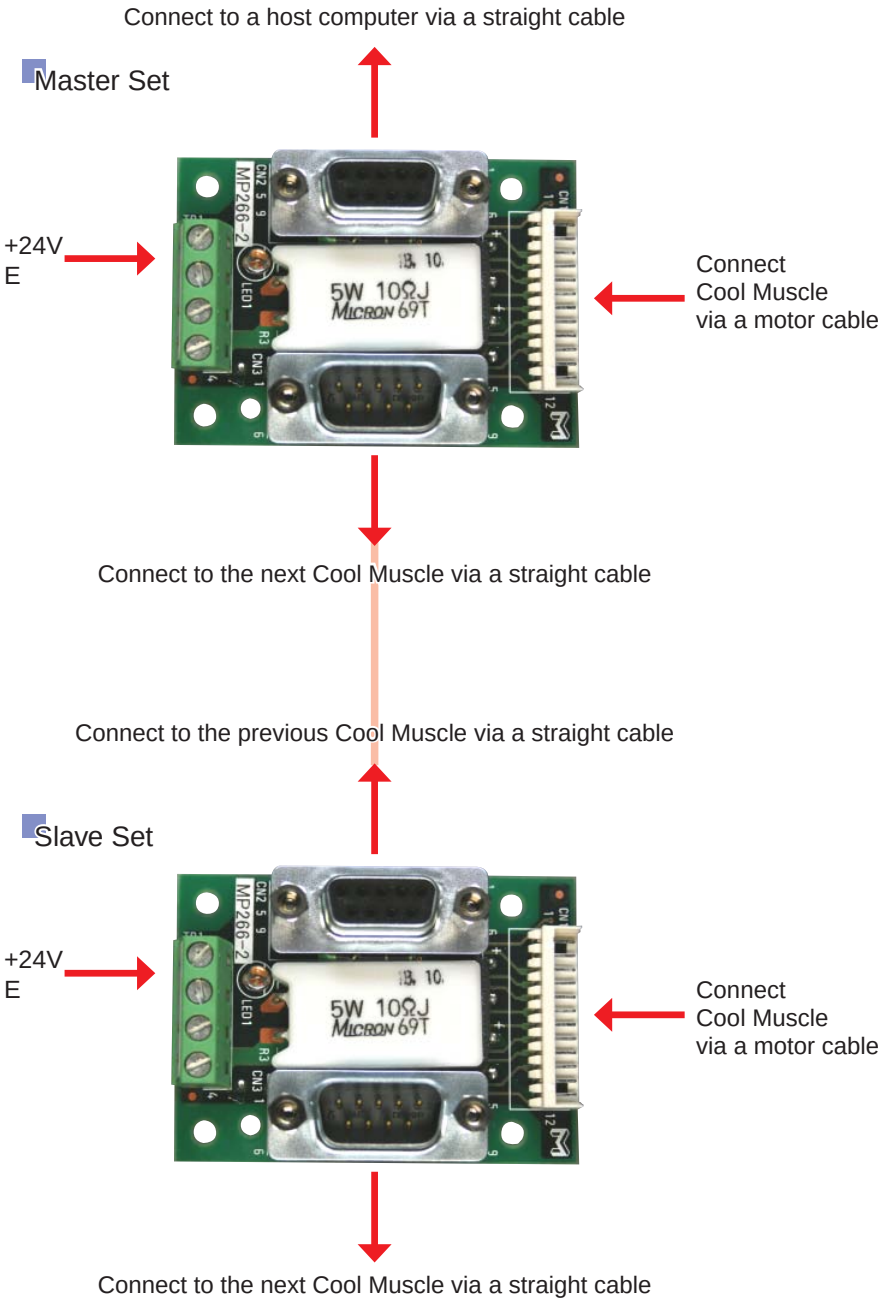
<Example>

How to attach Network card

1. Cut and remove 4 corners of sticker on a driver board to expose the nuts. * Do not remove whole sticker
2. Unscrew the nuts that lock a lid of driver case then place the attached spacers.
3. Fix Network card on the spacers by the attached screws.
4. Connect Cool Muscle and Network card by the attached motor cable (35mm).

Connect Network Cards to Cool Muscle

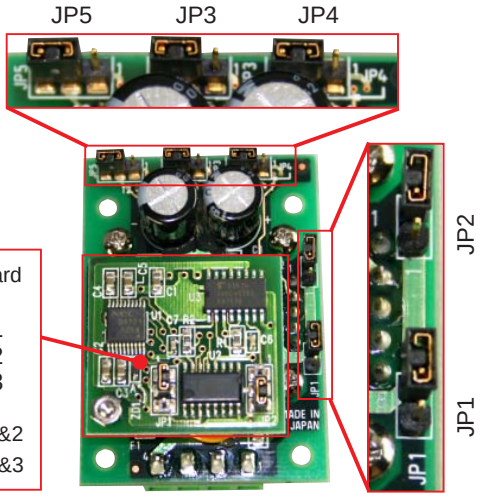
About wiring, please refer to AP4-121.



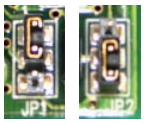
Set Jumpers

The Jumper pins connection of Master Set and Slave Set is different. Please confirm that Jumpers are set properly on Network Cards before connecting Network Cards to Cool Muscle.

Master Set



On Serial Daughter Card



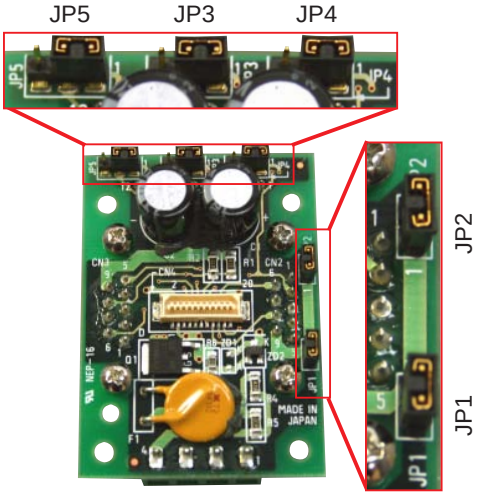
pin 1
pin 2
pin 3

JP1:Connect the pin 1&2
JP2:Connect the pin 2&3

JP 3, JP 4, JP 5
- No require any pin connected

JP 1, JP 2
- Leave the JP1&JP2 open

Slave Set



JP 3, JP 4, JP 5
- Connect the pin 1&2 on each JP

JP 1, JP 2
- Connect the pin 1&2 on the JP1&JP2
- When power is supplied through the terminal block on the card, leave the JP1&JP2 open

Communication with Cool Muscle

P V C

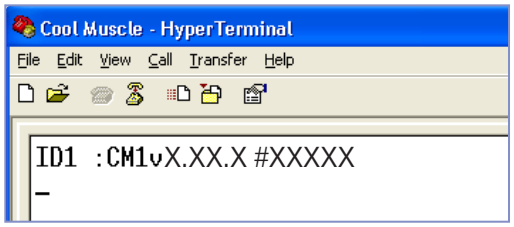
Connect Cool Muscle to your PC to make sure that the communication is established and the default parameters are set properly. When you can not establish the communication, please refer to the Trouble Shooting section that is included in the next page.

1. Connect the RS-232C Cable to Cool Muscle, PC and DC+24V power supply, referring to the Section 3 "Setting Up Cool Muscle". Please make sure that the power is turned off.

2. Start up Windows PC.

3. Start up Cool Works that is available on the CD provided with Cool Muscle or can be downloaded from Muscle website at http://www.coolmuscle.com.
Or Hyper Terminal on Windows is also available.
Please set up Hyper Terminal for Cool Muscle referring to the Section 5 "How to Set Up Hyper Terminal".

4. Power Cool Muscle on. As the drawing below, when motor information is displayed on a screen, the communication is established.



5. Please check the default parameter.
Enter ?90 and press the Enter key ↵ , all the user parameter shall appear on the screen.

6. Turn off Cool Muscle and close Cool Works.

Trouble Shooting of Communication

Nothing appears when Cool Muscle is powered on.

How to find the COM port No. in Window XP

Open the Control panel, click [Performance and Maintenance] and then [System].
Choose [Hardware] Tab on the opened window and then click [Device Manager].
The available COM ports are displayed in the tree selection [Ports (COM & LPT)] .

- Is proper baud rate set when communicating with Hyper Terminal? Once a baud rate is set on Hyper Terminal, it can not be changed. When a wrong baud rate is set, please re-set a Hyper Terminal referring to as it follows.
  Connection: Selected COM port (ex: COM1)

  Baud Rate: 38400
  Data Bit: 8
  Parity: N/A
  Stop Bit: 1
  Hand Shake: None

- Is Cool Muscle powered on?
  Please make sure that there is a servo rock on the motor shaft.

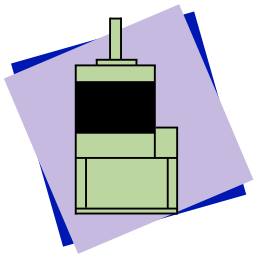
- Please wait for a few minutes.
  At the first communication, sometimes it takes a few minutes to receive a replying data from Cool Muscle.

- Do you have multiple terminal applications running in the back ground? Or do you have a software for PDAs or other programs that occupy COM ports running? Make sure that these programs are disable and not running in the background.

Nothing appears when ?90 is entered.

- Parameters are not properly displayed. Turn the motor off and on. If the motor responds with its version information, communication is established.

Please check your PC setting including a key board.



SECTION 4
INPUT AND OUTPUT

Pin Assignment and Layout

P V C

Cool Muscle has 4 inputs and 2 outputs that are user definable. Each I/O port can be assigned multiple functions by setting motor parameters using CML. Please refer to the SECTION 7.

12 1

PIN Layout

PIN	Color	Name	Function	Pulse		Analog	Computer
				CW/CCW	Step/Dir		
1	Orange	+24V DC IN	Motor Power				
2	Black	GROUND 1	GND				
3	Brown	INPUT 2-	Return For Pin9	CCW-	Direction-		
4	Yellow	OUTPUT 2	Digital Output, Serial TX, Analog Output				Serial
5	Green	OUTPUT 1	Digital Output, Serial TX				Serial
6	Blue	INPUT 4	Digital Input, Analog Input			V+	
7	Purple	INPUT 3	Digital Input				
8	Black	INPUT 1-	Return For Pin10	CW-	Step-		
9	Gray	INPUT 2+	Digital Input, Pulse Counter, Serial RX	CCW+	Direction+		Serial
10	White	INPUT 1+	Digital Input, Pulse Counter, Serial RX	CW+	Step+		Serial
11	Black	GROUND 2	GND			V-	
12	Red	+5V DC OUT	5V Power Out (Max.10mA)				

*About wiring example, please refer to Appendix 1.

Assignable Functions-Input

P V C

Digital Input

Multiple functions can be assigned to a digital input port. By setting the duration, the quick response and slow response signal can be performed. Furthermore, functions can be assigned at the rising and falling edges and target voltage level of either quick or slow response signals.

Assignable input functions at the target voltage level

#	Function
0	No Action
1	General Use
2	Origin Sensor Signal
3	Manual Feed CW
4	Manual Feed CCW
6	CW Limit Sensor (Combined with Origin Sensor)
7	Emergency Stop
8	Full Stop (the same as][↵][↵])
9	CCW Limit Sensor (Combined with Origin Sensor)

Assignable input functions at the rising and falling edges

#	Function
0	No Action
1	Reset Alarm/Pause
2	Motor Free/Enable Motor
3	Reset Counter
4	Execute Next Step
5	Execute Previous Step
6	Execute Bank 1
7	Go Origin
8	Manual Jog CW
9	Manual Jog CCW

Example:

Input 4 is configured to be

K28=8000

K30=4000

K50=10

1. Assign Manual Jog of 10 pulses at the rising edge of quick response signal
2. Assign Manual Feed CW at the target level of slow response signal

When quick response input signal is detected, motor will turn 10 pulses. When a slow response signal is detected, the motor turns continuously for the duration of the signal.

P

Pulse Counter

Pulse signal can be applied to input 1 and 2 when using Pulse type Cool Muscle.

CW/CCW

Step/Direction

V C

Analog Input

Input 4 can be used for Analog input when using V or C type Cool Muscle. Either speed or position can be cotrolled by Analog input voltage.

P V C

Serial Input (Communication)

Input 1 (and 2 as well when networked) is used for serial communication when using C type Cool Muscle.

Cool Muscle establishes its communication by automatic detection of input 1 & 2 voltage level when powering on.

Please refer to the SC7-40.

Input ports and assignable input types

I/O	Digital In	Analog In	Pulse In	Serial In
Input 1, 2	O	X	O	O
Input 3 (Max 5V)	O	X	X	X
Input 4 (Max 5V)	O	O	X	X

O: Assignable

X: Not Assignable

Assignable Functions-Output

P V C

Digital Output

Assignable Output Functions

#	Function
0	Commnad
1	In-Position
2	Alarm
3	General Use
4	General Use
5	Analog Output (Assignable only at Output 2)
6	In-Position at passing points in Merge Mode
7	Position Mark (K24 must be set separatelly)
8	During Motor Free
9	During Push Mode

Analog Output

The data as below can be output by assigning the Analog Output Function at Output 2.

Assignable Analog Output Functions

#	Analog Output Function
0	Target Position
1	Target Position Magnified by 8
2	Current Position
3	Current Position Magnified by 8
4	Position Error
5	Position Error Magnified by 8
6	Current Speed
7	Current Speed Magnified by 8
8	Current Torque
9	Current Torque Magnified by 8

Serial Output

Serial Transmit to Host

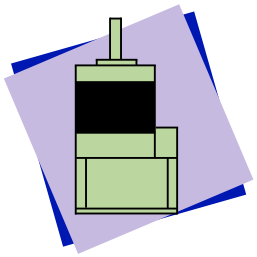
Serial Transmit to Slave

Output ports and assignable output types

I/O	Digital Out	Analog Out	Serial Out
Output 1	O	X	O
Output 2	O	O	O

O: Assignable

X: Not Assignable



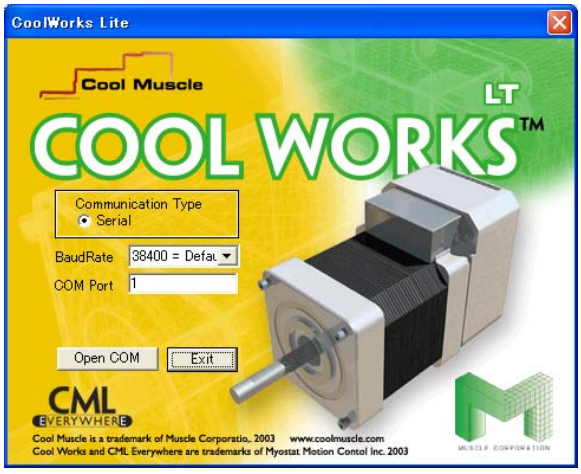
SECTION 5
COMMUNICATION METHOD

There are two (2) methods for the communication with Cool Muscle.
The one is via special software, CoolWorks Lite and the other is via Hyper Terminal, pre-installed application in Windows.

CoolWorks Lite

P V C

CoolWorks Lite is a utility software for CoolMuscle.
CoolWorks Lite can communicate with a CoolMuscle directly. It lets you modify and save parameters and data. It can jog the motor, plot motor data on a graph and do gain tuning. CoolWorks Lite is CoolMuscle Language (CML) compatible.
CoolWorks Lite is a user-friendly software. It assists in easy operation of Cool Muscle.



Refer to "COOLWORKS LITE USER'S MANUAL" in Manual CD for how to use CoolWorks Lite.

CoolWorks Lite is included in Manual CD provided by each agency when it buys first time. The latest CoolWorks Lite can be downloaded for free from the following web site also: http://www.musclecorp.com/

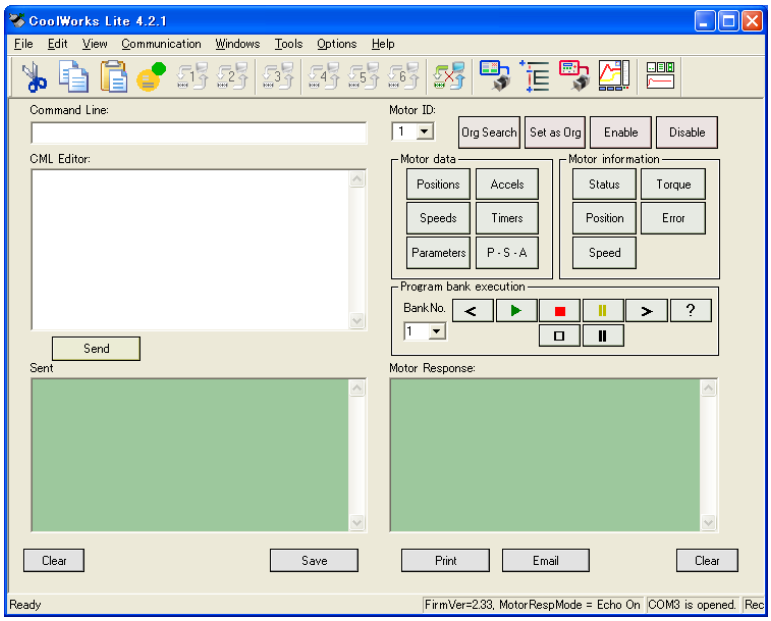
Compatible OS: Windows 98 / 2000 / ME / XP
File Size : 2.35MB

*CWL would be updated without notice.

Main features

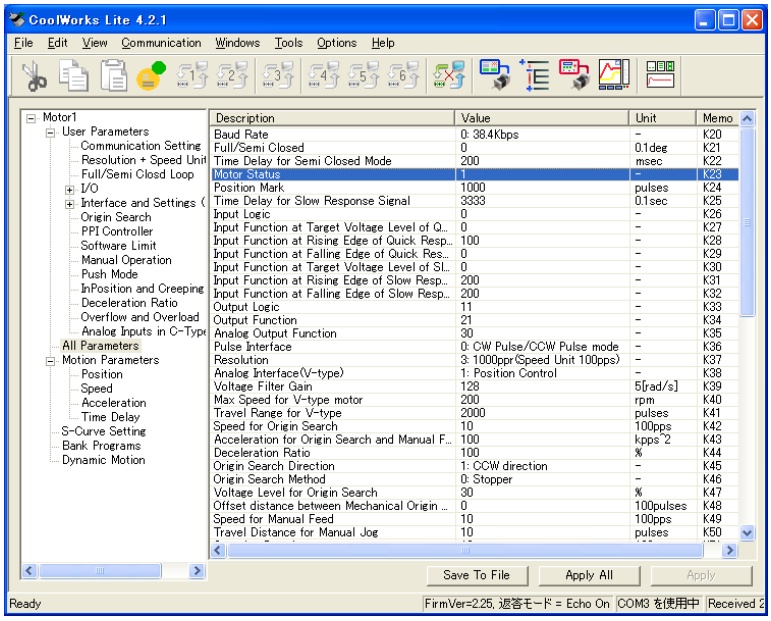
Terminal function

In the terminal window, data and bank programs can be set and the status of motion monitored.



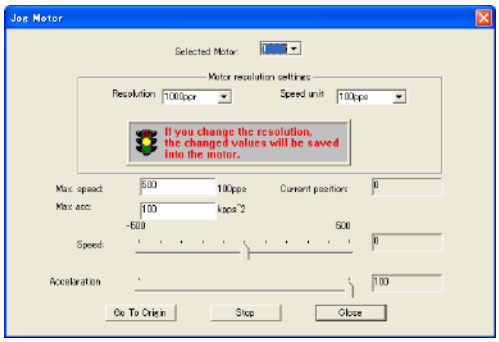
Motor browser function

In the motor browser window, the motor parameters are easily set.



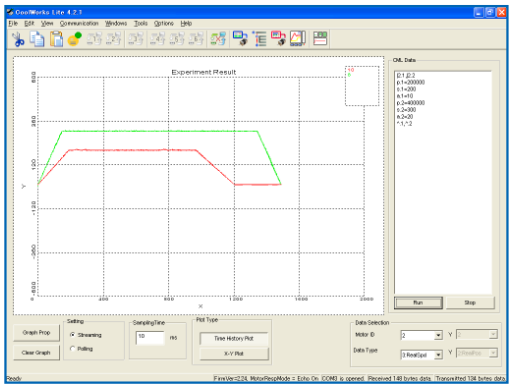
Jog motion function

In the Jog window, the motor can be rotated by dragging a slider with the mouse.



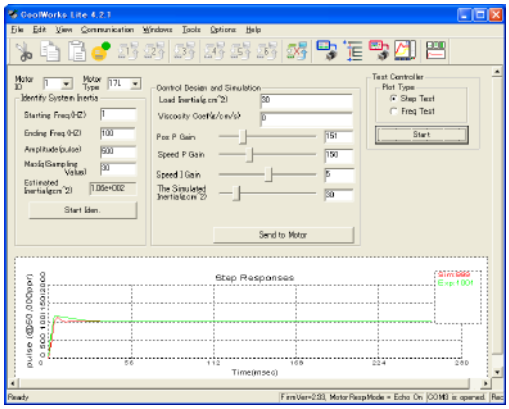
Graph function

In the graph window, the position, speed, torque, etc can be displayed graphically in real time.



Tuning function

In the tuning window, controller gain can be easily tuned by step response or frequency-response.



* This window will not work for Ver 1.07 or before.

How to Set Up Hyper Terminal

P V C

Hyper Terminal is a Communication Software, that is pre-installed in Windows.
Communication is possible by command in text format, editing and downloading of program file is possible as well.
The setting method of Hyper Terminal is explained.

Start Hyper Terminal and Set a communication method

1. Start up Hyper Terminal
(Start / Program/ Accessory / Communication / Hyper Terminal)

2. Form a New Connection
Enter a name in the “Connection Description” window.

Name :
Enter a simple name.
Ex): Cool Muscle

Icon :
Choose an Icon and click “OK”.

3. Set a communication method

Click “OK” after selecting a Com-Port that Cool Muscle is connected to in the “Connect To” window.

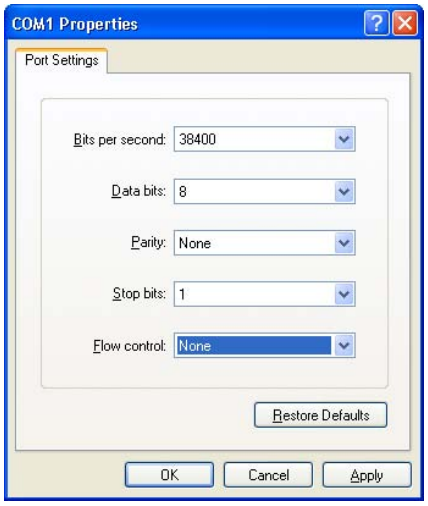
How to find the COM port No.

Open the Control panel, click [Performance and Maintenance] and then [System].

Choose [Hardware] Tab on the opened window and then click [Device Manager].

The available COM ports are displayed in the tree selection [Ports (COM & LPT)] .

4. Set the COM port as below and click “OK”.

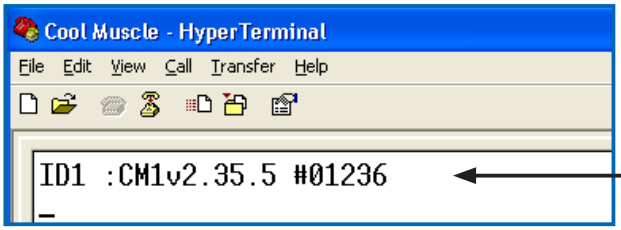


Baud Rate (bps)	:	38400
Data bits	:	8
Parity	:	None
Stop bits	:	1
Flow control	:	None

5. Connect Cool Muscle, confirm the COM port that Cool Muscle is connected then power on Cool Muscle.

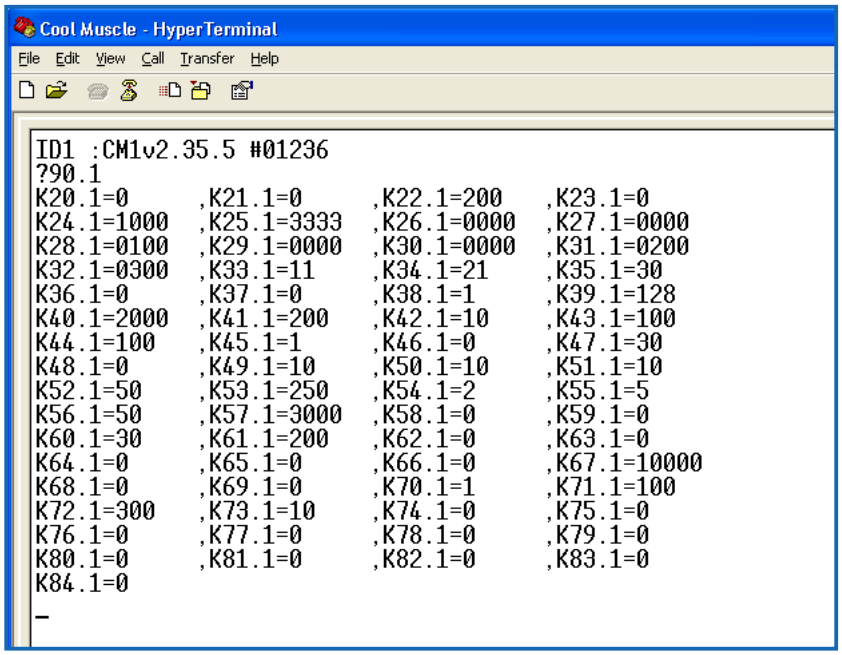
The motor information will appear when the communication is established.

*It might take a few minutes to establish a communication with a PC when Cool Muscle is connected for the first time.



Operation method of Cool Muscle

1. Enter ?90 then press "Enter↵" key, the user parameters that are saved in Cool Muscle will be displayed.



Parameter setting, modification, the Direct Mode operation, the Program Mode operation and the text file transfer are possible.

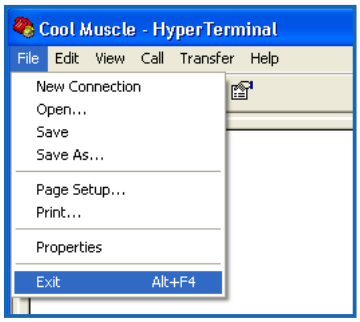
Click Transfer / Text File then send the program file when transferring a file from Hyper Terminal. When the Line Feed is required, select the "Line Feed" from Menu/Property/ASCII.

2. Send a text file through Hyper Terminal.
Click Transfer / Text File then send the program file when transferring a file from Hyper Terminal. When the Line Feed is required, select the "Line Feed" from Menu/Property/ASCII.

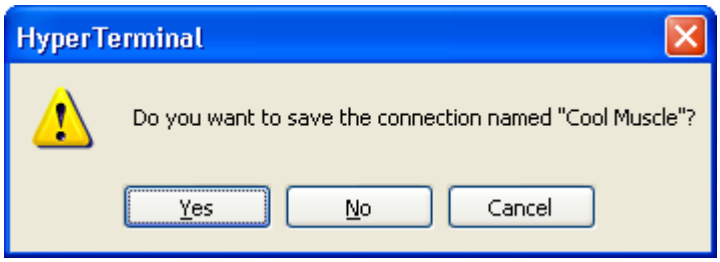
3. Save log data and print.
Click Transfer / Text Capture then save log data of Hyper Terminal. When printing, select Transfer / Capture and Print.

