

EtherCAT CoolMUSCLE Bridge User's Guide
MDUG-CMB/16B01E-01

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|---|
| <ul style="list-style-type: none"><input type="checkbox"/> Before use, read through this User's Guide to ensure proper use.<input type="checkbox"/> In particular, be sure to read "Instructions for Safety" without fail for safety purpose.<input type="checkbox"/> Keep this User's Guide at an easily accessible place so as to be referred anytime as necessary. |
|---|

- The contents of this User's Guide are only for EtherCAT Cool Muscle Bridge customer sample (CS) product.
- The contents of this User's Guide are subject to change without notice for the improvement in product, specification, or usability of this User's Guide.
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- Please read the following related manuals before using EtherCAT Cool Muscle Bridge.
 - "CM1 User's Guide" for the usage of COOL MUSCLE 1.
 - "CM2 User's Guide" for the usage of COOL MUSCLE 2.
 - "CML User's Guide" for the usage of COOL MUSCLE 2 operation language
 - "Object Dictionary" for EtherCAT Cool MUSCLE Bridge
 - EtherCAT Cool Muscle Bridge Setup Tool manual
- EtherCAT Cool Muscle Bridge is tested with Beckhoff Automation TwinCAT3.1. and Trio Motion Technology's MC4N.

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Instructions for Safety

【Be sure to read before use for safety】

To ensure safe use

- To ensure the safe and proper use of our products, it is important that you read this User's Guide thoroughly prior to its use. Failure to read, fully understand and implement following instructions and precautions may result in damage to the product, the machine to which it is installed, or operator injury.
- Please employ fail-safe systems when applying these products to the equipment in which any failure on its part can be expected to cause a serious accident or loss.

Safety Precautions

Please read following precautions in order to ensure safe and proper use of the product, and avoid damages on machinery and injuries to the operators and other people.

In this User's Guide, safety precautions are classified as either "Warning" or "Caution", indicating the level of hazard seriousness possibly occurred when handling the product incorrectly.

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

Note that some items described as  Cautions may result in more serious damage under certain conditions. Please observe the precautions of both levels because they are important to personnel safety.

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

 Indicates a prohibited action (what must not be done).	Ex.  "No disassemble"
 Indicates a necessary action (what must be done).	Ex.  "Grounding"



Warning

Do not touch the terminals or do not attempt to disassemble the device and touch the interior thereof while the power is being supplied. In addition, do not turn on electricity when the cover is removed.



Those could result in electric shock.

Do not attempt to disassemble, repair or modify the device.

Those could result in malfunction or electric shock.



Fail-safe measures must be taken by the customer to secure safety in case of abnormal signals caused by broken signal lines, momentary power interruption, etc. Not doing so could result in serious accidents.



Make sure that emergency stop circuits, interlock circuits, limit circuits and similar safe measures must be provided outside the device.



Make sure to apply the voltage/current within the specified range to the device. Not doing so may cause a malfunction or fire.



Caution

Pay attention to the polarities(+/-) when wiring the DC power supply. Wrong connection may cause malfunction of the system.



Precautions for Safe Use

- When transporting the product, use dedicated packing boxes and prevent it from being exposed to excessive vibration or impact during transportation.
- Make sure that the product is securely fastened.
- Do not bundle cables. Always separate cables to prevent unstable operation due to signal interference when used in multiple systems.
- Make sure that the terminal blocks, communications cables and other items with locking mechanism are properly locked before use.
- Abide by the specifications for a communication distance and the number of devices to be connected.
- Pay careful attention as metal piece does not get into the product when wiring or installing.
- Always use the specified communications cables and connectors.
- Pay careful attention to the polarity of terminals when wiring them.
- Always use the power supply voltage specified in this manual.
- Do not forcibly bend the cable or pull on by excessive power.
- Observe the following precautions when wiring the communication cables.
 - Do not bend the communications cables beyond their natural limit.
 - Do not pull on the communication cables excessively.
 - Do not place a heavy object on top of the communication cables.
 - Separate the communication cables from the power lines or high-tension wires.
 - Wire the communication cables through a duct.
- Before touching the device, be sure to first touch a grounded metallic object in order to discharge static electricity.
- Before wiring the communication cables, be sure to turn off the power of controller and all slaves.
- Fail-safe measures must be taken by the customer to ensure safety in case of abnormal signals caused by broken signal lines, momentary power interruptions, etc.
- Ensure that the created user program should be migrated to regular operation after the adequate confirmation of system operation.
- Ensure that all wiring and switch settings are correct before applying power to the product.

Precautions for Correct Use

- Ensure correct installation as specified in this User's Guide. Improper installation could result in malfunction.
- Do not drop the product or give excessive vibration or shock to the product. Doing so may cause a failure or malfunction.
- Do not install the product in the following locations:
 - Locations subject to direct sunlight.
 - Locations subject to temperature or humidity outside the range of specifications.
 - Locations subject to condensation caused by severe changes in temperature.
 - Locations exposed to corrosive or inflammable gases.
 - Locations exposed to dust, dirt, salt or iron powder.
 - Locations exposed to water, oil, acid or chemicals.
 - Locations exposed to vibration or shock.
- Take appropriate shielding measures when using the device in the following locations:
 - Locations subject to noise such as static electricity.
 - Locations subject to strong electromagnetic fields.
 - Locations subject to possible exposure to radioactivity.
 - Locations close to power lines.
- Ensure correct wiring as specified in this User's Guide.
- Always use the correct wiring components when wiring.
- Pay careful attention to the voltage specifications when wiring communication lines and power supply.
Incorrect wiring may result in malfunction.

Explanation of Icon

Icons used in this User's Guide.

	Warnings and notices
	Important points
	Supplemental explanations

Contexture of this User's Guide

The Chapter contexture of this User's Guide is shown as below.

Read the necessary parts referring to the following.

Contexture	
Chapter 1. Overview	Explains about product overview, parts description / function, product code and connection configuration to Cool Muscle.
Chapter 2. Specifications	Explains about the product general specifications, Cool Muscle communication specifications, EtherCAT communication specifications, dimensions, connector specifications and cable specifications.
Chapter 3. Installation / Connection	Explains about installation (mounting, operating environment) and cautions for connecting and wiring.
Chapter 4. Network Connection / Status Indicator	Explains about multi-axis configuration (network connection) and indicators (LEDs) that show EtherCAT status and Slave operation status.
Chapter 5. Device Architecture	Explains about device architecture overview, EtherCAT State Machine, state transition and related Application Layer register, PDO and SDO.
Chapter 6. Device Control / Operation Mode (CiA402 Drive Profile)	Explains about CiA402 drive profile's operation mode, csp (cyclic synchronous position mode) and hm (homing mode) and its structure of device state control / state transition and Controlword / Statusword.
Chapter 7. Manufacturer Specific	Explains about objects of manufacturer specific (State transition, CML transmission, settings and readings for each ID and status information).
Chapter 8. Operation	Explains about EtherCAT setting and operation check by using setting software.
Chapter 9. Fault and Maintenance / Inspection	Explains about points to be checked when a trouble occurs, diagnosis and countermeasures against fault and periodical maintenance / inspection.
Chapter 10. Accessories	Explains about cables (optional) to connect the product.
Appendix	<ol style="list-style-type: none"> 1) Commands transmission: CMD_Mode transmission flow 2) Mailbox function: CML transmission flow 3) Switch operation mode: Mode switch flow 4) Homing mode: Homing mode flow 5) Cool Muscle's max. value of position data for each encoder resolution 6) Object List

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1.1. Overview

“EtherCAT Cool MUSCLE Bridge” is the interface (device) that adapts / connects Muscle Corporation’s Integrated AC Servo System, Cool Muscle 1 and/or Cool Muscle 2 (hereafter referred to as CM1, CM2 or CM1/CM2 or collectively called Cool Muscle or CM) to EtherCAT field network system.

4 pieces of CM1/CM2 can be connected per the bridge that realizes 4-axis Cool Muscle EtherCAT Slave that conformed to EtherCAT network. It allows you to control Cool Muscle EtherCAT Slave from EtherCAT Master via network that realizes a high performance motor control system.

The application layer of EtherCAT Slave is conformed to CiA402 Drive Profile and the operation mode meets Cyclic Synchronous Position mode (csp) and Homing mode (hm). EtherCAT Master sends position commands to EtherCAT Slave at the communication cycle 1msec and at the same time EtherCAT Slave sends the Cool Muscle’s current position back to EtherCAT Master. Also various motion and data settings are possible by using manufacturer specific.

The parameters of Cool Muscle can be read and written by the communication between EtherCAT Master and EtherCAT Slave by using the Mailbox function. Also the Direct Command to Cool Muscle can be done by using the Mailbox function.

As described above, by the effective combination of EtherCAT’s high speed data communication and Cool Muscle’s servo controllability and drivability, you can create the multi-axis, high speed and precise position control system.

This manual introduces the specifications, functions and usage of “EtherCAT Cool MUSCLE Bridge” and the EtherCAT Slave device that is composed by the Bridge and Cool Muscle.

■ EtherCAT is an abbreviation of Ethernet for Control Automation Technology.

EtherCAT is an open field network developed by a German company, Beckhoff Automation, that is compatible to Ethernet.

(IEEE802.3 Ethernet conformed)

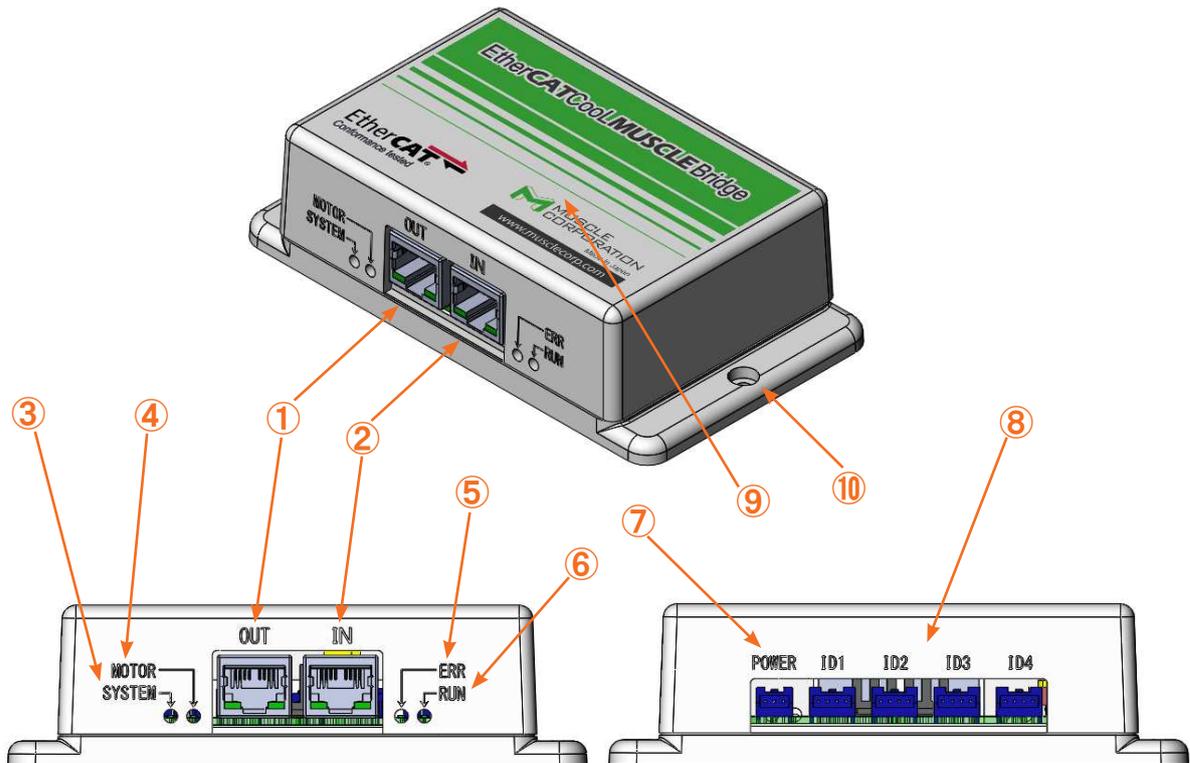
■ COOL MUSCLE 1 & COOL MUSCLE 2

Integrated AC Servo System with embedded a controller and driver developed by Muscle Corporation.

The motors of CM1 are stepper motors and the ones for CM2 are servo motors.

1.2. Parts Description and Functions

Refer to the below diagram for names and functions of each part.



No	Name	Usage • Function
1	EtherCAT Communication Connector OUT	EtherCAT Communication OUT Port
2	EtherCAT Communication Connector IN	EtherCAT Communication IN Port
3	SYSTEM LED	SLAVE Status Indicator
4	MOTOR LED	CM Status Indicator
5	ERR LED	EtherCAT Communication Error Indicator
6	RUN LED	EtherCAT Communication Status Indicator
7	Power Connector	Connector for Power Supply
8	CM Communication Connector ID1, ID2, ID3, ID4	CM Connection Port
9	Case	Cover
10	Mounting Hole	For mounting / fixing

1.3. Product Code

■ EtherCAT Cool MUSCLE Bridge

Name	Product Code	Remarks
CM1 EtherCAT Cool MUSCLE Bridge	EB01	Connect up to 4pcs of CM1
CM2 EtherCAT Cool MUSCLE Bridge	EB02	Connect up to 4pcs of CM2
CM1-2 EtherCAT Cool MUSCLE Bridge	EB12	Connect up to 2pcs of each CM1 & CM2

■ Cable

Name	Product Code	Category	Remarks
EtherCAT Cool MUSCLE Bridge / CM1 Communication Cable 2m Double Connectors	EH01-2000W	For CM1 / 2m	
EtherCAT Cool MUSCLE Bridge / CM2 Communication Cable 2m Double Connectors	EH02-2000W	For CM2 / 2m	
EtherCAT Cool MUSCLE BridgePower Cable 2m Single Connector	EHPW-2000S	For Power / 2m	

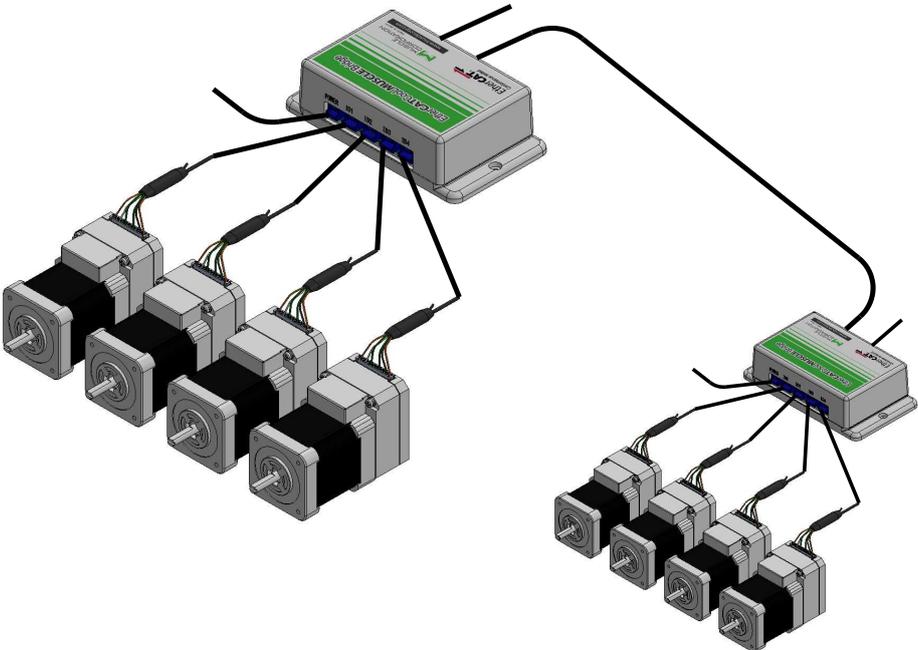
1.4. Cool Muscle Connection Configuration

Up to 4 pcs of Cool Muscles can be connected for one product. There are 3 different types of interfaces so that the right interface shall be selected along with which Cool Muscle you use.

Due to that the EtherCAT Bridge controls 4 motors separately, the ID numbers of CM communication connectors (displayed on the case) are applied as each Cool Muscle's ID number.

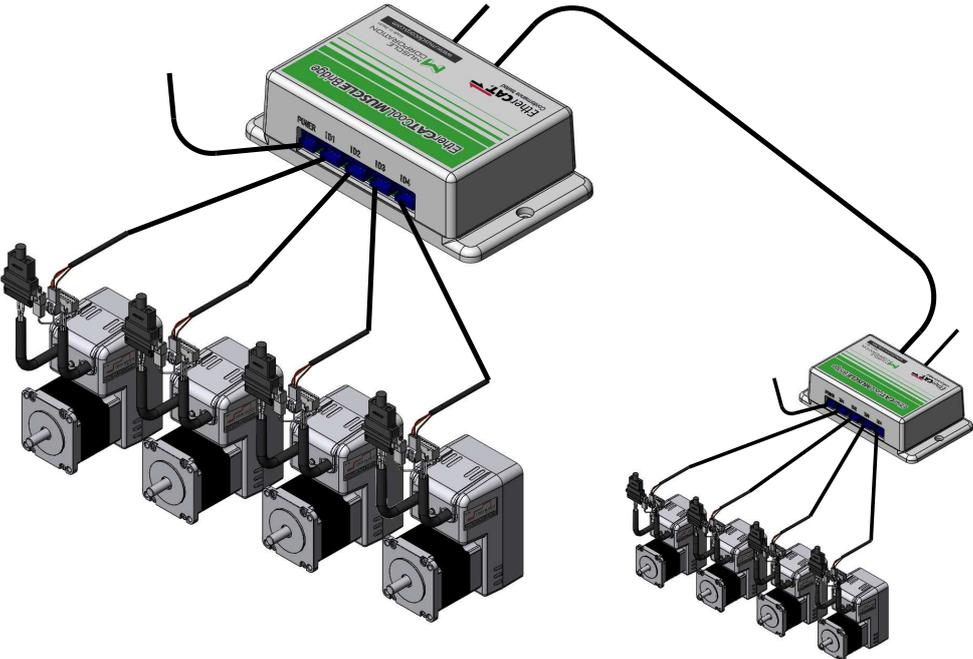
1.4.1. Configuration 4pcs of CM1

- EtherCAT Bridge No#: EB01
- Up to 4 pcs of only CM1 can be connected.



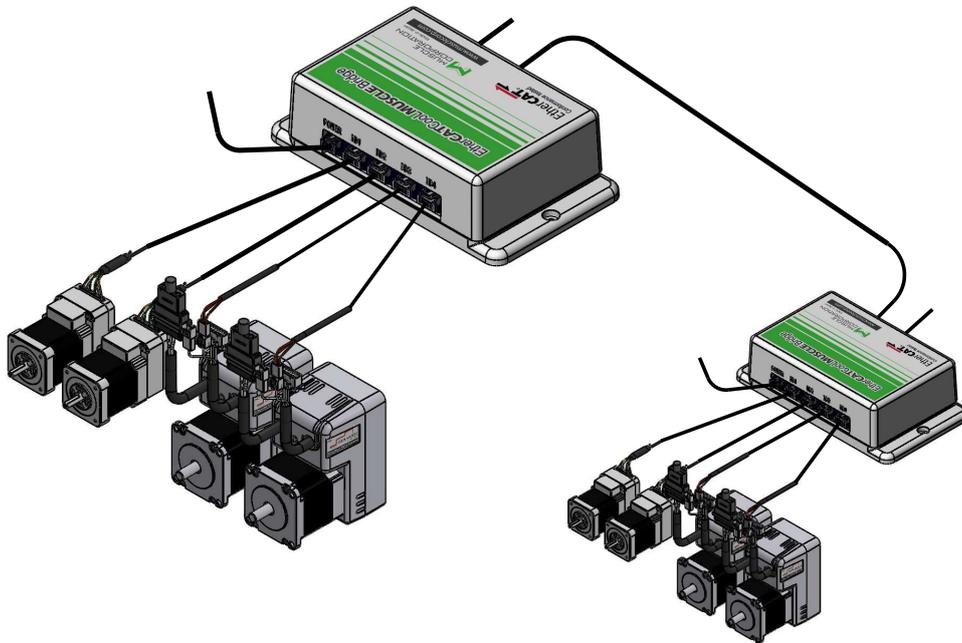
1.4.2. Configuration 4pcs of CM2

- EtherCAT Bride No# : EB02
- Up to 4 pcs of only CM2 can be connected.



1.4.3. Configuration 2pcs of CM1 & 2pcs of CM2

- EtherCAT Bride No# : EB12
- Up to 2 pcs of CM1 & 2 pcs of CM2 can be connected.



CM1 must be connected to ID1, ID2 and CM2 must be connected to ID3, ID4.

Chapter 2

Specifications

2.1. General Specifications

Item		Specs
Input DC Supply [V]	Voltage	DC+9 ~ +24V ($\pm 10\%$)
	Rated Current [Arms]	Max. 0.15A (When DC+24V is applied) Max. 0.4A (When DC+9V is applied)
Environment	Operating Temperature / Humidity	0 ~ +40°C • 25 ~ 90%RH (Non-condensing)
	Storage Temperature / Humidity	-20 ~ +60°C • 25 ~ 90%RH (Non-condensing)
	Operating / Storage Ambient	No inflammable or corrosive gas
	Altitude	Less than 1,000m above sea level
	Pollution Level	Pollution Degree 2
	Vibration	Less than 1G
	Impact	Less than 10G
Insulation Resistance	More than 50Mohm/DC500V	
Withstand Voltage	AC500V/1min	
Dimensions	127(W) X 36(H) X 72(D)	
Mass [kg]	130g	

2.2. CM Communication Specifications

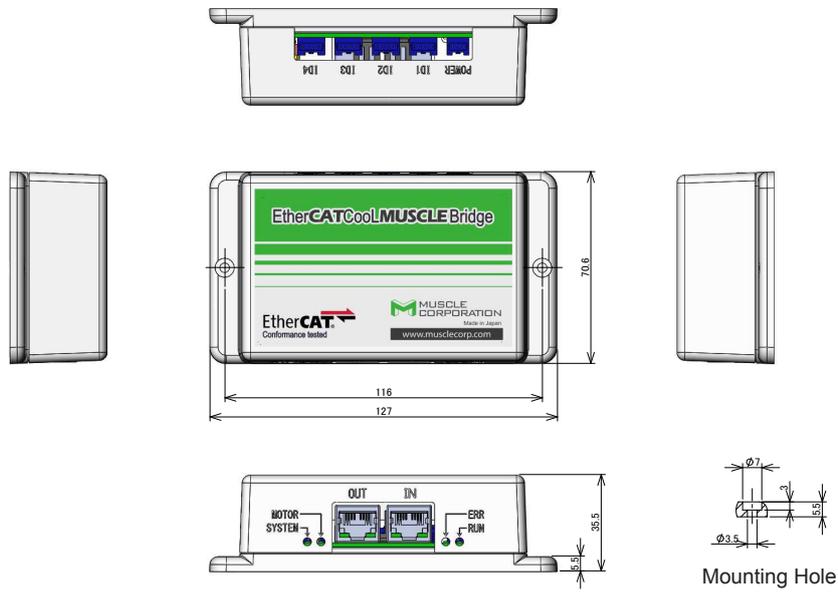
Item	Specs
COOL MUSCLE Connection	CM1 and CM2 with EtherCAT Bridge connection function Additional number "EB" follows CM product number
Communication Port	CM1: UART CM2: RS-232C
Communication Speed	Baud Rate: 178Kbps

2.3. EtherCAT Communication Specifications

Item	Spec
Communication Standard	IEC 61158 Type 12
Physical Layer	100BASE-TX (IEEE802.3)
Transmission Speed	100 Mbps (Duplex)
Topology	Daisy Chain
Cable	Twisted-pair cable higher than Category 5 (Double shielded by aluminium tape and braid cable is recommended)
Transmission Distance	Less than 100m between nodes
Connector	RJ45 × 2 (Shielded) (IN : EtherCAT Input, OUT: EtherCAT Output)
Frame Data	Max.1,484 bytes
LED Indicator	L/A IN (Link/Activity IN) × 1 L/A OUT (Link/Activity OUT) × 1 RUN × 1 ERR × 1 SYSTEM × 1 MOTOR × 1
Communication Object	<ul style="list-style-type: none"> • SDO (Service Data Object) • PDO (Process Data Object)
SyncManager	<ul style="list-style-type: none"> •SM0: Mailbox Output (Master → Slave) •SM1: Mailbox Input (Slave → Master) •SM2: Process Data Output (Master → Slave) •SM3: Process Data Input (Slave → Master)
FMMU	<ul style="list-style-type: none"> • FMMU0: Process Data Output • FMMU1: Process Data Input • FMMU2: Mailbox Status
Synchronization Mode	<ul style="list-style-type: none"> • Free Run • Synchronized by SyncManager Event
Device Profile	CoE: CAN application layer over EtherCAT
Application Profile	<p>IEC 61800-7 Profile type 1 (CiA402 Drive Profile)</p> <p>Operation Mode:</p> <ul style="list-style-type: none"> • Standard <ul style="list-style-type: none"> csp (cyclic synchronous position mode) hm (homing mode) • Manufacturer Specific

2.4. Dimensions / Appearance

■ Dimensions



■ EtherCAT Communication Connector Side Image



■ CM Communication Connector Side Image



2.5. Connector Specifications

2.5.1. EtherCAT Communication Connector

Connector for EtherCAT twist pair shielded cable.

- Connector: J00-0045NL (Manufacturer: Pulse)
- Electric Characteristics: Conformed to IEEE802.3
- Connector Configuration: RJ45, 8 pin modular connector (Conformed to ISO8877)

Pin No#	Signal Name	Symbol	Function • Discription
1	TXD+	TD+	Output
2	TXD-	TD-	Output
3	RXD+	RD+	Input
4	-	-	-
5	-	-	-
6	RXD-	RD-	Input
7	-	-	-
8	-	-	-
-	GND	FG	Shield

2.5.2. CM Communication Connector (ID1, ID2, ID3, ID4)

- Connector: Post with Base S04B-PASK-2 (Manufacturer: JST)
- Connector (Cable side) Housing: PAP-04V-S, Pin: SPHD-001T-P0.5 (Manufacturer: JST)

■ CM1 Communication Channel

Pin No#	Signal Name	Symbol	Function • Discription	Remarks
1	RXD+	RxD+	Data Receive +	CM1 +5V
2	RXD-	RxD-	Data Receive -	CM1 OUTPUT1
3	TXD-	TxD-	Data Transmission -	CM1 INPUT1-
4	TXD+	TxD+	Data Transmission +	CM1 INPUT1+

■ CM2 Communication Channel

Pin No#	Signal Name	Symbol	Function • Discription	Remarks
1	RXD	RxD	Data Receive +	CM2 TXD
2	-	-	-	
3	GND	GND	Data Transmission GND	CM2 GND
4	TXD	TxD	Data Transmission +	CM2 RXD

2.5.3. Power Supply Connector

- Connector: Post with Base S03B-PASK-2 (Manufacturer: JST)
- Connector (Cable side) Housing: PAP-03V-S, Pin: SPHD-001T-P0.5 (Manufacturer: JST)

Pin No#	Signal Name	Symbol	Function • Discription	Remarks
1	Power+	V+	Bridge Power Supply +	
2	Power-	V-	Bridge Power Supply -	
3	Earth	FG	GND for Safety	

2.6. Cable Specifications

2.6.1. EtherCAT Communication Cable

Use a straight LAN Cable higher than Category 5.

No#	Signal Name	Color	Remarks
1	TXP	White/ Green	
2	TXN	Green	
3	RXP	White/ Orange	
4	-	Blue	
5	-	White/ Blue	
6	RXN	Orange	
7	-	White/ Brown	
8	-	Brown	
FG1, FG2	FG	-	Shield

2.6.2. CM1 Communication Cable

- Cable Product Code: EH01-2000W Cable Length: 2000mm
- Connector: Board Side Connector PAP-04V-S (Manufacturer: JST)
CM1 Side Connector 51065-1200 (Manufacturcer: Molex)

Board Side Connector / Signal Name, Wire Specs

No#	Signal Name	Color	Wire	Remarks
1	RXD+	Red	UL Standard; AWG24	CM1 +5V
2	RXD-	Green	UL Standard; AWG24	CM1 OUTPUT1
3	TXD-	Gray	UL Standard; AWG24	CM INPUT1-
4	TXD+	White	UL Standard; AWG24	CM INPUT1+

CM1 Side Connector / Signal Name, Wire Specs

No#	Signal Name	Color	Wire	Remarks
1	+24V	Orange	UL Standard; AWG22	
2	GND1	Black	UL Standard; AWG22	
3	-	-	-	No Use
4	-	-	-	No Use
5	OUTPUT1	Green	UL Standard; AWG24	
6	-	-	-	No Use
7	-	-	-	No Use
8	INPUT-	Gray	UL Standard; AWG24	
9	-	-	-	No Use
10	INPUT+	White	UL Standard; AWG24	
11	-	-	-	No Use
12	+5V	Red	UL Standard; AWG24	

2.6.3. CM2 Communication Cable

- Cable Product Code: EH02-2000W Cable Length: 2000mm
- Connector: Board Side Connector PAP-04V-S (Manufacturer: JST)
CM2 Side Connector XARR-O3VF (Manufacturer: JST)

Board Side Connector / Signal Name, Wire Specs (ID1, ID2, ID3, ID4)

No#	Signal Name	Color	Wire	Remarks
1	RXD	Red	UL Standard; AWG24	CM2 TXD
2	-	-	-	
3	GND	Orange	UL Standard; AWG24	CM2 GND
4	TXD	Brown	UL Standard; AWG24	CM2 RXD

CM2 Side Connector / Signal Name, Wire Specs (ID1, ID2, ID3, ID4)

No#	Signal Name	Color	Wire	Remarks
1	RXD	Brown	UL Standard; AWG24	
2	TXD	Red	UL Standard; AWG24	
3	GND	Orange	UL Standard; AWG24	

2.6.4. Power Cable

- Cable Product Code: EHPW-2000S Cable Length: 2000mm
- Connector: Board Side Connector PAP-03V-S (Manufacturer: JST)
Power Supply Side Terminal : TMEV0.3-3 (Manufacturer: Nichifu Terminal Industries)

Signal Name, Wire Specs

No#	Signal Name	Color	Wire	Remarks
1	V+	Orange	UL Standard; AWG22	
2	V-	Black	UL Standard; AWG22	
3	FG	Green	UL Standard; AWG22	



Refer to Chapter 10 Accessory for the details about Cables.

