EtherCAT AC Servo Driver

User's Manual

nEXT1 Series

XSC-ECAT-ASDXX

VAS CORPORATION

About this Manual

This manual provides information for nEXT1 Servo Driver with EtherCAT Communications References, and to design, perform trial operation of, tune, operate, and maintain the Servo Driver.

Read and understand this manual to ensure correct usage of the nEXT1 Servo Driver.

Keep this manual in a safe place so that it can be referred to whenever necessary.

Outline of Manual

The contents of the chapters of this manual are described in the following table.

Refer to these chapters as required.

Chapter	Chapter Title	Contents
1	Basic Information on XSC AC Servo Driver	
2	Rating and Specifications	
3	Servo Driver Installation	Provides information on installing Servo Driver in the required locations.
4	Wiring and Connecting Servo Driver	Provides information on wiring and connecting Servo Driver to power supplies and peripheral devices.
5	Basic Functions That Require Setting before Operation	Describes the basic functions that must be set before you start servo system operation. It also describes the setting methods.
6	Application Functions	Describes the application functions that you can set before you start servo system operation. It also describes the setting methods.
7		-

WARRANTY

- **Warranty Period**

The product is warranted against defective materials for a period of one year from date of delivery to the original purchaser.

- **Warranty Coverage**

Warranty is extended to operating in conditions described in this handling manual and all malfunctions occurred during the warranty period are serviced at no cost.

However, following conditions even during the warranty period will be serviced at cost.

① Improper use and inappropriate repairs or contributed to modifications.

② Cause is contributed to dropping the product after purchase and caused during transport.

③ Usage outside of the scope of the product specification.

④ Caused by fire earthquakes, lightning, storm and flood damages, salt damage, abnormal voltage, other natural disasters.

⑤ Caused by water, oil, metal pieces, other foreign substance penetration.

Scope of warranty is extended only to the main body of the product sold and damages caused by sold product failure are excluded from the warranty coverage.

WARNING

We assumes no liability for damages consequent to the use of this product. We reverses the right to change this manual at any time without notice. The information furnished by us is believed to be accurate and reliable. However, no responsibility is assumed by us for its use, not for any infringements of patents or other right of third parties resulting from its use.

TRADEMARK

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CONTACT US

If you have any questions, please feel free to contact us via email at:

info@vascorporation.com

Contents

1. Basic Information on nEXT1 Servo Driver

1.1. nEXT1 Servo Driver

The nEXT1 Servo Driver is EtherCAT AC Servo Driver. nEXT1 Servo Driver has compact size, using DC power supply up to 350 volt and current output up to 20A. It support a wide variety of position feedback sensors from Tamagawa, Yaskawa, Panasonic,...

nEXT1 Servo Driver has built-in EtherCAT CiA402 Drive Profile. It is installed by daisy chain connection that provides a more scalable system with fewer wires and easy setup with EtherCAT master and other EtherCAT Slave devices in the market.

The setup and tuning process in nEXT1 Servo Driver can be done easily through **nEXT Configurator software**. The product also support analysis and advance filtering function for enhanced dynamic performance application.

1.2. Introduction to EtherCAT

The CANopen over EtherCAT (CoE) Communications Reference Servo Driver implement the CiA 402 CANopen drive profile for EtherCAT communications (real-time Ethernet communications).

Basic position, speed control are supported along with synchronous position and speed control. You can select the type of control to match your system from basic positioning to high-speed, high-precision path control.

1.2.1. Introduction to CANopen

The CiA 402 CANopen profile is based on the IEC 61800-7-1, IEC61800-7-201, and IEC 61800-7-301 standards for international standardization of drive control and operation control.

1.2.2. CANopen over EtherCAT OSI Model

The OSI model implemented by the Servo Driver consists of three layers: the application layer (CANopen), the data link layer (EtherCAT), and the physical layer (Ethernet). The four layers other than the application layer, data link layer, and physical layer are not used. The data link layer is implemented with EtherCAT communications and the application layer is implemented with the DS402 CANopen drive profile.

This manual describes mainly the specifications of the application layer implemented in the Servo Driver. For detailed information on the data link layer (EtherCAT), refer to documentation provided by the EtherCAT Technology Group.

1.2.3. Sending and Receiving Data in EtherCAT (CoE) Comminications

Objects are used to send and receive data in EtherCAT (CoE) communications. Reading and writing object data is performed in process data communications (PDO service), which transfers data cyclically, and in mailbox communications (SDO service), which transfers data non-cyclically.

Process data communications are used to read and write PDOs. Mailbox communications (SDO) are used to read and write object dictionary data entries.

1.2.4. CoE Terminology

The EtherCAT and CANopen terms that are used in this manual are described in the following table.