Close Hyper Terminal

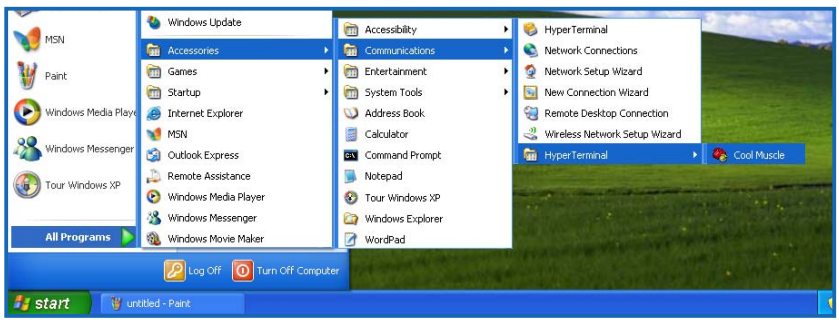
1. Save setting, exit Hyper Terminal and save the connection.
Power down Cool Muscle first then exit Hyper Terminal. Select File / Exit or click the "☒" on top right hand side of the screen.

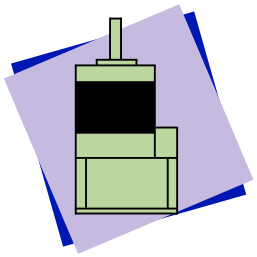


"Do you want to save the connection named "Cool Muscle"?" screen will appear when exiting Hyper Terminal. Then click "Yes" and save the connection setting.



2. Once the connection setting is saved, the saved file shall be able to open directly from Start / All Programs / Accessories / Communications / Hyper Terminal (folder) / Cool Muscle from next time.





SECTION 6
CML STRUCTURE

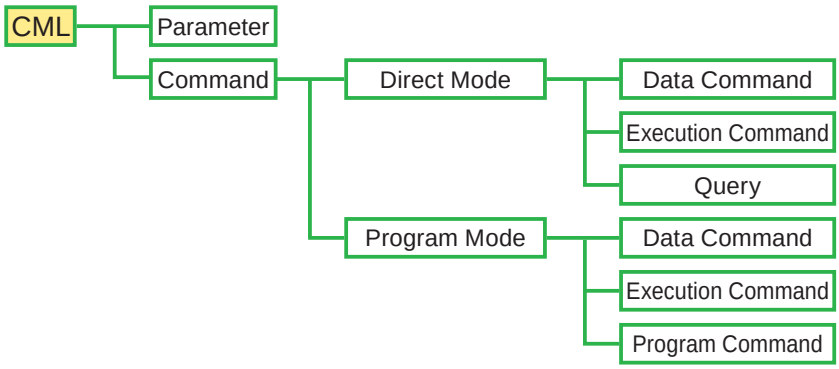
CML stands for **Cool Muscle Language**, the ASCII commands only for Cool Muscle.

Cool Muscle Language

P V C

CML (Cool Muscle Language) is a free method ASCII commands that provide a simple creation of a motion program for single or multi-axis systems. As CML can contain a motor ID, multiple Cool Muscles can perform coordinated motion.

CML is composed as follows.



Enter ".ID" (Motor ID No.) after all parameter and command to specify an ID number.
Data will be activated by entering "Enter ↵ " after it.

Parameters

P V C

By using CML, it is very simple to set parameters.
It is also very simple to change parameters to suit your specifications, although it is set to the default parameter when delivered.

Parameter Definition: K##.ID=Value

"K##" signifies a parameter number. ".ID" after K number signifies an ID number. The Number represents the data to be assigned to K##. A list of parameters and their corresponding numbers are outlined in Section 6 "SETTING PARAMETERS" (Refer to the Appendix 2 "Parameter List").

Ex: K37.1=3 sets resolution as 1000ppr

Commands

Command can be used in different two modes.
Comprehension of the difference between those 2 modes is required for Cool Muscle operation.

C

Program Mode
Operation by the program that is downloaded to a Cool Muscle.
A program can be triggered by an execution command or an input signal.

P V C

Direct Mode
Direct operation via PC to make an immediate action.

The communication using both Program / Direct mode with Cool Muscle can be made from a terminal program as Cool Works or Hyper Terminal.

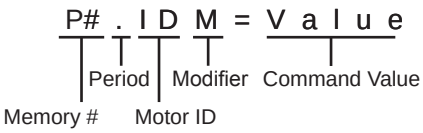
CML Structure

Command Structure & Rules

C

This section guides you to the Command Structure and Rules for Cool Muscle program mode.

The basic structure of a CML command is:



Memory Number

Each command has a limited number for memory locations.
For example, Position, Speed and Acceleration can be stored in 25, 15 and 8 memory locations respectively. Specify the memory location for the corresponding value.

Ex: P14.3=1000

The defined value 1000 is stored in position memory location 14 of the ID3 motor. The value set by the parameter is absolute.

Motor ID

When operating multiple Cool Muscles, motor ID must be specified in a program. The commands and parameters will be placed in the memory locations of the specified motor. When Motor ID is left out, it is assumed to be either motor 1 or the last ID value used.

Modifier

The most common modifier is the "+" that is used with the P command. Adding "+" after the ID number of P data makes the value relative. P14.3+ would command motor 3 to move relatively/incrementally 1000 pulses against Cool Muscle's current position.
(Refer to SC8-73.)

Value

All the value that is defined by commands shall be absolute. All values as A, S, P and T shall be set before making a program.

Spaces

Spaces should not be used in a command line.

Upper or lower case?

All the commands in CML program files can be either upper or lower case letters.

CML File Structure - Program Mode

C

CML files consist of 2 different parts. The first part defines memory contents as Positions, Speeds, Accelerations and Timers, and the second part defines program.

Example:

```
P1.1=30000
P2.1=250000
S1.1=500
A1.1=200
.
.
```

Data Command

```
B1.1
S1.1, A2.1, P1.1
B3.1
S1.1, A2.1, P3.1
.
.
```

Program Command

Memory Contents

Position, Speed, Acceleration and Timer definition takes the form of:

P#.ID=Value (#=1～25 memories)
S#.ID=Value (#=1～15 memories)
A#.ID=Value (#=1～8 memories)
T#.ID=Value (#=1～7 memories)

CML Program Banks

All programs shall be made by CML motion commands and stored in the specified bank memory. A program is defined as it follows:

B#.1

B# specifies the program bank number (up to 30 banks) and commands that make up the contents of program bank. Each program bank can be regarded as an object. Program Bank may contain up to 500 steps. CML commands and structures are outlined in the CML Command List.

CML Program File Example

C

K26.1=1111 / Set Input Logic
K49.1=15 / Set the Speed for Manual Feed
K58.1=500 / Set Software Limit CW
K59.1=-500 / Set Software Limit CCW
P1.1=1000 / Definition for Position Memory 1
P2.1=2000 / Definition for Position Memory 2
P3.1=4000 / Definition for Position Memory 3
S1.1=200 / Definition for Speed Memory 1
S2.1=500 / Definition for Speed Memory 2
A1.1=200 / Definition for Acceleration Memory 1
A2.1=100 / Definition for Acceleration Memory 2

B1.1 / Start of The Content of Bank 1
C2.1 / Call The Beginning of Bank 2
C3.1 / Call The Beginning of Bank 3

B2.1 / Start of The Content of Bank 2
S1.1, A1.1, P1.1 / Motion to P1 with A1 and S1
S2.1, A2.1, P2.1 / Motion to P2 with A2 and S2

B3.1 / Start of The Content of Bank 3
S1.1, A2.1, P3.1 / Motion to P3 with A2 and S1

(Please refer to SECTION 9 "CML Program Basic Example" for more detailed information.)

CML File Structure - Direct Mode

P V C

Motor can be directly operated by commands in Direct Mode. This mode is useful for debugging or voluntary movement. Direct mode is available in all types of Cool Muscle.

Direct Mode Structure:
S.ID=Value
A.ID=Value
P.ID=Value
^.ID (Execute)

In Program Mode, you need to define position, speed, acceleration and timer. In Direct Mode, you can directly operate Cool Muscle by entering motion profile.

Example:
S.1=250
A.1=100
P.1=10000
^.1

CML File / Command Downloading

P V C

To save the file by text format (.txt) is recommended to transfer the file directly from Cool Works or Hyper Terminal. It is also recommended to edit the content of the program.

There are a number of ways to use CML to set parameters, define motions, create programs, download program, execute programs and operate Cool Muscle.
CoolWorks Lite is a free software from Muscle Corporation designed to work with CML. Hyper Terminal is also available that is usually included with your Windows installation disk.

To change parameters, execute program banks, operate Cool Muscle in the Direct Mode can be executed by commands from Hyper Terminal or Cool Works via RS-232C communication.

Creating and Editing Program Banks

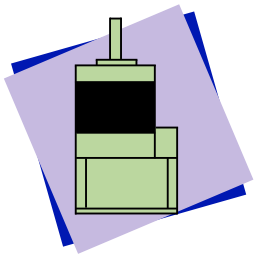
It is recommended to use editor programs such as Microsoft Word to creat and edit Program Bank files.
You can download Program Bank files via a terminal program by importing text files. You can also download parameters in the same method.

When changing parameters, only specified parameter shall be changed. It will not affect unspecified parameter.

When writing Program Bank, it must begin with "B1.1". Even when changing a part of Program Bank or whole content of another Bank, it must begin with "B1.1".

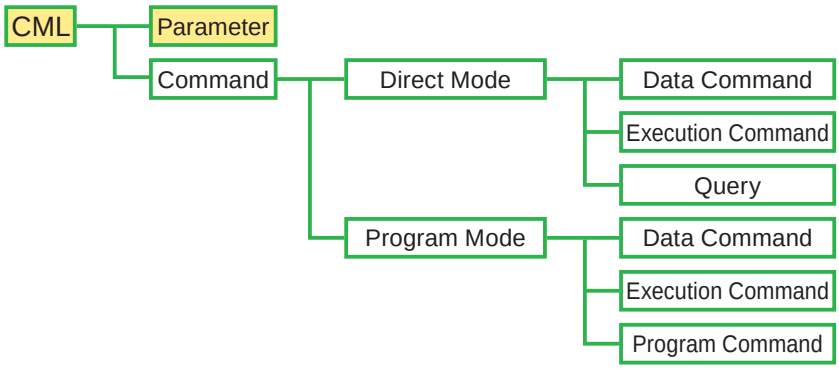
Please enter a "$" and "Enter ↵ " at the end of the CML program to save the data in Cool Muscle. When changing only parameter, the "$" does not need to be sent.

The limit of the number for over-writing each data is 100000 times.



SECTION 7
SETTING PARAMETERS

This section guides you to the details of parameters and instruction for setting. Please refer to Appendix 2 for Parameter List.



Before Setting Parameters

To set parameters on Cool Muscle, you need to connect Cool Muscle via RS-232C cable (CM1C2-2000A) or network card. You can set parameters on multiple Cool Muscles when they are networked via network cables.

P V C

RS-232C Cable

Connect the Cool Muscle (refer to SECTION 3 "SETTING UP COOL MUSCLE"). Start up Cool Works or the Hyper Terminal and turn Cool Muscle on. Make sure that there is communication established between Cool Muscle and your PC.

C

Network Cable

Connect Cool Muscles (refer to SECTION 3"). Start up CoolWorks Lite or the Hyper Terminal and turn Cool Muscle on. Each Cool Muscle is automatically given a motor ID. Make sure that communication is established between Cool Muscles and your PC (refer to SECTION 5). The motor information from the daisy-chained Cool Muscles will be displayed.

C

Please note that as it has been exemplified on right-hand side, Cool Muscle starts the Communication Mode automatically by the setting of Input1.

Automatic Identification

Cool Muscle executes an upper and lower communication status confirmation when power is supplied.

When power on

Input1	On	Communication Mode Accept only command
Input2	On	Communication Mode to a Daisy-Chained Slave(lower) Cool Muscle.

When Input1 and Input2 are on, Cool Muscle goes into Communication and Daisy-Chain Mode.
Therefore Input1, Output1 and Input2, Output2 shall be kept for Communication.

Only the last Cool Muscle in Daisy Chain recognize it the last end because Input2 shall stay off.
Therefore the Output2 of the last Cool Muscle can be used.

When operating by pulse signal (using input 1 & 2 for pulse signal), do not apply high voltage when powering on.

*External devices such as a sensor, are recommended to be connected to input 3 or 4.
Cool Muscle may establish communication by detecting high level signal when powering on, when external devices are connected to input 1 or 2.

Parameter Structure

P V C

The parameter of all types of Cool Muscle (P, V, C) can be set from PC. Each parameter is assigned specified functions. (Refer to Appendix 2 "Parameter List").

The structure of parameter is:

K##.ID = Value

Example:
K50.1=15
Manual jog travel distance of the ID1 motor is set to 15 pulses.

Please put ".ID" (Motor ID) after all parameters to specify Cool Muscle of the object.
It becomes effective by inputting "Enter ↵ " after each data.

Parameter

P V C

Baud Rate K20

Description

Set the baud rate to communicate with an upper controller.

Make sure that the same baud rate is set on the upper controller side.

#	Baud Rate
0	38.4 Kbps
1	9.6 Kbps
2	19.2 Kbps
3	57.6 Kbps

Example:

K20.1=0

Set baud rate to 38.4Kbps.

K20.1=0 (38.4Kbps) is the Cool Muscle's default value.

C

Open Loop Vector Angle K21

Description

By the combination of K21 and K22, Cool Muscle goes into an open loop mode when there is no position command during the set time by K22 after in-positioning.

If Cool Muscle moves off the set angle by K21, Cool Muscle goes into a closed loop again and back to the previous target position.

#	Rate
0	Full Closed Loop
1-36	Unit x 0.1 degree

Example:

K21.1=10

Set the vector angle to 1 degree.

If Cool Muscle moves off 1 degree, it goes into a closed loop again and back to the previous target position.

C

Trigger Timing for Open Loop Mode K22

Description
This parameter lets you set a trigger timing for an open loop.
This trigger timing is a time delay between in-position signal and the moment when Cool Muscle goes into an open loop.

Min	Max	Default	Unit
10	1000	200	msec

Example:
K22.1=500

Cool Muscle goes into an open loop mode when there is no position command for 500 msec after in-positioning.

P V C

Status Report K23

Description
Set the method of status report from Cool Muscle.

The registrable number is from 0 to 31 as shown below.
The number can be combined by addition.

0: Polling
1: In-position and Alarm
2: Report when input status changes
4: Report when output status changes
7: Combination of 1, 2, and 4
8: No Local Echo (No return input signal)
16: Display Error Messages

Message	Meaning
error : Out Of Range !!	Unsettable values for K parameters
error : syntax error !!	Description in Program Bank is wrong
error : too many steps !!	Steps in Banks are more than 500
[End Bank]	Program Banks are ended properly
Change Baud Rate ?? ×××Kbps (Y/N)	When Baud Rate is changed by K20 or K65
error : CW Limit !!	CW Limit Sensor ON
error : CCW Limit !!	CCW Limit Sensor ON

Example:
K23.1=0
Cool Muscle replies only against the queries that are sent to Cool Muscle. The local echo shall be displayed as well.

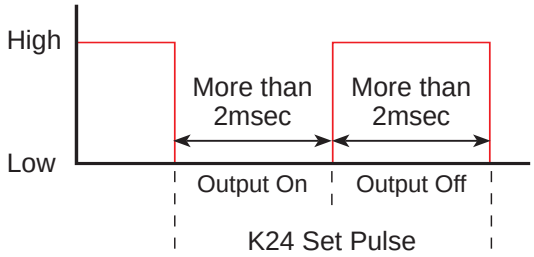
K23.1=13 (1+4+8)
Cool Muscle automatically reports the status when Inpositioning, Alarm and output status changes.
The local echo shall not be displayed.Description

P V C

Position Mark K24

Description
Turn output on/off at regular intervals with pulses (Set K34=7).
The signal wave pattern shall be as below.
Turn the output on at the first half of the set pulse then off at the last half of the set pulse by K24. (Refer to Appendix7.)

Min	Max	Default	Unit
10	32767	1000	pulses



P V C

Time Offset for Slow Response Signal K25

Description

This parameter sets the time delay to create two sets of signals, quick and slow response signal. Slow response signal is a vertual signal that is made by software, the specified time delay after the real signal to cover the paucity of input numbers.

If the signal is completed within the set time delay period, it is only recognized as a quick response signal but not as a slow response signal.

Min	Max	Default	Unit
1111	9999	3333	0.1sec

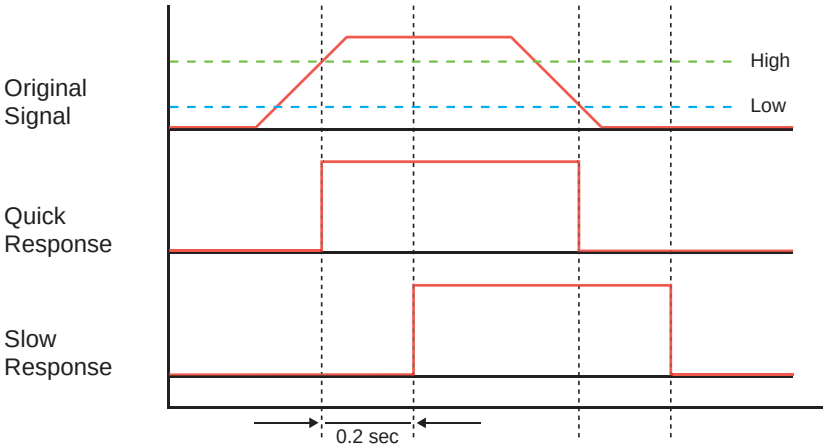
Input Order is In 4, 3, 2, 1. Each digit must be set individually.

Example: K25.1=6332

- Input 1 = 0.2sec
- Input 2 = 0.3sec
- Input 3 = 0.3sec
- Input 4 = 0.6sec

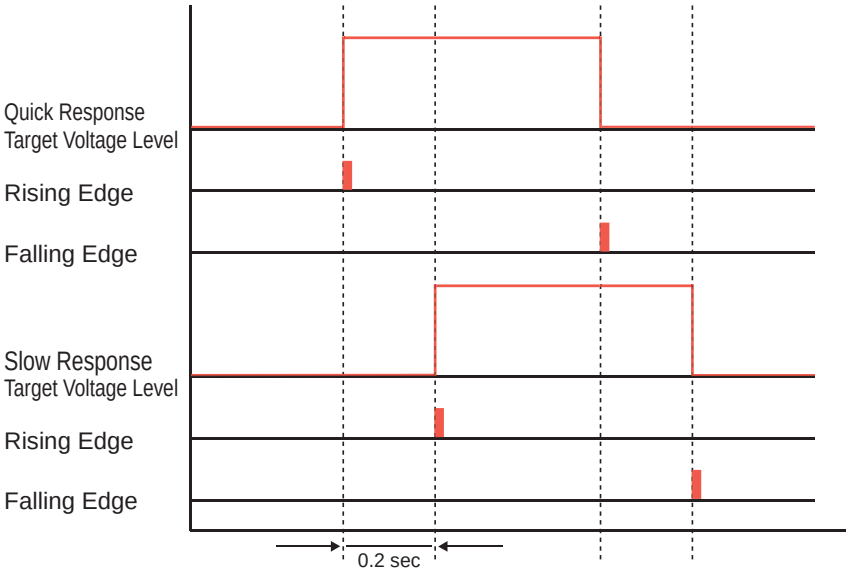
Quick and Slow response time off set

A quick response signal starts when it hits the high level. A slow response signal starts after the time offset set by the parameter K25. When K25.1=2222, the slow resoponse signal rises and falls 0.2sec after the quick response signal.



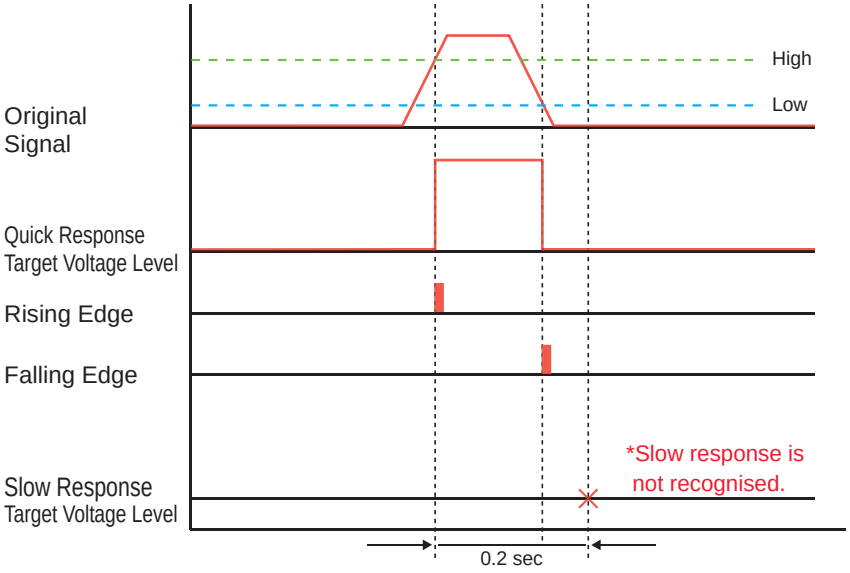
Quick and Slow response event triggers

Events (functions) can be assigned to the rising and falling edges and the target voltage of a quick and slow response signals.



Short Signal

When a signal is completed within the offset time, only a quick response signal is recognized.



P V C

Input Logic K26

Description

This parameter sets the input logic.

Min	Max	Default	Descriptions
0000	1111	0000	0: Active by low level signal 1: Active by high level signal

Input Order is In4, 3, 2, 1. Each digit must be set individually.

Please set the input logic referring to the output logic at the upper controller side.

Example: K26.1=1010

- Input 1 = Normally Open
- Input 2 = Normally Closed
- Input 3 = Normally Open
- Input 4 = Normally Closed

P V C

Input Functions at the Quick Response Target Voltage K27

Input Functions at the Slow Response Target Voltage K30

When input logic is active low, the target voltage level is less than DC+0.8V(7mA) and when active high, it is from DC+3V to DC+5V. The shortest signal shall be 10msec.

When a function is assigned to input 1 or 2, a signal from a PC might activate the function. Do not assign any function to input 1 and 2 when using in communication mode with PC.

When positioning to an origin after stopping by a limit sensor (function 6 or 9), position deviation may occur. The position deviation will be canceled by Enable Motor command " (" after limit sensor is on.

Description

These parameters assign functions performed for the duration of a signal. Assignable functions are listed below. (Refer to SC7-44)

Assignable Functions for the Target Voltage Level

#	Functions	Description
0	No Action	No Anction
1	General Use	Typically Used for the I command
2	Origin Sensor* (K27) -- (K30)	The signal from Origin Sensor (K27) -- (K30)
3	Manual Feed CW	Motor runs in a CW direction for the duration of the signal
4	Manual Feed CCW	Motor runs in a CCW direction for the duration of the signal
5	--	--
6	CW Limit Sensor with Origin Sensor	Usually used for a CW Limit sensor. But only after an origin search command, the sensor shall work as an origin sensor
7	Emergency Stop	Emergeny Stop (stop by Max deceleration)
8	Full Stop	Stop as][↵][↵]
9	CCW Limit Sensor with Origin Sensor	Usually used for a CCW Limit sensor. But only after an origin search command, the sensor shall work as an origin sensor

*Please refer to Appendix 7 for about Origin Sensor.

Min	Max	Default
0000	9999	0000 (K27)
0000	9999	0000 (K30)

Input Order is In4, 3, 2, 1. Each digit must be set individually.

Example: K27.1=1243

- Input 1 = Manual Feed CW
- Input 2 = Manual Feed CCW
- Input 3 = Origin Sensor
- Input 4 = General Use

* Origin sensor has a prior to the other function in Ver.2.25 and Ver2.35. The priority in -Ver.2.24, -Ver2.33 is in order of Input 4, 3, 2, 1. (AP7-130 for detail)

P V C

By setting K36=2, the execution of bank 2 or 3 can be assigned to either rising or falling edge of a signal.

Input Functions at the Quick Response Rising Edge	K28
Input Functions at the Quick Response Falling Edge	K29
Input Functions at the Slow Response Rising Edge	K31
Input Functions at the Slow Response Falling Edge	K32

Description

These parameters assign functions performed at the edge of a signal. Functions or events should be assigned to event triggers in such a way as to make sense.

For example, it may create undesirable movements if you assign Motor Free to the rising edge of a quick response signal and Go Origin to the duration of a slow response signal. With this input function assignment, when the motor is commanded to go back to origin, as it goes into a free state at the rising edge of a quick response signal, it will not be able to go back to origin. (Refer to SC7-44)

Assignable Functions at the rising and falling edges of an input signal Functions with <> indicate only for the falling edge.

#	Function	Description
0	No Action	
1	Reset Alarm/Pause	Reset Alarm: When Alarm is on, it resets the alarm Pause: Pause a motor. Send a start signal to resume a motion
2	Motor Free <Enable Motor>	Make a motor go into a motor free state <Enable a motor from a motor free state>
3	Counter Reset	Make the current position 0
4	Execute Next Line	Execute the next line in a Bank
5	Execute Previous Line	Execute the previous line in a Bank Availability depends on a program
6	Execute Bank 1	
7	Go Origin	
8	Manual Jog CW /Execute Bank 2	Motor runs in a CW direction. The other values shall be set by K43, 49 and 50. When K36=2, execute Bank 2.
9	Manual Jog CCW /Execute Bank 3	Motor runs in a CCW direction The other values shall be set by K43, 49 and 50. When K36=2, execute Bank 3.

The parameter List in the Appendix 2 shall be referred to.

Example: K28.1=7612

- Input 1 = Motor Free
- Input 2 = Reset Alarm/Pause
- Input 3 = Execute Bank 1
- Input 4 = Go Origin

P V C

Output Logic K33

Description

This parameter sets the output logic.

Min	Max	Default	Description
00	11	11	0: Normally Open 1: Normally Closed

Output Order is Out2, 1. Each digit must be set individually.

Example: K33.1=01

- Input 1 = Normally Closed
- Input 2 = Normally Open

P V C

Output Functions K34

Description

This parameter assigns a function to an output. Assignable functions are shown in the table below.

#	Function	Description
0	Command	
1	In-Position	In-Position signal when the motor reaches the target position
2	Alarm	
3	General Use	O Command / F Command
4	General Use	O Command / F Command
5	Analog Out (must be assigned in the second digit)	Outputs analog waves for monitoring. Select a type of information by parameter K35
6	Output In-Posiiton Signal in Merge Mode	Outputs a signal at the passing points in Merge Mode (K73 shall be set)
7	Position Mark	Outputs a signal at certain intervals. K24 shall be set for its intervals.
8	Motor Free	Outputs a signal during motor free
9	Push Mode	Outputs a signal during the push mode

Min	Max	Default
00	99	21

Output Order is Out2,1. Each digit must be set indivisually.

Example: K34.1=51

- Input 1 = In-Position
- Input 2 = Analog Out

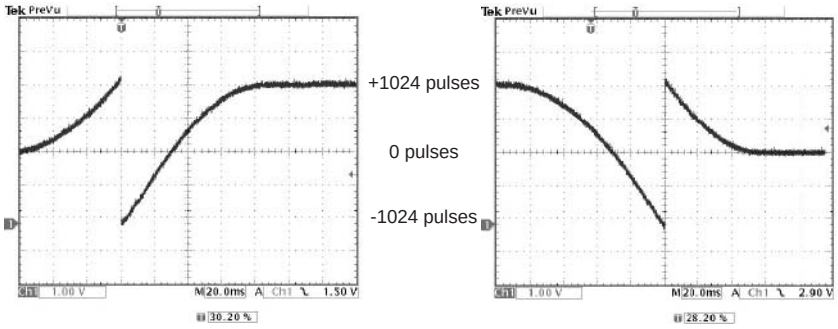
P V C

Analog Output K35

Description

This parameter sets an analog output type that you can monitor with an oscilloscope. Make sure that you select Analog Out by the parameter K34. The range of analog output is 0-5V. 2.5V is the baseline. The overall value is output but the analog output is displayed in the set range(0-5V).