Chapter 3

Installation / Connection

3.1. Installation

Please fix the case to an appropriate location by using the mounting holes aside the case.



Mounting

- Mounting direction is not constrained. Please install the product in the direction that you can see the indications on the case.
- Do not mount the product at footholding locations. Extreme force caused by standing or stepping on the product could result in damages.

Operational Environmental Conditions

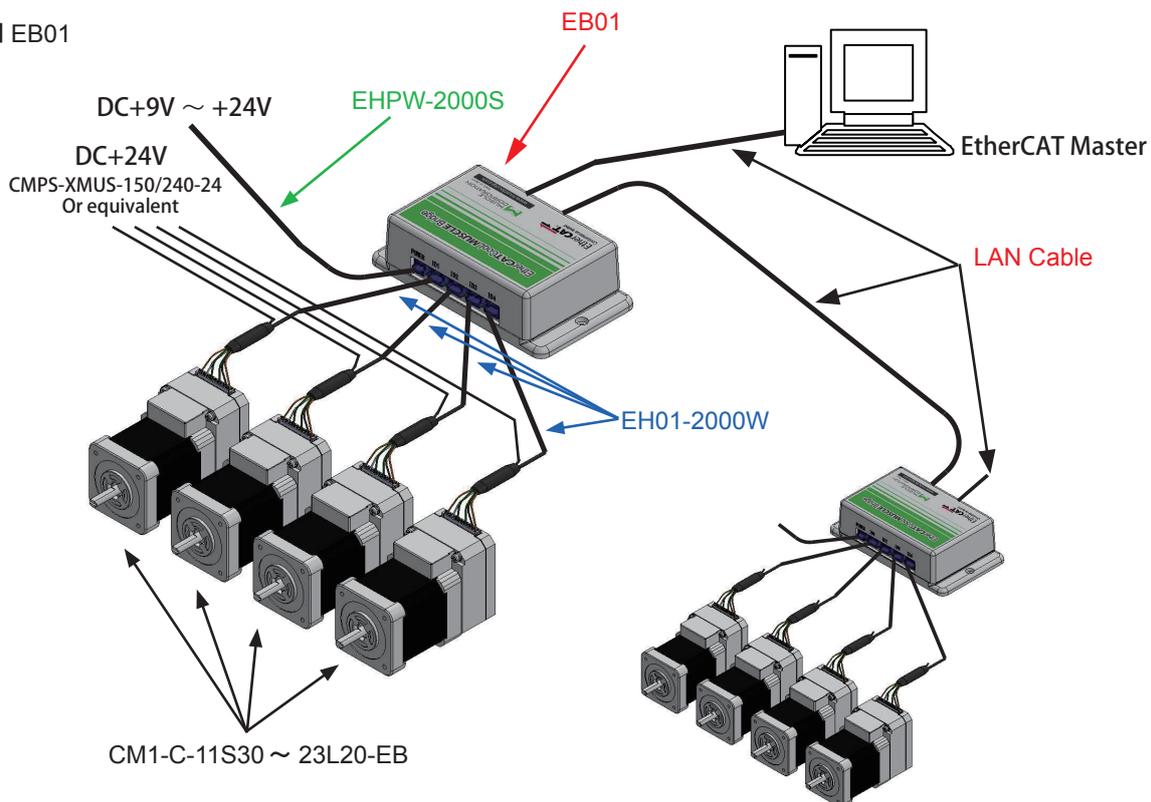
- Use the product under the following environmental conditions.
 - Operating Ambient Temperature: 0 ~ +40°C
 - Operating Ambient Humidity: 25 ~ 90%RH (Non Condensing)
 - Operating Ambience: No Inflammable or Corrosive Gas
 - Altitude: 1,000m above sea level or less
- Do not use the product where the product is exposed to oil or chemicals. If the product is exposed to chemicals such as coolant or cleaning liquid even for a short period of time, it could affect the product and result in damages or abnormal operation.
- Do not use the product where the product is exposed to corrosive gas or liquid. It could result in damages or abnormal operation.
- Do not use the product where a source of surge exists. If there is a machinery instrument such as an electro magnetic lifter, high-frequency induction furnace, motor, etc. nearby that produces a surge, that could

result in degradational damage of components inside of the product. Eliminate a surge source and prevent wires from contacting each other.

- When directly driving a load that produces a surge voltage, use a load product with a surge absorbing circuit, otherwise that could result in damage of the product.
- Prevent foreign matters such as wiring scraps from getting into the product. It could result in damages or abnormal operation.
- Install the product where there is no vibration or impact. Vibration or impact could cause damages or abnormal operation.
- Do not use under the temperature cycle environment. The product could result in damage when subject to severe temperature beyond normal temperature range.
- Do not use the product where there is a direct sun light. Block a direct sun light if there is. A direct sun light could cause damages and abnormal operation.
- Do not use the product where the product is exposed to radiation heat from heat source. Heat could cause abnormal operation.

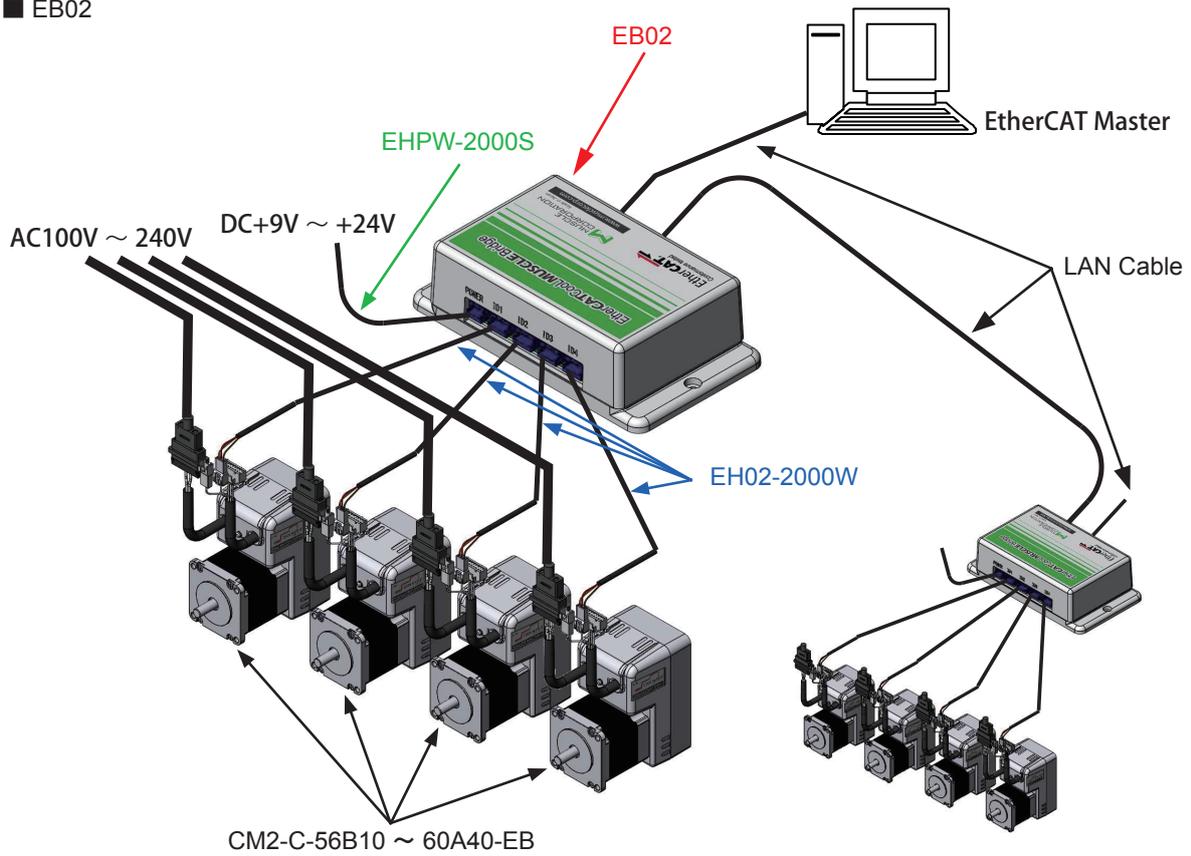
3.2. Connection

■ EB01

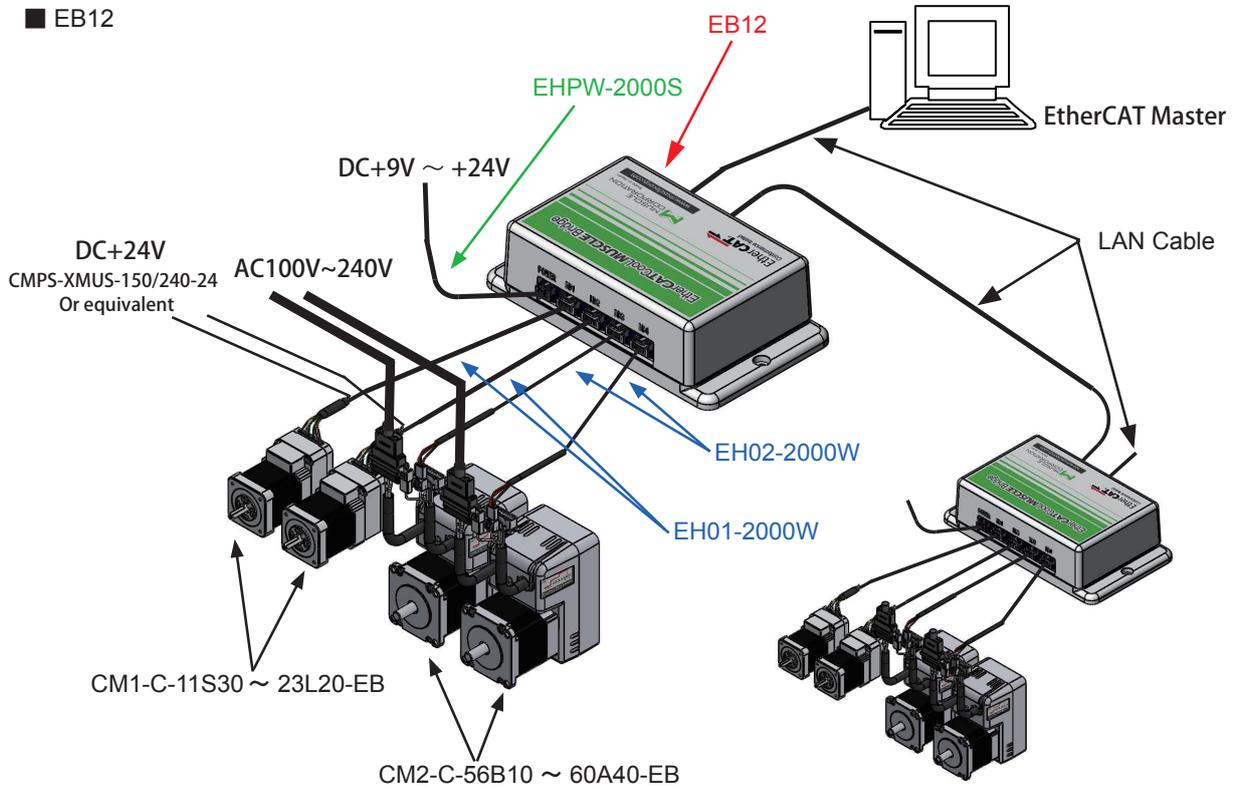


Connect LAN cable from EtherCAT Master to EtherCAT IN. EtherCAT OUT shall be connected to EtherCAT IN of the next node. Redundancy can be implemented by EtherCAT Master handles 2 LAN ports.

■ EB02



■ EB12



The items in the below table are needed to realize each configuration.

Name	Product Code	EB01	EB02	EB12
LAN Cable	N/A	△	△	△
Cool Muscle 1	CM1-C-11S30 ~ 23L20-EB	○	×	○
EtherCAT Cool MUSCLE Bridge CM1 RS-232C Cable 2m Double Connector	EH01-2000W	○	×	○
DC+24V Power Supply for CM1	CMPS-XMUS-150/240-24	▲	×	▲
Cool Muscle 2	CM2-C-56B10 ~ 60A40A-EB	×	○	○
EtherCAT Cool MUSCLE Bridge CM2 RS-232C Cable 2m Double Connector	EH02-2000W	×	○	○
AC100 ~ 240V Power Supply for CM2	N/A	×	△	△
EtherCAT Cool MUSCLE Bridge Power Supply	CMPS-XMUS-150/240-24	▲	▲	▲
EtherCAT Cool MUSCLE Bridge Power Cable 2m Single Connector	EHPW-2000S	○	○	○

○ : The number of use of Muscle Corporation's products are needed.

▲ : Muscle Corporation's products are needed or user must prepare equivalent product.

△ : User must prepare them.

× : No need.

3.3. Precaution about Wirings

Use specified cables to connect CM1/ CM2 without extension.

- Communication cables shall not be bundled with each other and separated from power cables.
- Cables shall not be bent or pulled repeatedly. Also do not place anything heavy or apply excessive force to cables. Those could result in damaging cables.
- Do not do incorrect wirings. Incorrect wirings could result in abnormal operation or damages.
- Do not do wiring during the power is supplied. It could result in damages of the product or IO circuit or abnormal operation.
- Do not wire the cables for the product in the same wiring line with power and/or high voltage lines. It could result in abnormal operation by signal noise or surge from power or high voltage lines. Wire power and/or high voltage lines separated from the product or the cables connected to the product.
- Be sure of isolation of wirings. Isolation failure such as contacting other wirings, isolation failure between terminals and etc. could result in damages to the product inputs and outputs by extremely high voltage or current.
- Implement a noise protection when installing the product in your instruments or machines, noise could produce abnormal operation.



Do not use same power supply to the product and Cool Muscle if possible.
The voltage change could result in abnormal operation or damages.

Chapter 4

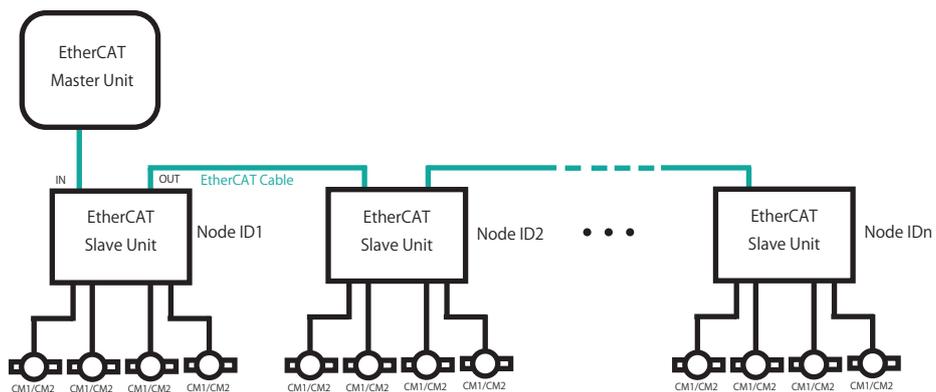
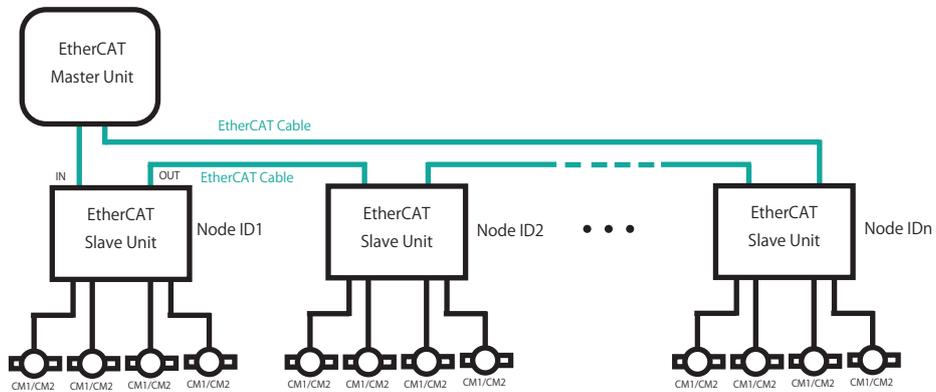
Network Connection / Status Indicator

4.1. Multi-axis Configuration and Node Address

When EtherCAT Master is powered up, Node ID will be automatically identified along with the order of the EtherCAT Slaves connected from EtherCAT Master.



Supply the power to all the nodes before EtherCAT Master executes the scan to identify the node addresses.

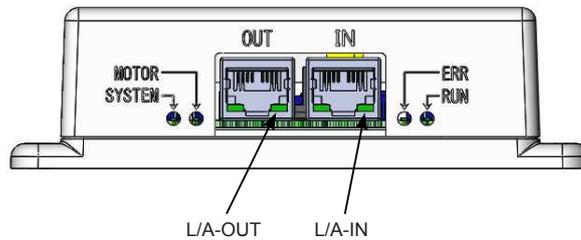


Redundancy can be implemented by EtherCAT Master handles 2 LAN ports.

4.2. Status Indicator

There are Indicators (LED) that show EtherCAT communication status.

There are RUN, ERR, L/A-IN and L/A-OUT for EtherCAT Status LEDs and MOTOR and SYSTEM for Salve Operation Status LEDs.



RUN, ERR, L/A-IN and LED L/A OUT indication is conformed to EtherCAT Slave specification. MOTOR and SYSTEM LED indication is based on the product's specification.

Indicator states of RUN and ERR LEDs

■ RUN LED <Green>

LED States	EtherCA Slave State	Remarks
OFF	Initializing	Initializing
Blinking	Pre-Operational	Mailbox is Ready
Single Flash	Safe-Operational	PDO TXD Ready
ON	Operational	PDO TXD / RXD Ready

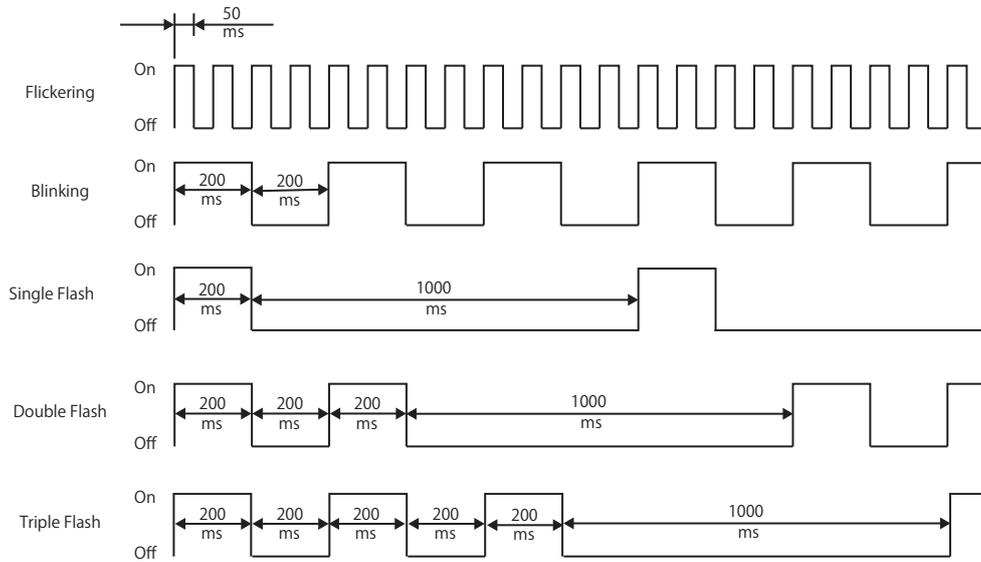


Refer to Chapter 5.2. EtherCAT State Machine (ESM) for the details of states indicated by RUN LED.

■ ERR LED <Red>

LED States	EtherCAT Slave State	Remarks
OFF	Normal Operation	
Blinking	Err-Operational No Communication	
Single Flash	Communication Error / Synchronization Error	
Double Flash	Process Data Communication Timeout	
ON	Data Error in EEPROM	

EtherCAT Blinking Specification (Reference)



Indicator states of L/A-IN and L/A-OUT LEDs

■ L/A-IN LED <Orange>

LED States	EtherCAT Slave State	Remarks
OFF	The link is not established	
ON	The link is processed	
Blinking	The link is established and Operational	

■ L/A-OUT LED <Orange>

LED States	EtherCAT Slave State	Remarks
OFF	The link is not established	
ON	The link is processed	
Blinking	The link is established and Operational	

Indicator states of MOTOR and SYSTEM LEDs

■ MOTOR LED <Green>

LED States	Slave Operation State	Remarks
OFF	Initializing	
Blinking	Cool Muscle Error	An error occurs on more than 1 CM in ID1 to ID4
ON	Operational	

■ System LED <Green>

LED States	Slave Operation State	Remarks
OFF	Power is not supplied	
Blinking	Not ready to receive Target Position	Status except operational
ON	EtherCAT Slave is Operational	Normal operational status

Chapter 5

Device Architecture

5.1. Architecture Overview

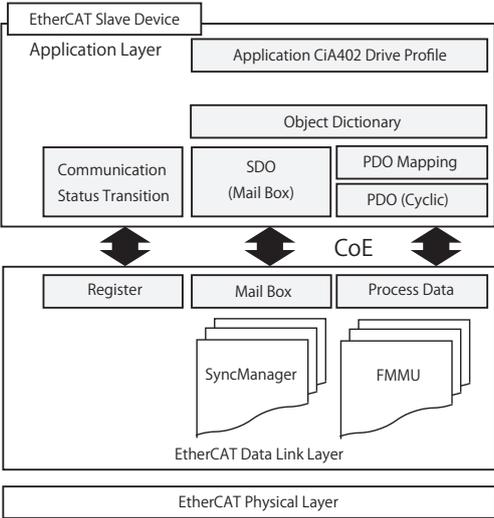
Physical layer of EtherCAT is based on IEC8802-3 (IEEE802.3) 100BASE-TX, standard Ethernet physics.

Data Link Layer (DL) is handled by EtherCAT Slave Controller (ESC) that splits specific Ethernet data frame in process data and Mailbox data.

Application Layer (AL) is connected via CAN application protocol over EtherCAT (CoE) and can handle SDO (Service Data Object) as well as the cyclic process data object.

Architecture of CoE device is realized by CANOpen application that handles SDO (Service Data Object) via Mailbox and PDO (Process Data Object) using cyclic communication data.

The drive functionality follows CiA402 Drive Profile based on IEC61800-7-201 and IEC61800-7-301.



5.1.1. CAN Application Protocol over EtherCAT (CoE)

Various interfaces for existing device profiles are provided for EtherCAT application layer and multiple communication protocols can be used. CAN application protocol over EtherCAT (CoE) is implemented in the product.

CANOpen device and application profile can be used in wide range of device classes and applications, and used such as application profiles of I/O components, drives, encoders, proportional valves and hydraulic controllers in plastic and fabric applications.

EtherCAT consists of the same communication mechanism as prevailed CANOpen. Since this mechanism is constituted of object dictionary, PDO (Process Data Object) and SDO (Service Data Object), the network management is compatible between EtherCAT and CANOpen.

An application communication such as a part of execution commands and parameter settings of Cool Muscle is expanded as manufacturer specific.

5.1.2. Application Profile

Application profile is conformed to CiA402 Drive Profile (IEC-61800-7 Profile type 1) that is used for the profile of servo drive system.

Objects of profile (CiA402 Drive Profile) are defined in Object Dictionary and PDO Mapping in application layer.

Contents in Object Dictionary are;

- Information about device
- Process Data
- Process Data Mapping
- Error and Status Information
- Object for Device Parameter
- Additional Manufacturer Specific Object

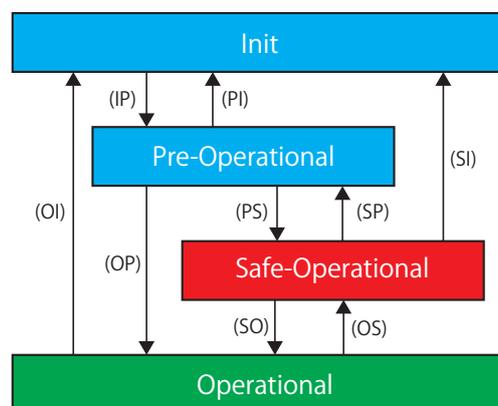
5.2. EtherCAT State Machine (ESM)

EtherCAT State Machine (ESM) that controls mutual communications between Master and Slaves is implemented in EtherCAT Slave.

The State Machine of EtherCAT Slave, that is controlled by EtherCAT Master, coordinates the definition of communication state of Slave Device and the communication relation between Master and Slaves.

5.2.1. Communicatin State Transition

EtherCAT Slave's state is controlled by EtherCAT State Machine and the State Transition is processed as shown in bellow drawing.



State	SDO Communication	PDO RXD	PDO TXD	Description
Init	× (Not possible)	×	×	Initializing the communication
Pre-Operation	○ (Possible)	×	×	Only Mailbox communication is possible. Network Initialization is on Process.
Safe-Operation	○	×	○	Mailbox Communication and PDO TXD from Master are possible.
Operational	○	○	○	Normal Operation is possible

■ Init

The communication on the application layer is not possible. Master can access to Slave's DL-Information register.

■ Pre-Operational

Mailbox communication on the application layer is possible. Master can read Slave's Vendor ID, Product Code, Product Name, Serial Number, etc. Various Slave information can be read in this status.

However, due to that no process data communication is not possible, Cool Muscles' current status can not be read in this state.

■ Safe-Operational

Mailbox communication on the application layer is possible. Process Data Input (Output of Slave) is possible but Output (Input to Slave) is not possible.

■ Operational

Process data inputs and outputs are possible. And also all EtherCAT communication functions are possible. Target Position to Cool Muscles can be transmitted via cyclic communication and motor status and current position information can be received.

Detail of State Transition

State Transition	Settings from Master to Slave
IP	Clear ESC register, read Vender ID / Product Code, etc. Set Station Address, ESC registers (Mailbox Communication SyncManager / FMMU), Request / Confirm state transition
PI	Clear ESC register (FMMU, Mailbox Communication SyncManager) Request / Confirm state transition
PS	Set ESC register (Process Communication SyncManager / FMMU) Request / Confirm state transition
SP	Clear ESC register (SyncManager, FMMU) Request / Confirm state transition
SO	Request / Confirm state transition
OS	Request / Confirm state transition
OP	Clear ESC register (SyncManager, FMMU) Request / Confirm state transition
SI	Clear ESC register (SyncManager, FMMU) Request / Confirm state transition
OI	Clear ESC register (SyncManager, FMMU) Request / Confirm state transition

5.2.2. Communication State and Application Layer (AL) Register

There are 3 registers for EtherCAT State Machine (ESM), requested status from EtherCAT Master and current status are memorized in AL Control and AL Status registers.

■ Control Register of Slave Communication Status

AL Control (Register Address : 0120h):

- Master requests the state transition to Slave

The register to control EtherCAT State Machine's state transition. It is controlled by Master but can be read by both Master and Slave.

AL Status (Register Address : 0130h)

- Slave's actual status

Slave executes or disclaims the transition request by Master.

The register for EtherCAT State Machine's actual status.

AL Status Code (Register Address : 0134h)

- Set error codes when an error occurs.

A register to memory a cause of error and other codes

Type of error can be specified when an error occurs.