Term	Abbreviation	Description
CAN in Automation	CiA	A non-profit organization established in 1992 as a joint venture between companies to provide CAN technical information, product information, and marketing information.
Controller Area Network	CAN	Communications protocol for the physical layer and data link layer established for automotive LANs. It was established as an international standard as ISO 11898.
CANopen	CANopen	An upper-layer protocol based on the international CAN standard (EN 50325-4). It consists of profile specifications for the application layer, communications, applications, devices, and interfaces.
CANopen over EtherCAT	CoE	A network that uses Ethernet for the physical layer, EtherCAT for the data link layer, and CANopen for the application layer in a seven-layer OSI reference model.
Distributed Clocks	DC	A clock distribution mechanism that is used to synchronize the EtherCAT slaves with the EtherCAT master.
Electrically Erasable Programmable Read Only Memory	EEPROM	A ROM that can be electrically overwritten.
EtherCAT Slave Controller	ESC	A hardware chip that processes EtherCAT communications (such as loopbacks) and manages the distributed clock.
EtherCAT Slave Machine	ESM	A state machine in which the state of EtherCAT (the data link layer) changes according to transition conditions.
EtherCAT Technology Group		An international organization established in 2003 to provide support for developing EtherCAT technologies and to promote the spread of EtherCAT technologies.
Ethernet for Control Automation Technology	EtherCAT	An open network developed by Beckhoff Automation.
Fieldbus Memory Management Unit	FMMU	A unit that manages fieldbus memory.
INIT	INIT	The Init state in the EtherCAT state machine.
OPERATIONAL	OP	The Operational state in the EtherCAT state machine.
Object Dictionary	OD	A group of objects and structure supported by an EtherCAT Servo Driver.
Process Data Object	PDO	Objects that are sent and received in cyclic communications.
Process Data Object Mapping	PDO mapping	Definitions of the applications objects that are sent with PDOs.
Service Data Object	SDO	Objects that are sent and received in mailbox communications.
PRE-OPERATIONAL	PREOP	The Pre-operational state in the EtherCAT state machine.
Process data	-	The data contained in application objects that are periodically transferred for measurements or controls.
SyncManager	-	The ESC unit that coordinates data exchange between the master and slaves.
Receive Process Data Object	RXPDO	The process data received by the ESC.
Transmit Process Data Object	TXPDO	The process data sent by the ESC.

1.2.5. Data Types

The following table lists the data types and ranges that are used in this manual.

Term	Abbreviation	Description
SINT	Sign 8-bit integer	-128 to 127
INT	Sign 16-bit integer	-32768 to 32767
DINT	Sign 32-bit integer	-2147483648 to 2147483627
USINT	Unsigned 8-bit integer	0 to 255
UINT	Unsigned 16-bit integer	0 to 65535
UDINT	Unsigned 32-bit integer	0 to 4294967295
STRING	Character string	-

1.2.6. Data Ranges

The following table lists the data units and notations that are used in this manual.

Notation	Description
Pos.unit	The user-defined position reference unit that is set in position user unit (2701h). 1 [Pos. unit] = 2701: 01h/2701: 02h [inc]
Vel.unit	The user-defined speed reference unit that is set in velocity user unit (2702h). 1 [Vel. unit] = 2702: 01h/2702: 02h [inc/s]
Acc.unit	The user-defined acceleration reference unit that is set in acceleration user unit (2703h). 1 [Acc. unit] = 2703: 01h/2703: 02h x 10^4 [inc/s^2]
Trq.unit	The user-defined torque reference unit that is set in torque user unit (2704h). 1 [Trq. unit] = 2704: 01h/2704: 02h [%]
inc	This is the encoder pulse unit. For a 24-bit encoder, the resolution is 16,777,216 [inc] per rotation.

2. Rating and Specifications

This section gives the ratings and specifications of nEXT1 Servo Driver

2.1. Ratings

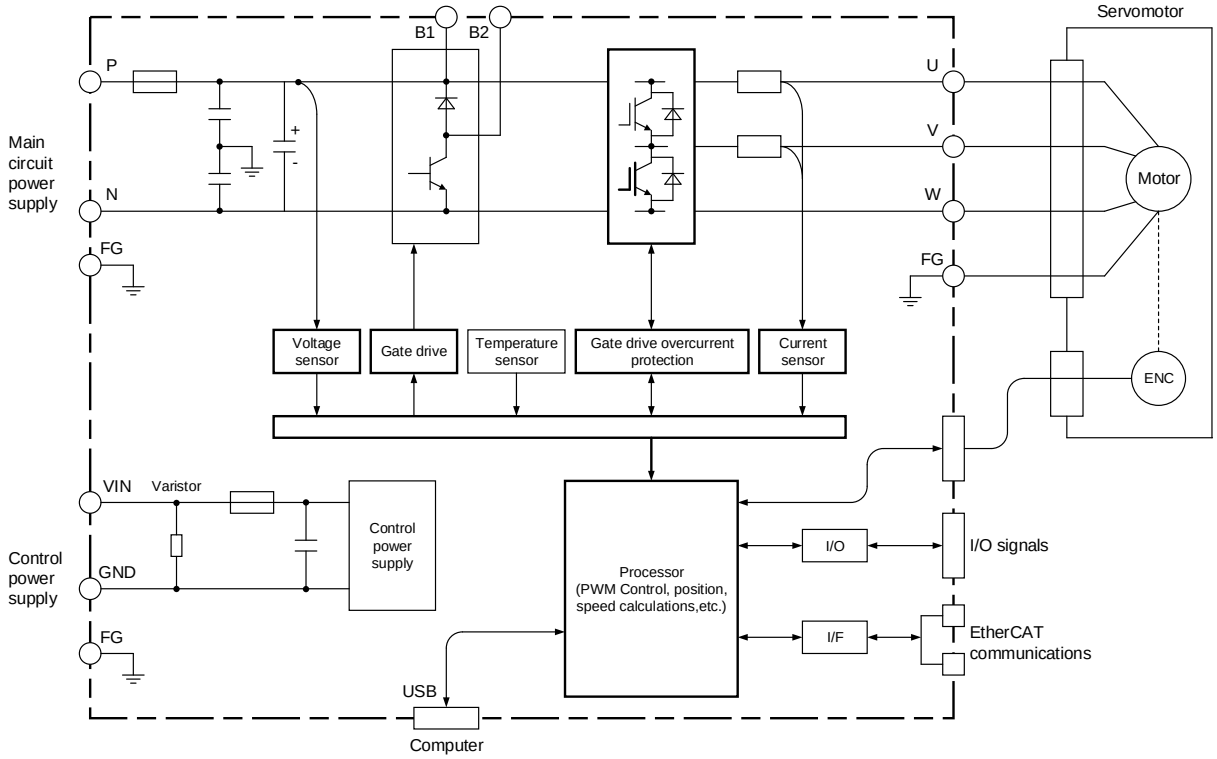
Item	Value	
	XSC-ECAT-ASD04	XSC-ECAT-ASD10
Maximum Applicable Motor Capacity [W]	400	1000
Continuous Output Current [Arms]	6.5A	15A
Instantaneous Maximum Output Current [Arms]	8A	20A
Main Circuit Power Supply	36 to 350 VDC	36 to 350 VDC
Control Power Supply	15 to 36 VDC	15 to 36 VDC