*This function is assignable only to Output 2



#	Analog Output Types	Unit
0	Target Position	±1024 pulses/±2.5V
1	Target Position magnified by 8	±128 pulses/±2.5V
2	Current Position	±1024 pulses/±2.5V
3	Current Position magnified by 8	±128 pulses/±2.5V
4	Position Error	±1024 pulses/±2.5V
5	Position Error magnified by 8	±128 pulses/±2.5V
6	Current Velocity	±2400 rpm/±2.5V
7	Current Veocity magnified by 8	±300 rpm/±2.5V
8	Current Torque	±9.3 kgfcm/±2.5V(23L20) ±5.1 kgfcm/±2.5V(17L30)
9	Current Torque magnified by 8	±1.16 kgfcm/±2.5V(23L20) ±0.64 kgfcm/±2.5V(17L30)

Min	Max	Default
00	90	30

Output Order is Out2, 1. Each digit must be set individually.

*The first digit is 0 without fail.

P C

Pulse Type K36

Description

This parameter sets Pulse Type Cool Muscle to either CW/CCW or Step/Direction.

#	Type
0	CW / CCW
1	Step / Direction
2	Changes the assignable input functions, Manual Jog CW and CCW to Execute Bank 2 and 3. K28-K32 shall be referred to. (C type Only)

If you are using C type Cool Muscle, this parameter allows you to assign Execute Bank 2 and 3 to rising and falling edges of input signals when K36=2.

P V C

Motor Resolution K37

Description

This parameter sets the motor's resolution (pulse/rotation) and the speed unit that is used by the speed command (S). The value 0-10 and 40-50 sets the speed unit to 100pps, and 20-30 and 70-80 sets to 10pps.

Please set the speed unit 100pps in normal operation. When using the extremely slow speed, please set it to 10pps speed unit.

Speed Unit 100pps				Speed Unit 10pps			
#	Resolution	#	Resolution	#	Resolution	#	Resolution
0	200	40	300	20	200	60	300
1	400	41	400	21	400	61	400
2	500	42	600	22	500	62	600
3	1000	43	800	23	1000	63	800
4	2000	44	1200	24	2000	64	1200
5	2500	45	1500	25	2500	65	1500
6	5000	46	3000	26	5000	66	3000
7	10000	47	4000	27	10000	67	4000
8	25000	48	6000	28	25000	68	6000
9		49	8000	29		69	8000
10	50000	50	12000	30	50000	70	12000

Do not change the resolution when motor is running.

Incremental movement can not be executed when K37 value is over 40.

The max values for each resolution are as below.

#	Max	#	Max
0, 20	8,589,934	40, 60	13,421,772
1, 21	17,179,869	41, 61	17,895,697
2, 22	21,474,836	42, 62	26,843,545
3, 23	42,949,672	43, 63	35,791,394
4, 24	85,899,345	44, 64	53,687,091
5, 25	107,374,182	45, 65	67,108,863
6, 26	214,748,364	46, 66	134,217,727
7, 27	429,496,729	47, 67	178,956,970
8, 28	999,999,999	48, 68	268,435,455
9, 29	N/A	49, 69	357,913,941
10, 30	999,999,999	50, 70	536,870,911

Continious mode (P=1000000000) is still available in any resolution.

Cool Muscle's internal counter has a limitation as shown in the above table and the operation within this limitation is recommended.

As exceptions, Cool Muscle can be operated over Max. position value only by continuous position command (P=1000000000) or incremetal command.
However, when Pausing or Stopping over Max.position value by continuous or incremental positioning, the internal counter value becomes over limitation and a polar (plus or minus) of current position will be switched in the internal counter then Cool Muscle will be operated from a polar switched current position to a set target position. Therefore please do not operate over Max. position value in general use. When operation over Max. position value is required for an application such as only one direction operation, please execute Counter Reset" by command or input functions

V C

Analog Type K38

Description

This parameter sets V-type Cool Muscle to either speed or position control.

#	Object for Control
0	Speed Control (CW/CCW)
1	Position Control (CW/CCW)
2	Speed Control (CW)
3	Speed Control (CCW)

V C

Voltage Filter Gain K39

Description

Cut-off frequency for Low Pass Fliter for AD converter.

Min	Max	Default	Unit
0	1024	128	5 [rad/sec]

Unit: 5000 [times/sec] / 1024=5 [rad/sec]

V C

Analog Speed Range K40

Description

This parameter sets the speed at 4.8V for speed type analog Cool Muscle. Increase an analog input voltage up to 4.8V to increase the speed (K38 shall be set separately).

When K38=0, K40=2000

The speed will increase up to 2000rpm in CW direction by increasing an analog input voltage from 2.6V to 4.8V. The speed will increase up to 2000rpm in CCW direction by decreasing an analog input voltage from 2.4V to 0.2V. Note that an area between 2.4V and 2.6V is a dead zone within which no motion will occur.

When K38=2, K40=1000

The speed will increase up to 1000rpm in CW direction by increasing an analog input voltage from 0.2V to 4.8V.

When K38=3, K40=1200

The speed will increase up to 1200rpm in CCW direction by increasing an analog input voltage from 0.2V to 4.8V.

Min	Max	Default	Unit
200	4000	200	rpm

Note if supply the power to Cool Muscle applying an analog voltage, Cool Muscle may start running following the applied analog voltage. (K64 for the reference)

V C

Analog Distance Range K41

Description

Cool Muscle V-Type changes position in proportion to the input voltage from DC+0.2V to DC+4.8V. This parameter sets the maximum travel distance at 4.8V (K38 shall be set separatety).

Min	Max	Default	Unit
-32767	32767	2000	pulses

When K38=1, K41=4000

The distance will control from 0 to 4000pulses by increasing an analog input voltage from 0.2V to 4.8V. (K64 for the reference)

P V C

Speed for Origin Search K42

Description

This parameter sets the speed when the motor goes back to an origin.

Min	Max	Default	Unit
1	5000	10	100pps

P V C

Acceleration for Origin Search K43

Description

This parameter sets the acceleration used when the motor searches origin. This acceleration is also used for manual feed.

Min	Max	Default	Unit
1	5000	100	$Kpps^2$

C

Deceleration Ratio K44

Description

This parameter sets the deceleration ratio based on acceleration (defined by the "A" command). The deceleration can be set as a percentage of acceleration. Note that the percentage set by this parameter willl apply to all deceleration in CML program files.
(Refer to SECTION 9)

Min	Max	Default	Unit
10	500	100	%

P V C

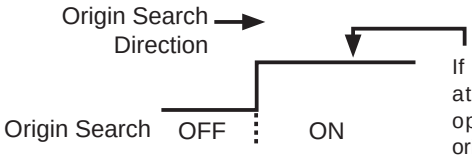
Origin Search Direction K45

Description

This parameter sets the direction for the origin search.

#	Direction
0 (Default)	CW
1	CCW

If origin search command is executed at the point where the origin sensor is on, the motor will move to the opposite direction until it detects the edge of the origin sensor signal.



If origin search command is executed at this point, motor will move in the opposite directin to move out of the origin sensor until it detects the edge of the signal.

P V C

Origin Search Method K46

Please set the proper input logic for Origin Sensor. If it is not set properly, motor recognizes as if sensor is on when it is off.

Description

This parameter specifies the method for the Origin Search. Origin can be determined using hard stop/bumper or an origin sensor. It also specifes if motor starts origin search automatically when the power is supplied to the motor.

#	Method
0 (Default)	Stopper / Bumper
1	Stopper / Bumper, Automatically when powered on
2	Origin Sensor
3	Origin Sensor, Automatically when powered on

The following related parameters shall be set separately

Stopper		Origin Sensor	
K42	Origin search speed	K42	Origin search speed
K43	Origin search acceleration	K43	Origin search acceleration
K45	Origin search direction	K27	Origin sensor
K47	Current level for Origin Search by Stopper		

P V C

Current Level for Origin Search by Stopper K47

When the acceleration for the origin search is set too high, the current level goes up to the set level by K47. Please reduce the K43 value in such a case.

Description

Sets the current level at which the motor will determine that the origin position has been reached during a stopper/bumper origin search routine. It is set by percentage.

Note ; The max, value 100 is the 80% of the motor's peak current.

Min	Max	Default	Unit
10	100	30	% of the peak current

P V C

Off Set Distance between Mechanical Origin And Electrical Origin K48

Description

This parameter sets the offset distance between the mechanical and electrical origins. The parameter is for the motor to find the mechanical origin then automatically go to the electrical origin (starting point). The mechanical origin and electrical origin are the same by the default parameter K48=0. The speed for moving from the mechanical origin to electrical origin is the same as the speed for the origin search.

Min	Max	Default	Unit
-32767	32767	0	x100 pulses

P V C

Manual Feed Speed K49

Description

This parameter sets the rotational speed for manual jog.

Min	Max	Default	Unit
1	5000	10	100 pps

P V C

Manual Jog Distance K50

Description

This parameter sets the travel distance for manual jog.

Min	Max	Default	Unit
1	100	10	1 pulses

Note ; The no speed and acceleration will be referred to for Manual Jog operation.

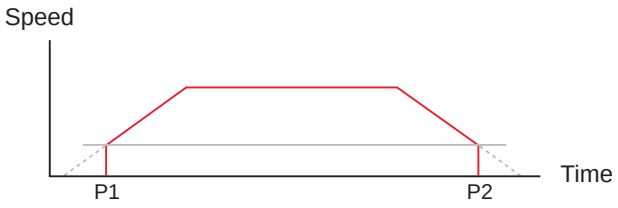
C

Creeping Speed K51

Description

Sets the creeping speed for the initial and terminal speed for a motion. The creeping speed is the speed from which motor starts to move and stop. The motion will be adjusted finely by changing creeping speed. Setting creeping speed too high may cause the motor to vibrate.

Min	Max	Default	Unit
1	100	10	100 pps



There is a number that can not be set by K37, “Resolution”.

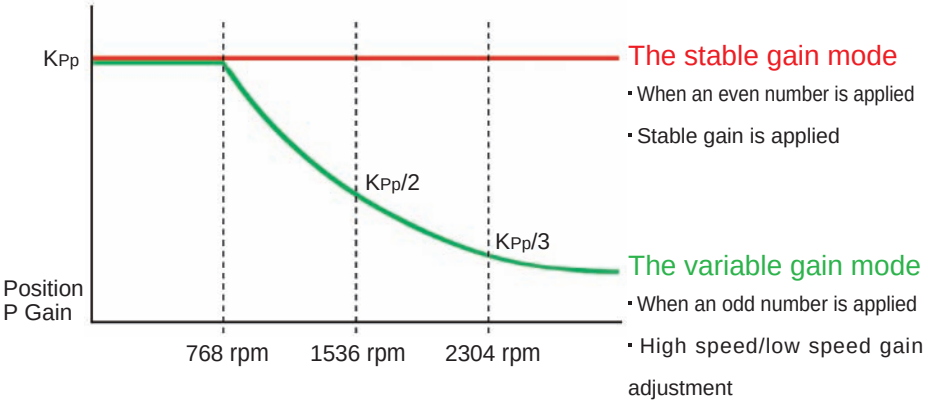
K51 Settable Value	K37		Resolution
more than 2	7	27	10000
more than 5	8	28	25000
more than 10	10	30	50000
more than 2	48	68	6000
more than 2	49	69	8000
more than 5	50	70	12000

P V C

Position P Gain K52

<Description>

Setting Position P Gain.



Refer to "The gain adjustment steps" in the Appendix 7.

For variable gain mode, setting gain value is applied to slow speed operation. Speed above 768rpm, the gain value reduces inverse proportion. When speed is 2304rpm, the gain value will be one-third of setting value. When K52=101, the gain value will be 100 during the slow speed (up to 768rpm) operation, and then the gain value reduces inverse proportion and when speed is 3000 rpm, the gain value will be 25.

* To switch stable gain mode and variable gain mode, it is switched by configuring an even number or an odd number.

<Setting value>

Min	Max	Default	Default for the shipping					
			11L	11S	17L	17S	23L	23S
0	300	50	70	70	151	50	151	50

* Each type of Cool Muscle has different default gain values for the shipping.

* When applying value outside range or it can accept, the values will not be changed.

When Cool Muscle other than Ver.2.25 and Ver.2.35 are handled, the values will be set back to default values above that are not to the default values for the shipping.

P V C

Speed P Gain K53

<Description>
Setting Speed P Gain

Refer to "The gain adjustment steps" in the Appendix 7.

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.
* To switch stable gain mode and variable gain mode, it is switched by configuring an even number or an odd number.

<Setting value>

Min	Max	Default	Default for the shipping					
			11L	11S	17L	17S	23L	23S
0	512	250	150	150	150	200	201	200

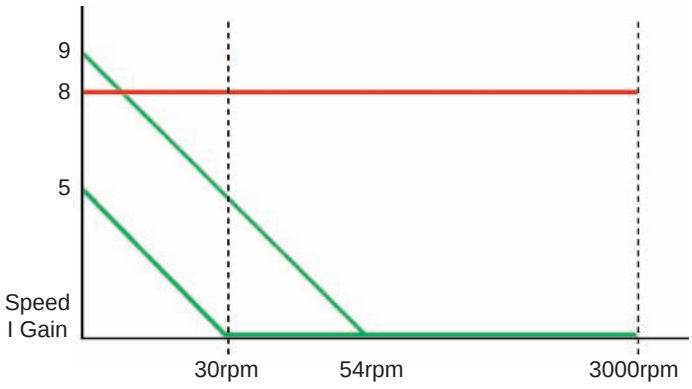
* Each type of Cool Muscle has different default gain values for the shipping.
* When applying value outside range or it can accept, the values will not be changed.
When Cool Muscle other than Ver.2.25 and Ver.2.35 are handled, the values will be set back to default values above that are not to the default values for the shipping.

P V C

Speed I Gain K54

<Description>

Setting Speed I Gain



The stable gain mode

- When an even number is applied
- Stable gain is applied

The variable gain mode

- When an odd number is applied
- High speed/low speed gain adjustment

Refer to "The gain adjustment steps" in the Appendix 7.

For variable gain mode, the speed that a set value and speed I gain become 0 is in the relation of proportion.

When K54=5, Speed I gain will be 0 after speed is getting over 30rpm. When K54=9, Speed I gain will be 0 after speed is getting over 54rpm

* To switch stable gain mode and variable gain mode, it is switched by configuring an even number or an odd number.

< Setting value>

Min	Max	Default	Default for the shipping					
			11L	11S	17L	17S	23L	23S
0	10	2	1	1	5	5	4	5

* Each type of Cool Muscle has different default gain values for the shipping.

* When applying value outside range or it can accept, the values will not be changed.

When Cool Muscle other than Ver.2.25 and Ver.2.35 are handled, the values will be set back to default values above that are not to the default values for the shipping.

P V C

In-Position Signal Range K55

In-positon signal is different from completion and is sent out when a motor reaches within the set pulse by K55.
A motor sends out an in-posiiton signal before reaching at the target position when under the conditions as a resolution is small, a motor speed is low and K55 value is big.

Description

Cool Muscle outputs an in-position signal and this parameter sets the range for an in-position.

When target position is 1000

K55=1

In-position signal will be sent out within the position 999 to 1001.

K55=5

In-position signal will be sent out within the position 995 to 1005.

Min	Max	Default	unit
1	100	5	Pulses

When a too small value is applied to this parameter, Cool Muscle will not detect an in-position and not be able to execute the next step.

P V C

Error Counter Over Flow K56

Description

This parameter sets the max value for the counter over flow error. If the error exceeds the set value, then the motor goes into a motor fee state.

Min	Max	Default	Unit
1	8000	50	K Pulse

P V C

Over Load Time K57

Cool muscle monitors the level of the regenerated voltage. If the dangerous regenerated voltage is detected, the motor becomes free.

Description

This parameter sets the time delay between the detection of overload and alarm signal output.

Min	Max	Default	Unit
100	10000	3000	msec

P V C

Software Limit CW K58

Software Limit CCW K59

Description

These parameters set the software limit on both CW and CCW sides. When the motor hits the limit position it immediately stops. In a Program Bank, the positioning over the limit can not be executed. When the distance is set to 0 (default value), there is no limit. Set + value for K58 and - value for K59.

	Min	Max	Default	Unit
K58	0	32767	0	100pulses
K59	-32767	0	0	100pulses

C

Push Mode Current Level K60

Description

This parameter sets the current level for the Push Mode. The currrent level can be set by percentage.

Note ; the max value 80 means 80% of the 80% of motor's peak torque.

Min	Max	Default	Unit
10	80	50	%

C

Push Mode Holding Time K61

Description

This parameter sets the holding time for the Push Mode.

The Push Mode time shall be from when current level goes up to the set level by the parameter K60 until motor finishes pushing an object. The endless push mode can be applied by setting K61=3001.

Min	Max	Default	Unit
10	3001	200	msec

C

Analog Input Setting K64

K40 value is always referred to, when K64 is set to either 2, 3 or 4.
Depending on the analog voltage level when the power is supplied to a motor, a motor possibly moves to the opposite direction from the set direction.

Description

This parameter sets the object controlled by an analog input.

#	Control type	Function
0	Normal	No Analog Control
1	Speed Control	Adjust S0 value within K40 range
2	Position Control	Adjust P0 value within K41 range
3	Speed Control	Adjust S13 value within K40 range
4	Position Control	Adjust P24 value within K41 range
9	V type	Normal V type operation

0: No analog function is assigned.
1: Increase an analog input voltage from 0.2V to 4.8V to increase the S0 value within the parameter K40 range.
2: Increase an analog input voltage from 0.2V to 4.8V to increase the P0 value within the parameter K41 range.
3: Increase an analog input voltage from 0.2V to 4.8V to increase the S13 value within the parameter K40 range.
4: Increase an analog input voltage from 0.2V to 4.8V to increase the P24 value within the parameter K41 range.
9: Normal V type operation.
refer to K38.

C

Baud Rate between Slave Motors K65

Description

This parameter sets the baud rate between slave motors in the Daisy Chain operation.

#	Baud Rate
0	38.4Kbps
1	9.6Kbps
2	19.2Kbps
3	57.6Kbps

*Please set the baud rate from the last motor in the Daisy Chain operation.

C

Gain for S-Curve K69

Description

This parameter sets the Gain for S-curve.

From 0 to 1024 can be applied. When 0, motor makes a trapezoidal motion and when 1024, motor makes a S-Curve motion.

Min	Max	Default
0	1024	0

P V C

Delimiter K70

Description

This parameter sets the delimiter at the end of replied data.

#	Delimiter
0	CR
1 (Default)	CRLF

P V C

Temperature Alarm Detection Level K71

Alarm reset is available after detected temperature goes down below (K71-10 ℃) degrees.

Description

This parameter sets the temperature alarm detection level.

When the temperature in the driver case that is detected exceeds this set value, [Ux=128 Tempareture Alarm] is output, and Cool Muscle will go into a Motor Free state.

Note; This parameter works at CM1 Type A series only.

P V C

Over Voltage Detection Level K72

Description

This parameter sets the over voltage detection level.

When the voltage of DC+24V that is detected exceeds this set value, [Ux=2 Over Voltage Alarm] output, and Cool Muscle will go into a Motor Free state.

Relating parameter : K57

The even number : The overvoltage is detected.

The odd number : The overvoltage is not detected.

When the regenerated energy is large, the alarm is generated, it is necessary to have the absorption circuit outside.

Note; This parameter works at CM1 Type A series only.

The Output Signal Range in Merge Mode K73

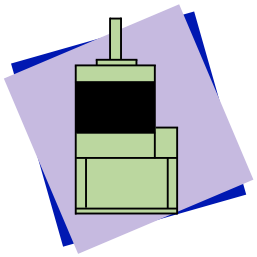
Description

This parameter sets the range of the signal that is output at the passing point in merge mode.

Note ; when the range is too wide in spite of the motor speed is high, the output siganls will be united and only one signal will be output through the merge mode operation.

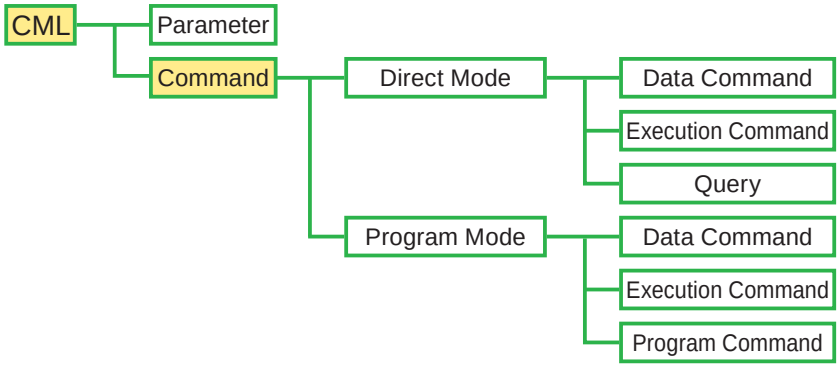
When the range is too narrow, the output level will not turn off until it passes the next target position and passes the multiple target position with one output signal. Please reduce the K73 value in such a case.

Min	Max	Default	Unit
0	1000	10	msec



SECTION 8
SETTING COMMANDS

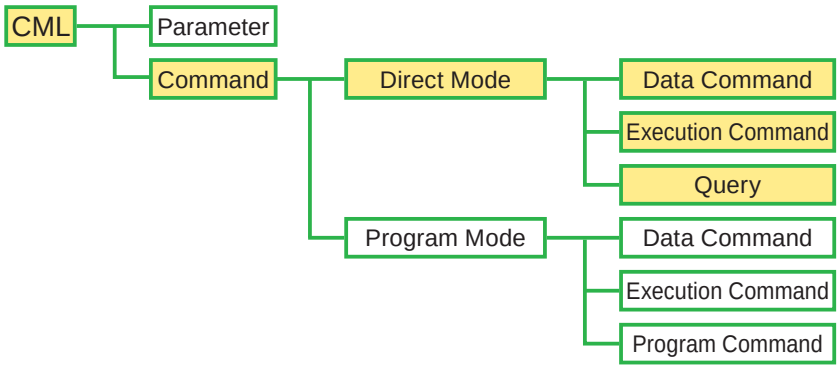
This section guides you to the details of commands and instruction for setting. Please refer to Appendix 3 for Command List.



Please put ".ID" (Motor ID) after all parameters to specify Cool Muscle of the object.
It becomes effective by inputting "Enter ↵ " after each data.

Direct Mode

This section contains Data Commands, Execution Commands and Queries for the Direct Mode.



P V C

Data Commands for Direct Mode

Position P

Description

This parameter can define the position for Direct Mode.

P.1=10000 (Unit: Pulse)

P.1=1000000000 is for continuous motion. Cool Muscle keeps running in a CW direction endlessly. Enter - value for the speed for CCW continuous motion.

Speed S

Description

This parameter can define the speed for Direct Mode.

S.1=250 (Unit: 100pps/10pps (Refer to K37))

Acceleration A

Description

This parameter can define the acceleration for Direct Mode.

A.1=250 (Unit: $Kpps^2$)

P V C

Execution Commands for Direct Mode

It becomes effective by inputting "Enter↵" after each data.

Execution ^

Description

Execute the Direct Mode referring to the defined data.

P.1=100000

S.1=200

A.1=100

^

Pause]

Description

] is the command to pause Cool Muscle's operation. Enter " ^ " again to restart.

Pause the Operation of the specified ID]1

Description

Pause the operation of the specified ID in the Daisy Chain operation.

Note this command is functional only in the Direct Mode.

Example:]1.3

Pause only ID3 Cool Muscle by Direct Command during Daisy Chain operation.

Origin Search	|

Description

Start Origin Search. The Origin Method shall be set by K46.

Go to Position 0	|1

Description

Makes the motor go to position 0.

Counter Clear	|2

Description

Clears the position counter and make the current position to 0.

Motor Free	)

Description

De-energizes the motor windings, leaving the rotor free to rotate. The motor's driver board and encoder remain activated, therefore there is no mis-steps.

Enable Motor	(

Description

Use this command to enable the motor in a Motor Free state.

Output On	O
Output Off	F

Description

On and Off the specified output discretionary.

K34 shall be set to 3 or 4.

Emergency Stop	*

Description
Make all Cool Muscle stop by max deceleration by sending Emergency Stop command.
This function can be assigned to inputs but shall not be assigned when operating in Communication Mode.

The cancellation of Emergency Stop is required when going back to normal operation after Emergency Stop.
When Emergency Stop is assigned as K27, K30=7, the normal operation will be executed by turning the input signal off.

Emergency Stop Cancellation	*1

Description
This command is required when going back to the operation after the Emergency Stop.

Data Save	$

Description
Saves CML Program Bank and P, S, A and T values to Cool Muscle. K parameter values are automatically saved when changed.

Example:
$.1
Saved!
$.2
Saved!
$.3
Saved!

When data is saved correctly, Saved! message will be replied from Cool Muscle.

P V C Query

Display the specified information.