■ Data in Each Register (Contents)

AL Control Register

Bit	Bit Name	Description
3-0	Control	Change State Transition of Device State Machine 1: Init State Request 2: Pre-Operational State Request 3: N/A 4: Safe-Operational State Request 8: Operational State Request
4	Error Acknowledgement	Error Indication 0: No Acknowledge of AL Status Register indication 1: Acknowledge AL Status Register indication
7-5	Reserved	0: N/A
15-8	Reserved	0: N/A

AL Status Register

Bit	Bit Name	Description
3-0	State	Actual status of Device State Machine 1: Init State 2: Pre-Operational State 3: N/A 4: Safe-Operational State 8: Operational State
4	Error	Error Indicator 0: Device is in requested state 1: Device is not in requested state
7-5	Reserved	0: N/A
15-8	Reserved	0: N/A

AL Status Code Register

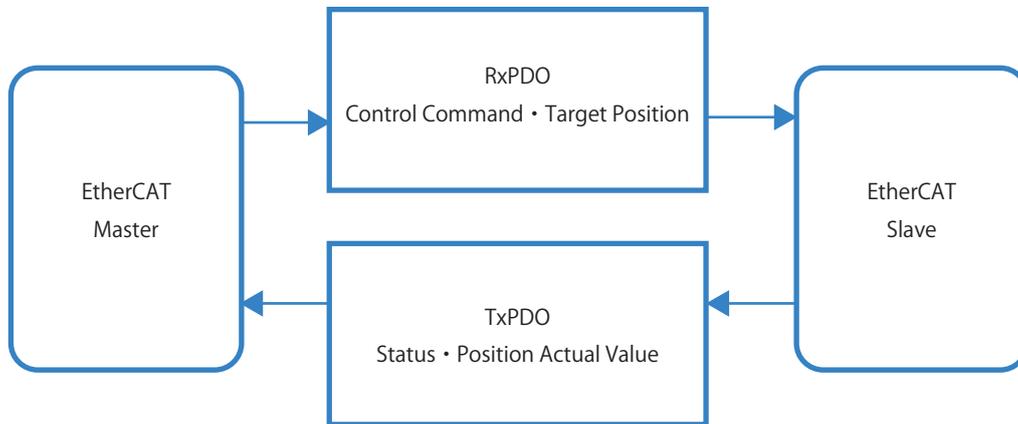
Bit	Bit Name	Description
15-0	Status Code	AL Status Code

Status Code

Code	Description
0000h	No error
0001h	Unspecified error
0011h	Invalid requested state change
0012h	Unknown requested state change
0013h	Boot state not supported
0014h	No valid firmware
0015h	Invalid mailbox configuration
0016h	Replace previous network description of old slave with the one of the new slave
0017h	Invalid Sync Manager configuration
0018h	No valid inputs available
0019h	No valid outputs available
001Ah	Synchronization error
001Bh	Sync manager watchdog
001Ch	Invalid Sync Manager Types
001Dh	Invalid Output Configuration
001Eh	Invalid Input Configuration
001Fh	Invalid Watchdog Configuration
0020h	Slave needs cold start
0021h	Slave needs INIT
0022h	Slave needs PREOP
0023h	Slave needs SAFEOP
0030h	Invalid DC SYNC Configuration
0031h	Invalid DC Latch Configuration
0032h	PLL Error
0033h	DC Sync IO Error
0034h	DC Sync Timeout Error
0042h	MBX_EOE
0043h	MBX_COE
0044h	MBX_FOE
0045h	MBX_SOE
004Fh	MBX_VOE

5.3. PDO (Process Data Object)

PDO (Process Data Object) is an object that is used for a real time data transmission by cyclic communication. PDO consists of PxDPO that Slave receives a data from Master and TxPDO that Slave sends its status to Master.



*The product supports csp mode (position command to motors) of CiA402 Drive Profile

csp: cyclic synchronous position mode

(Refer to the 6.3. Cyclic Synchronous Position mode (csp) for the details)

hm: homing mode

(Refer to the 6.4. Homing Mode (hm) for the details)

5.3.1. PDO Mapping

PDO Mapping indicates the mapping of application object (Real Time Process Data) from Object Dictionary to PDO (Process Data Object) and is the index that manages the tables of Process Data.

Index 1600h ~ 17FFh is used for RxPDO, 1A00h ~ 1BFFh is used for TxPDO in this mapping table. A number of mapped objects are memorized in Subindex 0h.

The RxPDO and TxPDO for each ID shall be as shown in the below.

<PDO Mapping>

RxPDO : Control Command, Target Position

ID1(1601h), ID2(1611h), ID3(1621h), ID4(1631h)

TxPDO : Status, Position Actual Value

ID1(1A01h), ID2(1A11h), ID3(1A21h), ID4(1A31h)

5.4. SDO (Service Data Object)

SDO (Service Data Object) communication can be used to set objects and monitor status. Objects can be set and status can be monitored by writing / reading data in the entry of the object dictionary from an EtherCAT Master.



Refer to the Chapter 7. Manufacturer Specific for the details about manufacturer specific objects.

5.4.1. Abort Code

The abort code when SDO communication error occurs is shown in the below list.

Value	Meaning
00000000h	No Error
05030000h	Toggle bit not changed
05040000h	SDO protocol timeout
05040001h	Client/Server command specifier not valid or unknown
05040005h	Out of memory
06010000h	Unsupported access to an object
06010001h	Attempt to read a write only object
06010002h	Attempt to write a read only object
06010003h	Entry can not be written because Subindex0 is not 0
06020000h	The object does not exist in the object directory
06040041h	The object can not be mapped into the PDO
06040042h	The number and length of the objects to be mapped would exceed the PDO length
06040043h	General parameter incompatibility reason
06040047h	General internal incompatibility in the device
06060000h	Access failed due to a hardware error
06070010h	Data type does not match, length of service parameter does not match
06070012h	Data type does not match, length of service parameter too high
06070013h	Data type does not match, length of service parameter too low
06090011h	Subindex does not exist
06090030h	Value range of parameter exceeded (only for write access)
06090031h	Value of parameter written to high
06090032h	Value of parameter written to low
06090033h	Detected Module Ident List (F030h) and Configured Module Ident list (F050h) does not match
06090036h	Maximum value is less than minimum value
08000000h	General error
08000020h	Data cannot be transferred or stored to the application
08000021h	Data cannot be transferred or stored to the application because of local control
08000022h	Data cannot be transferred or stored to the application because of the present device state
08000023h	Object dictionary dynamic generation fails or no object dictionary is present

Chapter 6

Device Control /Operation Mode

CiA402 Drive Profile is a servo drive profile that is one of the most popular applications for EtherCAT Slave Device. The position control, speed control and torque control for the motor drive can be achieved precisely by profiles. Servo Drive Profile (CiA402 Drive Profile) is implemented as an application profile in the device and cyclic synchronous position mode (csp) and homing mode (hm) are supported for the operation mode.

Manufacturer specific is implemented in this device as well. CiA402 and manufacturer specific can be switched by object.

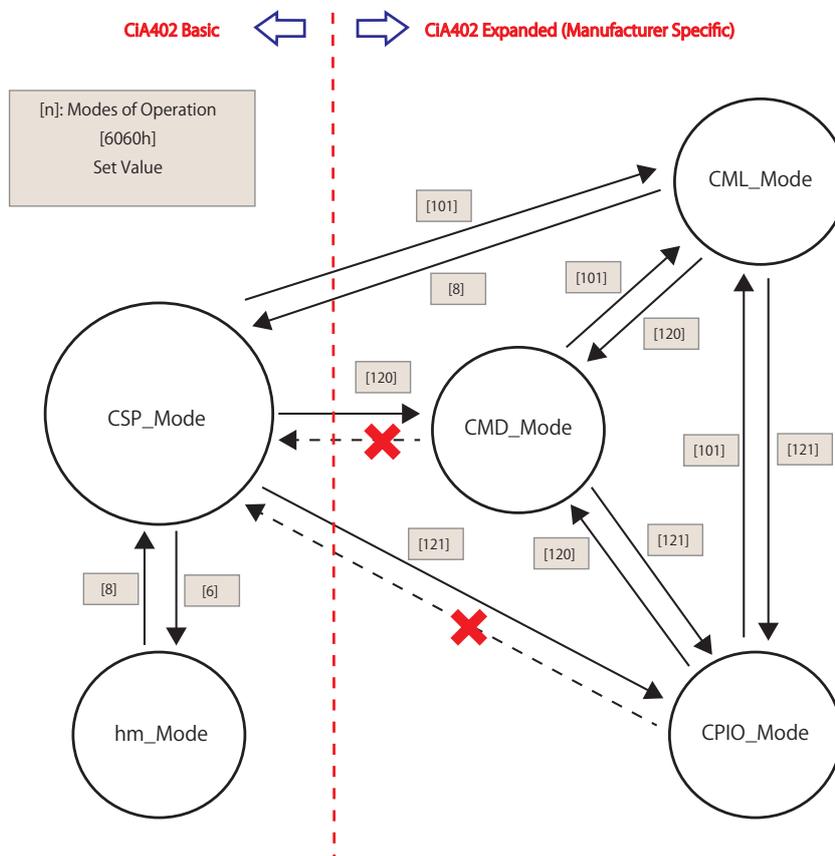
How to switch modes

Operation mode including manufacturer specific can be switched by the object Modes of operation (6060h).

Operation Modes List

Operation Mode	Value of Modes of Operation (6060h)	Standard / Manufacturer Specific
CiA402 csp mode	8 Note1	Standard
CiA402 hm mode	6	Standard
CML mode	101	Manufacturer Specific
CMD mode	120	Manufacturer Specific
CPIO mode	121	Manufacturer Specific

Note1: This device always starts with csp mode (8) after powering up



(Note)

- 1: ...Mode can not be transitted (Switched). Turn the power off first.
- 2: It will possibly result in operating abnormal when switched to CSP_mode from CMD_Mode or CPIO_Mode via CML_Mode.

The mode can be monitored by the object Modes of operation display (6061h) after switching mode.

Note: Please refer to the Appendix 3 mode change flow for the details

Note: Please refer to the Chapter7 for details of manufacturer specific

The product that conforms to CiA402 Drive Profile controls Cool Muscles by CANopen state control method of 4 axes servo driver. Device state control is defined by Controlword and Statusword.

Controlword is a state control command from Master to Slave. PDO (Process Data Object) consists of 2 Bytes per motor and the indexes of objects are 6040h (ID1), 6840h (ID2), 7040h (ID3), 7840h (ID4).

Statusword is the slave status from Slave to Master. PDO (Process Data Object) consists of 2 Bytes per motor.

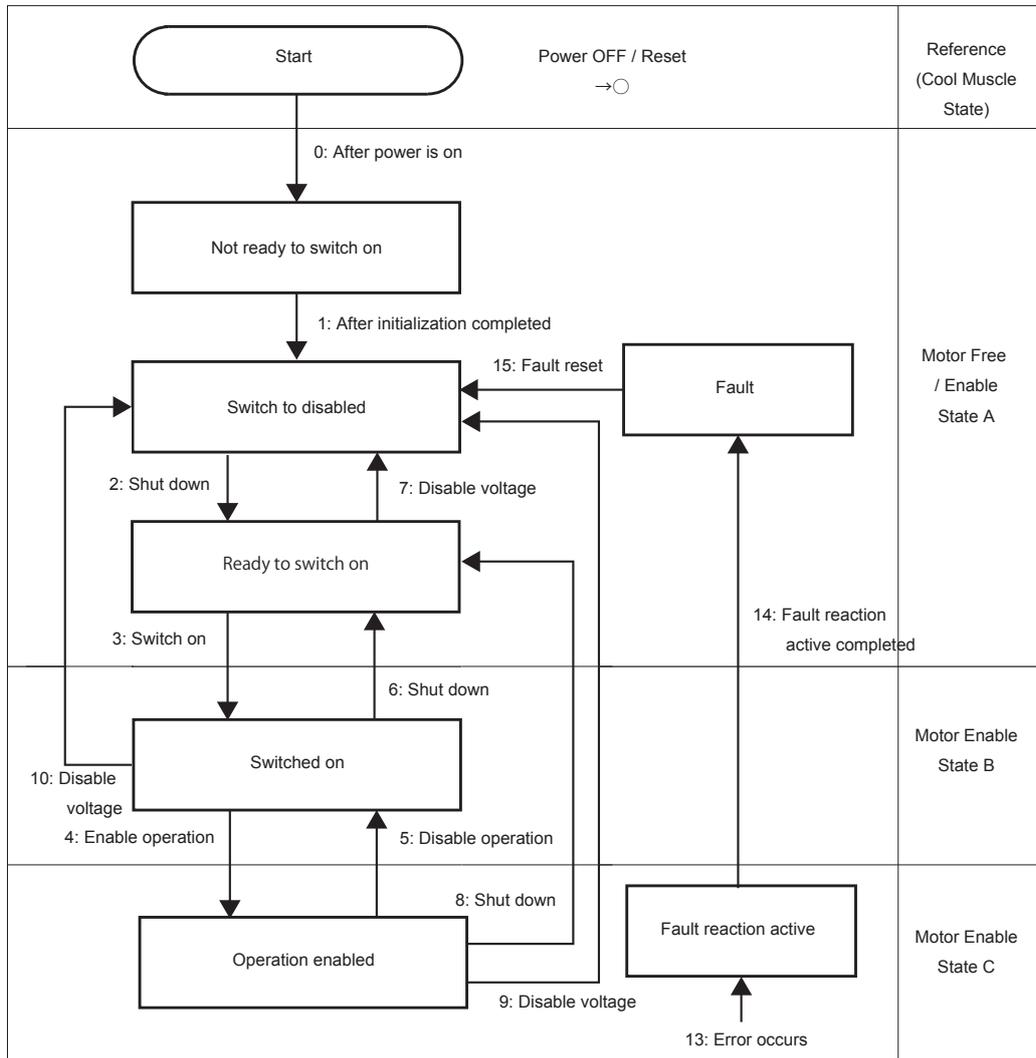
The indexes of objects are 6041h (ID1), 6841h (ID2), 7041h (ID3), 7841h (ID4).

6.1. CiA402 Drive Profile

CiA402 drive profile is controlled by 16 Bit Controlword and the state of control can be monitored by 16 bit Statusword.

6.1.1. State Transition of Slave Device

The State Transition of this slave device is defined as shown in the below table when using in csp and hm mode.



Note: Quick stop active is not available on this device. Do not send Quick Stop command since it ignores Quick stop active command when receiving it.

Description of Each State

State	Description of CiA402 Standard State	Reference (Cool Muscle State)
Not ready to switch on	Control power is supplied to its control circuit and initialization is being executed.	State A
Switch on disabled	Initialization completed.	State A
Ready to switch on	Main power can be turned on.	State A
Switched on	Main power is ON (servo ready)	State B
Operation enabled	Servo ON.	State C
Fault reaction active	Fault occurred in servo drive. A cause is being analyzed.	State C
Fault	Fault is occurring in servo drive.	State A

Description of Cool Muscle State

State	Reference (Cool Muscle State)
State A	<p>Motor Free</p> <p>1) When transiting to the state A after power is supplied, CM1 will be motor enable and CM2 is settable either motor enable or motor free by its parameter.</p> <p>CM2 Parameter</p> <p>K68=0: Motor Free</p> <p>K68=1: Motor Enable</p> <p>2) When transiting to state A from state B or C, Cool Muscle will be motor free automatically.</p>
State B	<p>Motor Enable</p> <p>When transiting to state B from state A, Cool Muscle will be motor enable automatically.</p>
State C	<p>Motor is ready for operation</p> <p>1) When fault occurs, fault can be reset in state A transited from state C. Then Cool Muscle can be enabled after transiting to state B.</p> <p>2) Quick stop active is not supported on this device. The device will ignore Quick stop active command when receiving.</p> <p>Main power can be turned on.</p>

6.1.2. CiA402 Controlword

State of this slave device can be controlled by executing commands in below table.

Command	Bit7	Bit3	Bit2	Bit1	Bit0	PDS Transition *2	Reference (State) *1
	Fault Reset	Enable Operation	Quick	Enable Voltage	Switch On		
Shut down	0	-	1	1	0	2, 6, 8	State A
Switch on	0	0	1	1	1	3	State B
Switch on & enable operation	0	1	1	1	1	3 + 4	State C
Enable operation	0	1	1	1	1	4	State C
Disable voltage	0	-	-	0	-	7, 9, 10	State A
Quick stop	0	-	0	1	-	-	N/A
Disable operation	0	0	1	1	1	5	State C
Fault reset	0 → 1	-	-	-	-	15	State C

*1 This state shows Cool Muscle state after executing command

*2 State Transition of PDS (Power Drive System). Numbers in the diagram are transition numbers in the transition number in the state transition diagram in 6.1.1..

Bit	Function	Availability
Bit8	Halt	N/A
Bit9	Operation Mode Specific	N/A
Bit10	Reserved	Reserved
Bit11-15	Manufacturer Specific	N/A

6.1.3. CiA402 Statusword

The state of slave device can be monitored by 16 Bit Statusword. Each Bit has meanings as shown in below chart.

A) Bit6 ---- Bit0

State	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Reference (State) *1
	Sod	Qs	Ve	F	Oe	So	Rtso	
Not ready to switch on	0	0	-	0	0	0	0	State A
Swich on disabled	1	-	-	0	0	0	0	State A
Ready to switch on	0	-	-	0	0	0	1	State A
Switched on	0	-	-	0	0	1	1	State B
Operation enable	0	-	-	0	1	1	1	State C
Fault reaction active	0	-	-	1	1	1	1	-
Fault	0	-	-	1	0	0	0	State A

*1 This state shows Cool Muscle state after executing command

Sod: switch on disable

Qs: quick stop (N/A)

Ve: voltage enable

F: fault

Oe: operation enable

So: switched on

Rtso: read to switch on

Bit	CiA402 Name	csp Mode	hm Mode
Bit7	Warning	0: Fixed, N/A	0: Fixed, N/A
Bit8	Manufacturer Specific	0: Fixed, N/A	0: Fixed, N/A
Bit9	Remote	1: Fixed	1: Fixed
Bit10	Operation Mode Specific	0: Fixed, N/A	1: Reach Target (Complete Homing)
Bit11	Internal Limit Active	0: Fixed, N/A	0: Fixed, N/A
Bit12	Operation Mode Specific	1: Follow Target Position	1: Homing Complete
Bit13	Operation Mode Specific	0: Fixed, N/A	1: Homing Error
Bit14	Manufacturer Specific	1: Motor Error	1: Motor Error
Bit15	Manufacturer Specific	1: Motor Free	1: Motor Free

Note: Error can be detected by Bit14 & 15 of Statusword when an error is occurring. Error detail can be checked by Mailbox, Subindex 5-8 of F530h Refer to "7.4. Manufacturer Specific Object / Status" for details.

6.2. CiA402 Operation Mode

Csp (cyclic synchronous position mode) and hm (homing mode) are supported by this device.

6.2.1. Confirmation of Supported Operation Mode

Supported operation mode can be confirmed by the object Supported drive modes (6502h) via Mailbox.

Supported Operation Mode

Bit	Modes of Operation	Abbr	Availability
0	Profile position mode (PTP)	pp	N/A
1	Velocity mode	vl	N/A
2	Profile verocity mode	pv	N/A
3	Torque profile mode	tp	N/A
4	Reserved	-	-
5	Homing mode	hm	Available
6	Interpolated position mode	ip	N/A
7	Cyclic synchronous position mode	csp	Available
8	Cyclic synchronous velocity mode	csv	N/A
9	Cyclic synchronous torque mode	cst	N/A
10	Cyclic synchronous torque mode with commutation angle	cstca	N/A

6.2.2. Switch and Confirmation of Operation Mode

Operation modes, csp and hm, can be switched by using the object Modes of operation (6060h) via Mailbox. Csp mode, value 8, is set as its default value. The value has to be changed to 6 before executing homing. The current mode can be confirmed by using the object Modes of operation display (6061h). Monitor the current mode by the object Modes of operation display (6061h) after switching the mode by the object Modes of operation (6060h) to confirm if the mode is set properly.

Value of Modes of operation (6060h)	Operation Mode
6	Homing mode (hm)
8	Cyclic synchronous position mode (csp)

Note1: Mode must be switched when motor is stopping.

Note2: Switch the mode with an interval at least more than 5 msec.

Note3. If the mode that is not available is set, it will be set to the default csp mode

6.3. Cyclic Synchronous Position Mode (csp)

Csp (cyclic synchronous position mode) is supported on the product.

Real time data transmission by cyclic communication is executed via PDO (Process Data Object). PDO (Process Data Object) consists of RxPDO that receives data from Master and TxPDO that sends data from Slave to Master. PDO (Process Data Object) supports a position control PDO mapping.

On this product, the cycle of cyclic synchronous communication between Master and Slave is 1msec. Due to the transmission speed between this product and Cool Muscle, communication cycle between master and this product is set as 1msec.

6.3.1. Process Data for Position Control

<Proces Data for 4 axes CM1/CM2>

RxPDO Map (24 Bytes)

Data Offset (byte)	Data Size	Description	Object Index
0	2 Bytes	ID1 Controlword	6040h
2	4 Bytes	ID1 Target Position	607Ah
6	2 Bytes	ID2 Controlword	6840h
8	4 Bytes	ID2 Target Position	687Ah
12	2 Bytes	ID3 Controlword	7040h
14	4 Bytes	ID3 Target Position	707Ah
18	2 Bytes	ID4 Controlword	7840h
20	4 Bytes	ID4 Target Position	787Ah

TxPDO Map (24 Bytes)

Data Offset (byte)	Data Size	Description	Object Index
0	2 Bytes	ID1 Statusword	6041h
2	4 Bytes	ID1 Position Actual Value	6064h
6	2 Bytes	ID2 Statusword	6841h
8	4 Bytes	ID2 Position Actual Value	6864h
12	2 Bytes	ID3 Statusword	7041h
14	4 Bytes	ID3 Position Actual Value	7064h
18	2 Bytes	ID4 Statusword	7841h
20	4 Bytes	ID4 Position Actual Value	7864h

6.3.2. Cyclic Synchronous Position Mode Objects

The objects in the below table are supported.

Supported object

Index (Motor ID)	Name	Size	Unit	Range	Default	EEPROM Save	PDO Map
6040h (ID1) 6840h (ID2) 7040h (ID3) 7080h (ID4)	Controlword	2 Bytes	-	*1	0	NO	RxPDO
607Ah (ID1) 687Ah (ID2) 707Ah (ID3) 787Ah (ID4)	Target position	4 Bytes	Pulse	*2	0	NO	RxPDO
6041h (ID1) 6841h (ID2) 7041h (ID3) 7841h (ID4)	Statusword	2 Bytes	-	*3	0	NO	TxPDO
6064h (ID1) 6864h (ID2) 7064h (ID3) 7864h (ID4)	Position Actual Value	4 Bytes	Pulse	*2	0	NO	TxPDO

*1: Please refer to 6.1.2. Controlword for the details

*2: Please refer to Appendix 3 for the details

*3: Please refer to 6.1.3. Statusword for the details

6.3.3. PDO Mapping Object

Please refer to the below object configuration chart for the configuration of PDO mapping objects.

The objects 1601h, 1611h, 1621h, 1631h are mapped to 1C12h SynchManager 2PDO.

The objects 1A01h, 1A11h, 1A21h, 1A31h are mapped to 1C13h SynchManager 3PDO.

RxPDO: Master to Slave

RxPDO		Mapped Object			
Mapping Object		(1st Object)		(2nd Object)	
Motor ID	Index	Name	Index	Name	Index
ID1	1601h	Controlword	6040h	Target Position	607Ah
ID2	1611h		6840h		687Ah
ID3	1621h		7040h		707Ah
ID4	1631h		7840h		787Ah

TxPDO: Slaver to Master

TxPDO		Mapped Object			
Mapping Object		(1st Object)		(2nd Object)	
Motor ID	Index	Name	Index	Name	Index
ID1	1A01h	Statusword	6041h	Position Actual value	6064h
ID2	1A11h		6841h		6864h
ID3	1A21h		7041h		7064h
ID4	1A31h		7841h		7864h

6.4. Homing Mode (hm)

Homing mode (hm) is supported by this device.

6.4.1. Settings for Homing Method

Homing can be executed by setting 1 to Bit4 of Controlword after setting homing method as speed, acceleration and etc. The status after homing execution can be monitored by EtherCAT master. Please refer to Appendix 4 for the homing flow.

Objects related to homing as shown in below table are supported by this device.

Objects for Homing Mode (hm)

Index	Name	Sub Index	Data Type	Access	Data Set Range	Save	PDO Mapping
6098h (ID1) 6898h (ID2) 7098h (ID3) 7898h (ID4)	homing method	-	U8	RW	1: Stopper CW 2: Stopper CCW 3: Switch CW 4: Switch CCW	NO	NO
6099h (ID1) 6899h (ID2) 7099h (ID3) 7899h (ID4)	homing speed	0h	U8	RO	2		NO
		1h	U32	RW	Speed during search for switch (CM K parameter K42 *Note1)	NO	NO
		2h	U32	RW	Speed during search for Stopper (CM K parameter K42 *Note1)	NO	NO
609Ah (ID1) 689Ah (ID2) 709Ah (ID3) 789Ah (ID4)	homing acceleration	-	U32	RW	Cool Muscle K parameter K43 value *Note2	NO	NO
607Ch (ID1) 687Ch (ID2) 707Ch (ID3) 787Ch (ID4)	home offset	-	U32	RW	Cool Muscle K parameter K48 value *Note3	NO	NO
60E3h (ID1) 68E3h (ID2) 70E3h (ID3) 78E3h (ID4)	supported homing method	0h	U8	RO	4: Number of sub index	NO	NO
		1h	INT16	RO	1: Stopper CW	NO	NO
		2h	INT16	RO	1: Stopper CCW	NO	NO
		3h	INT16	RO	1: Switch CW	NO	NO
		4h	INT16	RO	1: Switch CCW	NO	NO

Note1: K42 value

This parameter sets the speed for Origin Search. Set value are as show in below.

CM1

Min	Max	Default	Unit
1	5000	100	100pps

CM2

Min	Max	Default	Unit
1	32767	10	100pps

Note2: K43 value

This parameter sets the acceleration for Origin Search by the unit Kpps².

CM1

Min	Max	Default	Unit
1	5000	100	Kpps ²

CM2

Min	Max	Default	Unit
1	32767	100	Kpps ²

Note3: K48 value

This parameter sets the offset distance after Origin Search.

CM1

Min	Max	Default	Unit
-32767	32767	0	x100pulse

CM2

Min	Max	Default	Unit
-32767	32767	0	x100, 10 or 1 pulse Set by 2nd digit of K45

6.4.2 PDO for Homing Mode (hm)

Homing can be executed by Controlword mapped in PDO and its status can be monitored by Statusword that is also mapped in PDO.

After switching to Homing mode, homing is started by changing Bit4 of Controlword bit4 from 0 to 1.

Homing state can be monitored by Bit13, Bit12 and Bit10 of Statusword in homing mode.

Bit	Name	Abbr	Value	Description
10	Target reached	tr	0	During homing
			1	Homing start has not been started
12	Homing attained	ha	0	Homing has not been completed
			1	Homing completed
13	Homing error	he	0	Homing no error
			1	Homing error occurring

Refer to the Appendix 4 for the Homing mode flow.

6.5. Cool Muscle Digital IO in CiA402 csp Mode

Cool Muscle's inputs status indication and outputs setting are possible in CiA402 csp mode. This function is available when operation mode is csp mode and Cool Muscle is motor enable (state B or C) by controlword. Please refer to 6.1.1. State Transition of Slave Device for details.

Note that PDO mapping is not possible since PDO communication is not used for this function.

The digital inputs and outputs data are transitted via SDO (Mailbox Transmission).

6.5.1 Digital Inputs

The object Digital inputs indicates Cool Muscle's inputs status.

The configuration of object Digital inputs for each ID is as shown in the below chart.

Digital inputs Object	Motor ID	Index
	ID1	60FDh
	ID2	68FDh
	ID3	70FDh
	ID4	78FDh

The relationship between the bit of object Digital inputs and Cool Muscle's inputs is as shown in below chart. Each bit indicates Cool Muscle's inputs status.

Bit	31 ~ 6	5	4	3	2	1	0
CM1	-	-	-	In4	In3	In2	-
CM2	-	In6	In5	In4	In3	In2	In1

Detail of each bit is as shown in the below chart.

Value	Description
0	Input Signal is OFF
1	Input Signal is ON

Inputs status identified by Cool Muscle's CPU is indicated.

CM1 input1 is not available because it is used for the communication to the bridge.

The status of physical inputs depends on the parameter K26 (input logic) setting.

Please refer to the CM1 and CML User's Guide for the details of Cool Muscle input logic.

6.5.2 Digital Outputs

The object Digital outputs is used for setting Cool Muscle's outputs on/off.

Also the output mask function is available.

The configuration of object Digital outputs for each ID is as shown in the below chart.

	Motor ID	Index	Sub Index
Digital outputs Objects	ID1	60FEh	0: Number of entries
			1: Physical outputs *1
			2: Bit Mask *2
	ID2	68FEh	Same as above
	ID3	70FEh	Same as above
ID4	78FEh	Same as above	

*1 Physical outputs: Set outputs on/off.

*2 Bit mask: Set output mask function.

The relationship between the bit of object Digital outputs and Cool Muscle's outputs is as shown in below chart. Each bit indicates the setting for Cool Muscle's outputs on/off.

Bit	31 ~ 4	3	2	1	0
CM1	-	-	-	Out2	-
CM2	-	Out4	Out3	Out2	Out1

Detail of each bit is as shown in the below chart.

Object	Value	Description
Sub Index 1	0	Output Signal OFF
Physical Outputs	1	Output Signal ON
Sub Index 2	0	Output not available (Output signal is kept OFF)
Bit mask	1	Output available (Output signal is set ON or OFF)

Outputs status identified by Cool Muscle's CPU is indicated.

CM1 output1 is not available because it is used for the communication to the bridge.

The status of physical outputs depends on the parameter K33 (output logic) setting.

Please refer to the CM1 and CML User's Guide for the details of Cool Muscle output logic.

Chapter 7

Manufacturer Specific

7.1. Device Control State of Manufacturer Specific

This device has CML_Mode, CMD_Mode and CPIO_Mode as its control state of manufacturer specific

7.1.1. Control State of Manufacturer Specific

CML_Mode

In this state, you can send & receive CML and read & write parameters via Mailbox for Cool Muscles. Refer to the Appendix 3 for the mode switch flow and the Appendix 2 for the operational flows.

CMD_Mode

You can send 5 commands as follows to Cool Muscle. Refer to the Appendix 3 for the mode switch flow and the Appendix 1 for the operation flows.

Motor Free	(F107h)
Motor Enable	(F207h)
Origin Search	(F307h)
Re-set Counter	(F407h)
Origin Search Abort	(F607h)

CPIO_Mode

This state is CiA402 Position Control Mode and also Cool Muscle's Output control is available. Bit4 – 7 are for OUT1, OUT2, OUT3 and OUT4 control. The state of Cool Muscle's Input can be indicated by Statusword. Refer to the Appendix 3 for the mode switch flow and the Appendix 5 for the operation flows.