2.2. Specifications

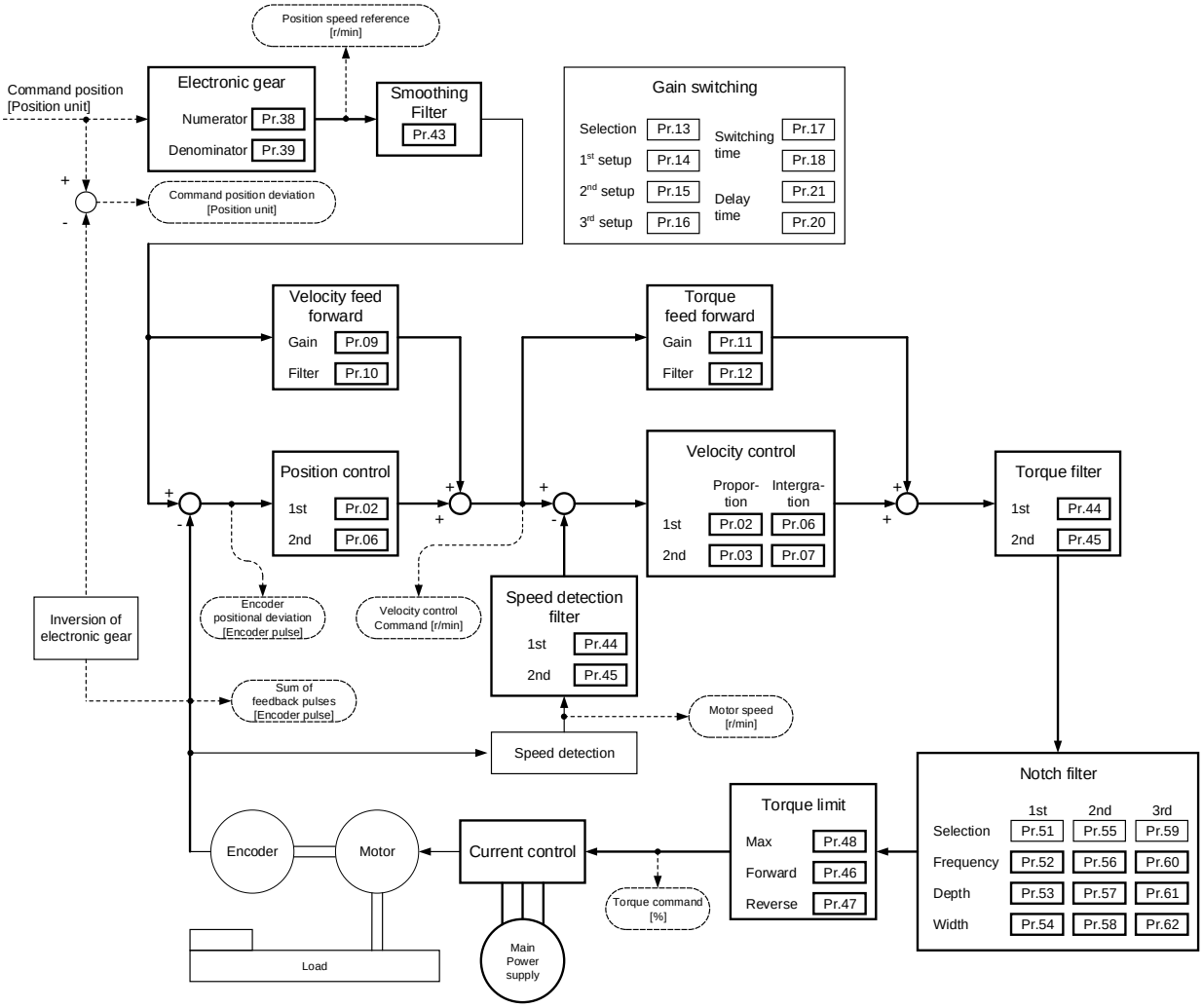
Item		Specification
Control Method		IGBT-based PWM control, sine wave current drive
Feedback		Hall Sensor + Quadrature Incremental encoder Serial encoder: • Tamagawa serial encoder • Panasonic minas A4, A5, A6 serial encoder • Yaskawa Sigma II, III, V, VII serial encoder • ...
Environmental Conditions	Surrounding Air Temperature	0 to 55ºC
	Storage Temperature	0 to 85ºC
	Pollution Degree	Must be no corrosive or flammable gases Must be no exposure to water, oil, or chemicals Must be no dust, salts, or iron dust
	Others	Do not use the Servo Driver in the following locations: Locations subject to static electricity noise, strong electromagnetic/magnetic fields, or radioactivity
Mounting		Base-mounted
I/O Signals	Sequence Input Signal	Input method: Open Collector (NPN) Number of input: 6 Input Signals Allocation: • Forward Drive Prohibit Input Signal (POT) • Reverse Drive Prohibit Input Signal (NOT) • Home Signal (HOME) • Touch Probe 1 Input Signal (TP1) • Touch Probe 2 Input Signal (TP2) • General purpose input 1, 2 (DI1, DI2)
	Sequence Output Signal	Output method: Open Collector (NPN) Number of Output: 4