<table>
<tr><th>Command</th><th>Function</th><th>Comment</th></tr>
<tr><td>?0-30.n</td><td>Bank
ID number must be 1</td><td>?0: Show the content of the direct mode.
?1-30: Show the content of the bank 1-30.</td></tr>
<tr><td>?70.n</td><td>Input status</td><td>Display input status by 16 numbering system
<table>
<tr><td>Input</td><td>4</td><td>3</td><td>2</td><td>1</td><td></td><td></td></tr>
<tr><td>Status</td><td>8</td><td>4</td><td>2</td><td>1</td><td>Status</td><td>Breakdown</td></tr>
<tr><td rowspan="16">Signal</td><td>X</td><td>X</td><td>X</td><td>O</td><td>In.n=1</td><td>1</td></tr>
<tr><td>X</td><td>X</td><td>O</td><td>X</td><td>In.n=2</td><td>2</td></tr>
<tr><td>X</td><td>X</td><td>O</td><td>O</td><td>In.n=3</td><td>2+1</td></tr>
<tr><td>X</td><td>O</td><td>X</td><td>X</td><td>In.n=4</td><td>4</td></tr>
<tr><td>X</td><td>O</td><td>X</td><td>O</td><td>In.n=5</td><td>4+1</td></tr>
<tr><td>X</td><td>O</td><td>O</td><td>X</td><td>In.n=6</td><td>4+2</td></tr>
<tr><td>X</td><td>O</td><td>O</td><td>O</td><td>In.n=7</td><td>4+2+1</td></tr>
<tr><td>O</td><td>X</td><td>X</td><td>X</td><td>In.n=8</td><td>8</td></tr>
<tr><td>O</td><td>X</td><td>X</td><td>O</td><td>In.n=9</td><td>8+1</td></tr>
<tr><td>O</td><td>X</td><td>O</td><td>X</td><td>In.n=A</td><td>8+2</td></tr>
<tr><td>O</td><td>X</td><td>O</td><td>O</td><td>In.n=B</td><td>8+2+1</td></tr>
<tr><td>O</td><td>O</td><td>X</td><td>X</td><td>In.n=C</td><td>8+4</td></tr>
<tr><td>O</td><td>O</td><td>X</td><td>O</td><td>In.n=D</td><td>8+4+1</td></tr>
<tr><td>O</td><td>O</td><td>O</td><td>X</td><td>In.n=E</td><td>8+4+2</td></tr>
<tr><td>O</td><td>O</td><td>O</td><td>O</td><td>In.n=F</td><td>8+4+2+1</td></tr>
</table></td></tr>
<tr><td>?71.n*</td><td>Temperature in driver case</td><td>The present temperature in driver case</td></tr>
<tr><td>?72.n*</td><td>Power-supply voltage</td><td>The present power-supply voltage level</td></tr>
<tr><td>?74.n</td><td>Analog input value</td><td>The voltage level of analog-input</td></tr>
<tr><td>?85.n</td><td>Version title</td><td>The title of the version</td></tr>
<tr><td>?90.n</td><td>User parameter</td><td>The user parameter from K20 to K82</td></tr>
<tr><td>?91.n</td><td>Position list</td><td>All the position data (1-25)</td></tr>
<tr><td>?92.n</td><td>Speed list</td><td>All the speed data (1-15)</td></tr>
<tr><td>?93.n</td><td>Acceleration list</td><td>All the acceleration data (1-8)</td></tr>
<tr><td>?94.n</td><td>Timer list</td><td>All the timer data (1-7)</td></tr>
<tr><td>?95.n</td><td>Position error</td><td>Deviation of positioning</td></tr>
<tr><td>?96.n</td><td>Current position</td><td>The current position</td></tr>
<tr><td>?97.n</td><td>Current speed</td><td>The current speed</td></tr>
<tr><td>?98.n</td><td>Current torque</td><td>The current torque</td></tr>
<tr><td>?99.n</td><td>Motor status</td><td>The Current motor status
Ux.n=0 Running
Ux.n=1 Counter Overflow / Push Mode Error
Ux.n=2 Over Speed / Regenerative Current
Ux.n=4 Overload
Ux.n=8 Inposition
Ux.n=16 Motor Free
Ux.n=32 During Push Mode
Ux.n=40 End of Push Mode
Ux.n=128 Temperature Alarm
Ux.n=255 Emergency Stop Alarm
The above status numbers could be combined.</td></tr>
<tr><td>?1000.n</td><td>Contents of Bank Programs</td><td>Show all the contents in Bank Programs</td></tr>
</table>

*Type A series only

About Alarm / Status

Content of display of the following Alarm / Status information

0 : During motor running

1 : When positioning / Deviation Counter Overflow

- ●The alarm when the deviation between motor's current position and target position becomes bigger than the value set by K56
- ●When in push mode / Reaching at Target Position
- ●The alarm when reaching the target position before completion of Push Mode operation

2 : Over Speed or Re-generative Current

- ●The alarm when motor can not reach the target acceleration or when re-generative current is generated by steep deceleration

4 : Over Load

- ●The alarm when motor can not move because of external over load

8 : In-position

16 : Motor Free

- ●The alarm when motor becomes free intentionally by Command or Input Signal

32 : During Push Mode

40 : Completion of Push Mode

128 : Over Heat

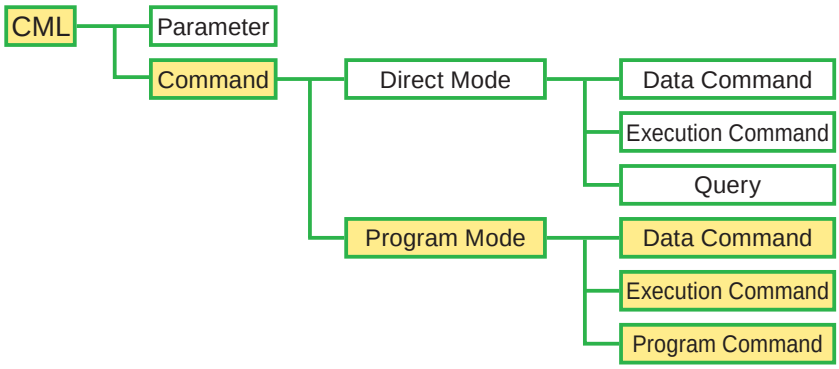
- ●The alarm when the temperature in the driver board is more than the set value by K71
- ●The alarm can be canceled when the temperature goes down to K71–10 degrees then motor becomes operative

255 : Emergency Stop

- ●The emergency stop status by " * " command. Motor will become operative by the emergency stop cancellation command " *1"
- ●When emergency stop function is assigned to inputs, motor will be operative by turn off the input signal

Program Mode

This section contains Data Commands and Execution Commands for the Program Mode. Commands for creating and executing program banks are explained.



C

Data Commands for Program Mode

Position	P

Except 1000000000, K37 in the page SC7-51, Parameter Setting shall be referred to for the max values for P command at each resolution.

Description

This parameter can define multiple positions(Max.25). The position set by the P command is absolute. To make values relative, add "+" after memory location. Once positions are defined, you can query the position data by memory number.

When the value is P.1=1000000000, Cool Muscle will run continuously CW as defined by speed setting. To make Cool Muscle run continuously in a CCW direction, set the speed value to a negaive value.

Example:

P23.1=250000

Set 250000 pulses to the memory 23 of ID1 motor.

P24.2=1000000000

Set endless target position to memory 24 of ID2 motor.

Memory#	Min	Max	Unit
25	-1000000000	1000000000	pulses

Speed S

Description

This parameter can define multiple speeds(Max.15). The speed unit can be set to either 100pps or 10pps by the parameter K37.

Example:

S10.2=20

Set the 2000pps to the memory 10 of ID2 motor

Memory#	Min	Max	Unit
15	1	32767	100pps or 10pps

Acceleration A

Description

This parameter can define multiple accelerations (Max.8). The accelerations set by this command are absolute. This command in combination with K44 also defines deceleration.

Example:

A2.3=200

Set 200Kpps^2 to the memory 2 of ID3 motor.

Memory#	Min	Max	Unit
8	1	32767	Kpps^2

Timer T

Description

This parameter can define multiple timers (Max.7).

Example:

T1.1=1000

Set 1000msec to the memory 1 of ID1 motor.

Memory#	Min	Max	Unit
7	1	32767	msec

Incremental	+

When executing an incremental program after rotating a motor shaft in motor free status, motor moves to a relative position from the current position before motor free. Execute "Counter Reset" in this case.

Description
By adding "+" after memory location of P command, the P value can be relative position data against the current position.

Example:
When current position is 10000
reference P data P1.1=1000

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

After execution, motor moves to P=11000

C Execution Commands for Program Mode

Execute Program Bank	[

Description
Execute the specified program bank
The ID number for execution command must always be 1 because the ID1 Cool Muscle manages all program banks.

Example:
[1.1
Execute Bank 1

Cool Muscle will send “End!!” status via communication line when finishing a program bank.

When alarm situation occurs during the daisy-chain operation, all daisy-chained motor shall be stopped.
Cancel the alarm and make the origin search then re-start a program.

Pause]

Description

] pauses Cool Muscle with deceleration that is the same as the current acceleration. Alarm shall be canceled as well.

[re-starts the motion that is currently paused.

Entering] twice will stop the motor completely. ( ]↵]↵)

Stop After Current Motion }

Description

Entering } will stop the motor when it completes the current line of the bank program.

Entering } twice will stop the motor completely. (}↵ }↵)

Execute Next Line >

Description

Entering > will execute a program line by line. This command is useful when debugging programs.

Example:

```
B1.1
A1.1,S1.1,P1.1
A2.1,S2.1,P2.1
A3.1,S3.1,P3.1
End
```

Entering > will execute line by line. The motor goes to P1.1, then to P2.1, by the next > command then to P3.1.

Execute Previous Line <

Description

Entering < will execute the previous line in a program bank.

Note ; This command will not be functional in some program such as Y or Z command is used in a line.

C

Program Commands

After parameters and motion values are defined, you can start creating motion programs. The command structure using A, S, P and T in a program bank is as below.

Cool Muscle moves to a target position referring to A and S data before P data in a program bank. Therefore A and S must be defined before P in a program bank.

B1.1
A1.1,S1.1,P1.1 (Go to P1 with S1 and A1)
End

Motion commands are separated by a comma. The speed and acceleration that are applied to reach the target position must be placed before the P command.
The max steps that each motor can store is 500. Each command is counted as one step. For example, there are four steps in the above program bank.

ID1 Cool Muscle manages all motion including the other Cool Muscles in the network. ID number for the B command must always be 1.

Program Bank B

Description
This command defines the beginning of a program bank and a program bank number as well. The max number for program banks is 30. Note that when you enter the B command, all the existing program banks will be erased.

Example 1 :

B1.1	The beginning of program bank 1
A1.1,S1.1,P1.1	Go to P1 with A1 and S1
A1.1,S2.1,P3.1	Go to P3 with A1 and S2
End	

To save the file by text format(.txt) is recommended to transfer the file directly from Cool Works or Hyper Terminal. It is also recommended to edit the content of the program.

Example 2 :
B1.1
A1.2,S1.2,P1.2,A1.3,S1.3,P1.3
End

ID2 and ID3 motors go to P1 with A1 and S1

ID1 Cool Muscle manages all motion including the other Cool Muscles in the network. ID number for the B command must always be 1.

Call C

Description

This command calls and executes specified program bank. After execution of the called program bank by C command, it comes back to the original program bank.

Example:

```
B1.1                beginning of program bank 1
C2.1                call B2 and execute
C3.1                call B3 and execute
B2.1                beginning of program bank 2
A1.1,S3.1,P1.1
B3.1                beginning of program bank 3
A2.1,S2.1,P3.1
End
```

Jump J

Description

This command jumps to and executes specified program.

The difference from the C command is that after execution of jumped bank by J command, it will not come back to the original program bank.

The other usage is the same as C command.

Example:

```
B1.1                beginning of program bank 1
J2.1                jump and execute program bank 2
B2.1                beginning of program bank 2
A1.1,S3.1,P1.1
End
```

Output On	O

Output Off	F

Description
The O command turns the specified output on and the F command turns the specified output off.
K34 shall be set to 3 or 4.

Example:
B1.1
A2.1,S1.1,P1.1
O2.1 Motor moves to P1 with A2 and S1 then turn output 2 on.
P2.1
F2.1 Then moves to P2 with A2 and S1 then turn output 2 off.

End

It is effective as the trigger signal to other equipment.

Input	I

Input T0 (No Action) command when you do not make the motor work after it diverges by the presence of the signal. (Refer to SC8-80)

Description
This command makes a Cool Muscle perform specified actions or program banks based on the specified input status. This command takes the following form.

I#.ID,Action when true, Action when false

Example:
B1.1
I4.1,C2.1,C4.1
End

If input 4 is on, execute program bank 2. If input 4 is off, execute program bank 4.

Push Mode Q

Description

The Q command takes the position value defined in a position memory location and commands Cool Muscle to perform a push mode.

When entering Q1, Cool Muscle starts pushing against the P1 as a target position. Cool Muscle will push an object against the target position for the given time at a set current level by the parameter K60. Set K61=3001 for the continuous push mode.

Push Mode error (Ux=1) will occur when reaching at the target position before the completion of Push Mode. Please set the target position further ahead of the object for Push Mode.

By "]", the pause command, Cool Muscle stops pushing the object but still remain in torque control mode. Then by "]", pause command again, full stop command, Cool Muscle stops controlling its torque.

The target position for a push mode shall be a couple of rotations beyond an object. When the deviation between the object and target position is too small, the current will not go up to the set level and push mode will not be executed properly.

Example

```
B1.1
A1.1, S1.1,P1.1
S2.1,Q2.1
End
```

Goes into a push mode between P1 and P2 referring to K60 for the current level and K61 for its time.

Loop X

Description

You can specify the number of times for a specific program bank to loop. The times shall be specified after X.

The max value for X command is 255. The ID number for X command must always be 1.

The value X0 (zero) = infinite loops. When the loop is not specified (without X), program will be executed only once.

When the number for the loop is not specified (no number after X), program shall be considered as X0 and loops continuously.

Example:

```
B1.1
X3.1        Execute the reciprocating motion between P1 and P2 three times.
A1.1,S1.1,P1.1
P2.1
End
```

Program banks must finish with P command for the last positioning. When networking, a program bank must finish with P commands for all motors.

P command without a wait Y

Description

When the Cool Muscles are networked, a master motor waits for in-position signals from slave motors before executing the next line in a program bank (with P command). Y command instead of P command enables networked motors to execute motion without waiting for in-positions of the specified motor at Y position.

Example:

```
B1.1
A1.2,S1.2,Y1.2
A1.1,S1.1,P1.1
End
```

When paused during the positioning by Y command, Origin Search is required after full stop.

The ID1 motor moves to P1 without waiting for an in-position of the ID2 motor at P1 (Y1).

Q command without a wait — Z

Description

The definition of the Z command is the same as the Y command. Z command instead of Q command enables networked motors to execute motion without waiting for in-position of the Push Mode of the specified motor at Z position.

Example:

```
B1.1
A1.3,S1.3,Z1.3
A1.2,S1.2,P1.2
End
```

The ID2 Cool Muscle moves to P1 without waiting for an in-position of the Push Mode of the ID3 Cool Muscle at Z1(P1).

Max 30 characters (include "/") can be used for a comment. The characters must be English one byte character.

Comment — /

Description

Comments can be entered after a "/" in the CML program files. Comments are not downloaded to Cool Muscle.

No Action — T0

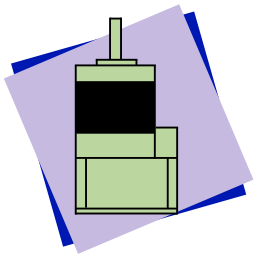
Description

This command is used with the I command and executes No Action then goes to the next line in a program bank.

Example:

```
B1.1
I4.1,C2.1,T0.1
A1.1,S1.1,P4.1
B2.1
A1.1,S3.1,P2.1
End
```

When input 4 is true, execute bank 2. When input 4 is false, execute T0 then move to P4.



C

Refer to Appendix 7 about Merge Mode.

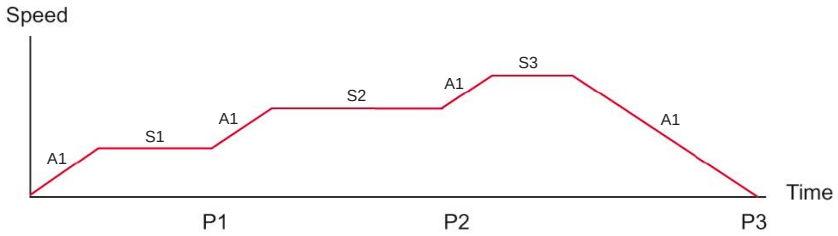
SECTION 9
BASIC CML PROGRAM EXAMPLE

Continuous Point to Point motion with different speeds (Merge Mode)

B1.1

A1.1, **S1.1, P1.1, S2.1, P2.1, S3.1, P3.1**

By combining the motion commands in 1 line in a program bank, the motion below is created.



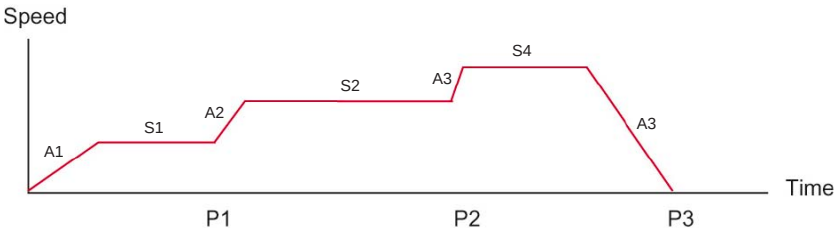
As compared to basic point to point motion, the program bank above has no stops in its motion between Origin and P3. Speed is changed at each point and the acceleration and deceleration remaine equal throughout.

Continuous Point to Point motion with different speeds and accelerations (Merge Mode)

B2.1

A1.1, **S1.1, P1.1, A2.1, S2.1, P2.1, A3.1, S4.1, P3.1**

Including acceleration changes at each point and increasing the speed prior to the last point may create motion similar to the chart below.



Motion definitions

```
A1=10
A2=50
A3=100
S1=200
S2=100
S3=250
P1.1=5000
P2.1=0
P3.1=-15000
T1.1=200
```

Basic Point to Point motion

```
B1.1
A1.1,S1.1,P1.1
T1.1
A2.1,S2.1,P2.1
T1.1
A3.1,S3.1,P3.1
T1.1
A2.1,S2.1,P2.1
END
```

Move to position P1 with acceleration A1 and speed S1
Wait for T1 time
Move to position P2 with acceleration A2 and speed S2
Wait for T1 time
Move to position P3 with acceleration A3 and speed S3
Wait for T1 time
Move to position P2 with acceleration A2 and speed S2

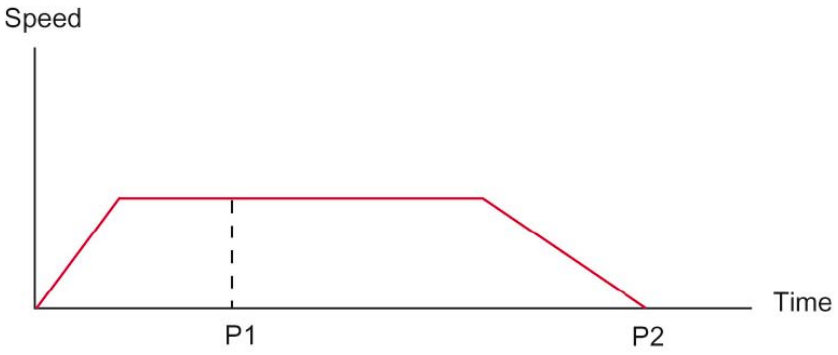
Point to Point motion with different deceleration

The deceleration rate is always equal to the last acceleration rate specified taking into account the value of parameter K44.
This can be modified in two ways. The first way is to set the Acceleration / Deceleration Ratio parameter. This results in setting ratio for every motion. The second way is to place multiple commands within a single line of CML, it is possible to specify both an acceleration and a deceleration. Suppose the final destination is P2 and a quick acceleration followed by a slow deceleration is required.

Motion definitions
A2.1=50
A3.1=8
S2.1=100
P1.1=5000
P2.1=15000

Example :

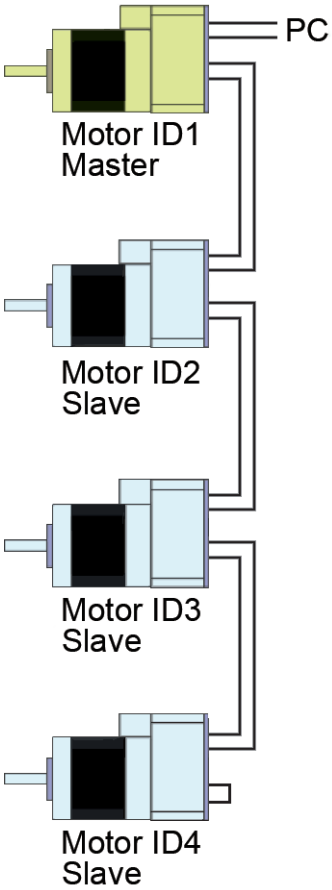
```
B1.1
A2.1,S2.1,P1.1,A3.1,P2.1
END
```



Keeping the speed across the two points equal and changing the acceleration value will give you a different deceleration to reach the final destination.

C Networking Cool Muscle

Cool Muscle serial networks are arranged for daisy chain communication and formed by a master motor that is closest to an upper controller and slave motors.
The master motor manages all program banks to control all networked motors. Motion definitions (P, S, A) are stored in each motor. However, only Timer definition refers to master motor's data. Then only the master motor will respond to a "[" execution command.



Master motor has program banks to control all 4 motors .

Slave motors have motion definitions as P, S and A data. Parameters shall be set up for each motor as well.

Defining Motion for Multiple Motors

When programing multiple motors, the motor ID numbers need to be specified at each step in a program banks. Once motor ID is specified, the same ID number is applied to the following steps until another ID number is specified again. The specified data by ID numbers shall be downloaded to each motor.

```
.1      (ID 1 / Master)
P1=1000
P2=2000
S1=200
A1=100
A2=300
.2      (ID 2)
P1=2000
P2=2500
S1=200
S2=400
A1=100
A2=300
.3      (ID 3)
P1=20000
P2=24000
S1=300
S2=400
A1=50
A2=300
.4      (ID 4)
P1=5000
P2=12500
S1=150
S2=75
A1=100
A2=150
$.1
$.2
$.3
$.4
```

Save all data above to all networked motors.

ID numbers can be specified in the following format as well.

P1.1=1000
Set the position1 data of ID1 motor as 1000 pulses
P1.2=2000
Set the position1 data of ID2 motor as 2000pulses
P1.3=2000
Set the position1 data of ID3 motor as 2000pulses
S1.2=400
Set the speed1 data of ID2 motor as 40000pps

How to create network program

Network of Cool Muscle is formed by a master motor and slave motors. Therefore, the master motor shall have the program banks for all slave motors. Note that program shall be made through the ID number order.

Basic network program example 1:

```
.1
P1=10000,P2=20000,P3=0
S1=100,S2=200
A1=50,A2=100
.2
P1=30000,P2=0
S1=200,S2=300
A1=50,A2=100
.3
P1=20000,P2=0
S1=125,S2=100
A1=20,A2=150
.4
P1=12500,P2=0
S1=150,S2=75
A1=15,A2=40
$.1
$.2
$.3
$.4
(Save all data above to all networked motors)

B1.1
A1.1,S1.1,P1.1,A1.2,S1.2,P1.2
P2.1,P2.2
P3.1
END
```

Line 1 : Commands for both motors in the same line make both motors start at the same time. The ID1 motor moves to P1 with S1 and A1 and the ID2 motor moves to P1 with S1 and A1.

Line 2 : After both motors have reached the first target positions , they execute the motion defined by line 2. The ID1 motor moves to P2 with S1 and A1. The ID2 motor moves to P2 with S1 and A1.

Line 3 : After both motors have reached the target positions, the ID1 motor moves to P3 with S1 and A1.

Basic network program example 2:

```
.1
P1=10000,P2=20000,P3=0
S1=100,S2=200
A1=50,A2=100
.2
P1=30000,P2=0
S1=200,S2=300
A1=50,A2=100
.3
P1=20000,P2=0
S1=125,S2=100
A1=20,A2=150
.4
P1=12500,P2=0
S1=150,S2=75
A1=15,A2=40
$.1
$.2
$.3
$.4
(Save all data above to all networked motors)

B1.1
A1.1,S1.1,P1.1,A1.2,S1.2,P1.2
P2.1,Y2.2
P3.1
END
```

Line 1 : Commands for both motors in the same line make both motors start at the same time. The ID1 motor moves to P1 with S1 and A1 and the ID2 motor moves to P1 with S1 and A1.

Line 2 : After both motors have reached the first target positions , they execute the motion defined by line 2. The ID1 motor moves to P2 with S1 and A1. The ID2 motor moves to P2 with S1 and A1.

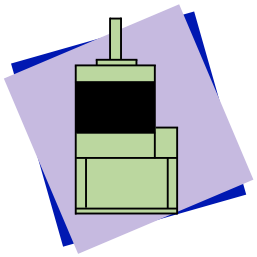
Line 3 : After the ID1 motor have reached the target position, the ID1 motor moves to P3 with S1 and A1 without wait the ID2 motor.

Basic network program example 3:

```
.1
P1=10000,P2=20000,P3=0
S1=100,S2=200
A1=50,A2=100
.2
P1=30000,P2=0
S1=200,S2=300
A1=50,A2=100
.3
P1=20000,P2=0
S1=125,S2=100
A1=20,A2=150
.4
P1=12500,P2=0
S1=150,S2=75
A1=15,A2=40
$.1
$.2
$.3
$.4
(Save all data above to all networked motors)

B1.1
A1.1,S1.1,P1.1
A1.2,S1.2,P1.2
A1.3,S1.3,P1.3
A1.4,S1.4,P1.4
S2.1,P3.1,S2.2,P2.2,A2.3,P2.3,A2.4,P2.4
END
```

Line 1 : The ID1 motor moves to P1 with S1 and A1.
Line 2 : The ID2 motor moves to P1 with S1 and A1.
Line 3 : The ID3 motor moves to P1 with S1 and A1.
Line 4 : The ID4 motor moves to P1 with S1 and A1.
Line 5 : The ID1 motor moves to P3 with S2 and A1, the ID2 motor moves to P2 with S2 and A1, the ID3 motor moves to P2 with S2 and A1, the ID4 motor moves to P2 with S2 and A1, at the same time.

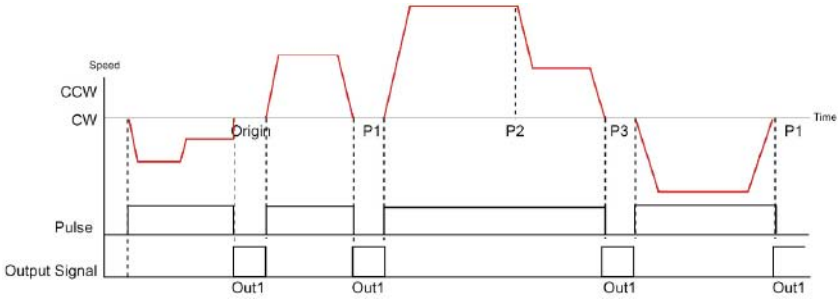


C

SECTION 10
APPLIED CML PROGRAM EXAMPLE

This section shows you applied CML program examples using the parameters and commands.

Ex. 1 : Setting I/O Functions



Parameters

K25=1122 (Set time delay between quick and slow response signal to 0.1sec, 0.1sec, 0.2sec, 0.2sec for input 4,3,2,1)
K26=1111 (Set input logic for Input 4,3,2,1 to active high)
K27=2000 (Set QTV functions)
K31=0217 (Set SR functions)
K32=0200 (Set SF functions)
K33=00 (Set output logic for output 2,1 to active high)
K34=21 (Set output functions)

Input

	QTV	SR	SF
Input 1		Origin Search	
Input 2		Alarm Reset	
Input 3		Motor Free	Enable Motor
Input 4	Origin Sensor		

Output

	Output Signal
Output 1	In-Position
Output 2	Alarm

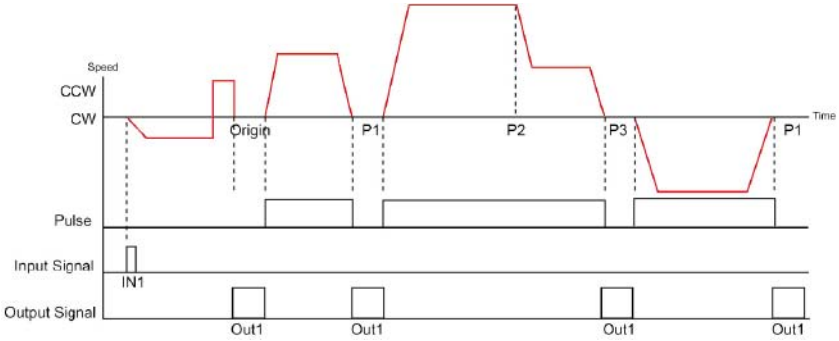
Program Bank

B1.1
S1.1,A1.1,P1.1
S2.1,A2.1,P2.1,S3.1,P3.1
S1.1,A1.1,P1.1

Motion Description

This example shows you that multiple functions can be assigned to a single input. K25 sets the time delay between quick and slow response signals.

Ex. 2 : Origin Search using a bumper



Parameters

K25=1122 (Set the time duration between the quick and slow response signal)
K26=1111 (Set the input logic to the active high)
K27=0000 (Set functions to the target voltage level of the quick response signal)
K28=0007 (Set functions to the rising edge of the quick response signal)
K31=0210 (Set functions to the rising edge of the slow response signal)
K32=0200 (Set functions to the falling edge of the slow response signal)
K33=00 (Set the output logic to the active high)
K34=21 (Set the output functions)
K42=15 (Set the Origin Search speed)
K43=150 (Set the Origin Search acceleration to 150Kpps^)
K45=0 (Origin Search direction CW)
K46=0 (Set the Origin Search Method)
K46=0 (Set the Origin Search Method)
K47=30 (Set the current level for Origin Search by Stopper)

Input

	QR	SR	SF
Input 1	Origin Search		
Input 2		Alarm Reset	
Input 3		Motor Free	Enable Motor

Output

	Output Functions
Output 1	In-position
Output 2	Alarm

Program Bank

B1.1

S1.1,A1.1,P1.1

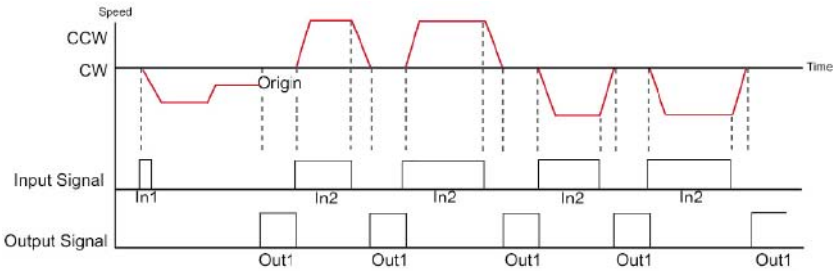
S2.1,A2.1,P2.1,S3.1,P3.1

S1.1,A1.1,P1.1

Motion Description

The previous example showed you how to search for the origin using an origin sensor. As an alternative, you can use a bumper or stopper to make the motor search for the origin. The motor starts to search for the origin when input 1 goes high (at the rising edge of a quick response signal). The motor turns in a CW direction at the speed and with the acceleration set by parameter K42 and K43.
The motor determines that it has found or reached the origin when its current reaches 30% of its peak current.