All modes of Manufacturer Specific can be set to each Cool Muscles connected to EtherCAT Cool Muscle Bridge.

7.1.2. Manufacturer Specific Controlword

The below is a list of manufacturer specific Controlword.

Mode	Function	Bit										Value (hex)	Description	
		15-12	11-8	7	6	5	4	3	2	1	0			
CMD_Mode	Motor Free	1111	0001	0	0	0	0	0	0	0	0	0	F107h	Free motor
	Motor Enable	1111	0010	0	0	0	0	0	0	1	1	1	F207h	Enable motor
	Origin Search	1111	0011	0	0	0	0	0	0	1	1	1	F307h	Origin Search
	Re-set Counter	1111	0100	0	0	0	0	0	0	1	1	1	F407h	Re-set Counter
	Origin Search Abort	1111	0110	0	0	0	0	0	0	1	1	1	F607h	Abort Origin Search
CPIO_Mode	CiA402 Position Control CM Output	1100	0000	0/1	0/1	0/1	0/1	1	1	1	1	1	C0*Fh Note1	CiA402 Position Control & Output Available

Note1: Relationship between Bit and Output in CPIO_Mode

Controlword Bit	Description	Remarks
Bit4	OUTPUT1 0: OFF, 1:ON	
Bit5	OUTPUT2 0: OFF, 1: ON	
Bit6	OUTPUT3 0: OFF, 1: ON	
Bit7	OUTPUT4 0: OFF, 1: ON	



OUT1,OUT2,OUT3 & OUT4 are available on CM2.

Only OUT2 is available on CM1. OUT1 is used for serial communication.

7.1.3. Manufacturer Specific Statusword

The below is a list of manufacturer specific Statusword.

Mode	Status	Bit				Description
		15-12	11-8	7-4	3-0	
CPIO_Mode	CiA402 Status	1100	CM Status Note1	CM INPUT1-4 Note2	CiA402 Lower 4Bit Status Note3	The highest 4Bit=1100 Bit11-4 CM Information
CMD_Mode	Origin Search Completion	1111	1000	N/A	N/A	Origin Search Completion by F8**h
	Origin Search Time Out	1111	1001	N/A	N/A	Origin Search Time Out by F9**h
	Motor Free Completion	1111	0001	N/A	N/A	Motor Free Completion by F1**h
	Motor Enable Completion	1111	0010	N/A	N/A	Motor Enable Completion by F2**h
	Re-set Counter Completion	1111	0100	N/A	N/A	Re-set Counter Completion by F4**h
	Origin Search Cancel Completion	1111	0110	N/A	N/A	Origin Search Cancel Completion by F6**h
	During Origin Search	1111	0011	N/A	N/A	During Origin Search by F3**h

Note1: Refer to the below diagram and CM1 & CML User's Guide for the details of CM Status.

CM Status	Bit11	Bit10	Bit9	Bit8
Counter Overflow Error	0	x	x	1
Over Speed / Regenerative Voltage Error	0	x	1	x
Overload Error	0	1	x	x
Serial Communication Error	1	1	1	1
Running	0	0	0	0
In-position	1	0	0	0

Note2: Relationship between Bit and Input in CPIO_Mode

Statusword	Description	Remarks
Bit4	INPUT1 0: OFF, 1: ON	
Bit5	INPUT2 0: OFF, 1: ON	
Bit6	INPUT3 0: OFF, 1: ON	
Bit7	INPUT4 0: OFF, 1: ON	



INPUT2 ~ 4 status will be replied on CM1

INPUT1 ~ 4 status will be replied but INPUT5 & 6 status are not replied on CM2

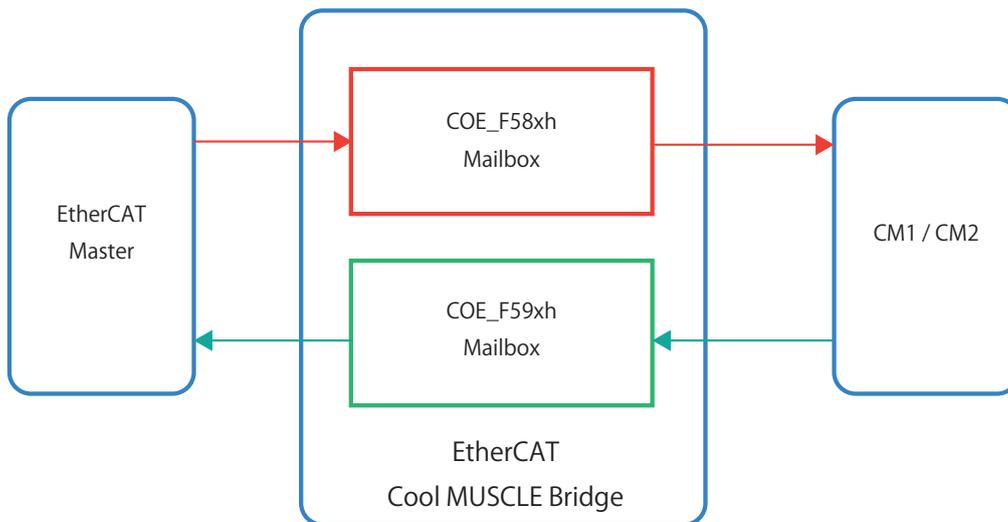
Note3: Standard CiA402 Statusword is replied

7.2. CML Transmission

7.2.1. Overview of CML Transmission

The product has manufacturer specific objects as well as standard CiA402 Objects. Those manufacturer specific objects are transmitted via Mailbox and allow you to flexibly control Cool Muscle and set parameters.

CML transmission is processed as shown in below diagram.



Refer to "CM1 User's Guide" and "CML User's Guide" for the detail of CML.

7.2.2. Configuration of CML Transmission Objects

Transmission	Mail Box Index	Function	Remarks
Master → Slave	F581h	CML String for ID1 CM	Max String Size 64bytes
	F582h	CML String for ID2 CM	Max String Size 64bytes
	F583h	CML String for ID3 CM	Max String Size 64bytes
	F584h	CML String for ID4 CM	Max String Size 64bytes
Slave → Master	F591h	CML String for ID1 CM	Max String Size 64bytes
	F592h	CML String for ID2 CM	Max String Size 64bytes
	F593h	CML String for ID3 CM	Max String Size 64bytes
	F594h	CML String for ID4 CM	Max String Size 64bytes

■ CML Send (Master → Slave)

- 1) The maximum size of the string that can be sent at one time is 64 bytes.
- 2) Multiple CML commands can be sent in the string at one time if the data string is less than 64bytes.
But Cool Muscle Bridge automatically adds {CR}{LF} at the end of command that is sent to Cool Muscle, do not add {CR}{LF} to the string from Master.



One CML command must not be separated in two strings.

- 3) Set time interval between each data string more than 4 msec when the data string is less than 32 bytes, 8 msec when the data string is more than 32 bytes.

■ CML Receive (Slave → Master)

- 1) You have to check the Mailbox to receive CML. When sending a query to Cool Muscle or event-driven status report is set to Cool Muscle, check reply data in the Mailbox.
- 2) When the data in the Mailbox is "Null{CR}{LF}", the Mailbox is empty.
- 3) When the data in the Mailbox is "Null{CR}{LF}", even after Master has sent a query by CML transmission, Cool Muscle Bridge has possibly not received the reply data from Cool Muscle. Check the Mailbox again.
- 4) When you can not receive expected reply in the Mailbox, set time out after appropriate time period and handle as an alarm in Slave.

7.2.3. CML Transmission Flow

Refer to Appendix2 CML_Mode Transmission Flow for the examples of CML Transmission flows.

7.3. Manufacturer Specific Objects / Cool Muscle Set Data

This section explains about Cool Muscle set data such as communication baud rate and communication synchronization between Bridge and Cool Muscle.

■ Configuration of Object for Each ID

Index	Function	Remarks
F511h	Read the set data of ID1 Cool Muscle	
F512h	Read the set data of ID2 Cool Muscle	
F513h	Read the set data of ID3 Cool Muscle	
F514h	Read the set data of ID4 Cool Muscle	

Sub-index	Function	Data / Description	Send Function	Receive Function	Default	EEPROM Save Function
0	Number of Entries	4: Fixed	Not Changeble	-	8	N/A
1	CM Type Manufacturer Default	1: CM1 2: CM2	Not Changeble	Read Set Data	CM1: 1 CM2: 2	Available
2	CM Serial Communication Baud Rate	1. N/A 2. N/A 3. N/A 4. N/A 5. N/A 6. 176,800bps	Not Changeble	Read Set Data	6	Available
3	CM Serial Communication Cycle Time	1. 1 msec	Not Changeble	Read Set Data	1	Available
4	Reserved	-	-	Read Set Data	0	-

7.4. Manufacturer Specific Objects / Status Information

Communication error status between Bridge and Cool Muscle.

Index	Function	Send / Receive	Remarks
F530h	Error Information	Receive	

■ Configuration of status information object

Sub-Index	Description	Remarks
0h	Number of Entries, 18h Fixed	
1h	ID1 Serial Communication Receive Error Counter 0: No Error Not 0: Number of Error Occurs	
2h	ID2 Serial Communication Receive Error Counter 0: No Error Not 0: Number of Error Occurs	
3h	ID3 Serial Communication Receive Error Counter 0: No Error Not 0: Number of Error Occurs	
4h	ID4 Serial Communication Receive Error Counter 0: No Error Not 0: Number of Error Occurs	
5h	ID1 Cool Muscle Error Code	
6h	ID2 Cool Muscle Error Code	
7h	ID3 Cool Muscle Error Code	
8h	ID4 Cool Muscle Error Code	
9h	ID1 Serial Communication; Transmission Count	
Ah	ID2 Serial Communication; Transmission Count	
Bh	ID3 Serial Communication; Transmission Count	
Ch	ID4 Serial Communication; Transmission Count	
Dh	ID1 Serial Communication; Receive Count	
Eh	ID2 Serial Communication; Receive Count	
Fh	ID3 Serial Communication; Receive Count	
10h	ID4 Serial Communication; Receive Count	
11h	PDO Receive; Max. Cycle Time	
12h	PDO Receive; Min. Cycle Time	
13h	PDO Receive; Cycle Time over 1,300us Count	
14h	PDO Receive; Cycle Time under 700us Count	
15h	System Test Information 1	
16h	System Test Information 2	
17h	System Test Information 3	
18h	System Test Information 4	



When serial communication error occurs on each IDs, the communication between Bridge and Cool Muscle is unstable. Too long cable, contact failure at connector, etc, would have caused errors.

■ Cool Muscle Status Information List

CM1 Status

Status	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Counter Overflow	0	0	0	0	0	x	x	1
Over Speed / Regenerative Current	0	0	0	0	0	x	1	x
Overload	0	0	0	0	0	1	x	x
CM1 Serial Communication Error	0	0	0	0	1	1	1	1
Running	0	0	0	0	0	0	0	0
In-position	0	0	0	0	1	0	0	0
Motor Free	0	0	0	1	0	0	0	0
During Push Mode	0	0	1	0	0	0	0	0
End of Push Mode	0	0	1	0	1	0	0	0
Temperature Alarm	1	0	0	0	0	0	0	0

CM2 Status

Status	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Position Error Over flow	0	0	0	0	0	x	x	1
Over Speed / Regenerative Voltage	0	0	0	0	0	x	1	x
Overload	0	0	0	0	0	1	x	x
CM2 Serial Communication Error	0	0	0	0	1	1	1	1
Motor is Running	0	0	0	0	0	0	0	0
In-position	0	0	0	0	1	0	0	0
Motor Free	0	0	0	1	0	0	0	0
Push Motion	0	0	1	0	0	0	0	0
Push Motion Completed	0	0	1	0	1	0	0	0
Power Module Over Current	0	1	0	0	0	0	0	0
Temperature Alarm	1	0	0	0	0	0	0	0



Bit 8 ~ 31 are fixed data (0).

7.5. Cool Muscle Parameter Setting

Cool Muscle K parameter can be set by means of Mailbox function. The configuration of K parameter setting object for each ID is as shown in the below chart. Cool Muscle K parameter K21 to K99 can be set by using sub-index 1h to 4Fh.

	Motor ID	Index	Sub Index	Parameter
K Parameter Setting Object (CM1/CM2)	ID1	60F6h	0h	Number of Parameters
			1h to 4Fh	K21 to K99
	ID2	68F6h	0h	Number of Parameters
			1h to 4Fh	K21 to K99
	ID3	70F6h	0h	Number of Parameters
			1h to 4Fh	K21 to K99
	ID4	78F6h	0h	Number of Parameters
			1h to 4Fh	K21 to K99

Servo Stiffness Parameter setting object is available for Cool Muscle 2. The configuration is as shown in the below chart.

	Motor ID	Index	Sub Index	Parameter
Cool Muscle Servo Stiffness Parameter (CM2 Only)	ID1	60FBh	0h	Number of Parameter
			1h	Servo Stiffness Adjustment
			2h to Ah	Reserved
	ID2	68FBh	0h	Number of Parameter
			1h	Servo Stiffness Adjustment
			2h to Ah	Reserved
	ID3	70FBh	0h	Number of Parameter
			1h	Servo Stiffness Adjustment
			2h to Ah	Reserved
	ID4	78FBh	0h	Number of Parameter
			1h	Servo Stiffness Adjustment
			2h to Ah	Reserved

- These objects can not be mapped in PDO.
- Each data is saved in EEPROM of Cool Muscle.
- Please refer to the CM1 and CML User's Guide for details such as an unit, range, default and etc, of each parameter.

8.1. Set Up

8.1.1. Items to Prepare

For the use of product, please prepare items along with EtherCAT Cool Muscle Bridge you use.

Name	Product Code	EB01	EB02	EB12
LAN Cable	N/A	△	△	△
Cool Muscle 1	CM1-C-11L30 ~ 23L20-EB	○	×	○
EtherCAT Cool MUSCLE Bridge CM1 RS-232C Cable 2m Double Connector	EH01-2000W	○	×	○
DC+24V Power Supply for CM1	CMPS-XMUS-150/240-24	▲	×	▲
Cool Muscle 2	CM2-C-56B10 ~ 60A40A-EB	×	○	○
EtherCAT Cool MUSCLE Bridge CM2 RS-232C Cable 2m Double Connector	EH02-2000W	×	○	○
AC100 ~ 240V Power Supply for CM2	N/A	×	△	△
EtherCAT Cool MUSCLE Bridge Power Supply	N/A	▲	▲	▲
EtherCAT Cool MUSCLE Bridge Power Cable 2m Single Connector	EHPW-2000S	○	○	○

○ : The number of use of Muscle Corporation's products are needed.

▲ : Muscle Corporation's products are needed or user must prepare equivalent.

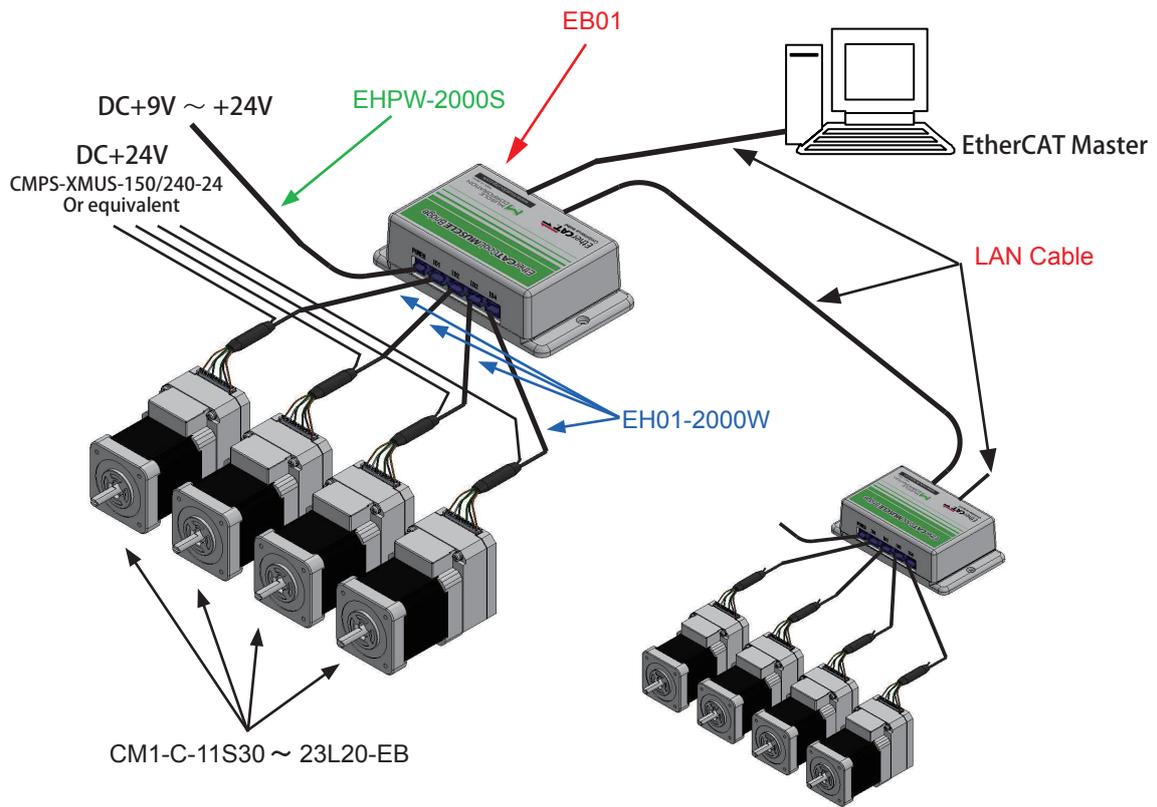
△ : User must prepare them.

× : No need.

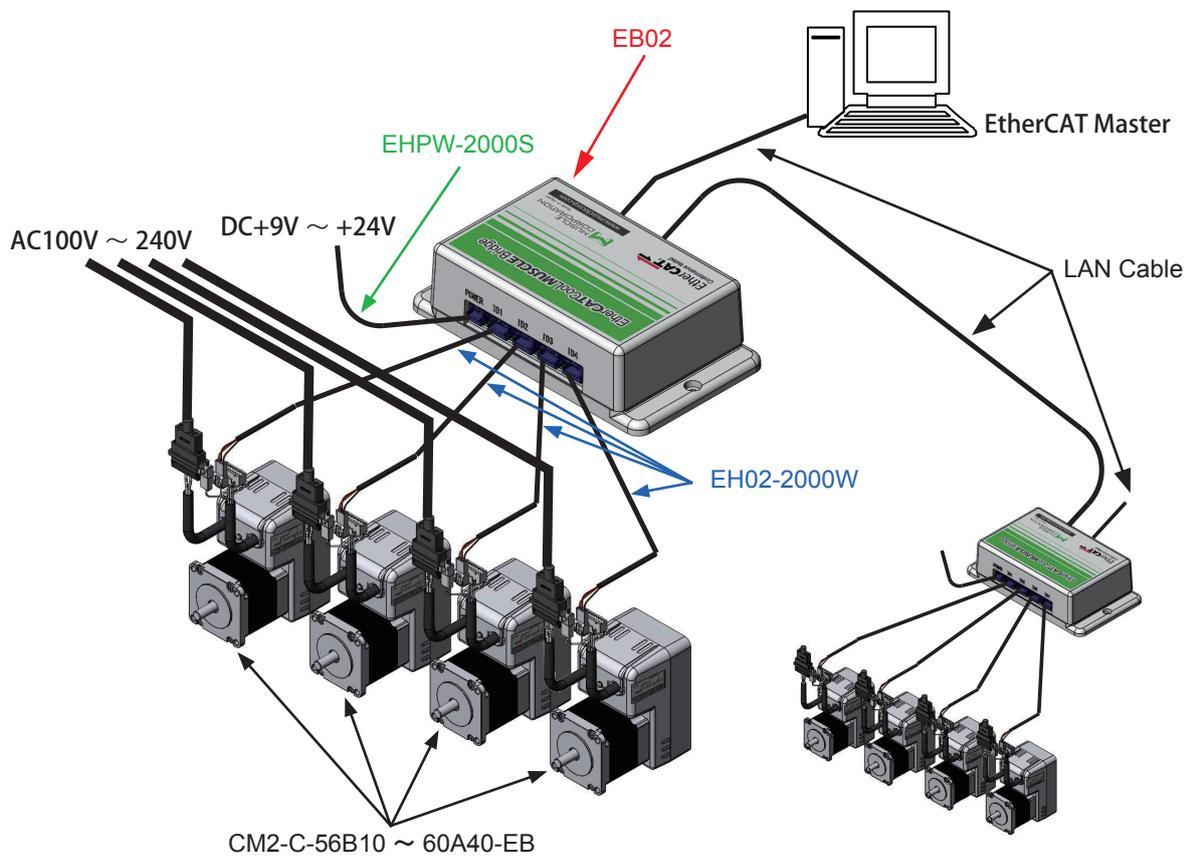
8.1.2. Connections

Connect the items following the connection examples of each product.

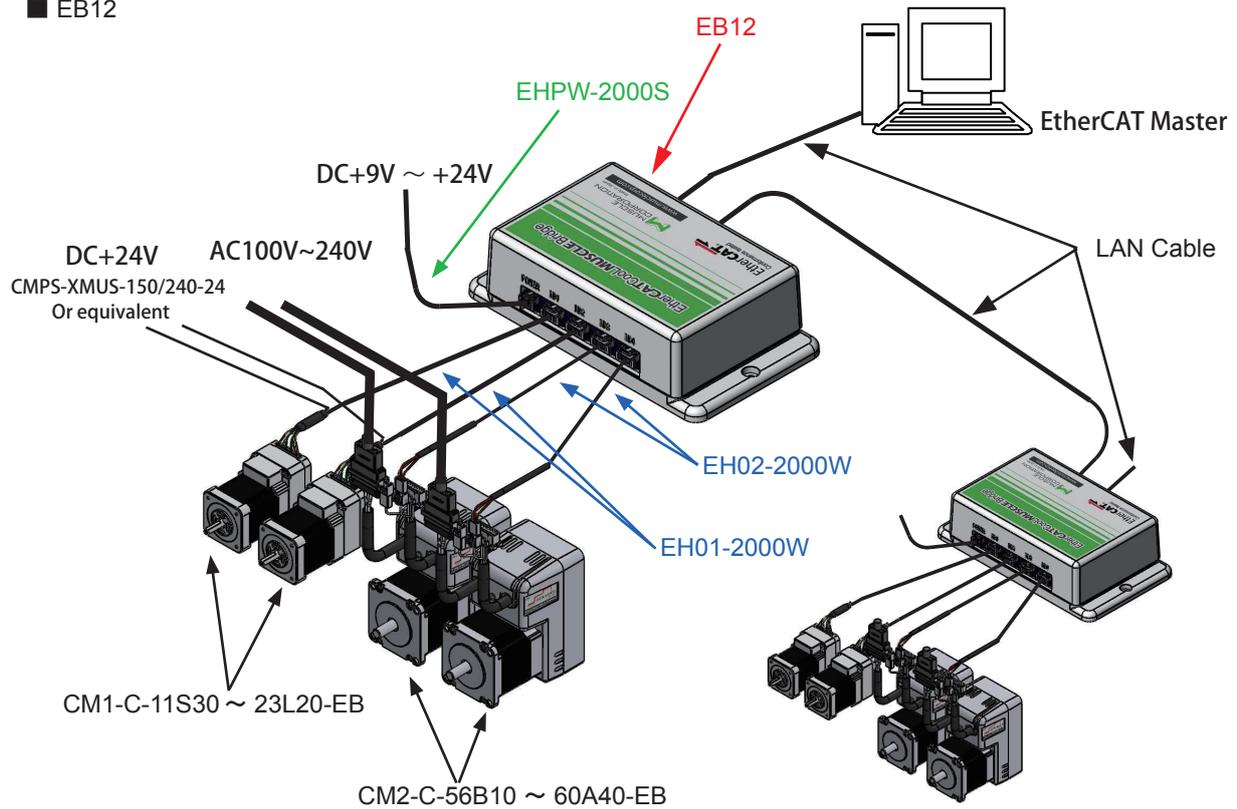
■ EB01



■ EB02



■ EB12



8.1.3. Initial Settings

Check EtherCAT communication and Cool Muscle motion

For the use of the product, before connecting the product to EtherCAT Master that control your system, set / confirm EtherCAT communication, parameters and Cool Muscle motion by using Muscle Corporation's setting software, EtherCAT Bridge Setup Tool. Please refer to the EtherCAT Bridge Setup Tool manual.

8.1.4. Install ESI File

Download the ESI file from Muscle's website (Registration needed) then set your EtherCAT Master after installing the ESI file for the product to your EtherCAT Master.

8.1.5. Check System Operation from EtherCAT Master

After completing the above steps, check the Cool Muscle operation from EtherCAT Master then the system operation with Cool Muscles connecting to your mechanical instrument.

Chapter 9

Fault and Maintenance / Inspection

9.1. Maintenance

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

■ Checkup Items

Type	Cycles	Inspection Items
Daily Inspection	Daily	<ul style="list-style-type: none"> • Are there dust or foreign object on and/or around the product? • Is the cabling OK? No damage? • Is there any loose connection or misalignment at each connecting point to other devices? • Is the supply voltage normal?

9.2. Troubleshooting

■ EtherCAT Communication Error Diagnosis

Name	Situation of Error	Cause	Countermeasure
Incorrect State Transition Request	During operation	Received an incorrect state transition command that can not be transitted in the current state.	Check the State Transition command from EtherCAT Master
Unknown State Transition Request	During Operation	Received an unknown State Transition command.	Check the State Transition command from EtherCAT Master
Communication Synchronization Error	During Operation	It remain without receiving data that is supposed to be received at the communication synchronous timing. It exceeds set value (communication error) of "2200h" object .	<ul style="list-style-type: none"> • Wire EtherCAT communication cable correctly • Check if there's excessive noise applied to EtherCAT communication cable or not
		Control board fault	EtherCAT Cool MUSCLE Bridge's control PCB fault. Replace a product or inquiry to fix it.
SyncManager Watch Dog Error	During Operation	PDO communication has been stopped for a certain period of time	<ul style="list-style-type: none"> • Check EtherCAT Master's operation • Wire EtherCAT communication cable correctly
ESC Initialization Error	When power is supplied	Mis wiring of EtherCAT cable	Wire EtherCAT communication cable correctly
SII Reference Error	When power is supplied	Control board fault	EtherCAT Cool MUSCLE Bridge's control PCB fault. Replace a product or inquiry to fix it.

■ Error Diagnosis by LED Indicator

Aspect	Cause of Fault	Confirmation & Countermeasures
ERR LED Double Flash	Process Data Communication Time Out	<ul style="list-style-type: none"> • Check if EtherCAT Master is fault or not. • Check if connector is connected properly. • Check if the power that meets EtherCAT Cool MUSCLE Bridge's specifications is supplied or not. Supply the power again if the power meets the specifications. • Check if cables that meet the specifications or not. • Check if the other Slaves than this product is working properly or not.
	Communication cable is damaged	Supply the power and re-start the system after checking cable connections.
ERR LED Blinking except Double Flash	EtherCAT communication Error	Check if there's communication error from EtherCAT Master
ERR LED: On	ESC EEPROM Data error	Write ESI file to EEPROM from EtherCAT Master
MOTOR LED Blinking	Answer has occurred on one or more of CM.	<ul style="list-style-type: none"> • Cancel Cool Muscle's error from EtherCAT Master • Check error status then change it to applicable motion and/or parameter settings
LED (L/A IN), LED (L/A OUT) Off	Link in EtherCAT communication physical layer has not been established.	Wire EtherCAT communication cable correctly
		Start EtherCAT Slave after checking EtherCAT Master has started properly.
SYSTEM LED Blinking	No fault. ESC has not been transited to OP Mode.	

■ Cool Muscle's Errors Diagnosis

Aspect	Cause of Fault	Investigation	Countermeasures
Cool Muscle Error Note1	Motor Free (MOTOR LED On)	Check Cool Muscle's status	Cancel motor free from EtherCAT Master
	Motor Error (MOTOR LED Blinking)	Check Cool Muscle's error status	<ul style="list-style-type: none"> • Cancel motor free from EtherCAT Master • Change the motion applicable in response to Cool Muscle alarm status
Impossible to check Cool Muscle's status	Impossible to establish the communication between Cool Muscle and the product	Check contacts on connectors and/or wire damages.	Wire cables correctly.
		Check if communication baud rate between Cool Muscle and the product is set correctly.	Set serial communication baud rate correctly from EtherCAT Bridge Setup Tool.