Item		Specification
		Output Signals Allocation: • Servo Alarm Output Signal (ALM) • Positioning Completion Output Signal (COIN) • Rotation Detection Output Signal (TGON) • Servo Ready Output Signal (SRDY) • Torque Limit Detection Output Signal (CLT) • Speed Limit Detection Output Signal (VLT) • Holding Brake Output Signal (HB) • General Output 1, 2, 3: DO1, DO2, DO3
	USB Communications Standards	Conforms to USB2.0 standard (12Mbps)
Displays/Indicators		EtherCAT RUN, ERR, L/A (A and B) indicator Driver RUN,ERR
EtherCAT Communications	Applicable Communications Standards	IEC61158 – 12, IEC 61800 – 7 CiA402 Drive Profile
	Physical Layer	100BASE-TX (IEEE802.3)
	Communications Connectors	RJ45: EtherCAT signal input/output connector
	Cable	Minimum require CAT5E
	Sync Manager	SM0: Mailbox output, SM1: Mailbox input, SM2: Process data output, SM3: Process data input
	FMMU	FMMU 0: Mapped in process data output (RxPDO) area. FMMU 1: Mapped in process data input (TxPDO) area. FMMU 2: Mapped to mailbox status.
	Mailbox (CoE)	Emergency messages, SDO requests, SDO responses
	Distributed Clocks	Free-Run Mode and DC Mode (Can be switched) Applicable DC cycles: 250 µs to 4ms
	Indicators	EtherCAT communications in progress: Link/Activity x 2 EtherCAT communication status: RUN x 1 EtherCAT error status: ERR x 1
CiA402 Drive Profile		• Homing mode • Cyclic Synchronous Position Mode • Touch Probe Function • Torque Limit Function
Dynamic Brake (DB)		Activated when a servo alarm occurs
Protective Functions		Overcurrent, overvoltage, low voltage, overload, etc.
Utility Functions		Gain adjustment, alarm history, jogging, etc.