Ex. 3 : Manual Feed and Jog



Parameters

K25=1122 (Set the time duration between the quick and slow response signal)
K26=1111 (Set the input logic to active high)
K28=9810 (Set functions to the rising edge of the quick response signal)
K30=4300 (Set functions to the target voltage level of the slow response signal)
K33=00 (Set output to active high)
K34=21 (Set output functions)
K42=15 (Set the speed for origin search)
K43=150 (Set the acceleration for origin search)
K45=0 (Set the origin search direction)
K46=1 (Set the origin search method)
K49=15 (Set Manual Feed speed)
K50=20 (Set Manual Jog pulses)

Input

	QR	STV
Input 2	Alarm Reset	
Input 3	Manual Jog CW	Manual Feed CW
Input 4	Manual Jog CCW	Manual Feed CCW

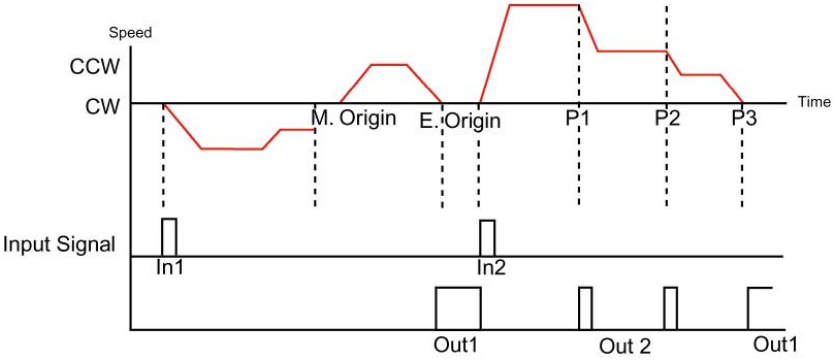
Output

	Output Functions
Output 1	In-position
Output 2	Alarm

Motion Description

The example shows manual jog and manual feed. The travel distance for the manual jog is set to 20 pulses by parameter K50.
The speed for manual feed is set to 1500pps by parameter K49.
The acceleration for manual feed is the same as the acceleration for the Origin Search. A short signal (less than 0.2sec) will trigger manual jog which turns the motor 20 pulses. If a signal longer than 0.2sec is sent, the motor turns continuously for the duration of the signal. In this case, manual jog and manual feed are merged.

Ex. 4 : Electric orientation with continuous PTP program



Parameters

K25=1122 (Set the time duration between the quick and slow response signal)

K26=1111 (Set the input logic)

K27=2000 (Set functions to the target voltage level of the slow response signal)

K28=0167 (Set functions to the rising edge of the quick response signal)

K33=00 (Set output to active high)

K34=21 (Set the output functions)

K42=15 (Set the speed for origin search)

K43=150 (Set the acceleration for origin search)

K45=0 (Set the origin search direction CW)

K46=1 (Set the origin search method)

K48=-100 (Set the off-set for the origin search)

Input

	QR	QTV
Input 1	Origin Search	
Input 2	Execute Bank 1	
Input 3	Pause/Alarm Reset	
Input 4		Origin Sensor

Output

	Output Functions
Output 1	In-position
Output 2	Alarm

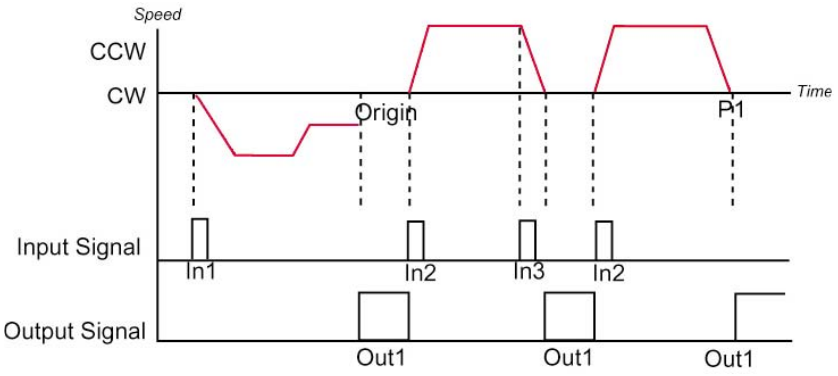
Program Bank

B1.1
S1.1,A1.1,P1.1,S2.1,P2.1,S3.1,P3.1
End

Motion Description

By setting the offset distance between the mechanical and electric origins, you can make the motor automatically move to the electric origin after it finds or goes to a mechanical origin. In this example, the electric origin is set to 10000 pulses away from the mechanical origin.
A program in Bank 1 is executed at the rising edge of the quick response signal on Input 2.

Ex. 5 : Pause



Parameters

K25=1122 (Set the time duration between the quick and slow response signal)
K26=1111 (Set the input logic)
K28=0761 (Set functions to the rising edge of the quick response signal)
K33=00 (Set the output logic)
K34=21 (Set the output functions)
K42=15 (Set the speed for origin search)
K43=150 (Set the acceleration for origin search)
K45=0 (Set the origin search direction CW)
K46=1 (Set the origin search method)

Input

	QR
Input 1	Pause/Alarm Reset
Input 2	Execute Bank 1
Input 3	Origin Search

Output

	Output Function
Output 1	In-position
Output 2	Alram

Program Bank

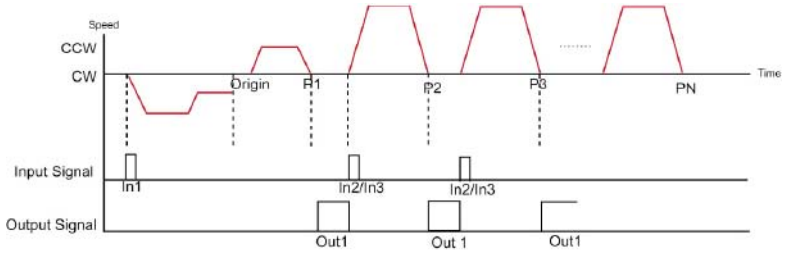
B1.1

S1.1,A1.1,P1.1

Motion Description

This example shows how you can pause a program. During the execution of Bank 1, the motor is paused somewhere in between the origin and P1. By making Input 2 high, the paused program will be resumed.

Ex. 6 : Bank Select using nesting



Parameters

K25=2222 (Set the time duration between the quick and slow response signal)
K26=1111 (Set the input logic)
K27=2111 (Set functions to the target voltage level of the quick response signal)
K28=0667 (Set functions to the rising edge of the quick response signal)
K33=00 (Set the output logic)
K34=21 (Set output functions)
K42=15 (Set the speed for origin search)
K43=150 (Set the acceleration for origin search)
K45=0 (Set the origin search direction)
K46=1 (Set the origin search method)

Input

	QR	QTV
Input 1	Origin Search	
Input 2	Execute Bank 1	General Use
Input 3	Execute Bank 1	General Use
Input 4		Origin Sensor

Output

	Output Function
Output 1	In-position
Output 2	Alarm

Program Bank

B1.1
T1.1
I2.1,C2.1,C3.1
B2.1
I3.1,C4.1,T0.1
S2.1,A1.1,P3.1
B3.1
I3.1,C5.1,T0.1
B4.1
S3.1,A1.1,P4.1
B5.1
S1.1,A1.1,P1.1
End

Motion Description

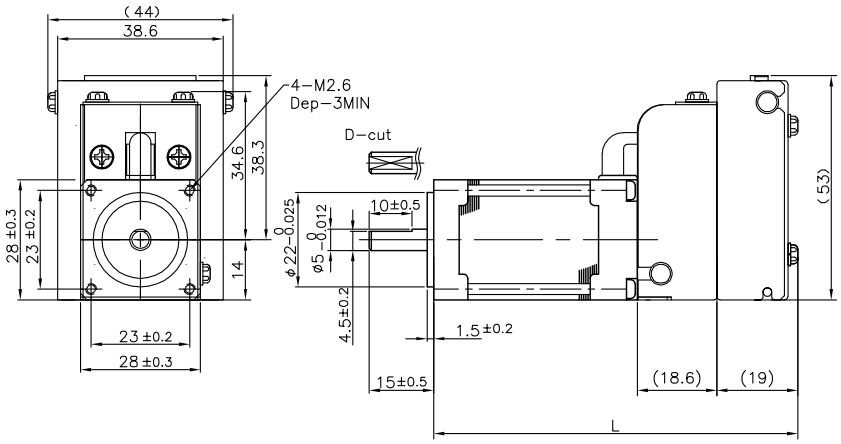
You can select a bank via digital inputs by using a nesting technique. The above motion program shows how you can program in such a way as to allow for bank select using two input ports.

Input 2	Input 3	Bank	Motion
high	low	B2	no action→P3
low	low	B3	no action
high	high	B4	P4
low	high	B5	P1

Appendix 1
Cool Muscle Dimensions

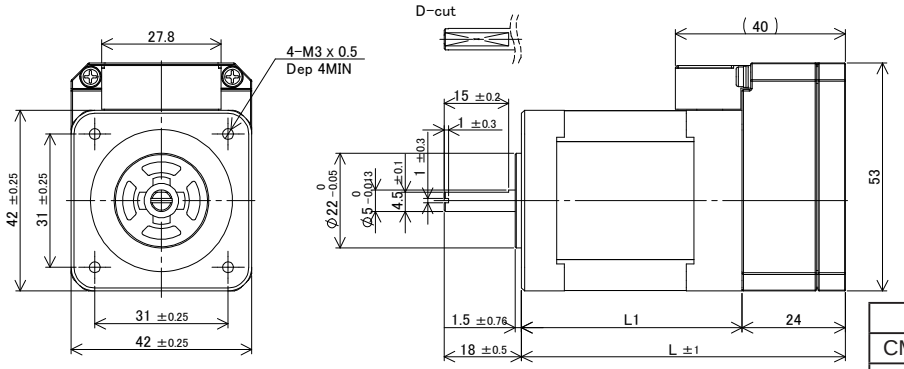
Unit (mm)

CM1-□-11□30



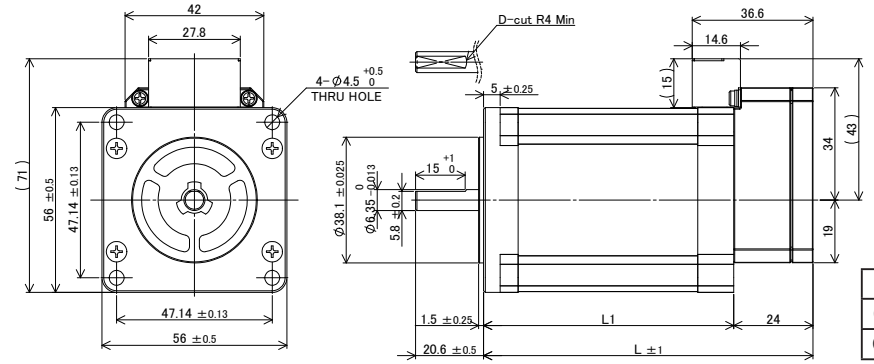
MODEL	L
CM-□11L30A	85
CM-□11S30A	71

CM1-□-17□30



MODEL	L1	L
CM-□17L30C	51.5	75.5
CM-□17S30C	36.5	60.5

CM1-□-23□□



MODEL	L1	L
CM-□ 23L20C	76	100
CM-□ 23S30C	42	66

Cool Muscle Specifications

Specification	CM1-☐-11		CM1-☐-17		CM1-☐-23	
	-L30	-S30	-L30	-S30	-L20	-S30
Motor Output Power	18W	9W	18W	18W	30W	45W
Max. Speed	3000rpm	3000rpm	3000rpm	3000rpm	2000rpm	3000rpm
Rated Continuous Torque Kgfcm(Nm)	0.56(0.055)	0.28(0.027)	3.7(0.36)	0.84(0.082)	8.9(0.87)	3.0(0.294)
Rated Peak Torque Kgfcm(Nm)	0.8(0.79)	0.4(0.039)	5.3(0.518)	1.2(0.117)	12.7(1.24)	4.3(0.42)
Load Inertia Allowance $g \cdot cm^2$	180	80	760	380	4600	1400
	Depending on the load inertia, servo gain needs to be adjusted within the above range: adjustable by parameters					
Motor Inertia $g \cdot cm^2$	18	8	74	36	360	100
Encoder	Incremental Magnetic Encoder(50000 pulses/Rotation)					
Control Method	Closed Loop Vector Control					
Input Supply Voltage	DC24V±10%					
Input Supply Current Rated (Continuous/Rated Peak)	1.2A/1.5A	0.8A/1.0A	1.5A/1.8A	0.8A/1.0A	2.6A/3.4A	3.9A/5.1A
Relosution Pulse Rotation (Pulse/Rotation)	From 200 to 50000 Set by parameter					
Environmental Conditions Operation/Storage	0℃～+40℃/-20℃～+60℃ No condensation condition					
Operative Humidity	Less than 90% RH					
Impact/Vibration	Less than 10G/Less than 1G					
Weight (Approx.)	300g	240g	480g	330g	1100g	550g

【Cool Muscle Parts Life Time】

The life time of each part depends on the actual operating conditions and how it has been used.

Defective parts should be replaced or repaired immediately.

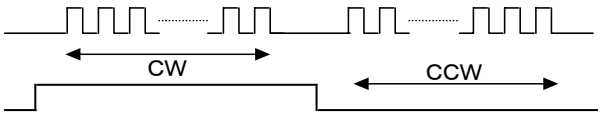
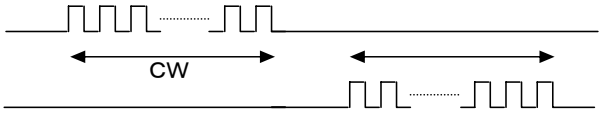
Part	CM1-☐-11		CM1-☐-17		CM1-☐-23	
	-L30	-S30	-L30	-S30	-L20	-S30
Grease	13 thousand hours		5 thousand hours			

Input / Output Signal

Input Signal	Voltage Specification : INPUT1+ - INPUT1- / High Level>3V INPUT2+ - INPUT2- / Low Level<0.8V INPUT3 / High Level>4.2V INPUT4 / Low Level<0.8V

Pulse Type : Command by input pulse signal.

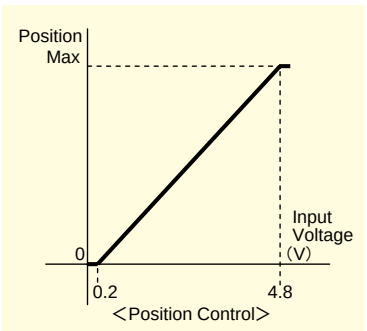
Cool Muscle moves following input pulse signal to input 1 and 2 (number of pulse for angle and pulse frequency for speed)

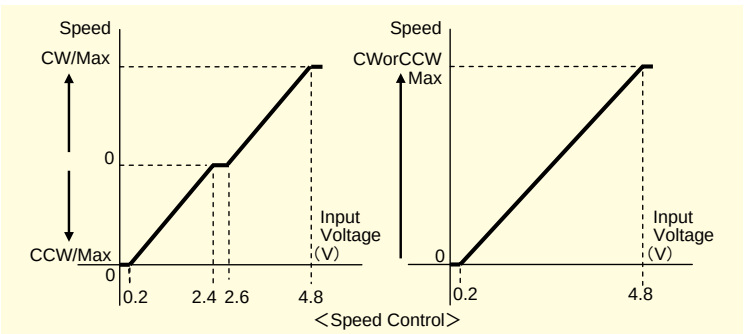
Method	Signal	Pattern of Signal and Motion
Step/Direction Pulse	Step	
	Direction	
CW/CCW Pulse	CW	
	CCW	

Max. Frequency : 500Kpps / Min Pulse Range : 0.8 micro sec

Analog Type : OP Amp usage is recommended (INPUT4) Resolution : 1024

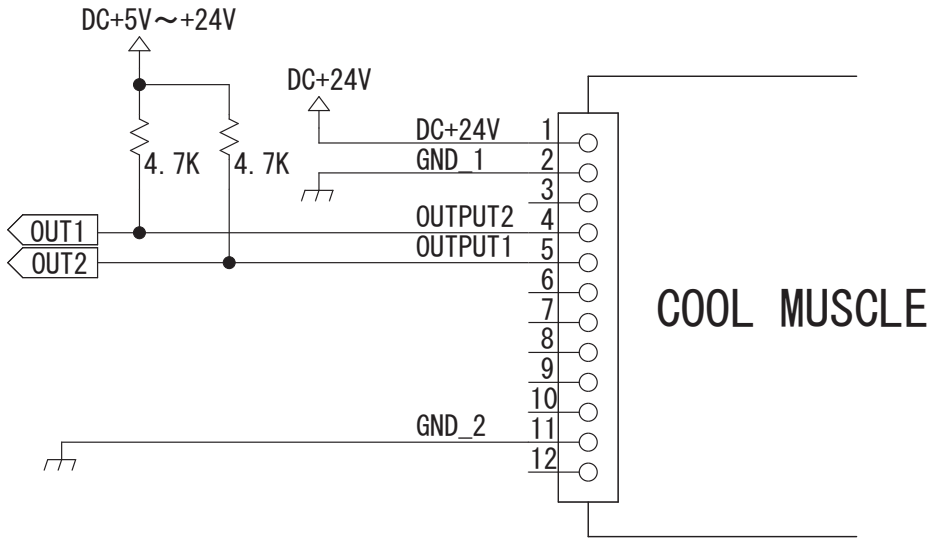
Method	Pattern of Signal and Motion
Position Control (Rotate Angle)(Distance)	Position control by input vlotage from 0V to DC+4.8V. Max. position range is settable by parameter
Speed Control (Rotate Direction/Speed)	The speed control in proportion to an input voltage from 0.2V to 4.8V. The max speed can be set by a parameter. Analog Voltage 2.6V to 4.8V : Increase speed in CW direction Analog Voltage 2.4V to 0.2V : Increase speed in CCW direction Or Analog Voltage 0.2V to 4.8V : Increase speed either in CW or CCW direction



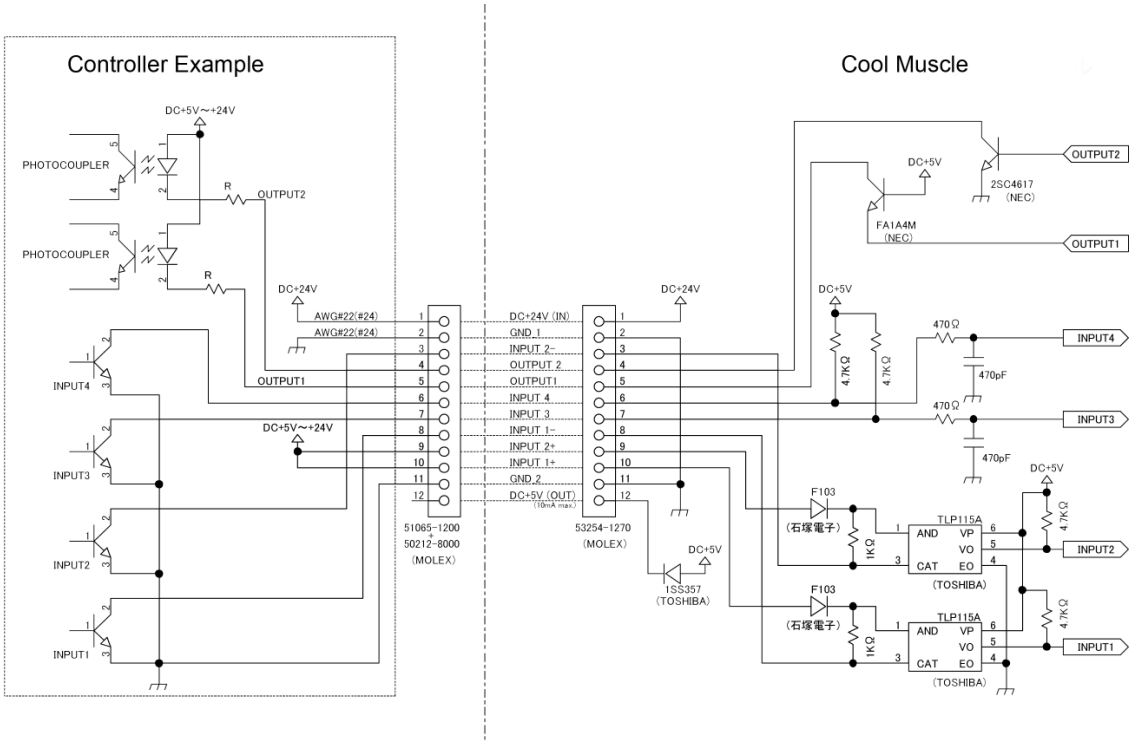


Computer Type : Digital Input (RS-232C)

INPUT1/2 shall be used for serial communication. Max. baud rate for communication : 57.6Kbps

Output Signal	High Level Output Voltage DC+5V - 24V(Recommended: 5V) Low Level DC+0.8V
Condition for Output Signal Measurement	

Interface Wiring Example



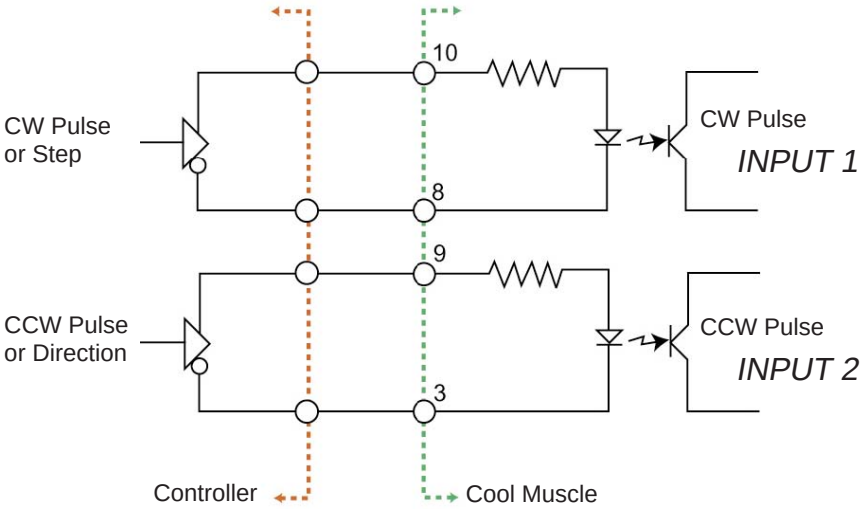
* Please make sure to turn off the motor before turning off the Controller.
And make sure to turn on the Controller before turning on the motor.

I/O Wiring Example

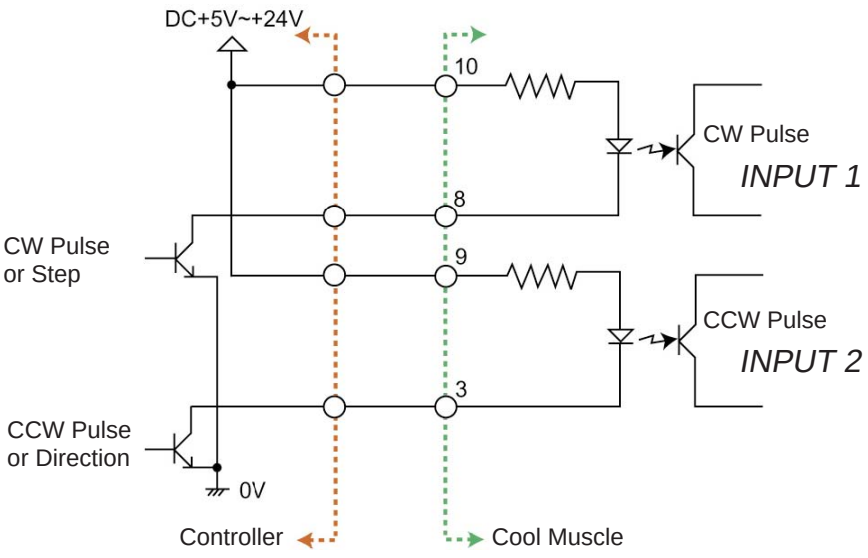
P

Pulse Type (CW/CCW or Step/Direction)

1. Linedriver



2. Open Collector



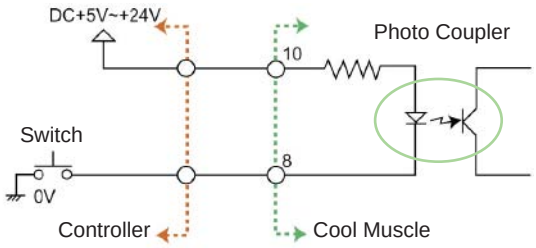
Open-collector output is not appropriate for the long length wiring.
In case of long wiring distance such as over 1 meter, the Open-collector output is not appropriate to connect. Please change to Line driver output.
(Refer to: WA-1)

V C

Digital Input: Switch and PLC

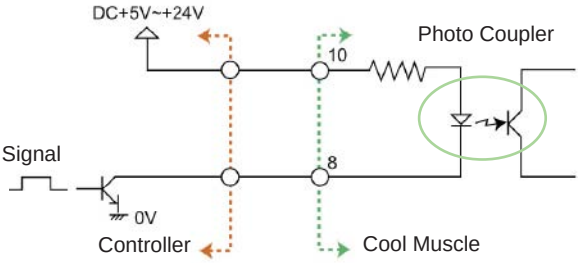
INPUT 1

Switch



It is recognized that it exists on the Cool Muscle side when the switch on the controller side is turned on.
The logic of the signal can be set by the parameter.

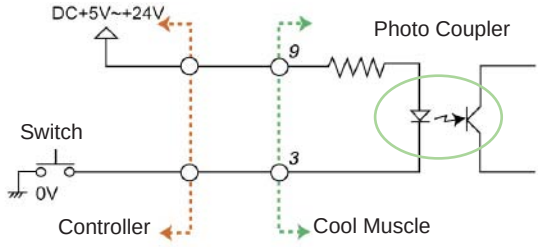
PLC



It is recognized that it exists on the Cool Muscle side when the transistor on the controller side is turned on.
The logic of the signal can be set by the parameter.

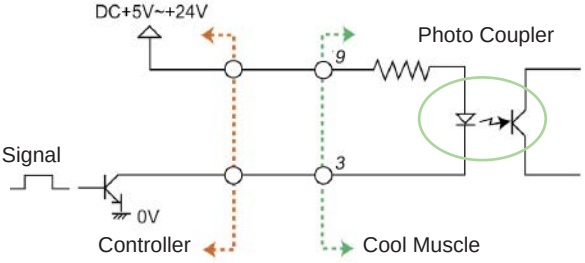
INPUT 2

Switch



It is recognized that it exists on the Cool Muscle side when the switch on the controller side is turned on.
The logic of the signal can be set by the parameter.

PLC

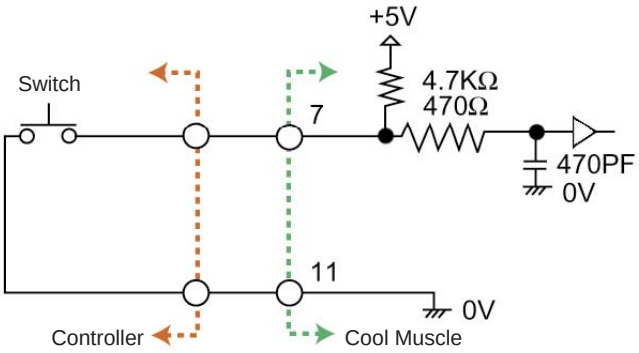


It is recognized that it exists on the Cool Muscle side when the transistor on the controller side is turned on.
The logic of the signal can be set by the parameter.