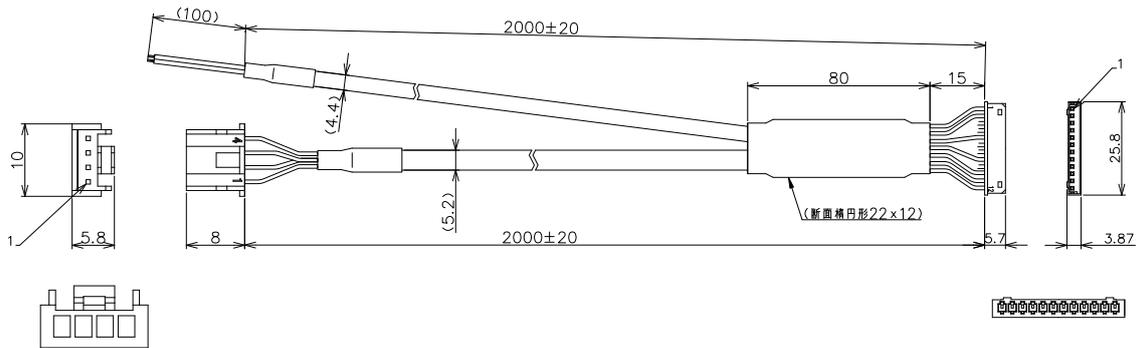
Note1: When motor error and motor free are happening at the same time, an error status (flash) will be indicated on the Motor LED on EtherCAT Cool Muscle Bridge

Chapter 10

Accessories

10.1. CM1 Communication Cable

EH01-2000W



Connector PAP-04V-S (JST)

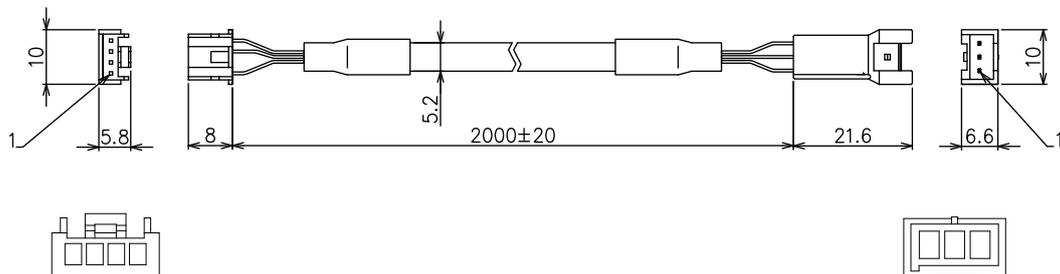
No.	SIGNAL	COLOR
1	+DC5V	Red
2	OUTPUT1	Green
3	INPUT1-	Gray
4	INPUT1+	White

Connector 51065-1200 (JST)

No.	SIGNAL	COLOR
1	DC+24V	Orange
2	E	Black
3~4		
5	OUTPUT1	Green
6~7		
8	INPUT1-	Gray
9		
10	INPUT1+	White
11		
12	DC+5V	Red

10.2. CM2 Communication Cable

EH02-2000W



Connector PAP-04V-S (JST)

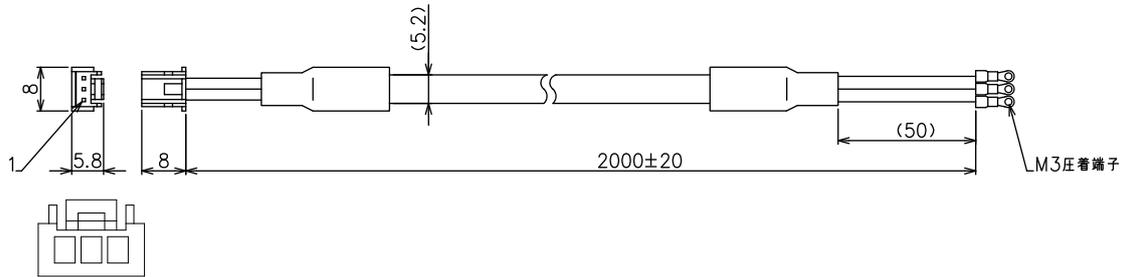
No.	SIGNAL	COLOR
1	TXDO	Red
2		
3	GND	Orange
4	RXDO	Brown

Connector XARR-03VF (JST)

No.	SIGNAL	COLOR
1	RXDO	Brown
2	TXDO	Red
3	GND	Orange

10.3. EtherCAT Cool MUSCLE Bridge Power Cable

EHPW-2000S



Connector PAP-03V-S (JST)

No.	SIGNAL	COLOR
1	V+	Orange
2	V-	Black
3	FG	Green

LAN Cable for EtherCAT Use

EtherCAT is a field-bus that is based on industrial Ethernet. You need to use a cable for industrial use though physical layer is based on Ethernet1.

A requirement of specification compliance for the use of twist-pair cable is prescribed in EN50173-1 Chapter7 as well as EN50288. In this requirement, requisites about shielded cable and unshielded cable are stated. But a shielded cable is highly recommended by EtherCAT. EN50288-2 states about fixed cable and flexible cable.

The above standard prescribes data as shown below.

EN50288-1

- Shielded Cable: 100MHz Fixed Cable
- Thickness: Equivalent of AWG24 ~ 21
- Loss: Max.21.3dB per 100m by 100MHz
- DC Loop Resistance: Less than 19 Ω per 100m

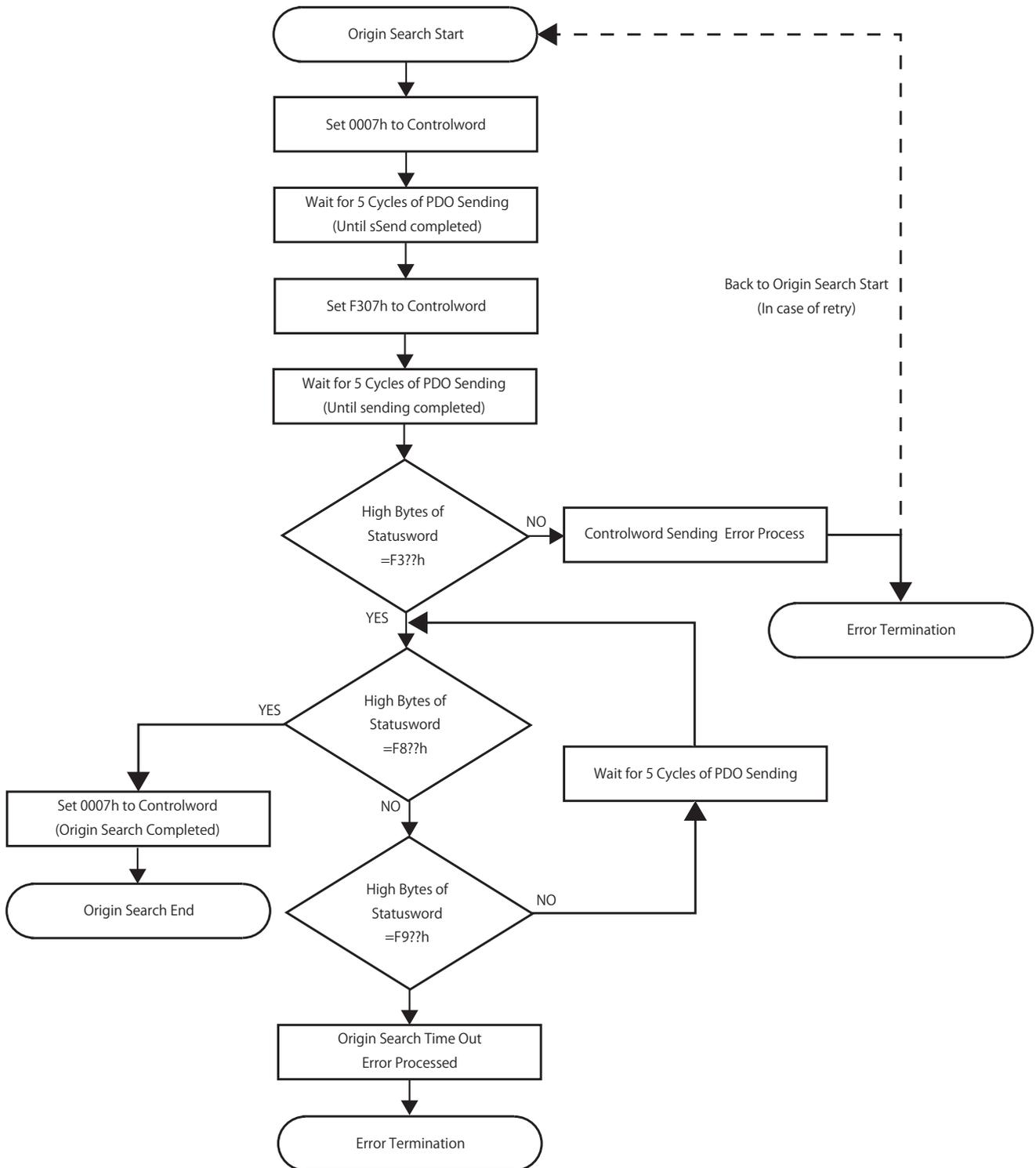
EN50288-2

- Shielded Cable: 100MHz For Device Connection
- Standard Wire: Single Wire or Twisted
- Loss: Max.32dB per 100m by 100MHz
- DC Loop Resistance: Less than 29 Ω per 100m

Appendix 1: CMD_Mode Transmission Flow

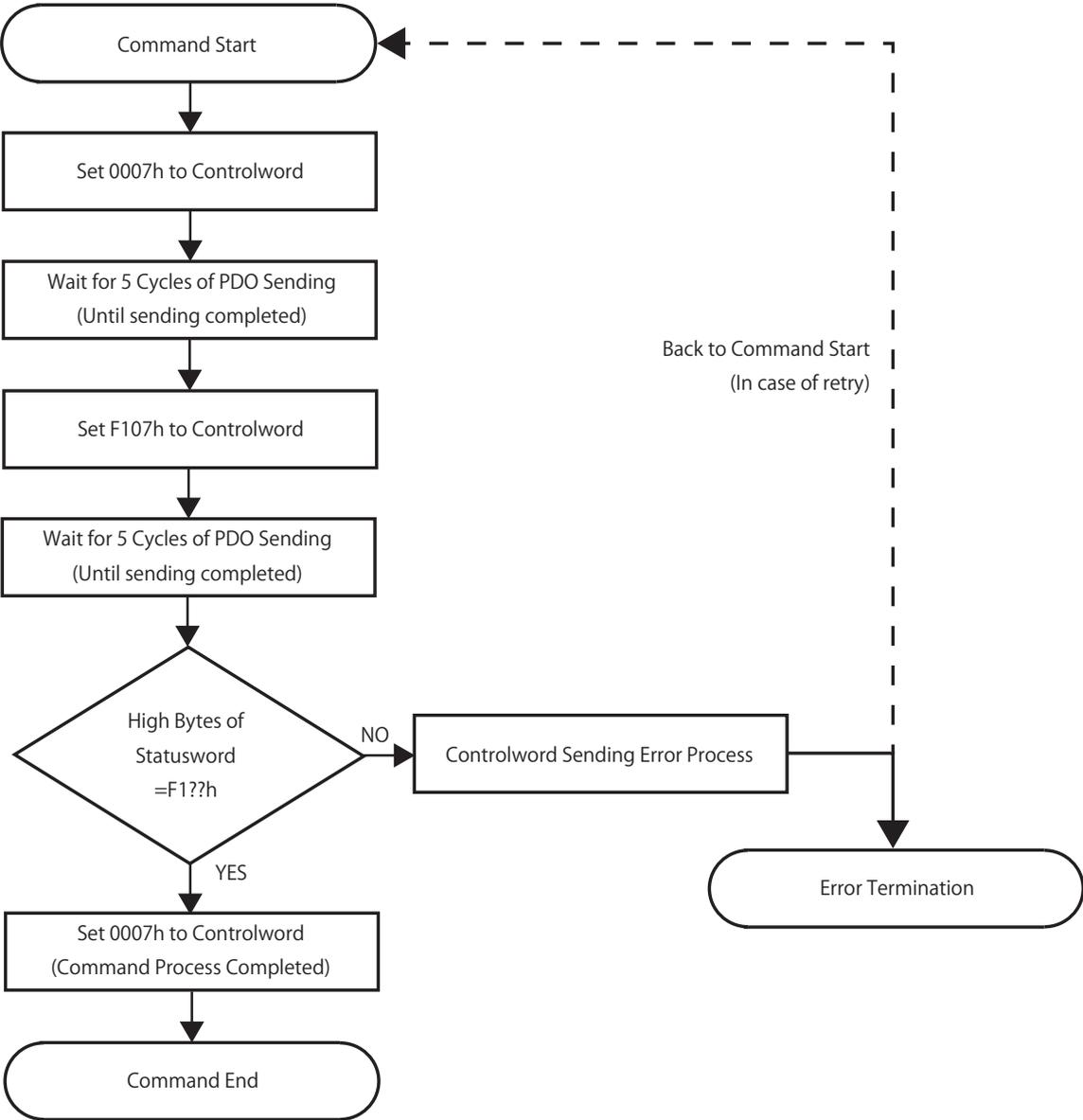
Appendix1.1. Example of Origin Search

■ CiA402 Expanded Command: Processing flow for sending Origin Search Command



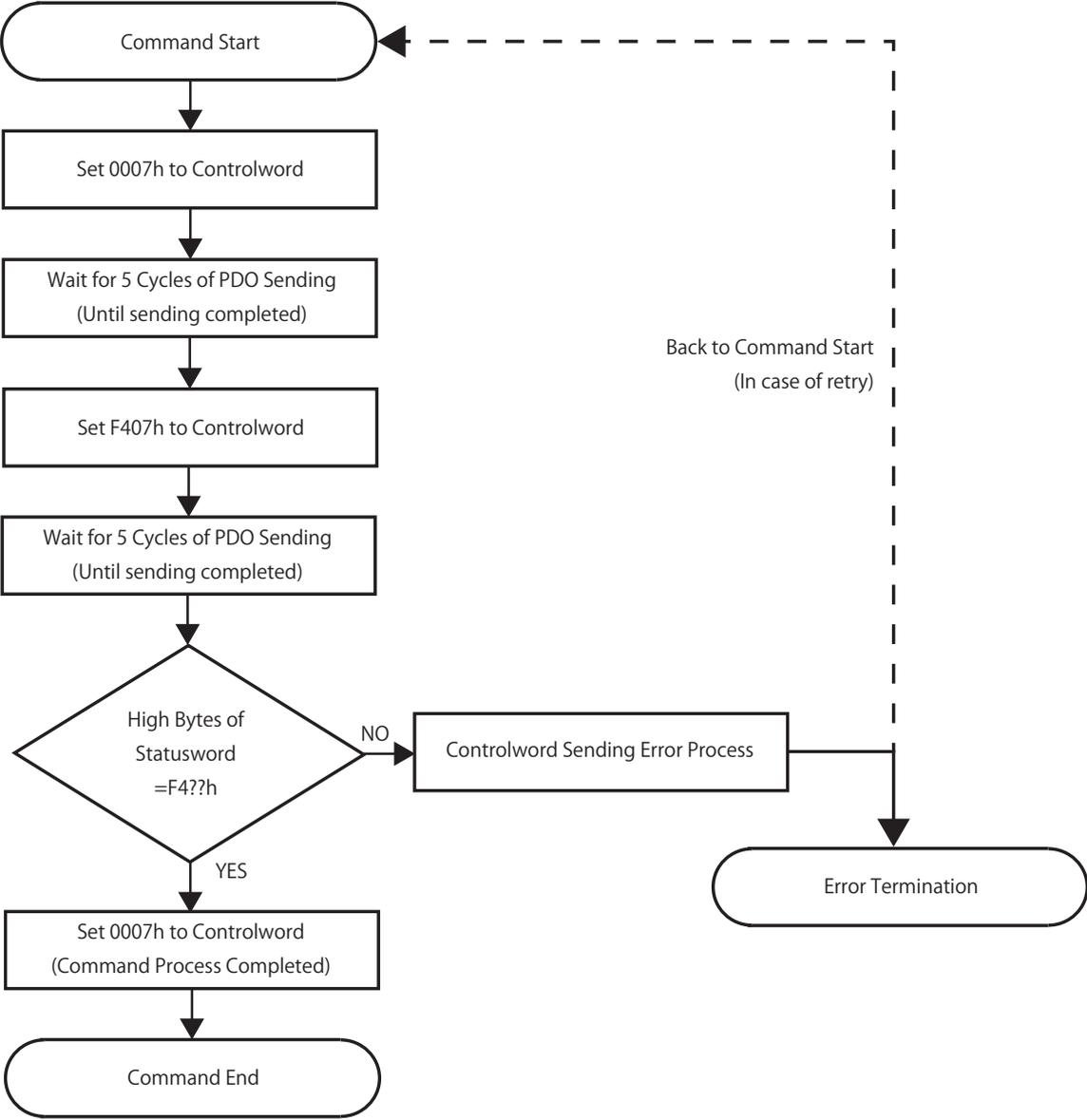
Appendix 1.2. Example of Motor Free

■ CiA402 Expanded Command: Processing flow for sending Motor Free Command



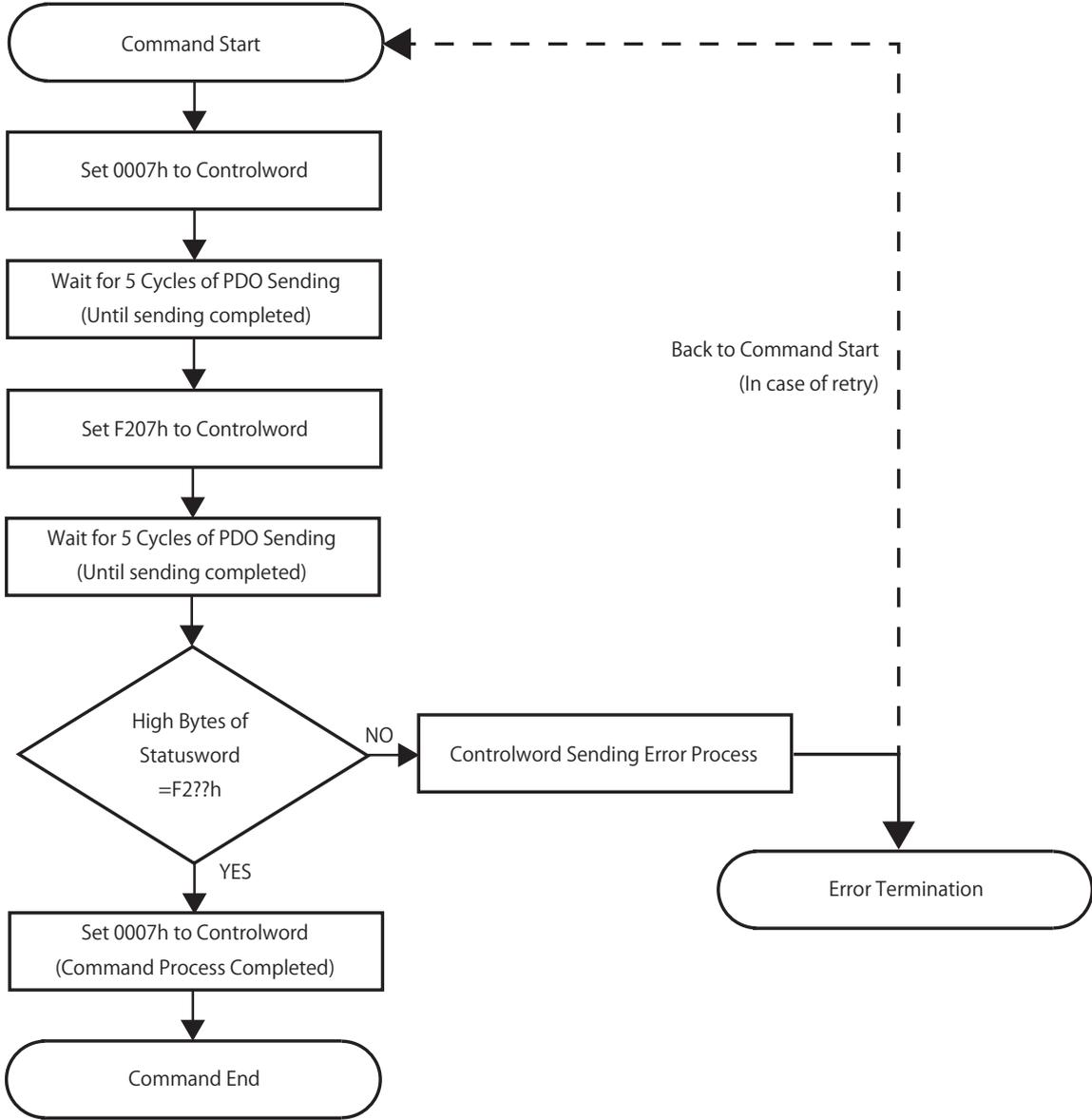
Appendix 1.3. Example of Re-Set Counter

■ CiA402 Expanded Command: Processing flow for Reset Counter Command



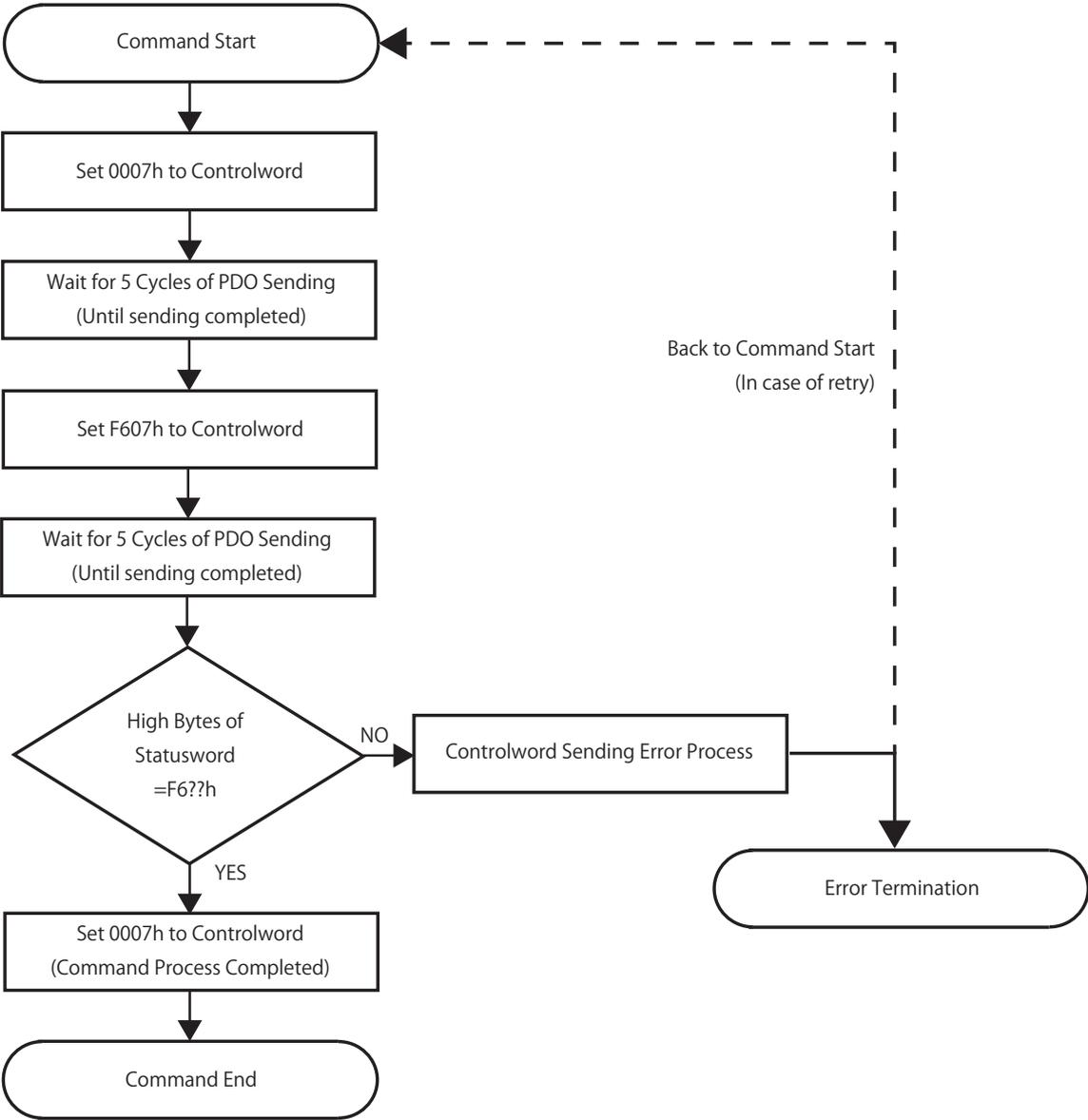
Appendix 1.4. Example of Motor Enable

■ CiA402 Expanded Command: Processing flow for Motor Enable Command



Appendix 1.5. Example of Origin Search Abort

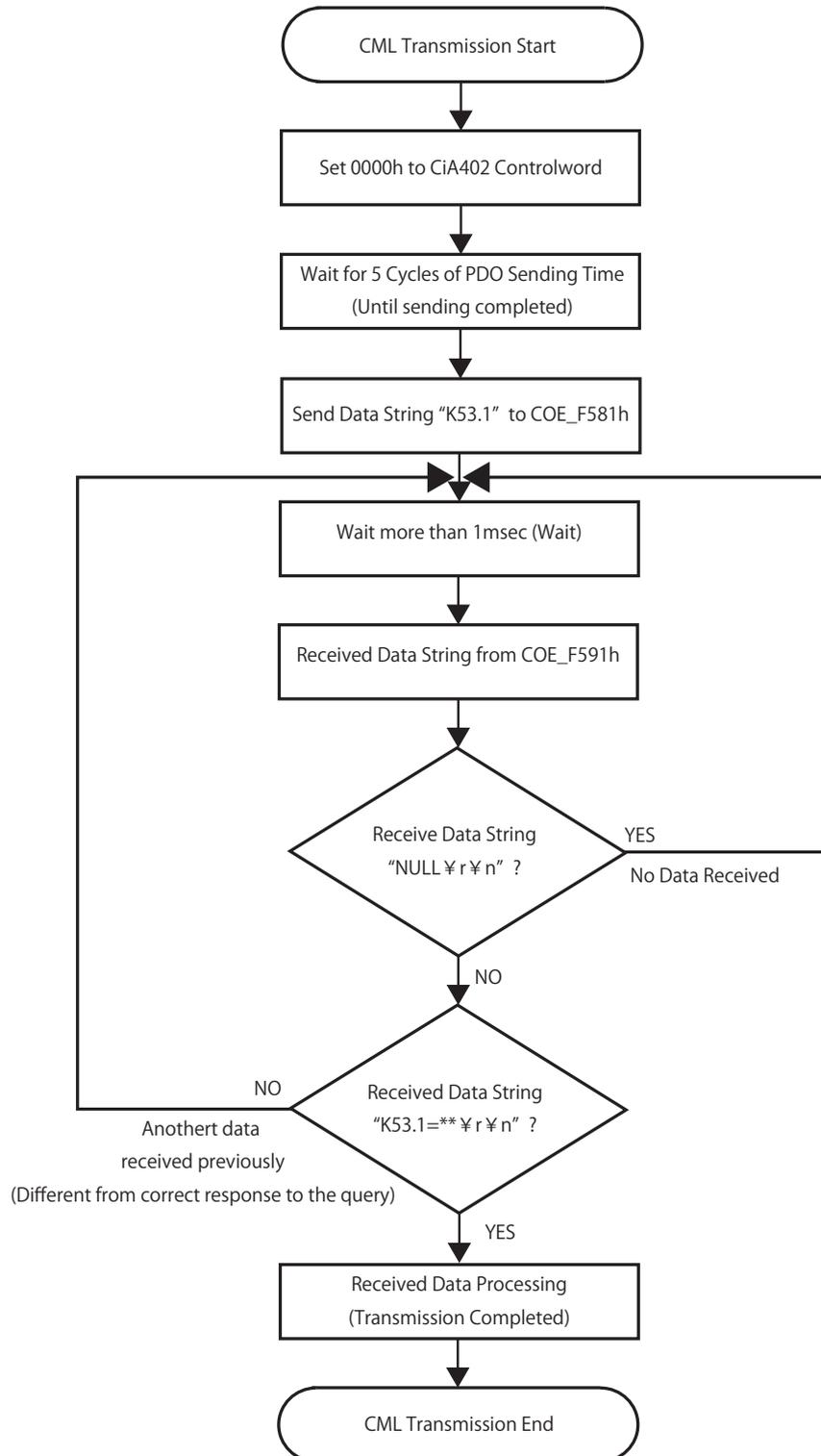
■ CiA402 Expanded Command: Processing flow for Origin Search Abort Command



Appendix 2: CML_Mode Transmission Flow

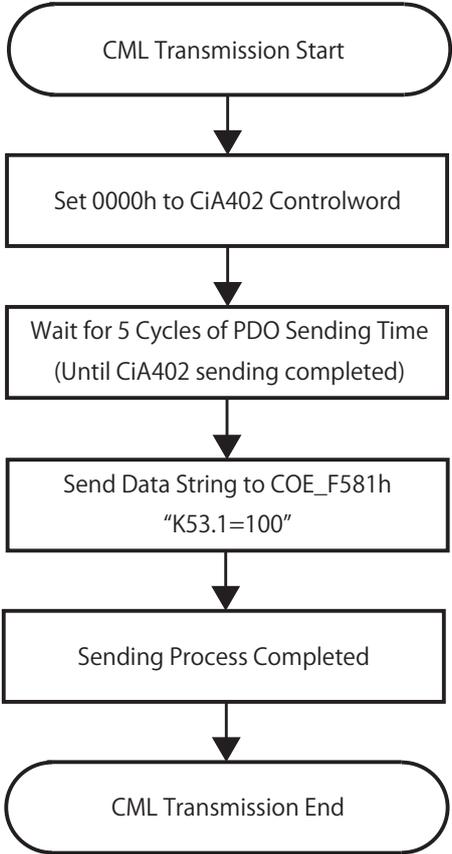
Appendix2.1. Read Parameter "K53.1"

■ CML Transmission via Mailbox: Processing flow for Reading Cool Muscle's Parameter