2.3. Block Diagram

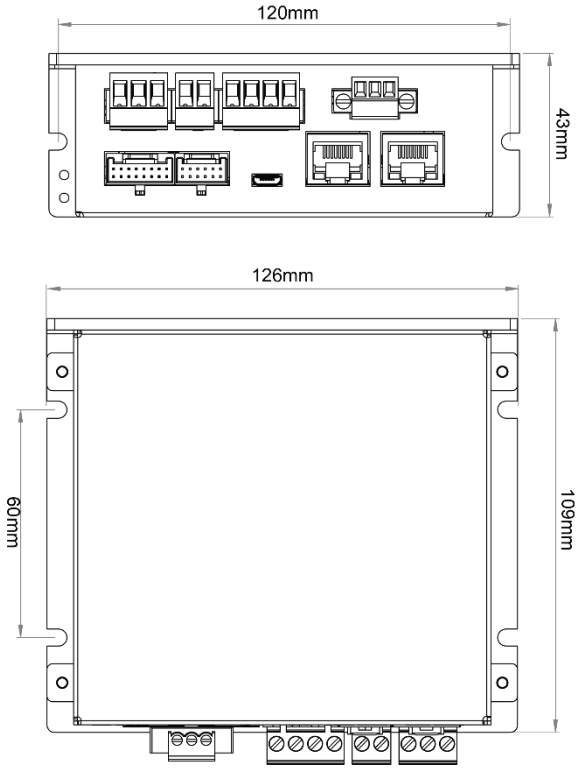


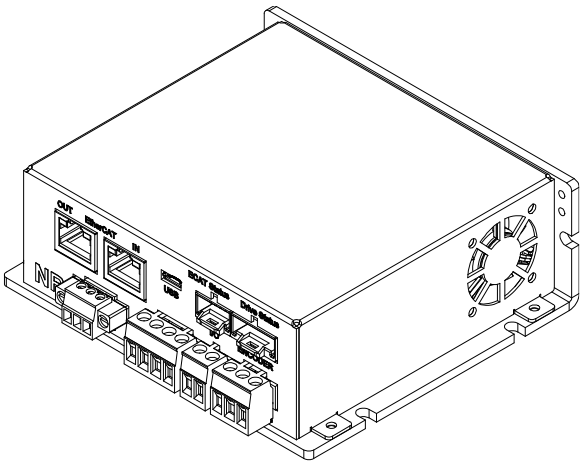
2.4. Control Block Diagram



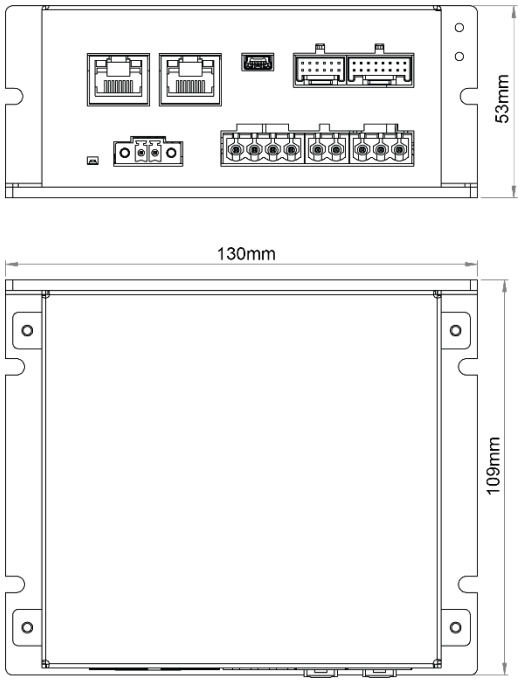
2.5. External Dimension

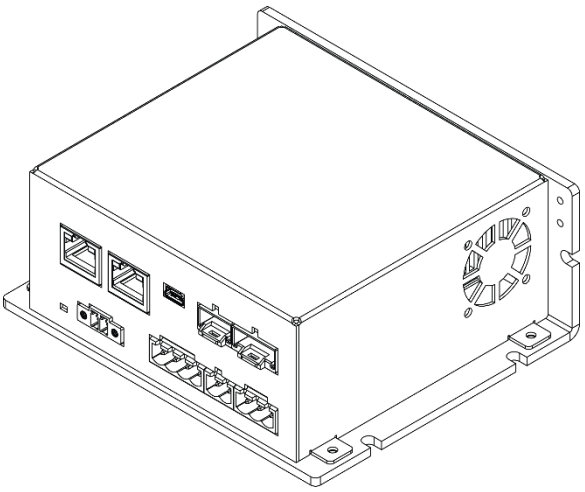
XSC-ECAT-ASD04 Dimension





XSC-ECAT-ASD10 Dimension





Servo Driver Installation

2.6. Installation Precautions

- **Installation Near Sources of Heat**

Implement measures to prevent temperature increases caused by radiant or convection heat from heat sources so that the ambient temperature of the Servo Driver meets the ambient conditions.

- **Installation Near Sources of Vibration**

Install a vibration absorber on the installation surface of the Servo Driver so that the Servo Driver will not be subjected to vibration.

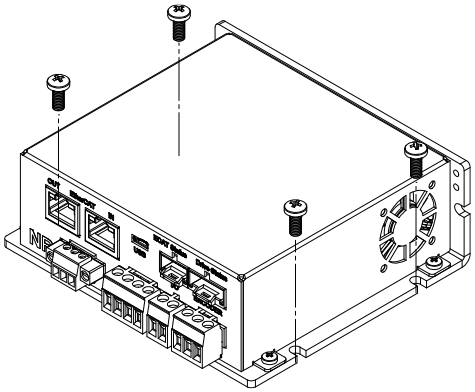
- **Other Precautions**

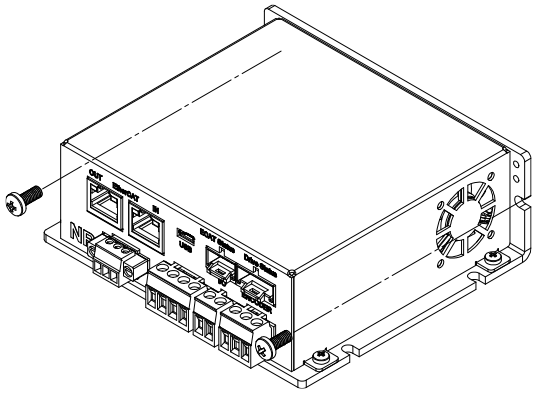
Do not install the Servo Driver in a location subject to high temperatures, high humidity, water drops, cutting oil, excessive dust, excessive dirt, excessive iron powder, corrosive gasses, or radioactivity.

2.7. Mounting Types and Orientation

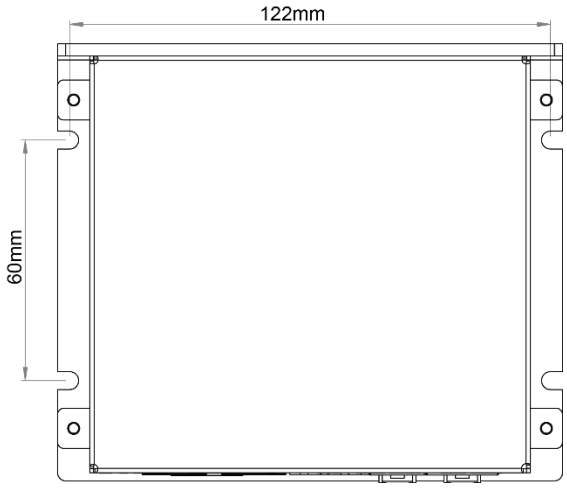
The Servo Driver is the base-mounted type.