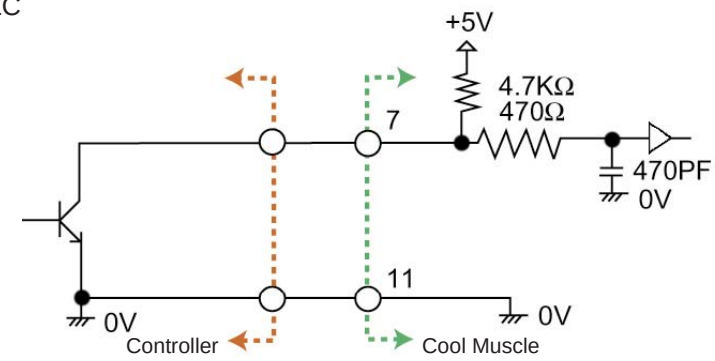
INPUT 3 (Max 5V)

P V C

Switch



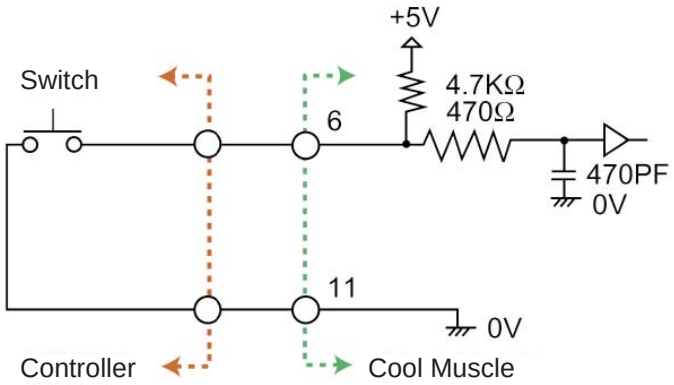
PLC



INPUT 4

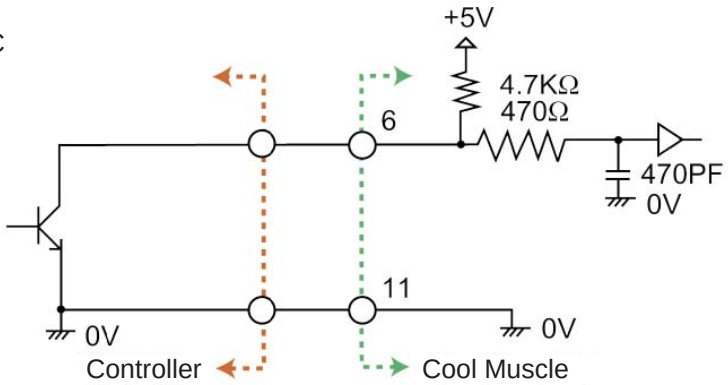
P C

Switch



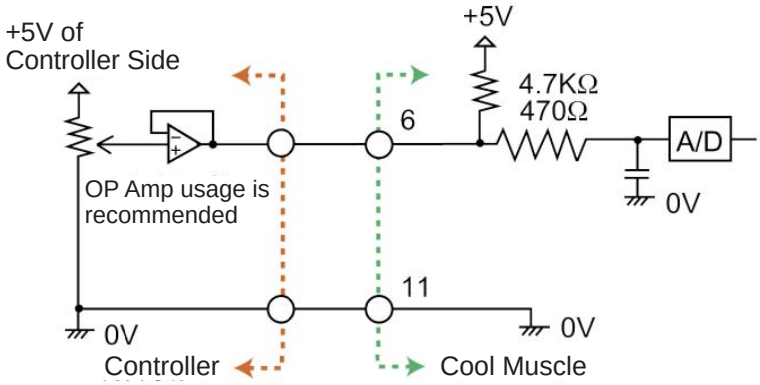
P C

PLC



V C

Analog

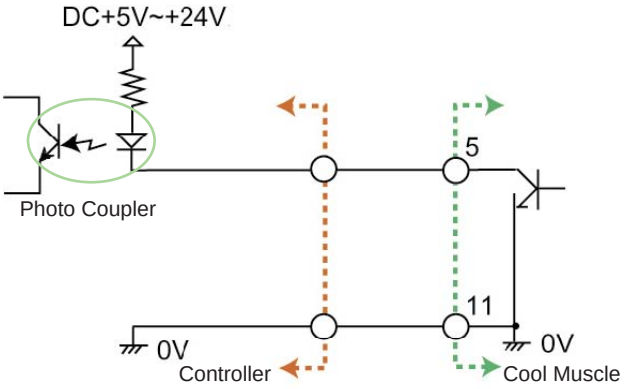


P V C

Output

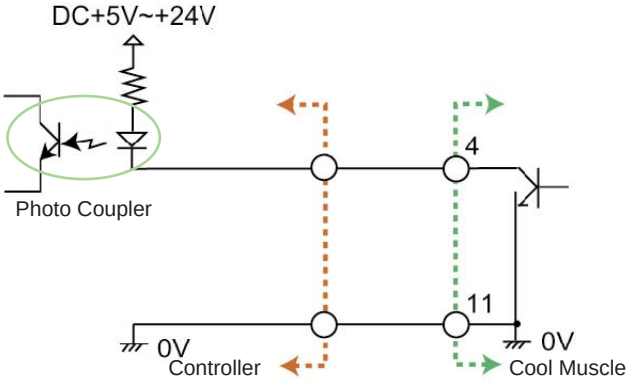
OUTPUT 1

Digital Output

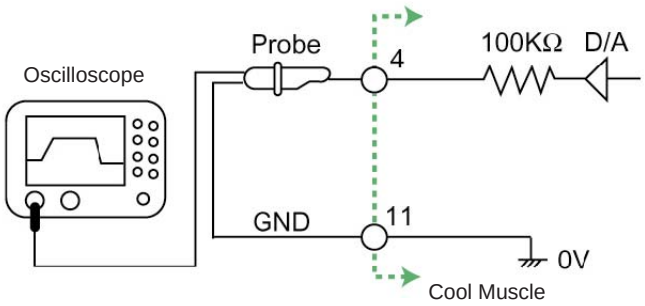


OUTPUT 2

Digital Output



Analog Output



Appendix 2

Parameter List

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
20	Baud Rate	0	3	0	-	0 : 38.4K, 1 : 9.6K, 2 : 19.2K, 3 : 57.6K	P,V,C
21	Full/Semi Closed	0	36	0	0.1°	0:Full Closed Loop 1:Set the range for the motor to remain in Open Loop mode. The unit is plus or minus 0.1degree(Max.36=3.6degrees). When the motor moves off the set angle, it goes into Closed Loop mode and back to the target position.	C
22	Time Delay for Semi Closed Mode	10	1000	200	msec	Set the time delay for the motor to go into an Open Loop mode after in-position signal	C
23	Motor Status	0	31	1	-	Described in Binary Code 0: Polling 1: In-position and Alarm 2: Report when input signal changes 4: Report when output signal changes 8: No Local Echo(No return input signal) 16: Display Error Messages (available only with C-type motor) Error: Out Of Range!! : Unsettable values for K parameters Error: syntax error : Description in Bank program is wrong Error: too many steps : Steps in Bank program are more than 500 [End Bank] : Bank programs are ended properly Change Baud Rate ?? ××× kbps (Y/N) : Confirmation Message when Baud Rate is changed by K20 or K65 error : CW Limit !! : CW Limit Sensor ON error : CCW Limit !! : CCW Limit Sensor ON Note) The numbers above can be combined by addition. Max. value is 31	P,V,C
24	Position Mark	10	32767	1000	pulses	Turn output on/off at regular intervals with Pulses(Set K34=7)	P,V,C
25	Time Delay for Slow Response Signal	1111	9999	3333	0.1sec	Set the time delay for slow response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually.	P,V,C
26	Input Logic	0000	1111	0000	-	Set the input logic. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: Active by Low level signal 1: Active by High level signal	P,V,C

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
27	Input Function at Target Voltage Level of Quick Response Signal	0000	9999	0000	-	Assign functions at the target voltage level of quick response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: No Action 1: General Use 2: Origin Sensor Signal 3: Manual Feed CW 4: Manual Feed CCW 5: -- 6: CW Direction Limit Sensor (dual usage as CW origin sensor) 7: Emergency Stop (Stop by max. deceleration) 8: Full Stop (the same as]↵]↵) 9: CCW Direction Limit Sensor (dual usage as CCW origin sensor)	P,V,C
28	Input Function at Rising Edge of Quick Response Signal	0000	9999	0100	-	Assign functions at the rising edge of quick response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: No Action 1: Alarm Reset/Pause 2: Motor Free 3: Reset the Position Counter 4: Execute the Next Line 5: Execute the Previous Line (Availability depends on the program) 6: Execute Bank 1 7: Start Origin Search 8: Manual Jog(CW) (Set K36=2, execute Bank 2) 9: Manual Jog(CCW) (Set K36=2, execute Bank 3)	P,V,C
29	Input Function at Falling Edge of Quick Response Signal	0000	9999	0000	-	Assign functions at the falling edge of quick response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: No Action 1: Alarm Reset/Pause 2: Enable Motor 3: Reset the Position Counter 4: Execute the Next Line 5: Execute the Previous Line (Availability depends on a program) 6: Execute Bank 1 7: Start Origin Search 8: Manual Jog(CW) (Set K36=2, execute Bank 2) 9: Manual Jog(CCW) (Set K36=2, execute Bank 3)	P,V,C

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
30	Input Function at Target Voltage Level of Slow Response Signal	0000	9999	0000	-	Assign functions at the target voltage level of slow response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: No Action 1: General Use 2: -- 3: Manual Feed CW 4: Manual Feed CCW 5: -- 6: CW Direction Limit Sensor (dual usage as CW origin sensor) 7: Emergency Stop(stop by max deceleration) 8: Full Stop (the same as][↵][↵) 9: CCW Direction Limit Sensor (dual usage as CCW origin sensor)	P,V,C
31	Input Function at Rising Edge of Slow Response Signal	0000	9999	0200	-	Assign functions at the rising edge of slow response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: No Action 1: Alarm Reset/Pause 2: Motor Free 3: Reset the Position Counter 4: Execute the Next Line 5: Execute the Previous Line (Availability depends on a program) 6: Execute Bank 1 7: Start Origin Search 8: Manual Jog CW (When K36=2, execute Bank 2) 9: Manual Jog CCW (When K36=2, execute Bank 3)	P,V,C
32	Input Function at Falling Edge of Slow Response Signal	0000	9999	0200	-	Assign functions at the falling edge of slow response signal. Input Order is In4, 3, 2, 1. Each digit must be set individually. 0: No Action 1: Alarm Reset/Pause 2: Enable Motor 3: Reset the Position Counter 4: Execute the Next Line 5: Execute the Previous Line (Availability depends on a program) 6: Execute Bank 1 7: Start Origin Search 8: Manual Jog CW (Set K36=2, execute Bank 2) 9: Manual Jog CCW (Set K36=2, execute Bank 3)	P,V,C

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
33	Output Logic	00	11	11	-	Set Output Logic Output Order is Out2, 1. Each digit must be set individually. 0: Active by High level signal when output is on 1: Active by Low level signal when output is on	P,V,C
34	Output Function	00	99	21	-	Assign Output functions Output Order is Out2, 1(Analog output can be assigned only at Output2). Each digit must be set individually. 0: No Output 1: Inposition 2: Alarm 3: General Use 4: General Use 5: Analog Output(must be assigned in the second digit) 6: Output Inposition signal in Merge Mode 7: Position Mark 8: Motor Free 9: Push Mode	P,V,C
35	Analog Output Function	00	90	30	-	When K34 is set to 5(analog output), one of the functions below shall be set Analog wave shall be monitored in the actual size or magnified by 8 times. Each digit must be set individually. 0: Target Position 1: Target Position(Magnified by 8) 2: Current Position 3: Current Position(Magnified by 8) 4: Position Error 5: Position Error(Magnified by 8) 6: Current Velocity 7: Current Velocity(Magnified by 8) 8: Current Torque 9: Current Torque(Magnified by 8)	P,V,C
36	Pulse Interface	0	2	0	-	Set the P-type motor to either CW/CCW mode or Step/Direction mode. Or assign functions at the rising/falling edge of the input signal. 0: CW Pulse/CCW Pulse mode 1: Step/Direction mode 2: Execute Bank 2 and 3(available only with C-type motor)	P,C

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
37	Resolution K37=0-10 Speed Unit 100pps K37=20-30 Speed Unit 10pps K37=40-50 Speed Unit 100pps K37=60-70 Speed Unit 10pps	0	70	3	-	Pulses Per Revolution 0, 20: 200ppr 40, 60: 300ppr 1, 21: 400ppr 41, 61: 400ppr 2, 22: 500ppr 42, 62: 600ppr 3, 23: 1000ppr 43, 63: 800ppr 4, 24: 2000ppr 44, 64: 1200ppr 5, 25: 2500ppr 45, 65: 1500ppr 6, 26: 5000ppr 46, 66: 3000ppr 7, 27: 10000ppr 47, 67: 4000ppr 8, 28: 25000ppr 48, 68: 6000ppr 9, 29: N/A 49, 69: 8000ppr 10, 30: 50000ppr 50, 70: 12000ppr Do not use the incremental move when K37= Over 40 .	P,V,C
38	Analog Interface(V-type)	0	3	1	-	Set V-type Motor to be either Speed Control or Position Control 0: Speed Control 1: Position Control 2: Speed Control CW 3: Speed Control CCW	V,C
39	Voltage Filter Gain	0	1024	128	5 [rad/s]	Set Cut-Off frequency for Voltage Low Pass Filter	V,C
40	Max Speed for V-type motor	200	4000*	200	rpm	Set the max. speed for V-type motor(K38 shall be set to 0, 1 or 2). When K38=0, 0.2V=max. speed in CCW direction 2.5V=speed 0 4.8V=max. speed in CW direction When K38=2, 0.2V=speed 0, 4.8V=max. speed in CW direction When K38=3, 0.2V=speed 0, 4.8V=max. speed in CCW direction	V,C
41	Travel Range for V-type	-32767	32767	2000	pulses	Set the max. travel range for V-type motor(K38 shall be set to 1). The position shall be 0 when the power is supplied. Motor moves within the set range referring to the analog voltage.	V,C
42	Speed for Origin Search	1	5000	10	100pps	Set the speed for origin search	P,V,C
43	Acceleration for Origin Search and Manual Feed	1	5000	100	$Kpps^2$	Set the acceleration for origin search and manual feed	P,V,C
44	Deceleration Ratio	10	500	100	%	Set the deceleration ratio in relation to Acceleration When K44=100, the acceleration and deceleration are the same.	C
45	Origin Search Direction	0	1	1	-	Set origin search direction 0: CW direction 1: CCW direction	P,V,C

*There is a limitation in the Max. value depending on the specification of the motor. (approx. 2000, 3000)

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
46	Origin Search Method	0	3	0	-	Set origin search method 0: Stopper 1: Stopper(Start origin search automatically when powered on) 2: Origin sensor 3: Origin sensor(Start origin search automatically when powered on)	P,V,C
47	Voltage Level for Origin Search	10	100	30	%	When K46=1 or 2, the current level can be set, at which point the motor determines that it has reached the origin. It shall be set by percentage.	P,V,C
48	Offset distance between Mechanical Origin and Electrical Origin	-32767	32767	0	x100pulses	When the off-set distance is set, the motor will automatically move to the electrical origin after reaching the mechanical origin. When it is set to 0, the electrical and mechanical origins are the same. The speed moving from mechanical origin to electrical origin is the same as the speed for origin search which is set by K42.	P,V,C
49	Speed for Manual Feed	1	5000	10	100pps	Set the speed for the manual feed	P,V,C
50	Travel Distance for Manual Jog	1	100	10	pulses	Set the manual jog travel distance. Note: No speed and acceleration are available for manual jog.	P,V,C
51	Creeping Speed	1	1000	10	100pps	Set the creeping speed	C
52	Position P Gain	0	300	50	1/256	Set the position P gain	P,V,C
53	Velocity P Gain	50	512	250	1/1024	Set the velocity P gain	P,V,C
54	Velocity I Gain	0	10	2	1/1024	Set the velocity I gain	P,V,C
55	In-position Tolerance	1	100	5	pulses	Set in-position tolerance The motor determines that it has reached the target position when it gets within the set in-position tolerance	P,V,C
56	Overflow Alarm Level	1	32767	50	Kpulses	Set overflow alarm level When position error is larger than the set value, the motor sends out an alarm	P,V,C
57	Time Delay for Overload Alarm	100	10000	3000	msec	The delay time between overload is detected and an alarm is sent out	P,V,C
58	Software Limit CW	0	32767	0	x100pulses	When K58=0, no software limit shall be set	P,V,C
59	Software Limit CCW	-32767	0	0	x100pulses	When K59=0, no software limit shall be set	P,V,C
60	Push Mode Current Level	10	80	50	%	Set the current level for push mode. Motor keeps pushing at the set current for the duration which is set by K61 K60 value is percentage from the motor`s coutinuous torque	C
61	Push Time	10	3001	200	msec	Set the duration time for the push mode When K61=3001, motor stays in the continous push mode until receiving a Stop command.	C

K	Function/Status	Min.	Max.	Default	Unit	Details	Adaption
62	System Parameter	-	-	-	-	Do not change	
63	System Parameter	-	-	-	-	Do not change	
64	Analog Input Settings	0	9	0	-	Select the control through Anolog input. The unit for position is pulse, the unit for speed is RPM 0: Normal 1: Adjust Speed (adjust S0 value within the K40 value) 2: Adjust Position (adjust P0 value within within the K41value) 3: Adjust Speed (adjust S13 within the K40 value) 4: Adjust Position (adjust P24 value within the K41 value) 9: V-type operation (refer to the K38 value)	C
65	Baud Rate between Slave Motors	0	3	0		Set the baud rate for Slave Motors in Daisy Chain operation. Note) The value must be set from the last motor in Daisy Chain.	C
66	System Parameter	-	-	-	-	Do not change	
67	System Parameter	-	-	10000	-	Do not change	
68	System Parameter	-	-	-	-	Do not change	
69	Gain for S-curve	0	1024	0	-	Set the gain for S-curve. Bigger value applied speed change with the S-curve.	C
70	Set the Delimiter	0	1	1		Set the delimiter at the end of each line of replied data. 0: CR 1: CRLF	P, V, C
71	Temperature Alarm Detection Level	0	150	100	℃	Set the temperature alarm *	P, V, C
72	Over Voltage Detection Level	0	391	300	0.1V	Set the over voltage detection level *	P, V, C
73	The output signal range in merge mode	0	1000	10	msec	Set the range of output signal at passing point in merge mode	C
74	System Parameter	-	-	-	-	Do not change	
75	System Parameter	-	-	-	-	Do not change	
76	System Parameter	-	-	-	-	Do not change	
77	System Parameter	-	-	-	-	Do not change	
78	System Parameter	-	-	-	-	Do not change	
79	System Parameter	-	-	-	-	Do not change	
80	System Parameter	-	-	-	-	Do not change	
81	System Parameter	-	-	-	-	Do not change	
82	System Parameter	-	-	-	-	Do not change	
83	System Parameter	-	-	-	-	Do not change	
84	System Parameter	-	-	-	-	Do not change	

Parameter default values (For the shipping)

The Cool Muscle's default parameters are set as below for the shipping.
When the values require to be set back to the default, please refer to the list below.
When applying value outside range of it can accept, the values will be not changed.
(When Cool Muscle other than Ver.2.25 and Ver.2.35 are handled, the values will be set back to the System Default value that are show in the Parameter List, but not to the values below.)

K	11L	11S	17L	17S	23L	23S
20	0					
21	0					
22	200					
23	1					
24	1000					
25	3333					
26	0					
27	0					
28	0					
29	0					
30	0					
31	0					
32	0					
33	11					
34	21					
35	30					
36	0					
37	3					
38	1					
39	128					
40	200					
41	2000					
42	10					
43	100					
44	100					
45	1					
46	0					
47	30					
48	0					
49	10					
50	10					
51	10					

K	11L	11S	17L	17S	23L	23S
52	70	70	151	50	151	50
53	150	150	150	200	201	200
54	1	1	5	5	4	5
55	5					
56	50					
57	3000					
58	0					
59	0					
60	50					
61	200					
62	0					
63	0					
64	0					
65	0					
66	0					
67	10000					
68	0					
69	0					
70	1					
71	100					
72	300					
73	10					
74	0					
75	0					
76	0					
77	0					
78	0					
79	0					
80	0					
81	0					
82	0					
83	0					
84	0					

Appendix 3

Command List

Data Command < Direct Mode >

Command	Function	Format	Unit	Description	Example
P	Set position data	P.n=value	pulses	Set position for direct mode	P.1=290327
S	Set speed data	S.n=value	100pps or 10pps	Set speed for direct mode	S.1=150
A	Set acceleration data	A.n=value	$Kpps^2$	Set acceleration for direct mode	A.1=100

Data Command < Program Mode >

Command	Function	Memories	Format	Unit	Description	Example
P	Position Data	25	P#.n=value # is memory number (1-25)	pulses	Set position data	P23.2=15000 Set the memory 23 position data of ID2 motor as 15000 pulses
S	Speed Data	15	S#.n=value # is memory number (1-15)	100pps or 10pps	Set speed data	S13.2=150 Set the memory 13 speed data of ID2 motor as 150

A	Acceleration Data	8	A#.n=value
			# is memory
			number(1-8)
				$Kpps^2$	Set acceleration datas	A6.3=100
						Set the memory 6 acceleration data of ID3 motor as 100$Kpps^2$

T	Timer Data	7	T#.1=value
			# is memory
			number(1-7)
			ID number must be 1
				msec	Set timer data	T2.1=500
						Set the memory 2 timer data of ID1 motor as 500msec

+	Incremental		P#.n=value # is memory number (1-25)	pulses	By adding "+" after ID number of P command, Position data can be incremental position data in a program. For CCW direction, set minus value for position data.	B1.1 A1.1,S1.1,P1.1+ Motor runs incrementaly from current position, refering to the memory 1 position data of ID1 motor as an incremental position data.

Execution Command < Direct Mode >

Command	Function	Format	Description	Example
^	Execute direct mode	^.n	Execute a specified data by Direct mode Data Command	^.1 The ID1 motor executes its direct mode
]	Pause	].n	Stop the motor and resets the program back to its first command line.	
]1	Stop the specified motor in the Daisy Chain	]1.n	Stop the specified motor in Daisy Chain operation (functional only in Direct Mode)	]1.3 Stop only ID3 motor
|	Go origin	|.n	Motor starts the origin search	
|1	Go to position 0	|1.n	Motor goes back to position 0 referring K42 and K43 for its speep and acceleration	
|2	Reset position counter	|2.n	Set the current position to 0	
)	Motor free	).n	Free the motor	
(	Enable motor	(.n	Enable the motor	
O	Set output on	O#.n # is output number	Set a specified output on.	O2.1
F	Set output off	F#.n # is output number	Set a specified output off.	F2.1
*	Emergency Stop	*	Make an emergency stop to all the motors. Must cancel an emergency stop to go back to an operation. Do not assign the Emergency Stop to the input when Emergency Stop is executed by communication.	
*1	Cancel Emergecy Stop	*1	Cancel an emergency stop	
$	Save	$.n	Save the over-writen data in E²PROM	$.1 Save the data of ID1 motor

Execution Command < Program Mode >

Command	Function	Format	Description	Example
[	Execute bank program	[#.1 # is bank number ID number must be 1	Execute a specified bank program	[2.1 Execute bank 2
]	Pause	].n	Pause by] Full stop by]]	]↵ : Pause]↵]↵ : Full Stop
}	Stop after current motion	}.1 ID number must be 1	Stop the motor when it completes the current line of the bank program.	}↵ : Pause }↵}↵ : Full Stop
>	Execute next line	>.1 ID number must be 1	Execute the next line in the program bank.	
<	Execute previous line	<.1 ID number must be 1	Execute the previous line in the program bank. This will not be functional in some program.	