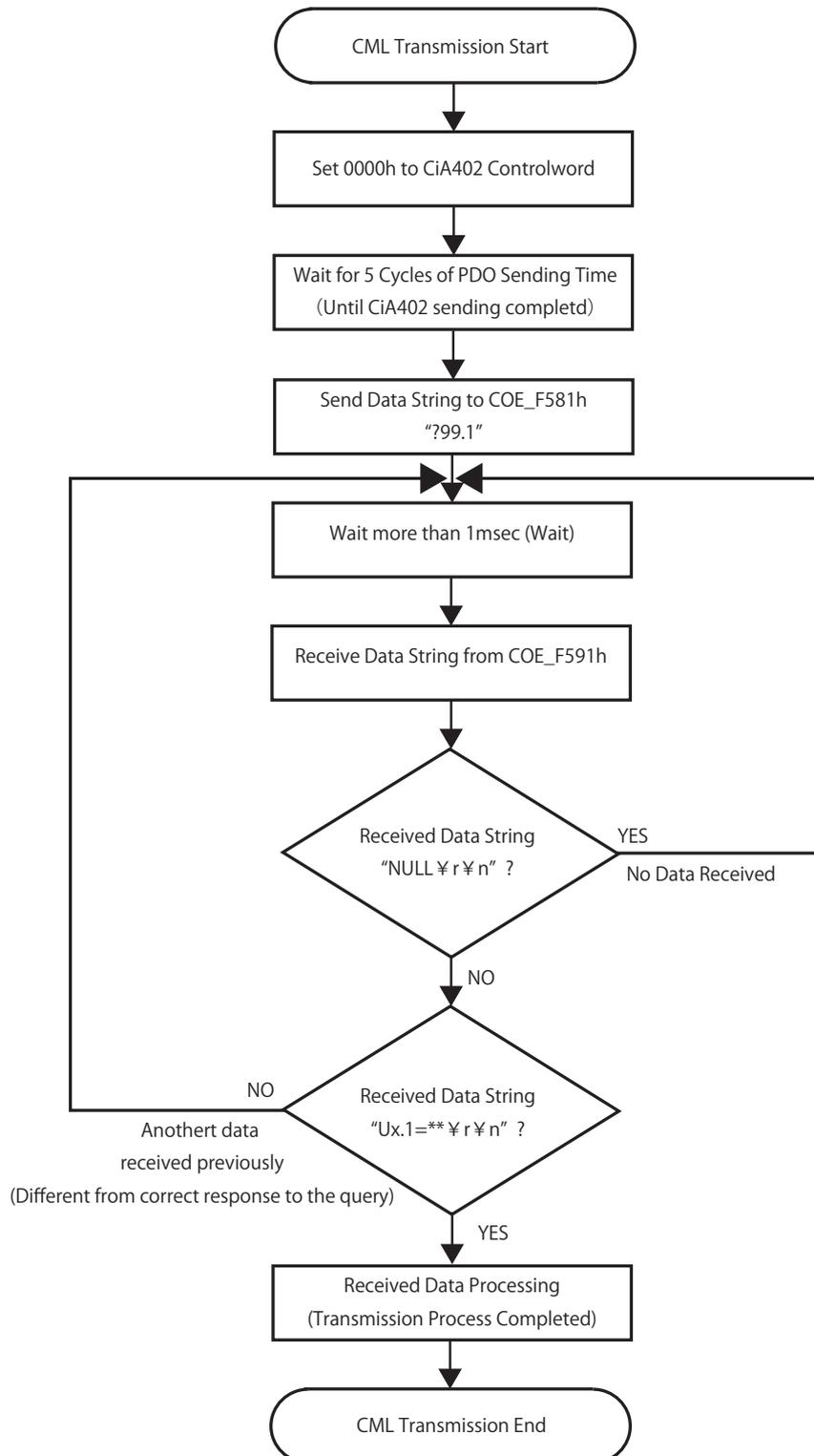
Appendix2.2. Write Parameter "K53.1"

■ CML Transmission via Mailbox: Processing flow for Writing Cool Muscle's Parameter



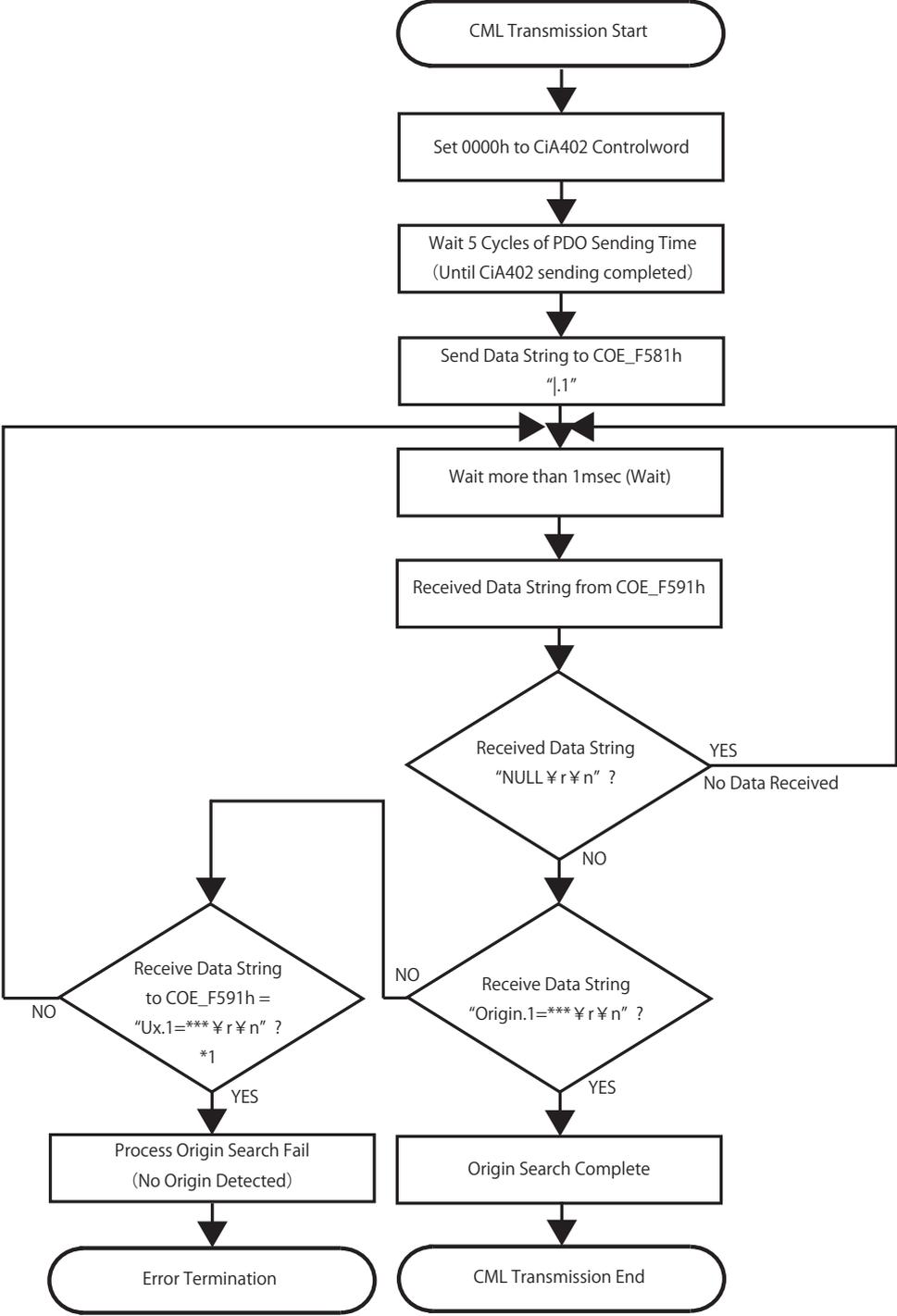
Appendix2.3. Query "?99.1" and Response

■ CML Transmission via Mailbox: Processing flow for Query to Cool Muscle



Appendix2.4. Origin Search Command "|.1" Transmission

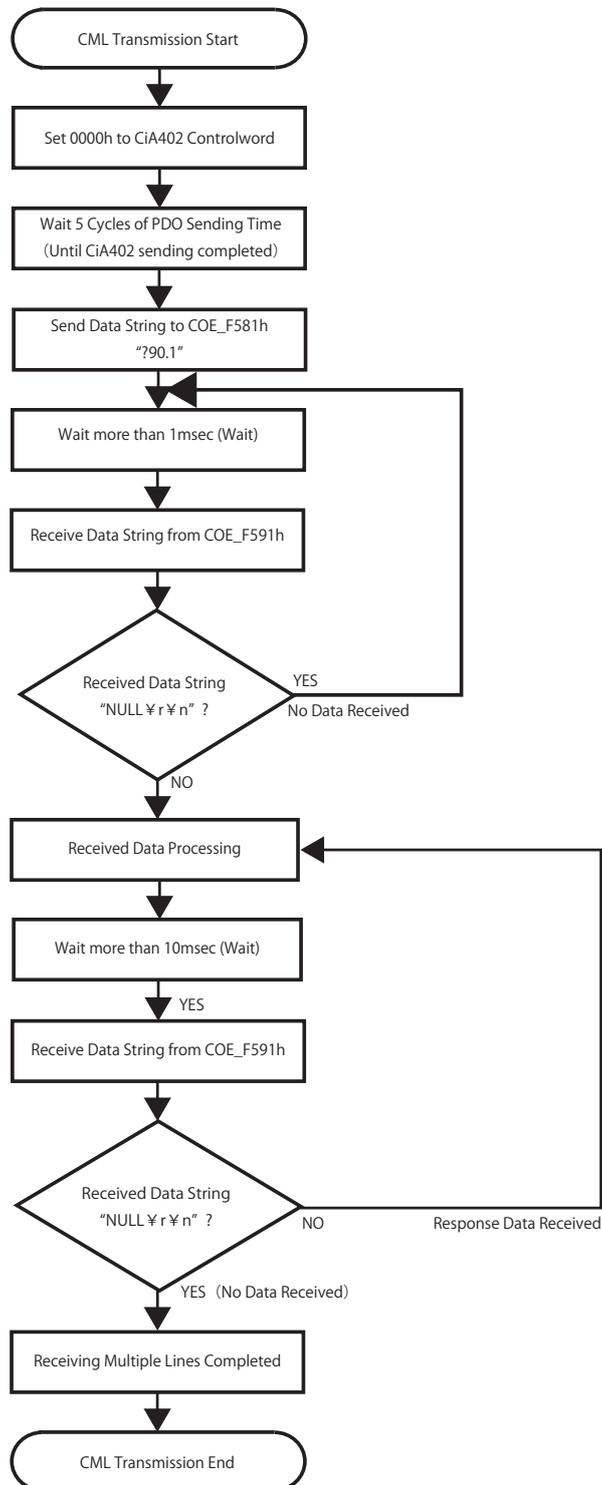
■ CML Transmission via Mailbox: Processing flow for Sending Origin Search command to Cool Muscle



*1: If Origin Search is completed, "Origin.1=***r n" is replied. If Origin Search is failed, "Ux.1=***r n" is replied.

Appendix2.5. Query and Multiple Lines Response

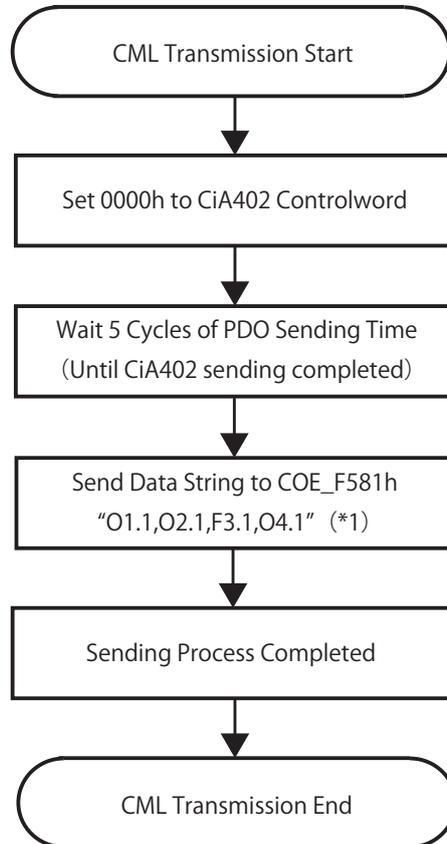
■ CML Transmission via Mailbox: Processing flow for Query to Cool Muscle and receiving multiple lines



Multiple lines of CML are replied for the CML query "?90.1". In this case, if there's a reply to the query "?99.1", continue to receive CML response every 10msec until receiving "NULL¥r¥n".

Appendix2.6. Turn Cool Muscle's Output On/Off

■ CML Transmission via Mailbox: Processing flow for Turning ON Cool Muscle's Output



*1: "O1.1,O2.1,F3.1,O4.1" is an example of turning on/off CM2's Output. The following 4 commands can be sent together.

O1.1: Output1 On

O2.1: Output2 On

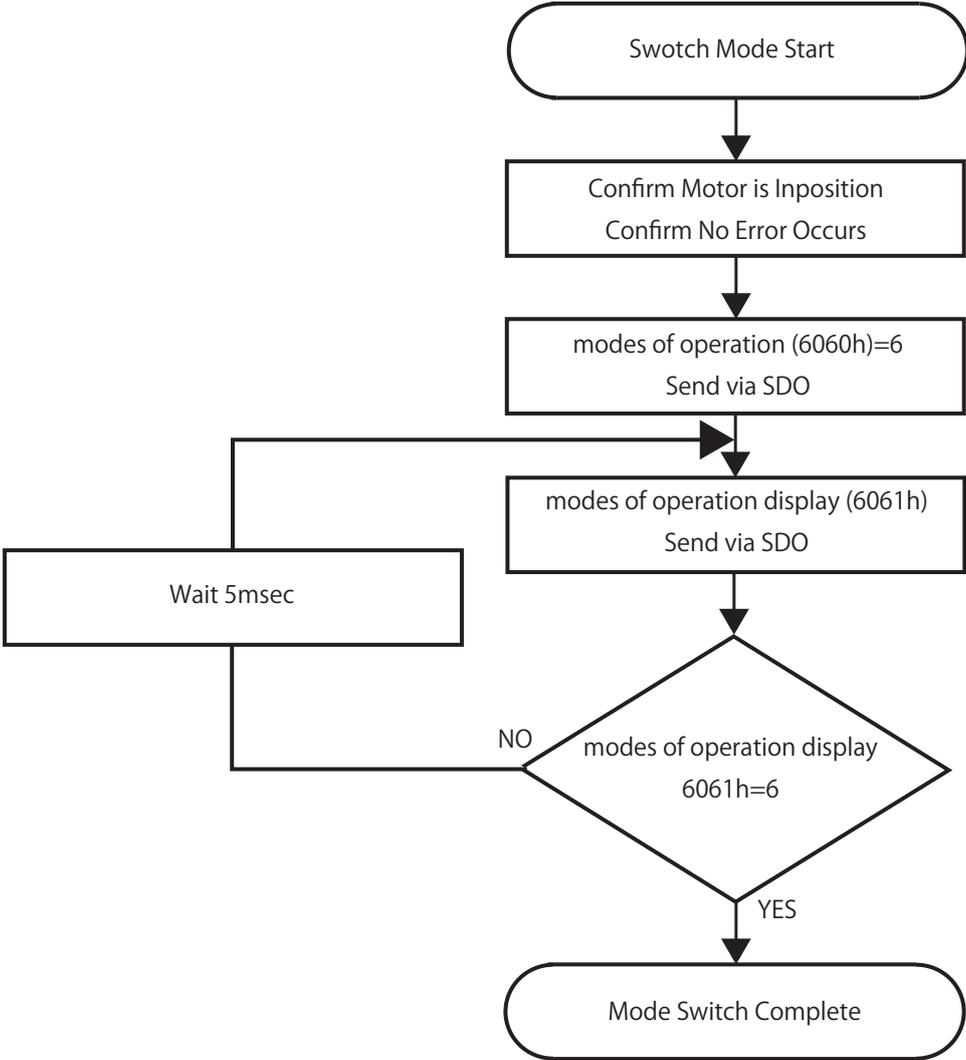
F3.1: Output3 Off

O4.1: Output4 On

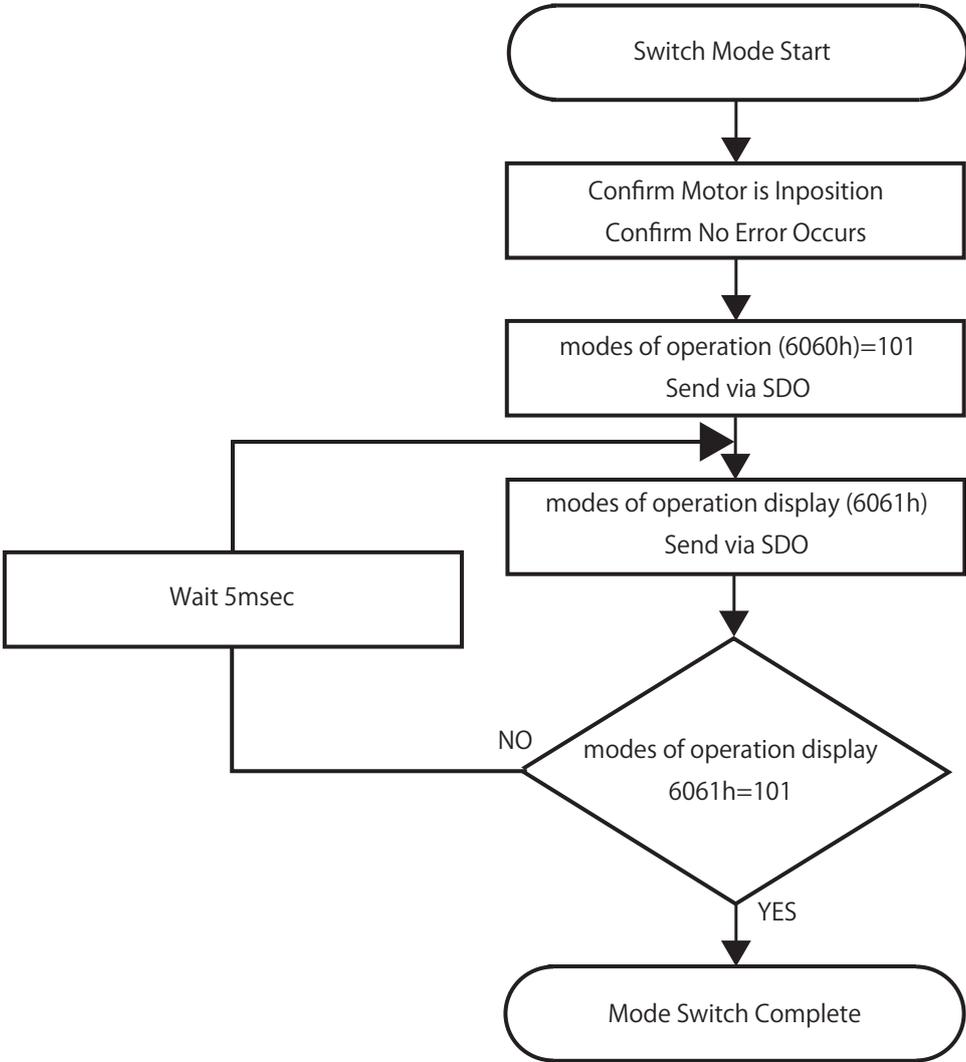
For CM1, Output1 is used for communication so that only Output2 is available. Please refer to CM1 User's Guide for the details.