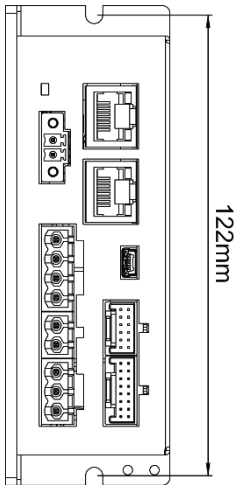
Mounting Screw size: M4



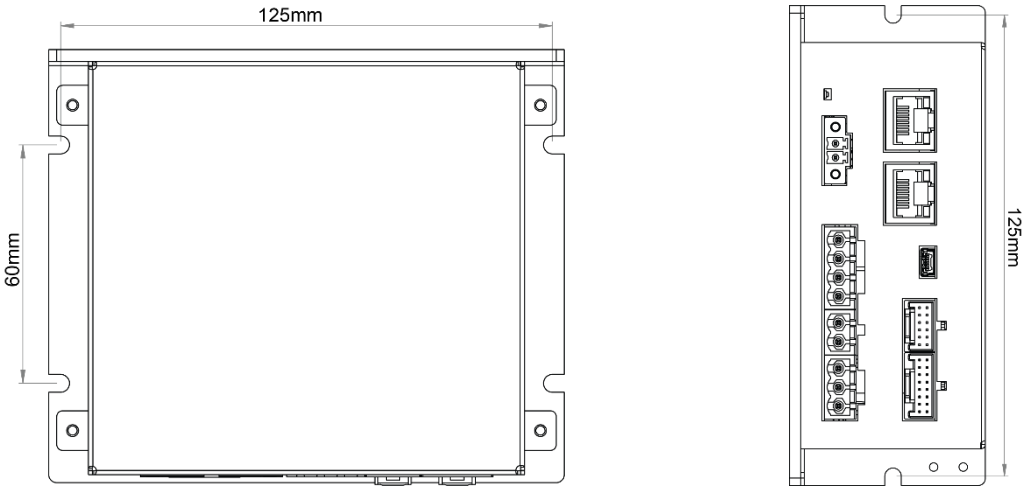


XSC-ECAT-ASD04 Mounting Dimension

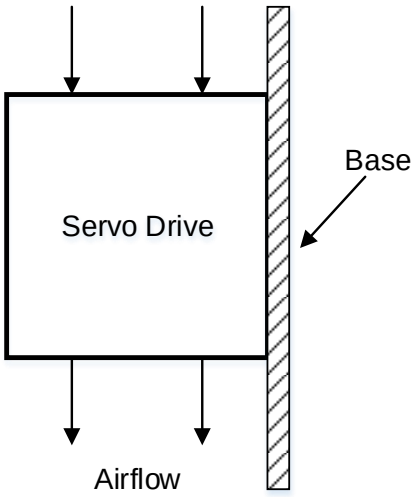




XSC-ECAT-ASD10 Mounting Dimension



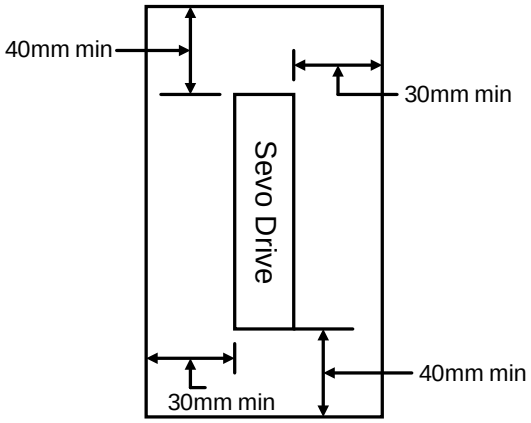
Base-mounted Servo Driver



2.8. Mounting Interval

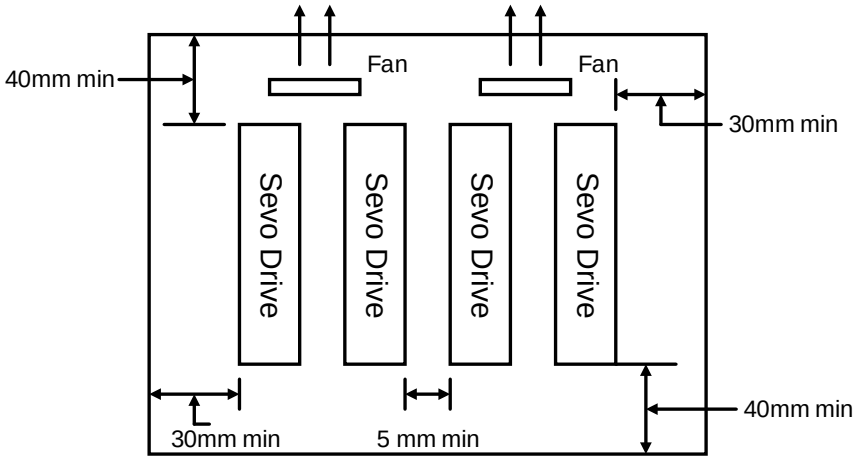
Installing One Servo Driver in a Control Panel

Provide the following spaces around the Servo Driver



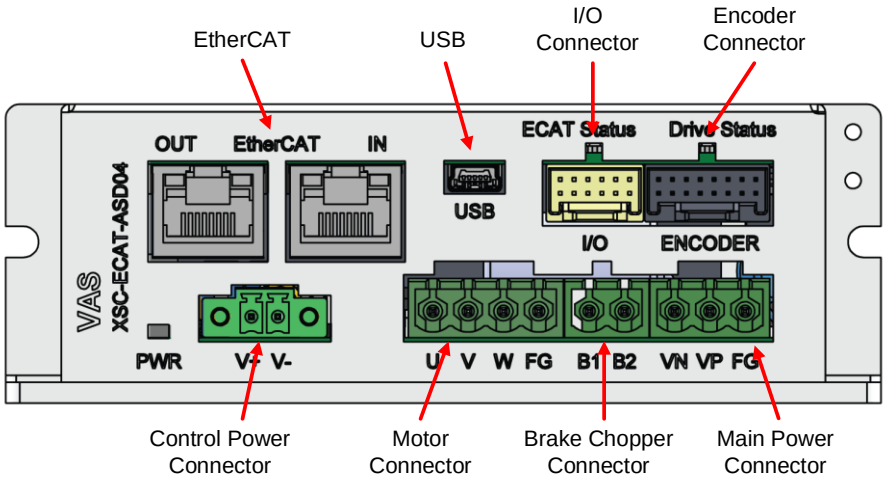
Installing More Than One Servo Driver in a Control Panel

Provide the following intervals between the Servo Drivers and spaces around the Servo Driver.