Program Command

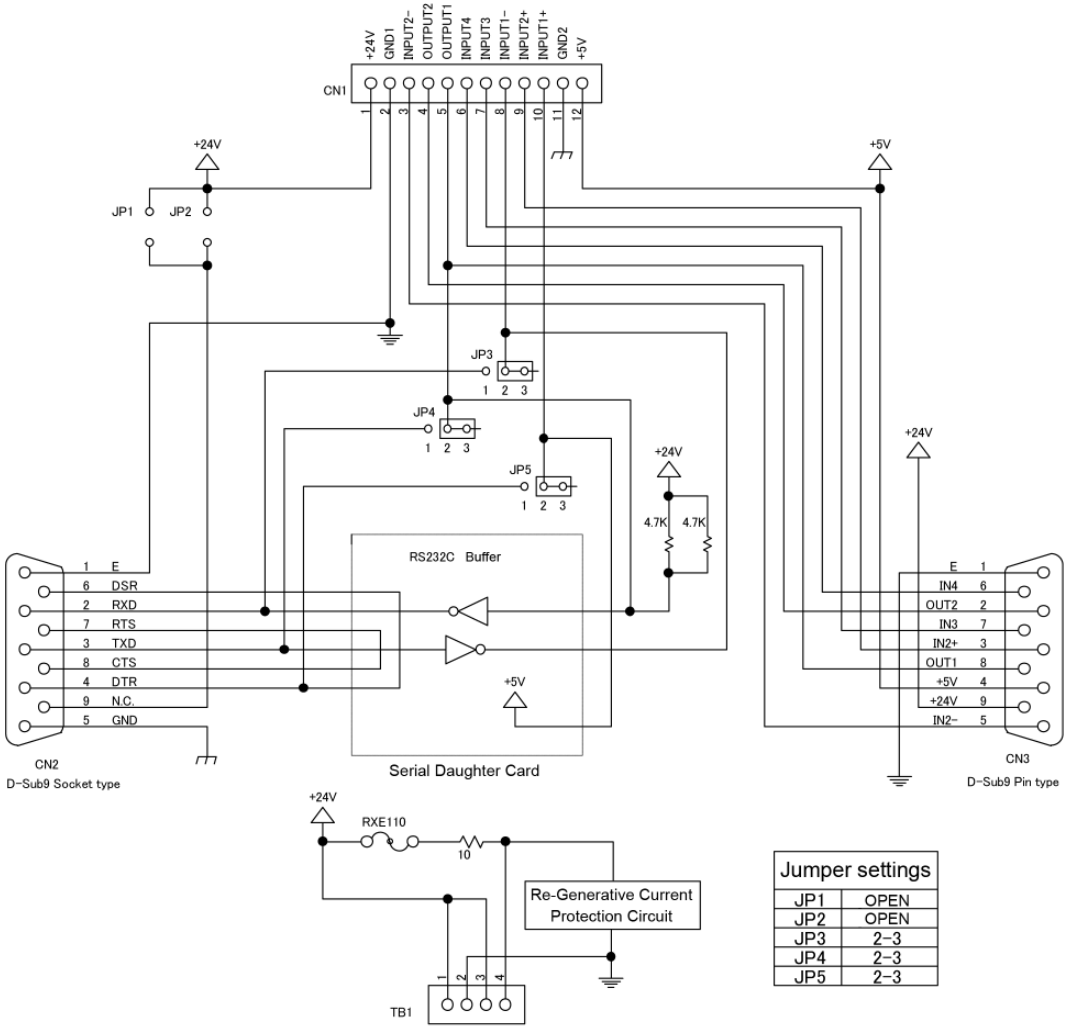
Command	Function	Format	Description	Example
B	Bank Program	B#.1 # is bank number. (1-30) ID number for Bank Program must be 1.	Set the number for bank program. Specify the beginning and content of bank program. Between the end of the Bank content and the next data, the single line space is required.	B1.1 A1.1,S4.1,P12.1 A2.2,S2.2,P6.2 Specify the content of the bank 1 from B1.1
C	Call	C#.1 # is bank number(2-30). ID number for C command must be 1.	Call the specified bank program and execute it in a program.	B1.1 A1.1,S4.1,P12.1 A2.2,S2.2,P6.2 C2.1 Call and execute bank 2 at the end of bank 1.
J	Jump	J#.1 # is bank number(2-30) ID number for J command should always be 1.	Jump and execute the specified bank program in a bank program but will not come back to the original bank after jumping to the specified bank.	B1.1 J2.1 Jump to bank 2 in bank 1

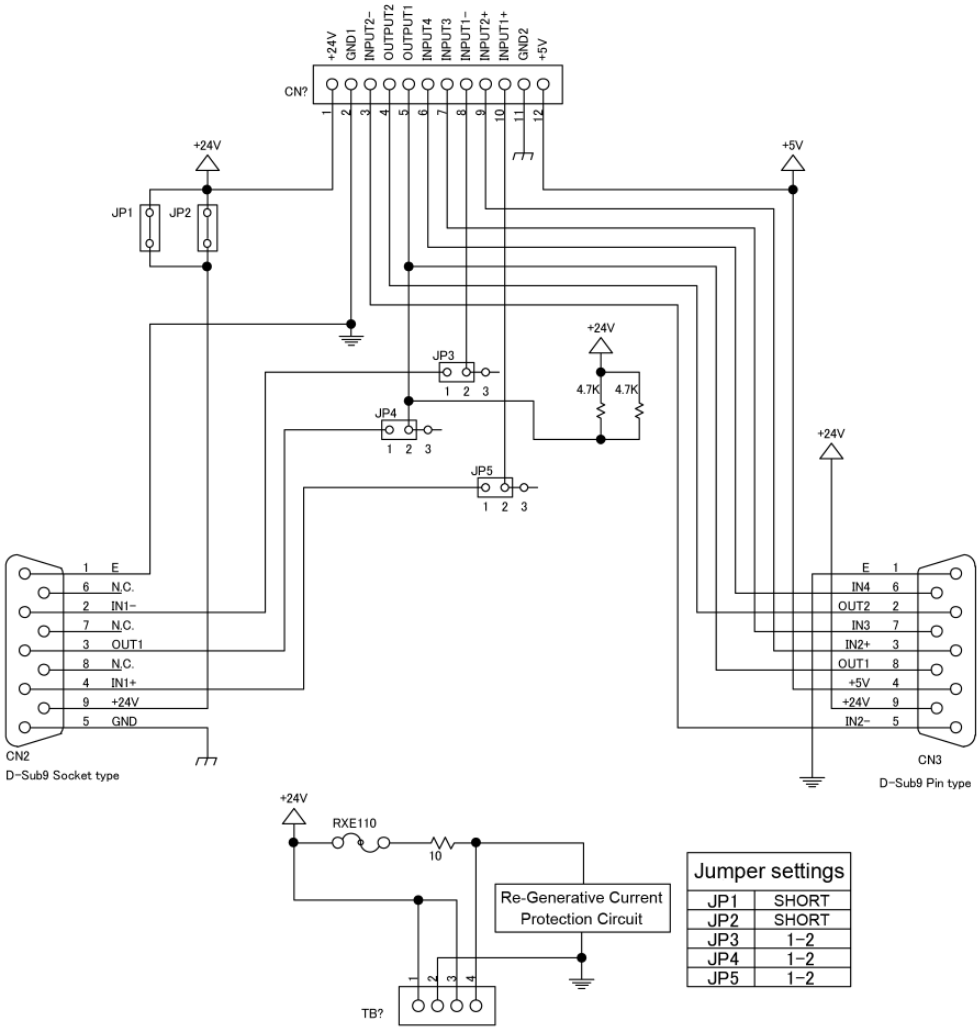
Command	Function	Format	Description	Example
O	Output On	O#.n # is output number	Turn the specified output on.	B1.1 A3.1,S5.1,P15.1 O2.1 Turn the output 2 of ID 1 motor on after reaching the position 15.
F	Output Off	F#.n # is output number.	Turn the specified output off.	B1.1 A3.1,S5.1,P15.1 F2.1 Turn the output 2 of ID 1 motor off after reaching the position 15.
I	Input	I#, signal-in, no signal # is input number	The I command monitors a specified input then execute a command based on the assigned input functions. Only C, J or T0 command can be used after I command.	I4.1,C2.1,C3.1 If Input4 is on, execute bank2 If Input4 is off, execute bank 3
Q	Push Mode	Q#.n=value # should be a memory number of P command(1-25).	The Q command is a replacement for the P command and used for Push Mode.	B1.1 A1.1,S4.1,Q10.1 The ID1 motor goes into a push mode towards the memory 10 position.
X	Loop	X#.1 # is a number of times for loop. ID number must be 1	Loop a program below X command for specified number of times by X command. X0 for continuous move. Max value is 255.	B1.1 X5.1 A1.1,S1.1,P1.1 P2.1 Loop the program below "X5.1" 5times.
Y	P without a wait	Y#.n=value # is a memory number of P command	In daisy chain, the other motors move without waiting for inposition of specified motor.	B1.1 A1.1,S1.1,Y1.1 A1.2,S1.2,P1.2 ID2 motor starts to move without waiting for the inposition of ID1 motor.
Z	Q without a wait	Z#.n=value # is a memory number of Q command	In daisy chain, the other motors move without waiting for inposition of specified motor in push mode.	B1.1 A1.1,S1.1,Z1.1 A1.2,S1.2,P1.2 ID2 motor starts to move without waiting for the inposition of ID1 motor in push mode.
/	Comment	B1.1/comment	Comment begins with / in a CML program file. All comments are stripped when a file is downloaded to a motor. Max value is 30.	B1.1/move to the first hole Note :Comments must be written by English one bite character.
T0	No Action	T0	Use with the I command. It is a place holder. T0(zero)	I3,C2,T0 If Input3 is on, execute bank2 If Input3 is off, no action

Query

Query	Function	Description	Supplement
?0-30.n	Bank ID number must be 1	The content of the specified bank program	?0: Show the content of the direct mode. ?1-30: Show the content of the bank 1-30.
?70.n	Input status	The status of input1-4	Ex: In.1 =D Input1, 3 and 4 of ID1 motor are on. Display the input status in Hex from the bit signal which is 8, 4, 2, 1 for input 4, 3, 2, 1.
?71.n*	Temperature in driver case *Type A series only	The present temperature in driver case	Ex: Temp.1=75 Display the present temperature in driver case(unit, ℃)
?72.n*	Power-supply voltage *Type A series only	The present power-supply voltage level	Ex: VSEN.1=240 The present power-supply voltage level (unit, 0.1V)
?74.n	Analog input value	The voltage level of analog-input	Ex: ADC2=488 When ADC2=1024, 5V is applied.
?85.n	Version title	The title of the version	
?90.n	User Parameter	The user parameter from K20 to K82	
?91.n	Position list	All the position data (1-25)	
?92.n	Speed list	All the speed data (1-15)	
?93.n	Acceleration list	All the acceleration data (1-8)	
?94.n	Timer list	All the timer data (1-7)	
?95.n	Position error	Deviation of positioning	Ex) Pe.n=20 Deviation between current position and target postion
?96.n	Current position	The current position	Ex) Px.n=50000 Current position(unit, pulse)
?97.n	Current speed	The current speed	Ex) Sx.n=200 Current speed (unit should be set by K37)
?98.n	Current torque	The current torque	Ex) Ix.n=15 The current torque.
?99.n	Motor status	The Current motor status	Ux.n=0 Running Ux.n=1 Counter Overflow / Push Mode Error Ux.n=2 Over Speed / Regenerative Current Ux.n=4 Overload Ux.n=8 Inposition Ux.n=16 Motor Free Ux.n=32 During Push Mode Ux.n=40 End of Push Mode Ux.n=128 Temperature Alarm Ux.n=255 Emergency Stop Alarm The above status numbers could be combined.
?1000.1	Contents of Bank Programs	Show all the contents in Bank Programs	ID number must be 1

Appendix 4
Wiring For Network Card



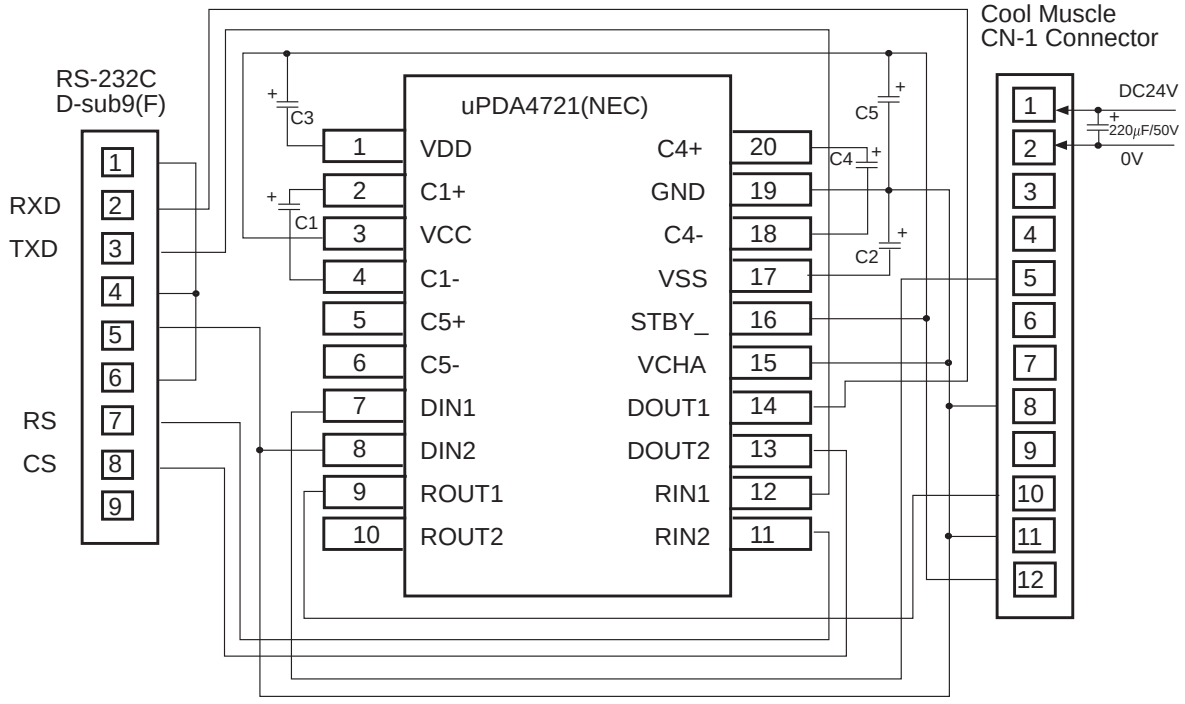


Jumper settings	
JP1	SHORT
JP2	SHORT
JP3	1−2
JP4	1−2
JP5	1−2

Slave Set

Wiring For Communication Cable

RS-232C communication can be established by the wiring below when not using RS-232C Cable(Y-cable) or Daisy Chain Network Board.

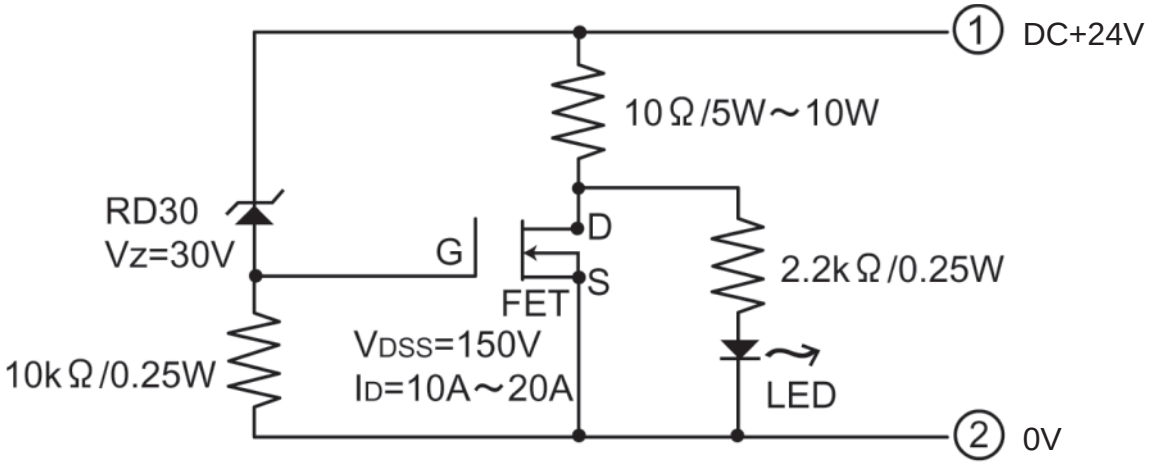


C1-C5 : 0.47 micro F/16V

* Non-pola capacitor with the same amount of capacity can be used.

Appendix 5

Re-Generative Current Protection Circuit



Appendix 6
Communication Time with Cool Muscle

The time that is shown below is the theoretical time. Please cordon a suitable time because communication time depends on upper controller such as computer and sequencer etc.

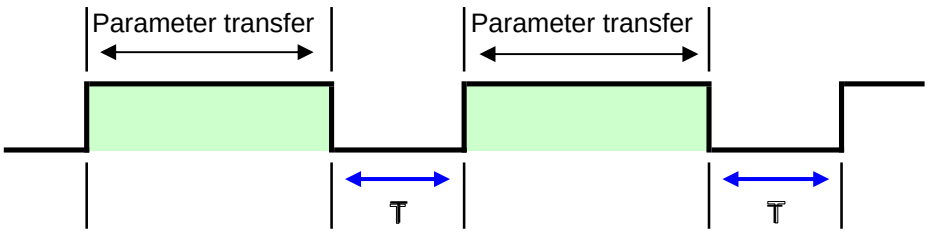
1: Transfer and Over-write

Data shall be written in Cool Muscle's memory (EEPROM) in predefined time according to temporal condition when they are being transferred.

Since longer time is required to over-write more data, when transferring more parameter the suitable time for whole the process will be longer.

Although Cool Muscle has a buffer for communication data processing, the buffer may be overflowed by a delay of communication data processing when a lot of parameters are transferred and over-written constantly in a high baud rate.

Note to cordon a suitable wait time between the transferred parameters according to baud rate and numbers of parameters that are transferred and over-written in Cool Muscle for a stable communication.

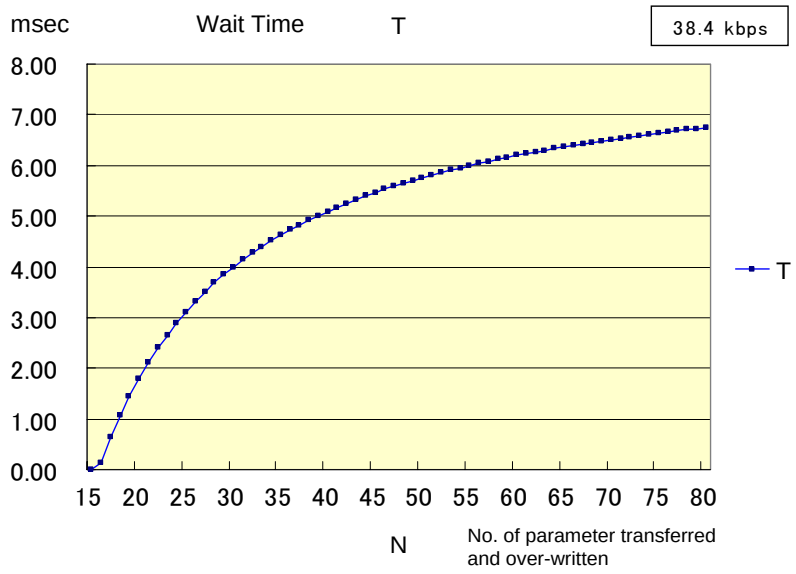


Wait Time
（Interval time for parameter transfer）

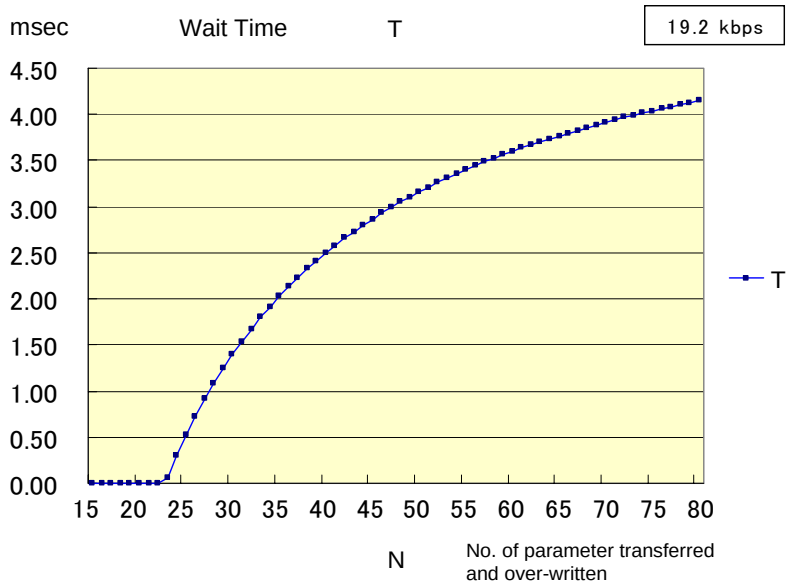
Wait Time T = The time between a delimiter and the first character of the next parameter transferred defining " , " or " CR " as a delimiter.

The relationship between numbers of parameters transferred and over-written and required wait time is as shown in the graph.

<Baud Rate = 38.4Kbps>



<Baud Rate = 19.2Kbps>



*Wait time will not be required in 9600bps. But the communication will be more stable if 1msec time interval is set between each data.

*Note the graph shows only a rough indication by epitomized calculation. Set the affordable interval time.

2: Transmission of Command

Set more than 1msec time interval between the commands transferred.

3: Transmission of Query

Send another query after receiving the response for the query before.

4: Response when using network

When more motors are used in network, more time will be needed for transmission of data.

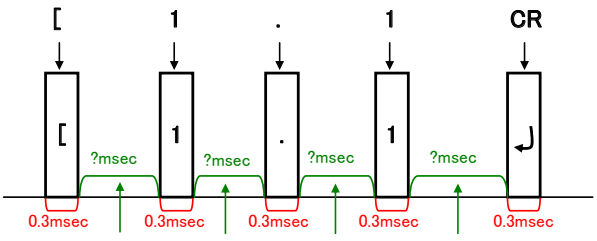
<Condition>
*The baud rate shall be all 38400bps
*The time for transmission of 1 character = 10bit / 38400bps = 0.000260417…= 0.3msec
*There shall not be an interval time between characters

.

<Example>
B1.1
A1.1,S1.1,P1.1,A1.2,S1.2,P1.2,A1.3,S1.3,P1.3,A1.4,S1.4,P1.4,A1.5,S1.5,P1.5,A1.6,S1.6,P1.6
END
$.1,$.2,$.3,$.4,$.5,$.6
[1.1

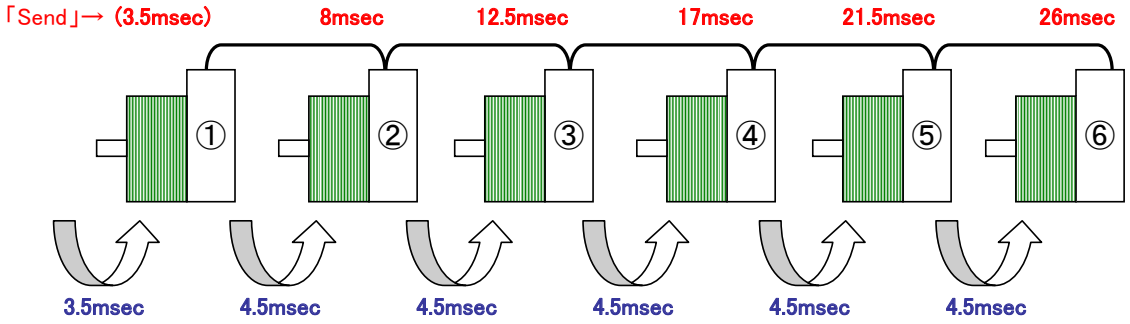
<Result>
1st Axis
[1.1CR shall be 5 characters composed by " [", " 1 ", " . ", " 1 ", " CR ".
Since it takes approximately 0.3msec for transmission of 1 character, 0.3 * 5 = 1.5msec.
So the internal processing time after Cool Muscle receiving " CR " that comes at the end of data until Cool Muscle starts its motion shall be approximately 2msec.

Therefore, after sending the data, it theoretically takes approximately 3.5msec until the actual motion starts.



This time will be different in each case.

2nd Axis and later



2nd Axis…A1.2,S1.2,P1.2,(15 characters)

0.3 * 15 = 4.5 that shows the 2nd Axis starts the motion 4.5msec after the 1st Axis.

3rd Axis…A1.2,S1.2,P1.2,A1.3,S1.3,P1.3, (30 characters)

0.3 * 30 = 9 that shows the 3rd Axis starts the motion 9msec after the 1st Axis.

4th Axis…A1.2,S1.2,P1.2,A1.3,S1.3,P1.3,A1.4,S1.4,P1.4, (45 characters)

0.3 * 45 = 13.5 that shows the 4th Axis starts the motion 13.5msec after the 1st Axis.

5th Axis…A1.2,S1.2,P1.2,A1.3,S1.3,P1.3,A1.4,S1.4,P1.4,A1.5,S1.5,P1.5, (60 characters)

0.3 * 60 = 18 that shows the 5th Axis starts the motion 18msec after the 1st Axis.

6th Axis… A1.2,S1.2,P1.2,A1.3,S1.3,P1.3,A1.4,S1.4,P1.4,A1.5,S1.5,P1.5,A1.6,S1.6,P1.6,CR

(75 Characters)

0.3 * 75 = 22.5 that shows the 6th Axis starts the motion 22.5msec after the 1st Axis.

* By defining only the “A” and “S” data for ID1 to 6 in the first line and “P” data for ID1 to 6 in the second line, the time delay between each motor shall be shorten to approximately 1.5msec.

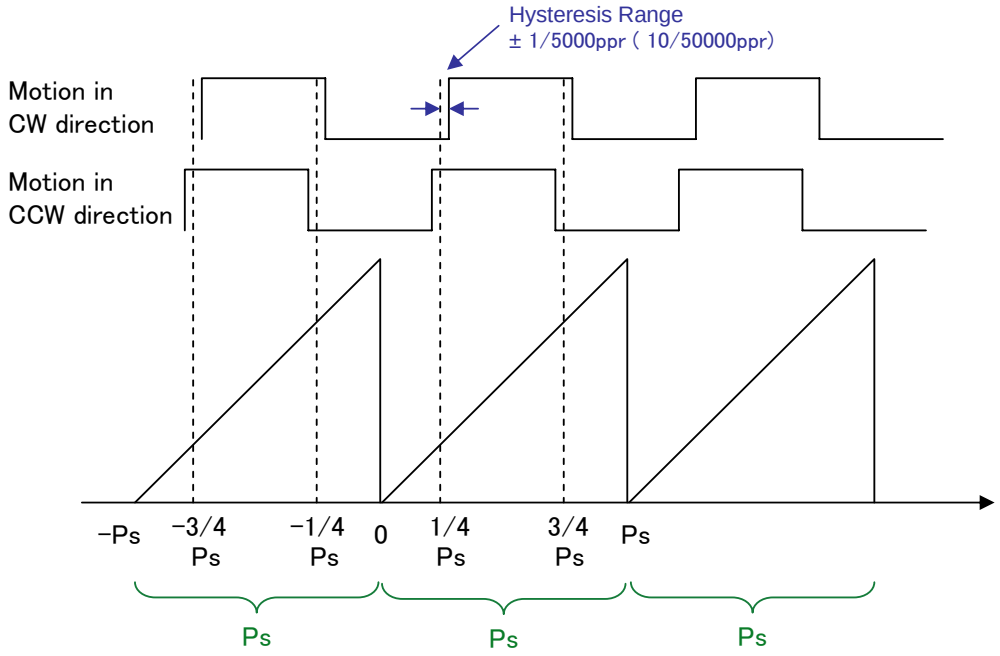
* Response time acts rashly, too, if the baud rate is made early and it is late if it slows down.

Appendix 7
Position Mark Output

<Explanation>
When setting K34 “Output Function” =7 “Position Mark”, the pulse signal will be output that shall be defined by K24 “Position Mark”.

<Motion>
The pulse signal according to motor’s current position will be output.
The motor’s current position shall be divided by the range of K24 value, the output will be on at the position of from 1/4ps to 3/4ps, then off at the other position range.
* Output logic can be set by K33 “Output Logic”.

The output timing will be different in CW and CCW direction as shown in the graph below.
That is because the threshold (at 1/4ps and 3/4ps) for output signal On and Off has plus minus 1/5000ppr (plus minus 10 in 50000ppr) hysteresis to cut the noise.



*Set K24, the width of Position Mark, to cordon more than 2msec for both signal On and Off time.
*The proper waveform may not be output when the width is set to less than 2msec.

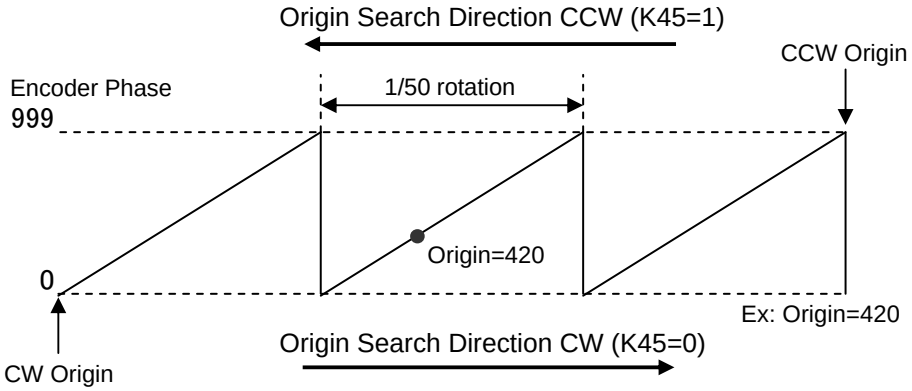
Origin Search

<Explanation>
Origin Search method can be set by K45 “Origin Search Direction” and K46 “Origin Search Method” and executed by the “ | (bar) “ command or setting of Input Function assigned to K28, K29, K31 or K32.

<Motion>
1: K46=0 or 1 Origin Search by Stopper
(Related Parameters: K42, K43, K45, K46 and K47)

Start Origin Search with the set acceleration and speed by K43 and K42 to the set direction by K45.
Origin Search completes when the current when pushing against the stopper reaches the set level by K47 and the speed goes 1/16 below the set speed by K42. Then the encoder phase value (Origin=***)will be displayed.
The encoder phase will straightly changes from 0 to 999 per 1/50 rotation. When the completion of Origin Search, in-position signal will be output at the encoder phase 0 point that is 1 cycle ahead of completion.

* For the stable origin search, adjust an attachment as a coupling for the Origin=value to be between 200 and 800.



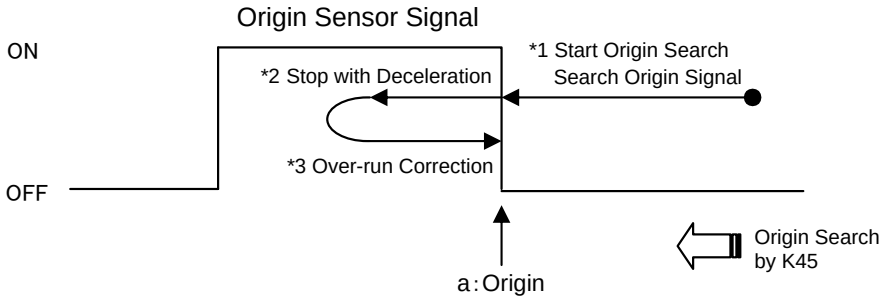
<Sequence for the Origin Search by Stopper>

When setting a value to K48 “Off Set Distance Between Mechanical and Electrical Origin”, Cool Muscle will move to its electrical origin after detecting the mechanical origin.
*The acceleration and speed to electrical origin shall be the same as the ones for origin search (K42, K43).