Appendix 3: Mode Switch Flow

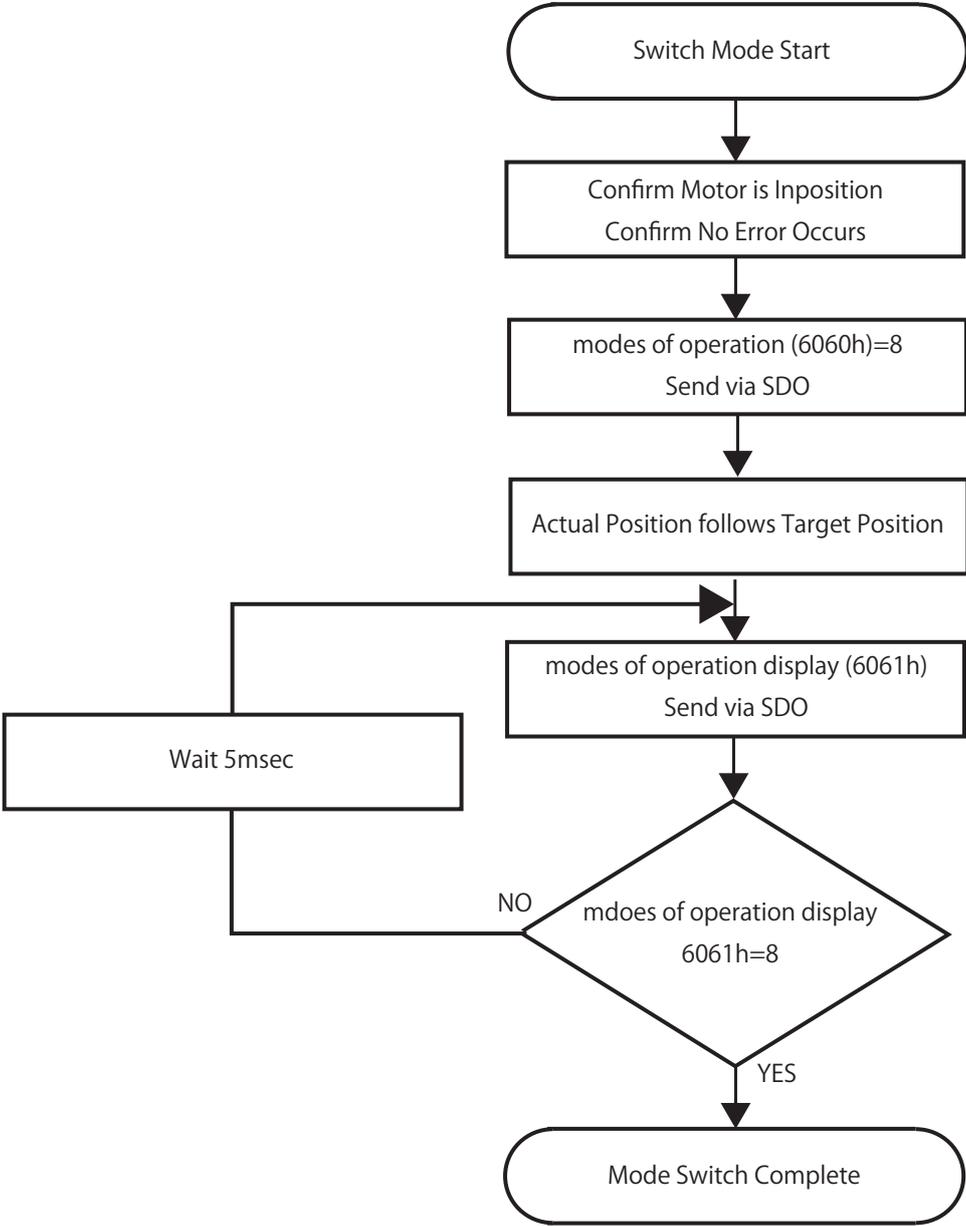
Appendix3.1. Mode Switch Flow to hm



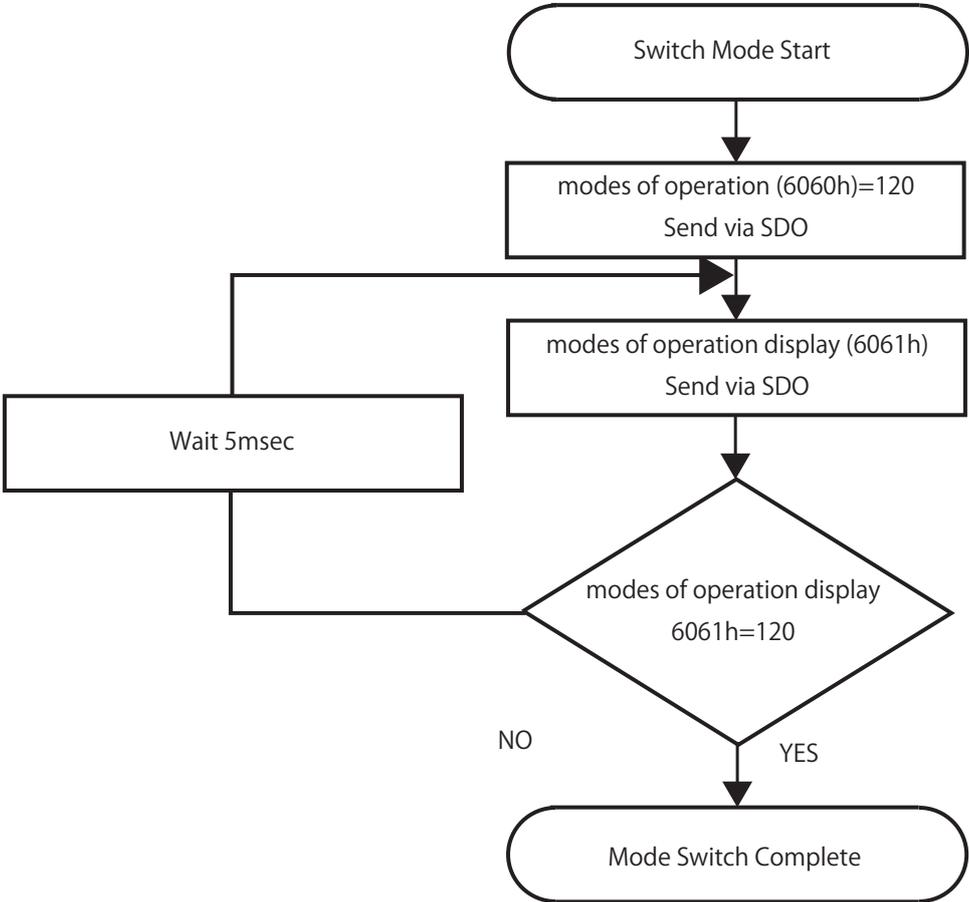
Appendix3.2. Mode Switch Flow to CML



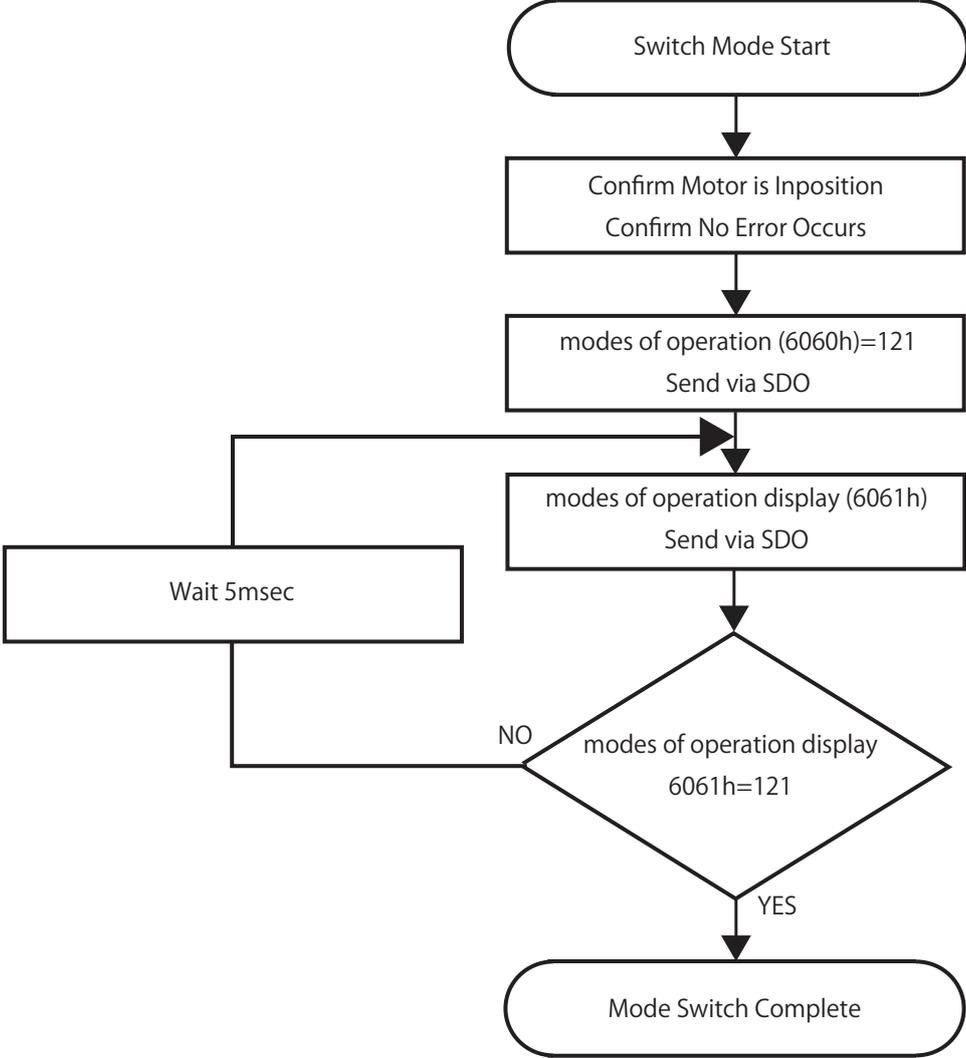
Appendix3.3. Mode Switch Flow to csp



Appendix3.4. Mode Switch Flow to CMD

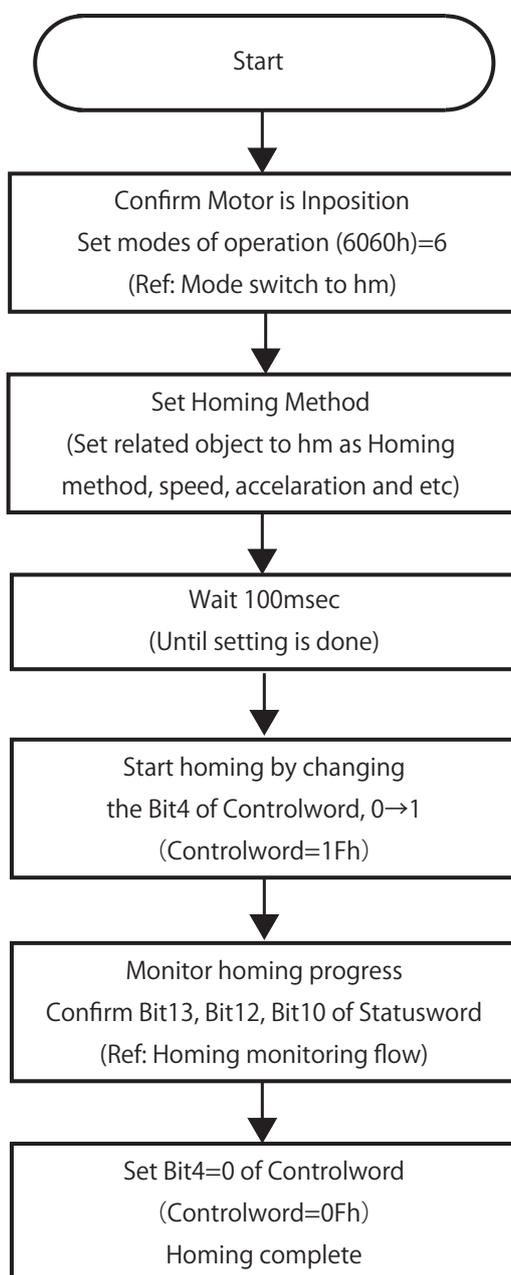


Appendix3.5. Mode Switch Flow to CPIO

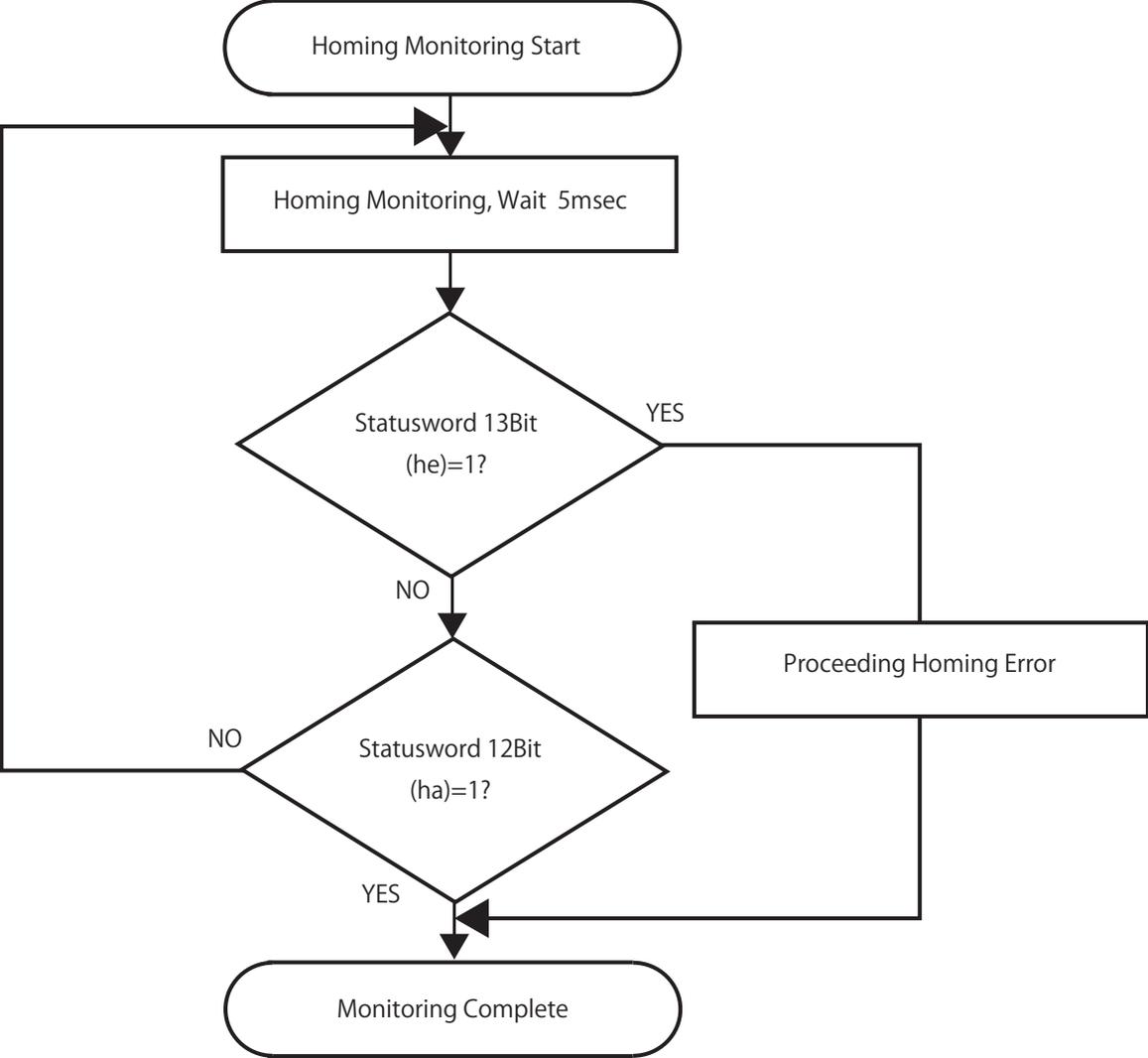


Appendix 4: Homing Mode Flow

Appendix4.1. Homing Sequence Flow



Appendix4.2. Homing Monitoring Flow



Appendix 5: Cool Muscle Resolution

■ Maximum P Data for Each Resolution for CM1

K37 Value	Maximum Value	K37 Value	Maximum Value
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

■ PMaximum P Data for Each Relosution for CM2

Speed Unit 100pps		Speed Unit 10pps		Speed Unit 1pps	
K37 Value	Maximum Value	K37 Value	Maximum Value	K37 Value	Maximum Value
0	8,589,934	20	8,589,934	80	8,589,934
1	17,179,869	21	17,179,869	81	17,179,869
2	21,474,836	22	21,474,836	82	21,474,836
3	42,949,672	23	42,949,672	83	42,949,672
4	85,899,345	24	85,899,345	84	85,899,345
5	107,374,182	25	107,374,182	85	107,374,182
6	214,748,364	26	214,748,364	86	214,748,364
7	429,496,729	27	429,496,729	87	429,496,729
8	999,999,999	28	999,999,999	88	999,999,999
9	N/A	29	N/A	89	N/A
10	999,999,999	30	999,999,999	90	999,999,999
40	12,884,901	60	12,884,901		
41	17,179,869	61	17,179,869		
42	25,769,803	62	25,769,803		
43	34,359,738	63	34,359,738		
44	51,539,607	64	51,539,607		
45	64,424,509	65	64,424,509		
46	128,849,018	66	128,849,018		
47	171,798,691	67	171,798,691		
48	257,698,037	68	257,698,037		
49	343,597,383	69	343,597,383		
50	515,396,075	70	515,396,075		

Appendix 6: Object List

Object list used for this product

Index	Name	Attribute	Availability
1000h	Device Type	32Bit: RO	Available
1001h	Error Register	8Bit: RO	Available
1008h	Manufacturer Device Name	String: RO	Available
1009h	Manufacturer Hardware Version	String: RO	Available
100Ah	Manufacturer Software Version	String: RO	Available

Index	Name	Sub Index	Name	Attribute	Availability
1018h	Identity Object	0h	Number of entries	8Bit: RO	Available
		1h	Vendor ID	32Bit: RO	Available
		2h	Product code	32Bit: RO	Available
		3h	Revision	32Bit: RO	Available
		4h	Serial number	32Bit: RO	Available
10F1h	Error settings	0h	Number of entries	8Bit: RO	Available
		1h	Local Error Reaction	32Bit: RW	Available
		2h	Sync Error Counter Limit	32Bit: RW	Available
1600h	ID1 csp/csv mode RxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID1 6040h Controlword	16Bit: RO	N/A
		2h	ID1 6060h Modes of operation	8Bit: RO	N/A
		3h	ID1 607Ah arget Position	32Bit: RO	N/A
		4h	ID1 60FFh Target velocity	32Bit: RO	N/A
1601h	ID1 csp mode RxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID1 6040h Controlword	32Bit: RO	Available
		2h	ID1 607Ah Target Position	32Bit: RO	Available
1602h	ID1 csv mode RxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID1 6040h Controlword	16Bit: RO	N/A
		2h	ID1 60FFh Target velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1610h	ID2 csp / csv mode RxPDO Mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID2 6840h Controlword	32Bit: RO	N/A
		2h	ID2 6860h Modes of operation	8Bit: RO	N/A
		3h	ID2 687Ah Target Position	32Bit: RO	N/A
		4h	ID2 68FFh Target velocity	32Bit: RO	N/A
1611h	ID2 csp mode RxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID2 6840h Controlword	32Bit: RO	Available
		2h	ID2 687Ah Target Position	32Bit: RO	Available
1612h	ID2 csv mode RxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID2 6840h Controlword	32Bit: RO	N/A
		2h	ID2 68FFh Target velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1620h	ID3 csp / csv mode RxPDO Mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID3 7040h Controlword	32Bit: RO	N/A
		2h	ID3 7060h Modes of operation	8Bit: RO	N/A
		3h	ID3 707Ah Target Position	32Bit: RO	N/A
		4h	ID3 70FFh Target velocity	32Bit: RO	N/A
1621h	ID3 csp mode RxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID3 7040h Controlword	32Bit: RO	Available
		2h	ID3 707Ah Target Position	32Bit: RO	Available
1622h	ID3 csv mode RxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID3 7040h Controlword	32Bit: RO	N/A
		2h	ID3 70FFh Target velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1630h	ID4 csp / csv mode RxPDO Mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID4 7840h Controlword	32Bit: RO	N/A
		2h	ID4 7860h Modes of operation	8Bit: RO	N/A
		3h	ID4 787Ah Target Position	32Bit: RO	N/A
		4h	ID4 78FFh Target velocity	32Bit: RO	N/A
1631h	ID4 csp mode RxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID4 7840h Controlword	32Bit: RO	Available
		2h	ID4 787Ah Target Position	32Bit: RO	Available
1632h	ID4 csv mode RxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID4 7840h Controlword	32Bit: RO	N/A
		2h	ID4 78FFh Target velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1A00h	ID1 csp/csv mode TxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID1 6041h Statusword	32Bit: RO	N/A
		2h	ID1 6061h Modes of Operation Display	8Bit: RO	N/A
		3h	ID1 6064h Actual position	32Bit: RO	N/A
		4h	ID1 606Ch Actual velocity	32Bit: RO	N/A
1A01h	ID1 csp mode TxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID1 6041h Statusword	32Bit: RO	Available
		2h	ID1 6064h Actual position	32Bit: RO	Available
1A02h	ID1 csv mode TxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID1 6041h Statusword	32Bit: RO	N/A
		2h	ID1 606Ch Actual velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1A10h	ID2 csp / csv mode TxPDO Mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID2 6841h Statusword	32Bit: RO	N/A
		2h	ID2 6861h: Modes of Operation Display	8Bit: RO	N/A
		3h	ID2 6864h: Actual position	32Bit: RO	N/A
		4h	ID2 686Ch: Actual velocity	32Bit: RO	N/A
1A11h	ID2 csp mode TxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID2 6841h: Statusword	32Bit: RO	Available
		2h	ID2 6864h: Actual position	32Bit: RO	Available
1A12h	ID2 csv mode TxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID2 6841h: Statusword	32Bit: RO	N/A
		2h	ID2 686Ch: Actual velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1A20h	ID3 csp / csv mode TxPDO Mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID3 7041h: Statusword	32Bit: RO	N/A
		2h	ID3 7061h: Modes of Operation Display	8Bit: RO	N/A
		3h	ID3 7064h: Actual position	32Bit: RO	N/A
		4h	ID3 706Ch: Actual velocity	32Bit: RO	N/A
1A21h	ID3 csp mode TxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID3 7041h: Statusword	32Bit: RO	Available
		2h	ID3 7064h: Actual position	32Bit: RO	Available
1A22h	ID3 csv mode TxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID3 7041h: Statusword	32Bit: RO	N/A
		2h	ID3 706Ch: Actual velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1A30h	ID4 csp / csv mode TxPDO Mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID4 7841h: Statusword	32Bit: RO	N/A
		2h	ID4 7861h: Modes of Operation Display	8Bit: RO	N/A
		3h	ID4 7864h: Actual position	32Bit: RO	N/A
		4h	ID4 786Ch: Actual velocity	32Bit: RO	N/A
1A31h	ID4 csp mode TxPDO mapping	0h	Number of entries	8Bit: RO	Available
		1h	ID4 7841h: Statusword	32Bit: RO	Available
		2h	ID4 7864h: Actual position	32Bit: RO	Available
1A32h	ID4 csv mode TxPDO mapping	0h	Number of entries	8Bit: RO	N/A
		1h	ID4 7841h: Statusword	32Bit: RO	N/A
		2h	ID4 786Ch: Actual velocity	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
1C00h	Sync Manager Communication Type	0h	Number of entries	8Bit: RO	Available
		1h	Mailbox Out (0x1)	8Bit: RO	Available
		2h	Mailbox In (0x2)	8Bit: RO	Available
		3h	Process data Out (0x3)	8Bit: RO	Available
		4h	Process data In (0x4)	8Bit: RO	Available
1C12h	Sync Manager 2 PDO Assignment	0h	Number of entries	8Bit: RO	Available
		1h	ID1 1601h: csp RxPDO)	16Bit: RW	Available
		2h	ID2 1611h: csp RxPDO)	16Bit: RW	Available
		3h	ID3 1621h: csp RxPDO)	16Bit: RW	Available
		4h	ID4 1631h: csp RxPDO)	16Bit: RW	Available
1C13h	Sync Manager 3 PDO Assignment	0h	Number of entries	8Bit: RO	Available
		1h	ID1 1A01h: csp TxPDO)	16Bit: RW	Available
		2h	ID2 1A11h: csp TxPDO)	16Bit: RW	Available
		3h	ID3 1A21h: csp TxPDO)	16Bit: RW	Available
		4h	ID4 1A31h: csp TxPDO)	16Bit: RW	Available

Index	Name	Sub Index	Name	Attribute	Availability
1C32h	Sync Manager 2 Synchronization	0h	Number of entries	8Bit: RO	Available
		1h	Synchronization Type	16Bit: RW	Available
		2h	Cycle Time	32Bit: RO	Available
		4h	Synchronization Types supported	16Bit: RO	Available
		5h	Minimum Cycle Time	32Bit: RO	Available
		6h	Calc and Copy Time	32Bit: RO	Available
		8h	Get Cycle Time	16Bit: RW	N/A
		9h	Delay Time	32Bit: RO	N/A
		Ah	Sync0 Cycle Time	32Bit: RW	N/A
		Bh	SM-Event Missed	16Bit: RO	N/A
		Ch	Cycle Time Too Small	16Bit: RO	N/A
		20h	Sync error	1Bit: RO	N/A
1C33h	Sync Manager 3 Synchronization	0h	Number of entries	8Bit: RO	Available
		1h	Synchronization Type	16Bit: RW	Available
		2h	Cycle Time	32Bit: RO	Available
		4h	Synchronization Types supported	16Bit: RO	Available
		5h	Minimum Cycle Time	32Bit: RO	Available
		6h	Calc and Copy Time	32Bit: RO	Available
		8h	Get Cycle Time	16Bit: RW	N/A
		9h	Delay Time	32Bit: RO	N/A
		Ah	Sync0 Cycle Time	32Bit: RW	N/A
		Bh	SM-Event Missed	16Bit: RO	N/A
		Ch	Cycle Time Too Small	16Bit: RO	N/A
		20h	Sync error	1Bit: RO	N/A

The below is the object for each Cool Muscle that are connected to EtherCAT Cool Muscle Bridge. ID1, ID2, ID3 and ID4 are the ID numbers of Cool Muscle.

The codes of attribute stand for "RO: Read Only" and "RW: Read and Write"

Object for ID1

Index	Name	Attribute	Availability
603Fh	Error Code	16Bit: RO	N/A
6040h	Controlword	16Bit: RW	Available
6041h	Statusword	16Bit: RO	Available
605Ah	Quick stop option code	16Bit: RW	N/A
605Bh	Shutdown Option Code	16Bit: RW	N/A
605Ch	Disable Operation Option Code	16Bit: RW	N/A
605Eh	Fault Reaction Code	16Bit: RW	N/A
6060h	Modes of Operation	8Bit: RW	Available
6061h	Mode of Operation Display	8Bit: RO	Available
6064h	Position Actual Value	32Bit: RO	Available
6065h	Following Error Window	32Bit: RW	N/A
6066h	Following Error Time Out	16Bit: RW	N/A
606Ch	Velocity Actual Value	32Bit: RO	N/A
6071h	Target Torque	16Bit: RO	N/A
6077h	Torque Actual Value	16Bit: RO	N/A
607Ah	Target Position	32Bit: RW	Available
607Ch	Home Offset	32Bit: RW	Available
6085h	Quick Stop Deceleration	32Bit: RW	N/A
6098h	Homing Method	8Bit: RW	Available
609Ah	Homing Acceleration	32Bit: RW	Available
60B1h	Velocity Offset	32Bit: RW	N/A
60B2h	Torque Offset	16Bit: RW	N/A
60F4h	Following Error Actual Value	32Bit: RO	N/A
60FDh	Digital Inputs	32Bit: RO	Available
60FFh	Target Velocity	32Bit: RW	N/A
6502h	Supported Drive Modes	32Bit: RO	Available
67FEh	Homing Switch Input No	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
607Bh	Position	0h	Number of entries	8Bit: RO	N/A
	Range Limit	1h	Min Position Range Limit	32Bit: RW	N/A
		2h	Max Position Range Limit	32Bit: RW	N/A
607Dh	Software Position Limit	0h	Number of entries	8Bit: RO	N/A
	Position Limit	1h	Min Software Position Limit	32Bit: RW	N/A
		2h	Max Software Position Limit	32Bit: RW	N/A
6099h	Homing Speed	0h	Number of entries	8Bit: RO	Available
		1h	Speed during search for switch	32Bit: RW	Available
		2h	Speed during search for stopper	32Bit: RW	Available
60C2h	Interpolation Time Period	0h	Number of entries	8Bit: RO	N/A
		1h	Interpolation Period	8Bit: RW	N/A
		2h	Interpolation Index	8Bit: RW	N/A
60E3h	Supported homing method	0h	Number of entries	8Bit: RO	Available
		1h	Stopper CW	16Bit: RO	Available
		2h	Stopper CCW	16Bit: RO	Available
		3h	Switch CW	16Bit: RO	Available
		4h	Switch CCW	16Bit: RO	Available

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
60F6h	Cool Muscle K Parameter	0h	Number of entries	32Bit: RW	Available	Available
		1h	K21 Parameter	32Bit: RW	N/A	N/A
		2h	K22 Parameter	32Bit: RW	N/A	N/A
		3h	K23 Parameter	32Bit: RW	Available	Available
		4h	K24 Parameter	32Bit: RW	Available	Available
		5h	K25 Parameter	32Bit: RW	N/A	N/A
		6h	K26 Parameter	32Bit: RW	Available	Available
		7h	K27 Parameter	32Bit: RW	Available	Available
		8h	K28 Parameter	32Bit: RW	N/A	N/A
		9h	K29 Parameter	32Bit: RW	N/A	N/A
		Ah	K30 Parameter	32Bit: RW	N/A	N/A
		Bh	K31 Parameter	32Bit: RW	N/A	N/A
		Ch	K32 Parameter	32Bit: RW	N/A	N/A
		Dh	K33 Parameter	32Bit: RW	Available	Available
		Eh	K34 Parameter	32Bit: RW	Available	Available
		Fh	K35 Parameter	32Bit: RW	N/A	N/A
		10h	K36 Parameter	32Bit: RW	N/A	N/A
		11h	K37 Parameter	32Bit: RW	N/A	N/A
		12h	K38 Parameter	32Bit: RW	N/A	N/A
		13h	K39 Parameter	32Bit: RW	N/A	N/A
		14h	K40 Parameter	32Bit: RW	N/A	N/A
		15h	K41 Parameter	32Bit: RW	N/A	N/A
		16h	K42 Parameter	32Bit: RW	Available	Available
		17h	K43 Parameter	32Bit: RW	Available	Available
		18h	K44 Parameter	32Bit: RW	N/A	N/A
		19h	K45 Parameter	32Bit: RW	Available	Available
		1Ah	K46 Parameter	32Bit: RW	Available	Available
		1Bh	K47 Parameter	32Bit: RW	Available	Available
		1Ch	K48 Parameter	32Bit: RW	Available	Available
		1Dh	K49 Parameter	32Bit: RW	N/A	N/A
		1Eh	K50 Parameter	32Bit: RW	N/A	N/A
		1Fh	K51 Parameter	32Bit: RW	N/A	N/A
20h	K52 Parameter	32Bit: RW	Available	N/A		
21h	K53 Parameter	32Bit: RW	Available	N/A		
22h	K54 Parameter	32Bit: RW	Available	N/A		
23h	K55 Parameter	32Bit: RW	N/A	N/A		
24h	K56 Parameter	32Bit: RW	Available	Available		
25h	K57 Parameter	32Bit: RW	Available	Available		
26h	K58 Parameter	32Bit: RW	N/A	N/A		
27h	K59 Parameter	32Bit: RW	N/A	N/A		
28h	K60 Parameter	32Bit: RW	N/A	N/A		
29h	K61 Parameter	32Bit: RW	N/A	N/A		

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
60F6h	Cool Muscle K Parameter	2Ah	K62 Parameter	32Bit: RW	-	N/A
		2Bh	K63 Parameter	32Bit: RW	-	N/A
		2Ch	K64 Parameter	32Bit: RW	N/A	Available
		2Dh	K65 Parameter	32Bit: RW	N/A	N/A
		2Eh	K66 Parameter	32Bit: RW	-	-
		2Fh	K67 Parameter	32Bit: RW	-	-
		30h	K68 Parameter	32Bit: RW	-	Available
		31h	K69 Parameter	32Bit: RW	N/A	N/A
		32h	K70 Parameter	32Bit: RW	N/A	N/A
		33h	K71 Parameter	32Bit: RW	Available	N/A
		34h	K72 Parameter	32Bit: RW	Available	N/A
		35h	K73 Parameter	32Bit: RW	N/A	N/A
		36h	K74 Parameter	32Bit: RW	-	N/A
		37h	K75 Parameter	32Bit: RW	-	N/A
		38h	K76 Parameter	32Bit: RW	-	N/A
		39h	K77 Parameter	32Bit: RW	-	N/A
		3Ah	K78 Parameter	32Bit: RW	-	N/A
		3Bh	K79 Parameter	32Bit: RW	-	N/A
		3Ch	K80 Parameter	32Bit: RW	-	N/A
		3Dh	K81 Parameter	32Bit: RW	-	N/A
		3Eh	K82 Parameter	32Bit: RW	-	N/A
		3Fh	K83 Parameter	32Bit: RW	-	-
		40h	K84 Parameter	32Bit: RW	-	-
		41h	K85 Parameter	32Bit: RW	-	-
		42h	K86 Parameter	32Bit: RW	-	-
		43h	K87 Parameter	32Bit: RW	-	-
		44h	K88 Parameter	32Bit: RW	-	-
		45h	K89 Parameter	32Bit: RW	-	-
		46h	K90 Parameter	32Bit: RW	-	-
		47h	K91 Parameter	32Bit: RW	-	-
		48h	K92 Parameter	32Bit: RW	-	-
		49h	K93 Parameter	32Bit: RW	-	-
4Ah	K94 Parameter	32Bit: RW	-	-		
4Bh	K95 Parameter	32Bit: RW	-	-		
4Ch	K96 Parameter	32Bit: RW	-	-		
4Dh	K97 Parameter	32Bit: RW	-	-		
4Eh	K98 Parameter	32Bit: RW	-	-		
4Fh	K99 Parameter	32Bit: RW	-	-		

Index	Name	Sub Index	Name	Attribute	Availability
60FBh	Servo Stiffness Adjustment Parameter (CM2 Only)	0h	Number of entries	32Bit: RW	Available
		1h	Servo Stiffness Adjustment	32Bit: RW	Available
		2h	Reserved	32Bit: RW	N/A
		3h	Reserved	32Bit: RW	N/A
		4h	Reserved	32Bit: RW	N/A
		5h	Reserved	32Bit: RW	N/A
		6h	Reserved	32Bit: RW	N/A
		7h	Reserved	32Bit: RW	N/A
		8h	Reserved	32Bit: RW	N/A
		9h	Reserved	32Bit: RW	N/A
		Ah	Reserved	32Bit: RW	N/A

Index	Name	Sub Index	Name	Attribute	Availability
60FEh	Digital Outputs	0h	Number of entries	8Bit: RO	Available
		1h	Physical Outputs	32Bit: RW	Available
		2h	Bit Mask	32Bit: RW	Available

Object for ID2 ;

The offset of object of ID2 against ID1 is 0x800.