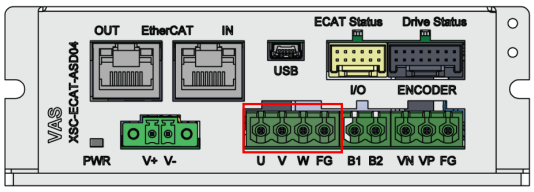
3. Wiring and Connecting Servo Driver

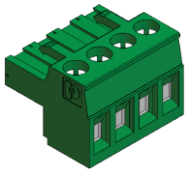
3.1. nEXT1 Servo Driver connectors and indicators



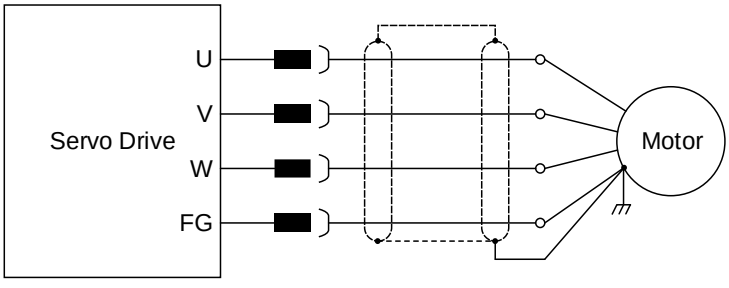
3.2. Motor Power Connector Pinouts

Pin	Signal	Function
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
4	FG	Motor Frame Ground





Phoenix Contact 1780002 or compatible



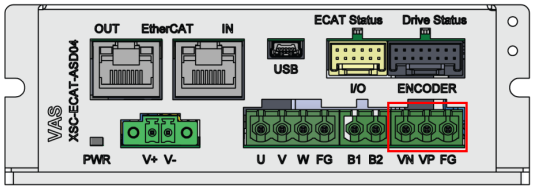
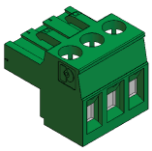
Motor Power Connection Diagram

4.3. Main Power and Control Power Connector Pinouts

The Servo Driver receives power from main power and control power supplies and delivers power to the motor.

Power Input	Voltage
Main power	36 to 350VDC
Control Power	15 to 36VDC

4.3.1. Main Power

Pin	Signal	Function
1	VN	Return power
2	VP	Positive power input
3	FG	Frame ground
	 Phoenix Contact 1779990 or compatible	

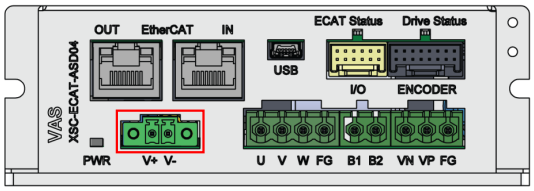
Connect the DC power cable to the P+ and P- on the terminal on the Main Power Connector.

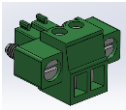
To connect the DC power supply:

1. The source of the VDC power supply must be isolated
2. For best immunity, it is highly recommended to use twisted and shield cables for the DC power supply. A 3-wire shielded cable should be used. The gauge is determined by the actual current consumption of the motor.
3. Connect the cable shield the closest ground connection near the power supply.
4. Connect the FG to the closest ground connection near the power supply.
5. Before applying power, first verify the polarity of the connection.

4.3.2. Control Power Supply

Pin	Signal	Function
1	V+	Positive power
2	V-	Return power





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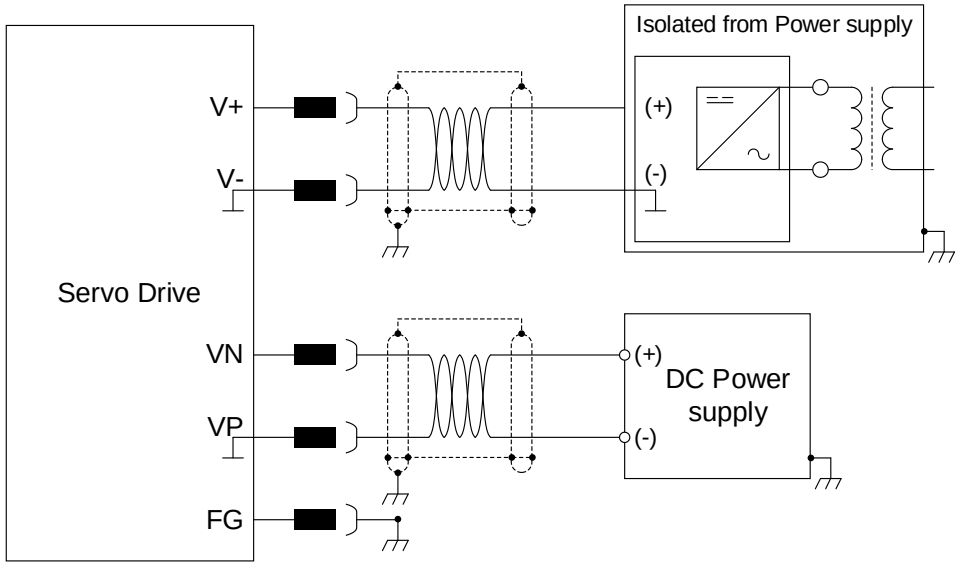
or compatible

Connect VL+ and VL- terminal to the Control Power Connector.