2: K46=2 or 3　Origin Search by sensor
(Related Parameters: K27, K42, K43, K45 and K46)

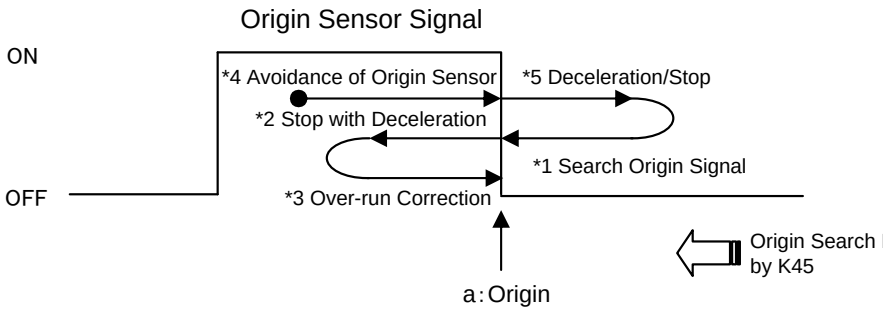
(1) When an origin sensor signal is off when starting origin search

Start Origin Search with the set acceleration and speed by K43 and K42 to the set direction by K45.
Start deceleration at the rising edge of sensor signal and complete origin search after returning to the point a.
When setting a value to K48 “Off Set Distance Between Mechanical and Electrical Origin”, Cool Muscle will move to its electrical origin after detecting the mechanical origin.



<Sequence for Origin Search by Sensor 1>

(2) When an origin sensor signal is on when starting origin search
Move off a sensor signal to the opposite direction against K45 to search the rising edge of sensor signal.
When passing the point a in the graph, start to decelerate after detecting a sensor signal off, then the same motion as the article (1) will be executed.

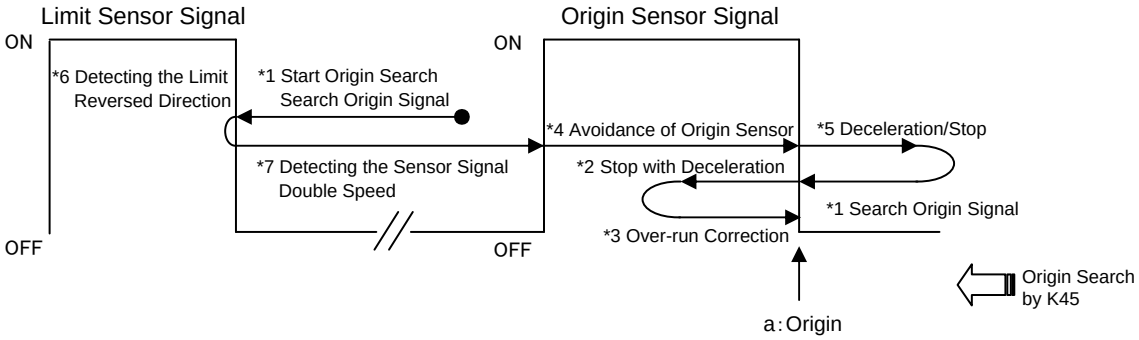


<Sequence for Origin Search by Sensor 2>

(3) When using Limit Sensor (Ver2.25 / Ver2.35 or later)

It will be operated as below when the Limit Sensor (6) (the same direction as an origin search) is assigned to an input and the Origin Sensor Signal(2) is assigned to another input.
When Origin Search Signal is not assigned to any input, the Origin Sensor function will be combined to Limit Sensor and operated as (2).

Start Origin Search with the set acceleration and speed by K43 and K42 to the set direction by K45.
Then to the reversed direction against the K45 after detecting the limit sensor signal that shows in the same direction as origin search and starts detecting the origin sensor signal at the double speed against K42. After detecting the origin sensor signal, then the same motion as the article (2) will be executed.



<Sequence for Origin Search by Sensor 3>

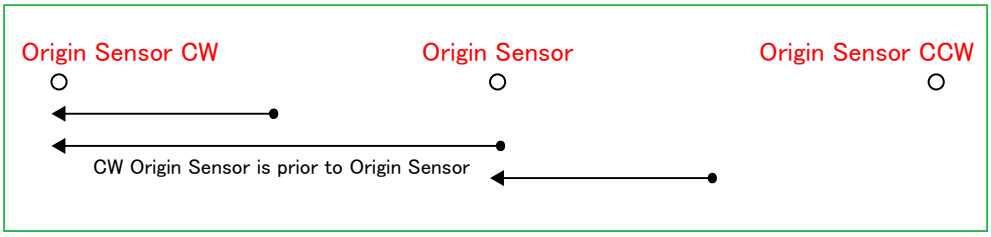
* Origin Sensor Signal must be assigned to K27
* Do not assign Origin Sensor Signal to multiple inputs.
  Proper Origin will not be detected because multiple inputs start processing the same signal.
* When acceleration and speed are set too high, deviation of the origin may occur according to the sensor precision. Set proper acceleration and speed in relation to mechanical and sensor precision.
* Origin Search may be canceled if send a Query during Origin Search.
  Do not send any Query during Origin Search.

Example for Motion when Origin Sensor is assigned

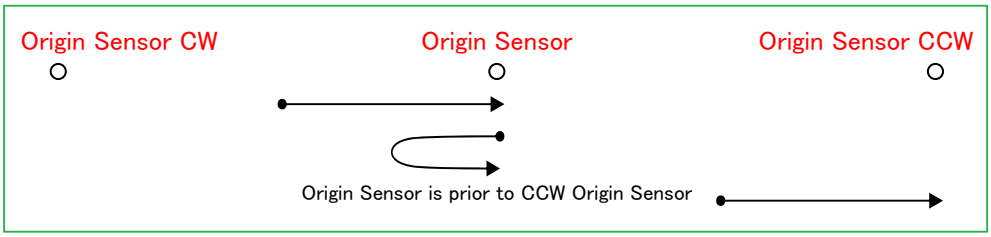
K27=6290 “Input Function at the Quick Response Target Voltage”
Input4: 6 “Limit Sensor CW (Combined with Origin Sensor CW)
Input3: 2 “Origin Sensor”
Input2: 9 “Limit Sensor CCW” (Combined with Origin Sensor CCW)
Input1: 0 “No Action”

< ~Ver.2.24 / ~ Ver.2.33>
Priority of Origin Sensor shall be In4, In3, In2 and In1.

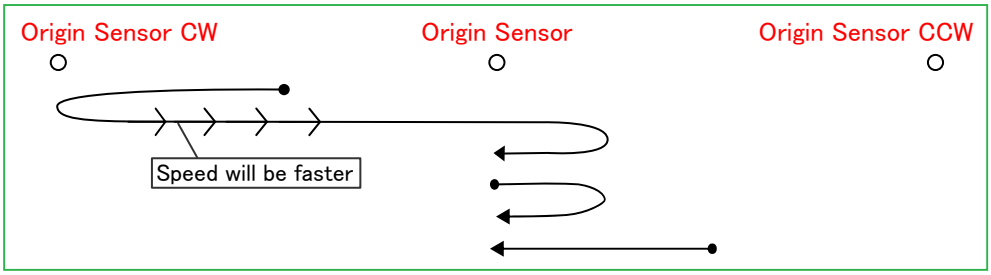
Ex1: K45=0 “Origin Search Direction” CW



Ex2: K45=1 “Origin Search Direction” CCW



<Ver.2.25 ~ / Ver.2.35~ >
Origin Sensor is prior to another.
Ex3: K45=0 “Origin Search Direction” CW



Merge Mode

<Explanation>
Merge Mode will be executed by programming multiple P commands in one (1) line dividing by comma.
Move to the final target position changing speed, acceleration, output status etc, at the passing points without stop.

<Motion>
(Related Parameters: K34, K73)
When setting K34=6 (The Output Signal Range in Merge Mode), the pulse signal that is set by K73 will be output.

*Note the following articles when using in Merge Mode
1: P command must be used for the positioning. The following commands can be used for the final command in the line.
Q, Y and Z
2: The following commands can be used between P commands dividing by comma.
A, S, O, F and ? (Query)
3: Merge Mode can be used only for P command of ID1 motor.

* Merge Mode will be automatically canceled in the following condition.
1: When Q, Y or Z commands are used with exception of final command.
2: When positioning command (P, Q, Y, Z) is not used for the final command in the line.
3: When the directions of positionings are opposite in the line.

<Example>
A1.1, S1.1, P1.1, P2.1, P3.1
P1.1=10000, P2.1=30000, P3.1=20000

The direction is opposite in the motion P1 to P2 and P2 to P3, Merge Mode will be canceled and it will be operated as below.

A1.1, S1.1, P1.1, P2.1 / Merge Mode from P1.1 to P2.1
P3.1 / Positioning to P3.1

4: When positioning in the opposite direction

<Example>

A1.1, S1.1, P1.1, P1.2, P2.1, P3.1

Merge Mode will be canceled because of P1.2.
It will operated as below

A1.1, S1.1, P1.1, P1.2 / P1.1 and P1.2 are executed at the same time.
P2.1, P3.1 / Merge Mode from P2.1 to P3.1

Example of Merge Mode

<Example 1>
A1.1=10, A2.1=15, A3.1=8
S1.1=50, S2.1=100, S3.1=70
P1.1=5000, P2.1=15000, P3.1=25000

< PTP Motion Between 3 Points >

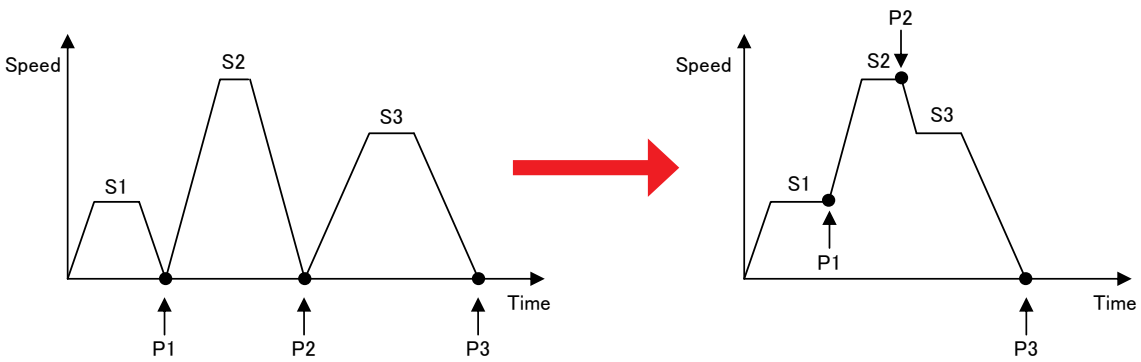
B1.1
A1.1, S1.1, P1.1
A2.1, S2.1, P2.1
A3.1, S3.1, P3.1
END

Move to P1.1 with the acceleration and speed that are stored in A1.1 and S1.1.
Move to P2.1 with the acceleration and speed that are stored in A2.1 and S2.1.
Move to P3.1 with the acceleration and speed that are stored in A3.1 and S3.1.

< 2 Point Merge Mode with variable speed and acceleration >

B1.1
A1.1, S1.1, P1.1, A2.1, S2.1, P2.1, A3.1, S3.1, P3.1
END

Move to P1.1 with the acceleration and speed that are stored in A1.1 and S1.1.
Move to P2.1 with the acceleration and speed that are stored in A2.1 and S2.1 without deceleration at P1.1.
Move to P3.1 with the acceleration and speed that are stored in A3.1 and S3.1 without deceleration at P2.1.



<Example 2>
2 Point Merge Mode with Output Status Change and Query

B1.1
A1.1, S1.1, P1.1, ?96.1, O2.2, S2.1, P2.1, O3.2, F2.2, S3.1, P3.1
END

Query ?96.1 and Output2.2 on at P1.1.
Move to P2.1 without deceleration at P1.1.
Output3.2 on and Output2.2 off at P2.1.
Move to P3.1 without deceleration at P2.1.

How to Adjust Gain

The Cool Muscle's gains can be adjusted by changing values of parameters K52, K53 and K54. Each type of Cool Muscle has different default gain values. The following gain adjustment steps will help you find the optimum gain values for your application.

Step 1

Set K52, K53 and K54 to the following values.

K52=1
K53=100
K54=0

Step 2

As you increase the value of K53, you may start hearing high frequency noises and noticing vibration. The K53 value should be just under the value that starts generating the noises and vibration. The higher the K53 value, the less vibrations and noises the motor will generate. However if you set the K53 parameter too high, the motor will generate high frequency noises and vibration.

Step 3

Once you find the optimum value for K53, start increasing the value of K52. The higher the value of K52, the smaller the positioning error becomes and the quicker the motor gets in-position. However, setting the K52 value too high will make the motor unstable causing it to vibrate.

Step 4

If you can not produce the desired motion by step 3, increase the value of K54. The K54 lets you further fine tune positioning errors. Setting the K54 too high will cause the motor to vibrate.

Appendix 8
Manual Terminology

Absolute	The abusolute positioning shall always be executed by the abusolute position data that is based on the position 0 (Origin). This function is adapted to a direct motion from an optional position to a specified position.
Acceleration Unit	Acceleration shall be set by A command. The unit is $Kpps^2$. The relation between A value and time for acceleration is T = S * Speed Unit / A * 1000
Analog Out	Cool Muscle can output the analog signal to monitor its position, speed and torque for the comprehension of operating condition. This analog signal output function is called "Analog Out" and useful for the measurement by oscilloscope.
Baud Rate	Baud Rate is set the speed to send and receive data. The unit is "bps" that is a number of bits that can be transferred per second. Baud Rate shall be confirmed when funny characters appear on a display.
Closed Loop	The control method with a feedback from a detecting device as an encoder is called "Closed Loop Control". Since a detecting device detects motor's rotation, "Closed Loop Control" controls on a comparison of command pulse with feedback position data through the feedback system. Therefore Cool Muscle always stays at a correct position even in the condition with an external load. Cool Muscle adopts the "Closed Loop Control".
Cool Works	Cool Works is the terminal software that is designed by Muscle for the simple operation for Cool Muscle and is download free from Muscle's website below. http://www.musclecorp.com

CR	Abbreviated form of "Carrige Return" (↵). To return to the head of the line.
Creeping Speed	Both initial speed and terminal speed of the motion are called "Creeping Speed". This function will shorten a takt time in some application. A motion may be unstable when too large value is applied to this parameter K51.
CRLF	Abbreviation form of "Carrige Return Line Feed". To return to the head of line with a line feed.
CW/CCW	A motor's rotating direction. CW stands for "Clockwise" and CCW stands for "Counter Clockwise". Looking at a motor from motor's output shaft side, rotating "Clockwise" is CW and "Counter Clockwise" is CCW.
CW/CCW Method	There are tow method for the pulse operation. One method is called "CW/CCW" that CW pulse is applied for the operation in CW direction and CCW pulse is applied for the operation in CCW direction.
Daisy Chain	An upper controller - ID1 motor - ID2 motor - ID3 motor ..... Daisy Chain is the method for the communication by connecting all networked Cool Muscles in line but not connecting all Cool Muscles to an upper controller individually. It is called Daisy Chain because Cool Muscles are connected as the shape of Daisy. Daisy Chained Cool Muscle shall be identified by ID number automatically when the power is supplied and each Cool Muscle download only data that matches their own ID numbers. Maximum 15 Cool Muscles can be controlled from one Com Port via RS-232C communication line.
Delimiter	Delimiter is a mark that delimits a character string and each command is recognized as a data by being delimit by delimiter. Type of delimiter can be selected by the parameter K70.

Deviation	It is difficult to detect an error when the deviation counter overflow value is too large but an error will be detected very often when the deviation counter overflow value is too small. K56 value shall be adjusted in accordance with an instrument. Cool Muscle always follows the command pulse for the precise positioning by Closed Loop System.
Deviation Counter	The difference between command pulse and feedback position data is called "Deviation" and the amount of deviation is called "Deviation Counter". For example, the deviation counter is 0, 1000 pulses is entered for command pulse and feedback position data is 700, the current deviation counter is 300. The value for the deviation counter overflow can be set by the parameter K56 and an error will be detected when Cool Muscle can not follow the command pulses for the set time.
Direct Mode	The direct mode will not require a motion program but shall be executed command by command directly from an upper controller. The A, S and P shall be used for the commands for Acceleration, Speed and position in Direct Mode. Direct Mode shall be executed by " ^ " command after defenition of A=#, S=#, P=#. ID number is required in a multiple axises operation by Daisy Chain. For example, an execution for ID2, A.2=#, S.2=#, P.2=#, ^.2 shall be sent.
Event Driven	The report method that Cool Muscle reports automatically when the event of Cool Muscle changes is called "Event Driven". The contents that Cool Muscle reports an upper controller can be set by the parameter K23.
Gain	The method to adjust a fine alignment between instruments and Cool Muscle. A smoother and more stable motion will be provided by a better adjustment. The Cool Muscle gain system is the same as the standard Servo motor's.

Incremental	The motion in specified direction for specified distance referring to the current position as the starting point for the next positioning is called "Incremental Motion". This function is adapted to the repeated constant distance feeding.
Live Driver	P type Cool Muscle is operated synchronizing the pulse signal from a pulse generator. One of a signal output method of a pulse generator is called "Line Driver". Line Driver has "The transfer of high frequency" and "Less Implication from Noise" for its feature and used for a high speed signal transmission. Line Driver is recommended when the distance between Cool Muscle and a pulse generator is long or the usage in a noisy environment.
Local Echo	The function that displays the transferred data on the display of connected device is called "Local Echo". Cool Muscle replies the recieved data on an upper controller and display the data on its screen. On the other hand, local echo could be iterrupted when communication line is busy. In such a case, Local Echo could be inactivated by the parameter K23. Note ; Confirmation of sent data can not be made after inactivating Local Echo.
Low Pass Filter	Cool Muscle has a function called Low Pass Filter that cuts the frequency of Analog input signal in Analog control. The cut off level can be set by the parameter K39.
Manual Feed	The function that Cool Muscle rotates to the specified direction at the specified speed when detecting the target voltage level of input signal then stop when input signal turns off, is called Manual Feed. The speed for Manual Feed shall be set by the parameter K49 and the direction by the parameter K27 or K30.

Manual Jog	The motion that Cool Muscle rotates the specified pulses that is set by the parameter K50 by applying a one-shot signal to an input is called "Manual Jog". This function is adapted to a manual fine adjustment of an instrument. Note that the speed and acceleration can not be set.
Master Motor	The first Cool Muscle (ID1) in Daisy Chain operation is called "Master Motor" and operates all other Cool Muscles when a multi-axises program is executed.
Merge Mode	The multiple positioning without stop is called Merge Mode (because individual positioning is merged to one motion). Merge Mode is comprised by the multiple position but reach the last position passing the positions between start position and final target position.
Motor Free	Non-excitation condition that power is interrupted is called "Motor Free". When Cool Muscle goes into a Motor Free condition, only the power to the motor coil will be interrupted but supplied to the driver board. Therefore Cool Muscle determines its current position even in the Motor Free condition.
Nesting	When programming a motion, program goes deeper by C command or J command and its depth is called "Nesting". This is one method for programming and nesting can be used for conditional branching that usually goes deeper in a program. The maximum nesting level for Cool Muscle's programming is 10 times. Note that C command and J command can be used only 9 times.
Number for Loop	Number for Loop set how many times a program will repeated. When loop is not set, a program will end after execution of program one time. When X0 is set, a program will be executed repeatedly until Cool Muscle receives a stop command.

Open Collector	One of the signal output method is called "Open Collector" and is one of the most simple method. There is a restriction for the distance between Cool Muscle and a pulse generator. An appropriate distance always depends on its environment. Therefore it shall be confirmed if there is no malfunction by things like noise before using.
Open Loop	The control method without a feedback system is called "Open Loop Control" and of stepper motor is synchronized with command pulse. Open Loop only deems that a motor reaches the target position being premised on that there is no disturbance or load fluctuation. Since there is no feedback system, motor can not compare command pulse with feedback position data. Therefore a motor can not detect its displacement by mis-step or external load.
Origin Offset	An electrical origin shall be made aside from a mechanical origin when a mechanical end can not be used for its origin, or when a separate origin is required for its operation. The distance between a mechanical origin and an electrical origin is called "Origin Offset".
Polling	The report method that Cool Muscle replies only when receiving queries from an upper controller is called "Polling". An upper controller sends query to Cool Muscle and Cool Muscle replies to each query.
Position	Target position shall be set by P command. The unit is pulse. Since the same P value will become different position on different resolution, those values shall be changed with attention. P=1000 (1 rotation when resolution 1000, 1/10 rotation when resolution 10000)

Program Bank	Program must be made for the usage of Cool Muscle in program mode. A series of program units is called "Bank". A program can be executed bank by bank or call or jump to another bank program.
Program Mode	The mode that program downloaded to Cool Muscle can be activated from an upper controller by execution commands or an input signal is called "Program Mode".
PTP Motion	Abbreviated form of "Point to Point" that means the motion from one point to another. Positioning shall be made by several optional points and a motor passes those positions one after another. The basic speed form of of the PTP motion is trapezium waveform.
Query	Cool Muscle can report several sorts of information as its current position, speed, torque and etc. Question command to gain required information from Cool Muscle is called "Query".
Quick Response Signal	Cool Muscle recognize input signal by two types of signal, quick and slow response signal. The input signal that rises and falls at the specified voltage level is called "Quick Response Signal". Cool Muscle responds a few msec after against Quick Response Signal.
Resolution	Resolution indicates the controllability that how many divisions can be made per rotation and defines the precision of motor. The unit is Pulse/Rotation. The maximum resolution of Cool Muscle is 50000 and the default value is 1000 when delivered. The resolution 1000 means that one rotation is devided by 1000 and positioning can be made every 1/1000 rotation. The resolution can be set by the parameter K37.
Slave Motor	The second (ID2) or later Cool Muscle in the Daisy Chain operation are called "Slave Motor".
Slow Response Signal	The signal that is recognized set time after the recognition of quick response signal is called "Slow Response Signal". The offset time between the quick and slow response signal shall be set by the parameter K25.

Status Report	Report method from Cool Muscle to confirm Cool Muscle's operating status as Running, Error and etc is called "Status Report". The content of report and report timing can be set by the parameter K23.
Step	The individual command that is used in a program as P data, S data, A data and etc is called "Step". B1.1 A1.1,S1.1,P1.1 There are four steps in above program. Cool Muscle can contain 500 steps in its storage.
Step/Direction Method	One of the method is called "Step/Direction" that Step pulse and Direction pulse must be applied separately. Direction pulse must be sent only when Cool Muscle is stopping completely or a few msec after Step pulse is sent to Cool Muscle.
Software Limit	Position limitation called software limit can be set by the parameter K58 and K59 at both CW and CCW end referring to the origin as position 0 and Cool Muscle will not be operated beyond those limited positions. This function enables you to remove hardware limit as limit sensor or mechanical stopper and will provides safeness and cost reduction.
Speed Unit	The speed shall be set by S command. The speed unit can be selected from below two by the parameter K37 setting. 1: * 100 pps 2: * 10 pps The relation between S value and rotating speed is RPM = S * S unit * 60 / Resolution Note that when resolution is changed after setting S value, the same S value makes different speed.
Timer	Timer shall be set by T command. The unit is msec. T=1000 timer for one second

Revision History

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

Revised Date	User's Guide No.	Page	Revised Item (The page number is the last one)
Jan., 2006	JP060123		The last print
Apr., 2006	MDUG-CM1/06405E-A1		Supplemental Document of JP060123
Dec., 2006	MDUG-CM1/06C31E-01	WA-1,2	WA-2 and TR-1 are integrated.
		SC0-3,4	SC1 is changed.
		SC1	WA-1 and SC8 "Cool Muscle Interface" are integrated.
		SC2-12	RS-232C Cable is changed.
		SC3-13~16	"How to connect Cool Muscle" is changed.
		SC4	SC9 "Input and Output" is moved.
		SC5	SC5 "How to use Cool Muscle" is changed.
		SC6 SC6-30	SC4 "CML Structure" is moved. Composition chart of CML is changed.
		SC7 SC7-39 SC7-40 SC7-42 SC7-46 SC7-49 SC7-50 SC7-51 SC7-52 SC7-57 SC7-58 SC7-62	SC6 "Setting Parameters" is moved. "Automatic Identification" is added. Note deletion concerning change in baud rate of K20. Error message of K23 is addes. "More than 2msec" in chart of K24 is addes. A common note to K27 and K30 is added. Note deletion concerning change in #2 of K30. The note concerning priority of Origin Sensor is added. #6 of K34 is changed. Default value of K35 is changed. Motor type of K36 is changed. The note concerning Incremental movement is added. Max value of K37 is changed. The settable value of K51 is added. Default value of K52, K53 and K54 are changed. Motor type of K69 is changed.
		SC8 SC8-65 SC8-68 SC8-69 SC8-70 SC8-74 SC8-75 SC8-76 SC8-78 SC8-79	SC7 "Direct Mode Command" and SC8-53 "Program Mode Command" are integrated. Name of Command is changed. Description of Acceleration (A) is changed. The note concerning Emergency Stop is added. ?72 and ?99 are changed. Alarm/Status is changed. Stop After Current Motion ({) is added. The note concerning END is added. A common note to C and J is added. The note concerning Push Mode error is added. Description of Loop (X) is added.
		SC9	SC8-65 "Basic CML Program Example" is changed.

		AP1-98 AP1-99 AP1-100 AP1-102 AP1-103	Dimension of CM1-☐-23☐☐ is changed. Unit and value of Inertia are changed. Chart of Analog Type is added. "Interface Wiring Example" is added. SC9-76 "Wiring Example" is moved.
		AP2 AP2-112 AP2-115	"Parameter List" is changed. Max value of K40 is changed. The note concerning defaylt value is added.
		AP3	"Command List" is changed.
		AP4-121, 122	"Wiring for Network Card" is added.
		AP6	"Communication Time with Cool Muscle" is added.
		AP7 AP7-130 AP7-134	"Position Mark Output" is added. "Origin Search" is added. "Merge Mode" is added.
Feb., 2008	MDUG-CM1/08207E-01	SC7-48	Min, Max and Default chart of K28, 29, 31 and 32 is deleted.
		SC7-58	Chart of each Gain is added.
		AP2-117	Values of K26-K32 are changed.
Jan., 2009	MDUG-CM1/09101E-01	WA-1	Caution is added.
		SC1-9	Note is changed.
		SC3-14, 15	"What Do I Need to Create a Daisy Chain?" is changed. "Attachment of Network card" is added.
		SC4-20	"PIN Layout" is changed and matched to the catalog.
		SC4-22	Explanation of "Serial input" is added.
		SC7-40	Explanation and caution are added.
		SC7-54	Explanation of K37 is added.
		SC8-73	"Query" is changed and matched to Appendix 3.
		SC8-77	Caution of "+" is added. Explanation of "Execute Program Bank" is added.
		AP1-103	"Cool Muscle Parts Life Time" is added.
		AP1-106	Caution is added.
		AP1-107	Caution is added.
		AP8-144	"Deviation Counter" is changed.
Apr., 2011	MDUG-CM1/11401E-01	AP1-102	Dimension of CM1-☐-17☐☐ is changed.
			Dimension of CM1-☐-23☐☐ is changed.
		AP1-103	Specification of CM1-☐-17☐☐ is changed.
			Specification of CM1-☐-23☐☐ is changed.