Index	Name	Attribute	Availability
683Fh	Error Code	16Bit: RO	N/A
6840h	Controlword	16Bit: RW	Available
6841h	Statusword	16Bit: RO	Available
685Ah	Quick stop option code	16Bit: RW	N/A
685Bh	Shutdown Option Code	16Bit: RW	N/A
685Ch	Disable Operation Option Code	16Bit: RW	N/A
685Eh	Fault Reaction Code	16Bit: RW	N/A
6860h	Modes of Operation	8Bit: RW	Available
6861h	Mode of Operation Display	8Bit: RO	Available
6864h	Position Actual Value	32Bit: RO	Available
6865h	Following Error Window	32Bit: RW	N/A
6866h	Following Error Time Out	16Bit: RW	N/A
686Ch	Velocity Actual Value	32Bit: RO	N/A
6871h	Target Torque	16Bit: RO	N/A
6877h	Torque Actual Value	16Bit: RO	N/A
687Ah	Target Position	32Bit: RW	Available
687Ch	Home Offset	32Bit: RW	Available
6885h	Quick Stop Deceleration	32Bit: RW	N/A
6898h	Homing Method	8Bit: RW	Available
689Ah	Homing Acceleration	32Bit: RW	Available
68B1h	Velocity Offset	32Bit: RW	N/A
68B2h	Torque Offset	16Bit: RW	N/A
68F4h	Following Error Actual Value	32Bit: RO	N/A
68FDh	Digital Inputs	32Bit: RO	Available
68FFh	Target Velocity	32Bit: RW	N/A
6D02h	Supported Drive Modes	32Bit: RO	Available
6FFEh	Homing Switch Input No	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
687Bh	Position	0h	Number of entries	8Bit: RO	N/A
	Range Limit	1h	Min Position Range Limit	32Bit: RW	N/A
		2h	Max Position Range Limit	32Bit: RW	N/A
687Dh	Software	0h	Number of entries	8Bit: RO	N/A
	Position Limit	1h	Min Software Position Limit	32Bit: RW	N/A
		2h	Max Software Position Limit	32Bit: RW	N/A
6899h	Homing Speed	0h	Number of entries	8Bit: RO	Available
		1h	Speed during search for switch	32Bit: RW	Available
		2h	Speed during search for stopper	32Bit: RW	Available
68C2h	Interpolation Time Period	0h	Number of entries	8Bit: RO	N/A
		1h	Interpolation Period	8Bit: RW	N/A
		2h	Interpolation Index	8Bit: RW	N/A
68E3h	Supported homing method	0h	Number of entries	8Bit: RO	Available
		1h	Stopper CW	16Bit: RO	Available
		2h	Stopper CCW	16Bit: RO	Available
		3h	Switch CW	16Bit: RO	Available
		4h	Switch CCW	16Bit: RO	Available

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
68F6h	Cool Muscle K Parameter	0h	Number of entries	32Bit: RW	Available	Available
		1h	K21 Parameter	32Bit: RW	N/A	N/A
		2h	K22 Parameter	32Bit: RW	N/A	N/A
		3h	K23 Parameter	32Bit: RW	Available	Available
		4h	K24 Parameter	32Bit: RW	Available	Available
		5h	K25 Parameter	32Bit: RW	N/A	N/A
		6h	K26 Parameter	32Bit: RW	Available	Available
		7h	K27 Parameter	32Bit: RW	Available	Available
		8h	K28 Parameter	32Bit: RW	N/A	N/A
		9h	K29 Parameter	32Bit: RW	N/A	N/A
		Ah	K30 Parameter	32Bit: RW	N/A	N/A
		Bh	K31 Parameter	32Bit: RW	N/A	N/A
		Ch	K32 Parameter	32Bit: RW	N/A	N/A
		Dh	K33 Parameter	32Bit: RW	Available	Available
		Eh	K34 Parameter	32Bit: RW	Available	Available
		Fh	K35 Parameter	32Bit: RW	N/A	N/A
		10h	K36 Parameter	32Bit: RW	N/A	N/A
		11h	K37 Parameter	32Bit: RW	N/A	N/A
		12h	K38 Parameter	32Bit: RW	N/A	N/A
		13h	K39 Parameter	32Bit: RW	N/A	N/A
		14h	K40 Parameter	32Bit: RW	N/A	N/A
		15h	K41 Parameter	32Bit: RW	N/A	N/A
		16h	K42 Parameter	32Bit: RW	Available	Available
		17h	K43 Parameter	32Bit: RW	Available	Available
		18h	K44 Parameter	32Bit: RW	N/A	N/A
		19h	K45 Parameter	32Bit: RW	Available	Available
		1Ah	K46 Parameter	32Bit: RW	Available	Available
		1Bh	K47 Parameter	32Bit: RW	Available	Available
		1Ch	K48 Parameter	32Bit: RW	Available	Available
		1Dh	K49 Parameter	32Bit: RW	N/A	N/A
		1Eh	K50 Parameter	32Bit: RW	N/A	N/A
		1Fh	K51 Parameter	32Bit: RW	N/A	N/A
20h	K52 Parameter	32Bit: RW	Available	N/A		
21h	K53 Parameter	32Bit: RW	Available	N/A		
22h	K54 Parameter	32Bit: RW	Available	N/A		
23h	K55 Parameter	32Bit: RW	N/A	N/A		
24h	K56 Parameter	32Bit: RW	Available	Available		
25h	K57 Parameter	32Bit: RW	Available	Available		
26h	K58 Parameter	32Bit: RW	N/A	N/A		
27h	K59 Parameter	32Bit: RW	N/A	N/A		
28h	K60 Parameter	32Bit: RW	N/A	N/A		
29h	K61 Parameter	32Bit: RW	N/A	N/A		

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
68F6h	Cool Muscle K Parameter	2Ah	K62 Parameter	32Bit: RW	-	N/A
		2Bh	K63 Parameter	32Bit: RW	-	N/A
		2Ch	K64 Parameter	32Bit: RW	N/A	Available
		2Dh	K65 Parameter	32Bit: RW	N/A	N/A
		2Eh	K66 Parameter	32Bit: RW	-	-
		2Fh	K67 Parameter	32Bit: RW	-	-
		30h	K68 Parameter	32Bit: RW	-	Available
		31h	K69 Parameter	32Bit: RW	N/A	N/A
		32h	K70 Parameter	32Bit: RW	N/A	N/A
		33h	K71 Parameter	32Bit: RW	Available	N/A
		34h	K72 Parameter	32Bit: RW	Available	N/A
		35h	K73 Parameter	32Bit: RW	N/A	N/A
		36h	K74 Parameter	32Bit: RW	-	N/A
		37h	K75 Parameter	32Bit: RW	-	N/A
		38h	K76 Parameter	32Bit: RW	-	N/A
		39h	K77 Parameter	32Bit: RW	-	N/A
		3Ah	K78 Parameter	32Bit: RW	-	N/A
		3Bh	K79 Parameter	32Bit: RW	-	N/A
		3Ch	K80 Parameter	32Bit: RW	-	N/A
		3Dh	K81 Parameter	32Bit: RW	-	N/A
		3Eh	K82 Parameter	32Bit: RW	-	N/A
		3Fh	K83 Parameter	32Bit: RW	-	-
		40h	K84 Parameter	32Bit: RW	-	-
		41h	K85 Parameter	32Bit: RW	-	-
		42h	K86 Parameter	32Bit: RW	-	-
		43h	K87 Parameter	32Bit: RW	-	-
		44h	K88 Parameter	32Bit: RW	-	-
		45h	K89 Parameter	32Bit: RW	-	-
		46h	K90 Parameter	32Bit: RW	-	-
		47h	K91 Parameter	32Bit: RW	-	-
		48h	K92 Parameter	32Bit: RW	-	-
		49h	K93 Parameter	32Bit: RW	-	-
4Ah	K94 Parameter	32Bit: RW	-	-		
4Bh	K95 Parameter	32Bit: RW	-	-		
4Ch	K96 Parameter	32Bit: RW	-	-		
4Dh	K97 Parameter	32Bit: RW	-	-		
4Eh	K98 Parameter	32Bit: RW	-	-		
4Fh	K99 Parameter	32Bit: RW	-	-		

Index	Name	Sub Index	Name	Attribute	Availability
68FBh	Servo Stiffness Adjustment Parameter (CM2 Only)	0h	Number of entries	32Bit: RW	Available
		1h	Servo Stiffness Adjustment	32Bit: RW	Available
		2h	Reserved	32Bit: RW	N/A
		3h	Reserved	32Bit: RW	N/A
		4h	Reserved	32Bit: RW	N/A
		5h	Reserved	32Bit: RW	N/A
		6h	Reserved	32Bit: RW	N/A
		7h	Reserved	32Bit: RW	N/A
		8h	Reserved	32Bit: RW	N/A
		9h	Reserved	32Bit: RW	N/A
		Ah	Reserved	32Bit: RW	N/A

Index	Name	Sub Index	Name	Attribute	Availability
68FEh		0h	Number of entries	8Bit: RO	Available
		1h	Physical Outputs	32Bit: RW	Available
		2h	Bit Mask	32Bit: RW	Available

Object for ID3 ;

The offset of object of ID3 against ID2 is 0x800.

Index	Name	Attribute	Availability
703Fh	Error Code	16Bit: RO	N/A
7040h	Controlword	16Bit: RW	Available
7041h	Statusword	16Bit: RO	Available
705Ah	Quick stop option code	16Bit: RW	N/A
705Bh	Shutdown Option Code	16Bit: RW	N/A
705Ch	Disable Operation Option Code	16Bit: RW	N/A
705Eh	Fault Reaction Code	16Bit: RW	N/A
7060h	Modes of Operation	8Bit: RW	Available
7061h	Mode of Operation Display	8Bit: RO	Available
7064h	Position Actual Value	32Bit: RO	Available
7065h	Following Error Window	32Bit: RW	N/A
7066h	Following Error Time Out	16Bit: RW	N/A
706Ch	Velocity Actual Value	32Bit: RO	N/A
7071h	Target Torque	16Bit: RO	N/A
7077h	Torque Actual Value	16Bit: RO	N/A
707Ah	Target Position	32Bit: RW	Available
707Ch	Home Offset	32Bit: RW	Available
7085h	Quick Stop Deceleration	32Bit: RW	N/A
7098h	Homing Method	8Bit: RW	Available
709Ah	Homing Acceleration	32Bit: RW	Available
70B1h	Velocity Offset	32Bit: RW	N/A
70B2h	Torque Offset	16Bit: RW	N/A
70F4h	Following Error Actual Value	32Bit: RO	N/A
70FDh	Digital Inputs	32Bit: RO	Available
70FFh	Target Velocity	32Bit: RW	N/A
7502h	Supported Drive Modes	32Bit: RO	Available
77FEh	Homing Switch Input No	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
707Bh	Position	0h	Number of entries	8Bit: RO	N/A
	Range Limit	1h	Min Position Range Limit	32Bit: RW	N/A
		2h	Max Position Range Limit	32Bit: RW	N/A
707Dh	Software	0h	Number of entries	8Bit: RO	N/A
	Position Limit	1h	Min Software Position Limit	32Bit: RW	N/A
		2h	Max Software Position Limit	32Bit: RW	N/A
7099h	Homing Speed	0h	Number of entries	8Bit: RO	Available
		1h	Speed during search for switch	32Bit: RW	Available
		2h	Speed during search for stopper	32Bit: RW	Available
70C2h	Interpolation Time Period	0h	Number of entries	8Bit: RO	N/A
		1h	Interpolation Period	8Bit: RW	N/A
		2h	Interpolation Index	8Bit: RW	N/A
70E3h	Supported homing method	0h	Number of entries	8Bit: RO	Available
		1h	Stopper CW	16Bit: RO	Available
		2h	Stopper CCW	16Bit: RO	Available
		3h	Switch CW	16Bit: RO	Available
		4h	Switch CCW	16Bit: RO	Available

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
70F6h	Cool Muscle K Parameter	0h	Number of entries	32Bit: RW	Available	Available
		1h	K21 Parameter	32Bit: RW	N/A	N/A
		2h	K22 Parameter	32Bit: RW	N/A	N/A
		3h	K23 Parameter	32Bit: RW	Available	Available
		4h	K24 Parameter	32Bit: RW	Available	Available
		5h	K25 Parameter	32Bit: RW	N/A	N/A
		6h	K26 Parameter	32Bit: RW	Available	Available
		7h	K27 Parameter	32Bit: RW	Available	Available
		8h	K28 Parameter	32Bit: RW	N/A	N/A
		9h	K29 Parameter	32Bit: RW	N/A	N/A
		Ah	K30 Parameter	32Bit: RW	N/A	N/A
		Bh	K31 Parameter	32Bit: RW	N/A	N/A
		Ch	K32 Parameter	32Bit: RW	N/A	N/A
		Dh	K33 Parameter	32Bit: RW	Available	Available
		Eh	K34 Parameter	32Bit: RW	Available	Available
		Fh	K35 Parameter	32Bit: RW	N/A	N/A
		10h	K36 Parameter	32Bit: RW	N/A	N/A
		11h	K37 Parameter	32Bit: RW	N/A	N/A
		12h	K38 Parameter	32Bit: RW	N/A	N/A
		13h	K39 Parameter	32Bit: RW	N/A	N/A
		14h	K40 Parameter	32Bit: RW	N/A	N/A
		15h	K41 Parameter	32Bit: RW	N/A	N/A
		16h	K42 Parameter	32Bit: RW	Available	Available
		17h	K43 Parameter	32Bit: RW	Available	Available
		18h	K44 Parameter	32Bit: RW	N/A	N/A
		19h	K45 Parameter	32Bit: RW	Available	Available
		1Ah	K46 Parameter	32Bit: RW	Available	Available
		1Bh	K47 Parameter	32Bit: RW	Available	Available
		1Ch	K48 Parameter	32Bit: RW	Available	Available
		1Dh	K49 Parameter	32Bit: RW	N/A	N/A
		1Eh	K50 Parameter	32Bit: RW	N/A	N/A
		1Fh	K51 Parameter	32Bit: RW	N/A	N/A
20h	K52 Parameter	32Bit: RW	Available	N/A		
21h	K53 Parameter	32Bit: RW	Available	N/A		
22h	K54 Parameter	32Bit: RW	Available	N/A		
23h	K55 Parameter	32Bit: RW	N/A	N/A		
24h	K56 Parameter	32Bit: RW	Available	Available		
25h	K57 Parameter	32Bit: RW	Available	Available		
26h	K58 Parameter	32Bit: RW	N/A	N/A		
27h	K59 Parameter	32Bit: RW	N/A	N/A		
28h	K60 Parameter	32Bit: RW	N/A	N/A		
29h	K61 Parameter	32Bit: RW	N/A	N/A		

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
70F6h	Cool Muscle K Parameter	2Ah	K62 Parameter	32Bit: RW	-	N/A
		2Bh	K63 Parameter	32Bit: RW	-	N/A
		2Ch	K64 Parameter	32Bit: RW	N/A	Available
		2Dh	K65 Parameter	32Bit: RW	N/A	N/A
		2Eh	K66 Parameter	32Bit: RW	-	-
		2Fh	K67 Parameter	32Bit: RW	-	-
		30h	K68 Parameter	32Bit: RW	-	Available
		31h	K69 Parameter	32Bit: RW	N/A	N/A
		32h	K70 Parameter	32Bit: RW	N/A	N/A
		33h	K71 Parameter	32Bit: RW	Available	N/A
		34h	K72 Parameter	32Bit: RW	Available	N/A
		35h	K73 Parameter	32Bit: RW	N/A	N/A
		36h	K74 Parameter	32Bit: RW	-	N/A
		37h	K75 Parameter	32Bit: RW	-	N/A
		38h	K76 Parameter	32Bit: RW	-	N/A
		39h	K77 Parameter	32Bit: RW	-	N/A
		3Ah	K78 Parameter	32Bit: RW	-	N/A
		3Bh	K79 Parameter	32Bit: RW	-	N/A
		3Ch	K80 Parameter	32Bit: RW	-	N/A
		3Dh	K81 Parameter	32Bit: RW	-	N/A
		3Eh	K82 Parameter	32Bit: RW	-	N/A
		3Fh	K83 Parameter	32Bit: RW	-	-
		40h	K84 Parameter	32Bit: RW	-	-
		41h	K85 Parameter	32Bit: RW	-	-
		42h	K86 Parameter	32Bit: RW	-	-
		43h	K87 Parameter	32Bit: RW	-	-
		44h	K88 Parameter	32Bit: RW	-	-
		45h	K89 Parameter	32Bit: RW	-	-
		46h	K90 Parameter	32Bit: RW	-	-
		47h	K91 Parameter	32Bit: RW	-	-
		48h	K92 Parameter	32Bit: RW	-	-
		49h	K93 Parameter	32Bit: RW	-	-
4Ah	K94 Parameter	32Bit: RW	-	-		
4Bh	K95 Parameter	32Bit: RW	-	-		
4Ch	K96 Parameter	32Bit: RW	-	-		
4Dh	K97 Parameter	32Bit: RW	-	-		
4Eh	K98 Parameter	32Bit: RW	-	-		
4Fh	K99 Parameter	32Bit: RW	-	-		

Index	Name	Sub Index	Name	Attribute	Availability
70FBh	Servo Stiffness Adjustment Parameter (CM2 Only)	0h	Number of entries	32Bit: RW	Available
		1h	Servo Stiffness Adjustment	32Bit: RW	Available
		2h	Reserved	32Bit: RW	N/A
		3h	Reserved	32Bit: RW	N/A
		4h	Reserved	32Bit: RW	N/A
		5h	Reserved	32Bit: RW	N/A
		6h	Reserved	32Bit: RW	N/A
		7h	Reserved	32Bit: RW	N/A
		8h	Reserved	32Bit: RW	N/A
		9h	Reserved	32Bit: RW	N/A
		Ah	Reserved	32Bit: RW	N/A

Index	Name	Sub Index	Name	Attribute	Availability
70FEh		0h	Number of entries	8Bit: RO	Available
		1h	Physical Outputs	32Bit: RW	Available
		2h	Bit Mask	32Bit: RW	Available

Object for ID4 ;

The offset of object of ID4 against ID3 is 0x800.

Index	Name	Attribute	Availability
783Fh	Error Code	16Bit: RO	N/A
7840h	Controlword	16Bit: RW	Available
7841h	Statusword	16Bit: RO	Available
785Ah	Quick stop option code	16Bit: RW	N/A
785Bh	Shutdown Option Code	16Bit: RW	N/A
785Ch	Disable Operation Option Code	16Bit: RW	N/A
785Eh	Fault Reaction Code	16Bit: RW	N/A
7860h	Modes of Operation	8Bit: RW	Available
7861h	Mode of Operation Display	8Bit: RO	Available
7864h	Position Actual Value	32Bit: RO	Available
7865h	Following Error Window	32Bit: RW	N/A
7866h	Following Error Time Out	16Bit: RW	N/A
786Ch	Velocity Actual Value	32Bit: RO	N/A
7871h	Target Torque	16Bit: RO	N/A
7877h	Torque Actual Value	16Bit: RO	N/A
787Ah	Target Position	32Bit: RW	Available
787Ch	Home Offset	32Bit: RW	Available
7885h	Quick Stop Deceleration	32Bit: RW	N/A
7898h	Homing Method	8Bit: RW	Available
789Ah	Homing Acceleration	32Bit: RW	Available
78B1h	Velocity Offset	32Bit: RW	N/A
78B2h	Torque Offset	16Bit: RW	N/A
78F4h	Following Error Actual Value	32Bit: RO	N/A
78FDh	Digital Inputs	32Bit: RO	Available
78FFh	Target Velocity	32Bit: RW	N/A
7D02h	Supported Drive Modes	32Bit: RO	Available
7FFEh	Homing Switch Input No	32Bit: RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
787Bh	Position	0h	Number of entries	8Bit: RO	N/A
	Range Limit	1h	Min Position Range Limit	32Bit: RW	N/A
		2h	Max Position Range Limit	32Bit: RW	N/A
787Dh	Software	0h	Number of entries	8Bit: RO	N/A
	Position Limit	1h	Min Software Position Limit	32Bit: RW	N/A
		2h	Max Software Position Limit	32Bit: RW	N/A
7899h	Homing Speed	0h	Number of entries	8Bit: RO	Available
		1h	Speed during search for switch	32Bit: RW	Available
		2h	Speed during search for stopper	32Bit: RW	Available
78C2h	Interpolation Time Period	0h	Number of entries	8Bit: RO	N/A
		1h	Interpolation Period	8Bit: RW	N/A
		2h	Interpolation Index	8Bit: RW	N/A
78E3h	Supported homing method	0h	Number of entries	8Bit: RO	Available
		1h	Stopper CW	16Bit: RO	Available
		2h	Stopper CCW	16Bit: RO	Available
		3h	Switch CW	16Bit: RO	Available
		4h	Switch CCW	16Bit: RO	Available

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
78F6h	Cool Muscle K Parameter	0h	Number of entries	32Bit: RW	Available	Available
		1h	K21 Parameter	32Bit: RW	N/A	N/A
		2h	K22 Parameter	32Bit: RW	N/A	N/A
		3h	K23 Parameter	32Bit: RW	Available	Available
		4h	K24 Parameter	32Bit: RW	Available	Available
		5h	K25 Parameter	32Bit: RW	N/A	N/A
		6h	K26 Parameter	32Bit: RW	Available	Available
		7h	K27 Parameter	32Bit: RW	Available	Available
		8h	K28 Parameter	32Bit: RW	N/A	N/A
		9h	K29 Parameter	32Bit: RW	N/A	N/A
		Ah	K30 Parameter	32Bit: RW	N/A	N/A
		Bh	K31 Parameter	32Bit: RW	N/A	N/A
		Ch	K32 Parameter	32Bit: RW	N/A	N/A
		Dh	K33 Parameter	32Bit: RW	Available	Available
		Eh	K34 Parameter	32Bit: RW	Available	Available
		Fh	K35 Parameter	32Bit: RW	N/A	N/A
		10h	K36 Parameter	32Bit: RW	N/A	N/A
		11h	K37 Parameter	32Bit: RW	N/A	N/A
		12h	K38 Parameter	32Bit: RW	N/A	N/A
		13h	K39 Parameter	32Bit: RW	N/A	N/A
		14h	K40 Parameter	32Bit: RW	N/A	N/A
		15h	K41 Parameter	32Bit: RW	N/A	N/A
		16h	K42 Parameter	32Bit: RW	Available	Available
		17h	K43 Parameter	32Bit: RW	Available	Available
		18h	K44 Parameter	32Bit: RW	N/A	N/A
		19h	K45 Parameter	32Bit: RW	Available	Available
		1Ah	K46 Parameter	32Bit: RW	Available	Available
		1Bh	K47 Parameter	32Bit: RW	Available	Available
		1Ch	K48 Parameter	32Bit: RW	Available	Available
		1Dh	K49 Parameter	32Bit: RW	N/A	N/A
		1Eh	K50 Parameter	32Bit: RW	N/A	N/A
		1Fh	K51 Parameter	32Bit: RW	N/A	N/A
20h	K52 Parameter	32Bit: RW	Available	N/A		
21h	K53 Parameter	32Bit: RW	Available	N/A		
22h	K54 Parameter	32Bit: RW	Available	N/A		
23h	K55 Parameter	32Bit: RW	N/A	N/A		
24h	K56 Parameter	32Bit: RW	Available	Available		
25h	K57 Parameter	32Bit: RW	Available	Available		
26h	K58 Parameter	32Bit: RW	N/A	N/A		
27h	K59 Parameter	32Bit: RW	N/A	N/A		
28h	K60 Parameter	32Bit: RW	N/A	N/A		
29h	K61 Parameter	32Bit: RW	N/A	N/A		

Index	Name	Sub Index	Name	Attribute	Availability	
					CM1	CM2
78F6h	Cool Muscle K Parameter	2Ah	K62 Parameter	32Bit: RW	-	N/A
		2Bh	K63 Parameter	32Bit: RW	-	N/A
		2Ch	K64 Parameter	32Bit: RW	N/A	Available
		2Dh	K65 Parameter	32Bit: RW	N/A	N/A
		2Eh	K66 Parameter	32Bit: RW	-	-
		2Fh	K67 Parameter	32Bit: RW	-	-
		30h	K68 Parameter	32Bit: RW	-	Available
		31h	K69 Parameter	32Bit: RW	N/A	N/A
		32h	K70 Parameter	32Bit: RW	N/A	N/A
		33h	K71 Parameter	32Bit: RW	Available	N/A
		34h	K72 Parameter	32Bit: RW	Available	N/A
		35h	K73 Parameter	32Bit: RW	N/A	N/A
		36h	K74 Parameter	32Bit: RW	-	N/A
		37h	K75 Parameter	32Bit: RW	-	N/A
		38h	K76 Parameter	32Bit: RW	-	N/A
		39h	K77 Parameter	32Bit: RW	-	N/A
		3Ah	K78 Parameter	32Bit: RW	-	N/A
		3Bh	K79 Parameter	32Bit: RW	-	N/A
		3Ch	K80 Parameter	32Bit: RW	-	N/A
		3Dh	K81 Parameter	32Bit: RW	-	N/A
		3Eh	K82 Parameter	32Bit: RW	-	N/A
		3Fh	K83 Parameter	32Bit: RW	-	-
		40h	K84 Parameter	32Bit: RW	-	-
		41h	K85 Parameter	32Bit: RW	-	-
		42h	K86 Parameter	32Bit: RW	-	-
		43h	K87 Parameter	32Bit: RW	-	-
		44h	K88 Parameter	32Bit: RW	-	-
		45h	K89 Parameter	32Bit: RW	-	-
		46h	K90 Parameter	32Bit: RW	-	-
		47h	K91 Parameter	32Bit: RW	-	-
		48h	K92 Parameter	32Bit: RW	-	-
		49h	K93 Parameter	32Bit: RW	-	-
4Ah	K94 Parameter	32Bit: RW	-	-		
4Bh	K95 Parameter	32Bit: RW	-	-		
4Ch	K96 Parameter	32Bit: RW	-	-		
4Dh	K97 Parameter	32Bit: RW	-	-		
4Eh	K98 Parameter	32Bit: RW	-	-		
4Fh	K99 Parameter	32Bit: RW	-	-		

Index	Name	Sub Index	Name	Attribute	Availability
78FBh	Servo Stiffness Adjustment Parameter (CM2 Only)	0h	Number of entries	32Bit: RW	Available
		1h	Servo Stiffness Adjustment	32Bit: RW	Available
		2h	Reserved	32Bit: RW	N/A
		3h	Reserved	32Bit: RW	N/A
		4h	Reserved	32Bit: RW	N/A
		5h	Reserved	32Bit: RW	N/A
		6h	Reserved	32Bit: RW	N/A
		7h	Reserved	32Bit: RW	N/A
		8h	Reserved	32Bit: RW	N/A
		9h	Reserved	32Bit: RW	N/A
		Ah	Reserved	32Bit: RW	N/A

Index	Name	Sub Index	Name	Attribute	Availability
78FEh		0h	Number of entries	8Bit: RO	Available
		1h	Physical Outputs	32Bit: RW	Available
		2h	Bit Mask	32Bit: RW	Available

Index	Name	Sub Index	Name	Attribute	Availability
F000h	Modular Device Profile	0h	Number of entries	8Bit;RO	Available
		1h	Module Index Distance	16Bit;RO	Available
		2h	Maximum Number of Modules	16Bit;RO	Available
F010h	Module Profile List	0h	Number of entries	8Bit;RO	Available
		1h	ID1 Device Profile Type (40192h)	32Bit;RO	Available
		2h	ID2 Device Profile Type (40192h)	32Bit;RO	Available
		3h	ID3 Device Profile Type (40192h)	32Bit;RO	Available
		4h	ID4 Device Profile Type (40192h)	32Bit;RO	Available
F030h	Configured Module Ident List	0h	Number of entries	8Bit;RO	Available
		1h	ID1 Configured Module Ident (219800h)	32Bit;RO	Available
		2h	ID2 Configured Module Ident (219800h)	32Bit;RO	Available
		3h	ID3 Configured Module Ident (219800h)	32Bit;RO	Available
		4h	ID4 Configured Module Ident (219800h)	32Bit;RO	Available
F050h	Module Detected List	0h	Number of entries	8Bit;RO	Available
		1h	ID1 Module Detected (219800h)	32Bit;RO	Available
		2h	ID2 Module Detected (219800h)	32Bit;RO	Available
		3h	ID3 Module Detected (219800h)	32Bit;RO	Available
		4h	ID4 Module Detected (219800h)	32Bit;RO	Available

Index	Name	Sub Index	Name	Attribute	Availability
F511h	Config Axis1 (ID1 Config Info)	0h	Number of entries	8Bit;RO	Available
		1h	Type	32Bit;RO	Available
		2h	CommSpeed	32Bit;RO	Available
		3h	CommTime	32Bit;RO	Available
		4h	Reserved	32Bit;RO	N/A
F512h	Config Axis2 (ID2 Config Info)	0h	Number of entries	8Bit;RO	Available
		1h	Type	32Bit;RO	Available
		2h	CommSpeed	32Bit;RO	Available
		3h	CommTime	32Bit;RO	Available
		4h	Reserved	32Bit;RO	N/A
F513h	Config Axis3 (ID3 Config Info)	0h	Number of entries	8Bit;RO	Available
		1h	Type	32Bit;RO	Available
		2h	CommSpeed	32Bit;RO	Available
		3h	CommTime	32Bit;RO	Available
		4h	Reserved	32Bit;RO	N/A
F514h	Config Axis4 (ID4 Config Info)	0h	Number of entries	8Bit;RO	Available
		1h	Type	32Bit;RO	Available
		2h	CommSpeed	32Bit;RO	Available
		3h	CommTime	32Bit;RO	Available
		4h	Reserved	32Bit;RO	N/A

Index	Name	Sub Index	Name	Attribute	Availability
F530h	SystemInfo	0h	Number of entries	8Bit;RO	Available
		1h	Axis1 Receive Error (ID1)	32Bit;RO	Available
		2h	Axis2 Receive Error (ID2)	32Bit;RO	Available
		3h	Axis3 Receive Error (ID3)	32Bit;RO	Available
		4h	Axis4 Receive Error (ID4)	32Bit;RO	Available
		5h	Axis1 Motor Error Code(ID1)	32Bit;RO	Available
		6h	Axis2 Motor Error Code(ID2)	32Bit;RO	Available
		7h	Axis3 Motor Error Code(ID3)	32Bit;RO	Available
		8h	Axis4 Motor Error Code(ID4)	32Bit;RO	Available
		9h	Axis1 Serial Send Counter(ID1)	32Bit;RO	Available
		Ah	Axis2 Serial Send Counter(ID2)	32Bit;RO	Available
		Bh	Axis3 Serial Send Counter(ID3)	32Bit;RO	Available
		Ch	Axis4 Serial Send Counter(ID4)	32Bit;RO	Available
		Dh	Axis1 Serial Receive Counter(ID1)	32Bit;RO	Available
		Eh	Axis2 Serial Receive Counter(ID2)	32Bit;RO	Available
		Fh	Axis3 Serial Receive Counter(ID3)	32Bit;RO	Available
		10h	Axis4 Serial Receive Counter(ID4)	32Bit;RO	Available
		11h	PDO MaxTime	32Bit;RO	Available
		12h	PDO MinTime	32Bit;RO	Available
		13h	PDO 1300uSec Time	32Bit;RO	Available
14h	PDO 700uSec Time	32Bit;RO	Available		
15h	SystemInfo1(DEBUG)	32Bit;RO	Available		
16h	SystemInfo2(DEBUG)	32Bit;RO	Available		
17h	SystemInfo3(DEBUG)	32Bit;RO	Available		
18h	SystemInfo4(DEBUG)	32Bit;RO	Available		

Index	Name	Sub Index	Name	Attribute	Availability
F540h	Config System	0h	Number of entries	8Bit;RO	Available
		1h	Musclecorp Mode	32Bit;RO	Available
		2h	Reserved	32Bit;RO	N/A
		3h	Reserved	32Bit;RO	N/A
		4h	Reserved	32Bit;RO	N/A
		5h	Master Mode	32Bit;RO	Available
		6h	CM Serial Cycle (mSec)	32Bit;RO	Available
		7h	Reserved	32Bit;RO	N/A
		8h	Reserved	32Bit;RO	N/A
		9h	Reserved	32Bit;RO	N/A
		Ah	Reserved	32Bit;RO	N/A
		Bh	CoolMuscle Device Config Code	32Bit;RO	Available
		Ch	Serial Number	32Bit;RO	Available

Index	Name	Sub Index	Name	Attribute	Availability
F550h	Test Command (Debug)	0h	Number of entries	8Bit;RO	Available
		1h	TestCommand-X	32Bit;RO	Available
		2h	TestCommand-Y	32Bit;RO	Available
		3h	TestCommand-Z	32Bit;RO	Available
		4h	TargetPositionFilter	32Bit;RO	Available
		5h	TestCommand1	32Bit;RO	Available
		6h	TestCommand2	32Bit;RO	Available

Index	Name	Attribute	Availability
F570h	SoftUpdateData	String :RW	N/A
F571h	SoftUpdateInfo	String :RO	N/A
F581h	Axis1 CML Command(ID1)	String :RW	Available
F582h	Axis2 CML Command(ID2)	String :RW	Available
F583h	Axis3 CML Command(ID3)	String :RW	Available
F584h	Axis4 CML Command(ID4)	String :RW	Available
F591h	Axis1 CML Command Response(ID1)	String :RO	Available
F592h	Axis2 CML Command Response(ID2)	String :RO	Available
F593h	Axis3 CML Command Response(ID3)	String :RO	Available
F594h	Axis4 CML Command Response(ID4)	String :RO	Available

Revision History

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

Revised Date	User's Guide No.	Page	Revised Item
Nov, 2016	MDUG-CMB/16B01E-01		New Draft