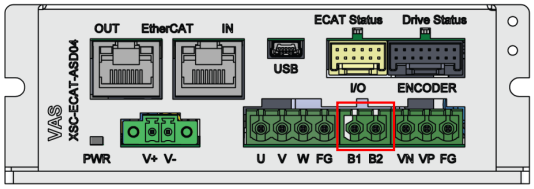
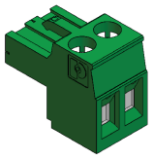
To connect the control power supply:

1. The source of the Control Power Supply must be isolated.
2. Connect the cable shield to the closest frame ground near the control power supply source.
3. Before applying power, first verify the polarity of the connection.

4.3.3. Connectivity

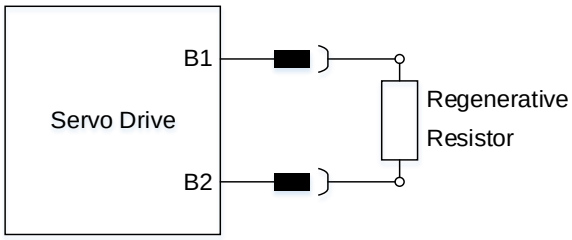


4.4. Brake Chopper Connector Pinouts

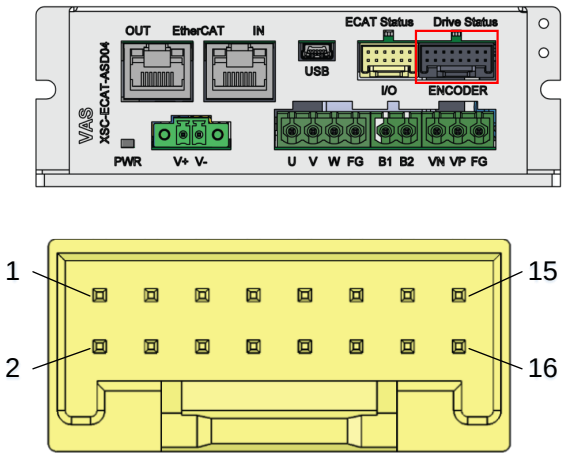
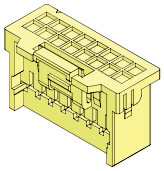
Pin	Signal	Function
1	B1	Connect to Regenerative resistor
2	B2	
		 Phoenix Contact 1779987 or compatible

Connect the terminal B1 and B2 to regenerative resistor.

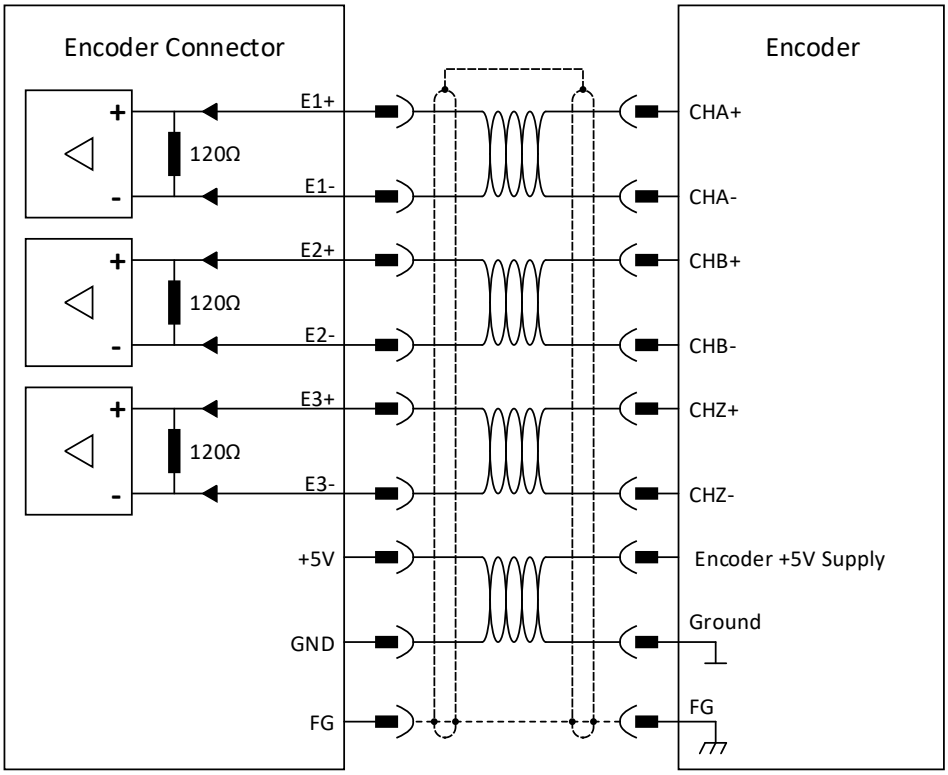
1. Need to connect Regenerative Resistor to Servo Driver when the power of Servo motor larger than 400W.
2. The value of Regenerative Resistor should be larger than 50 Ω.
3. Mounting the Regenerative to heat sink plane



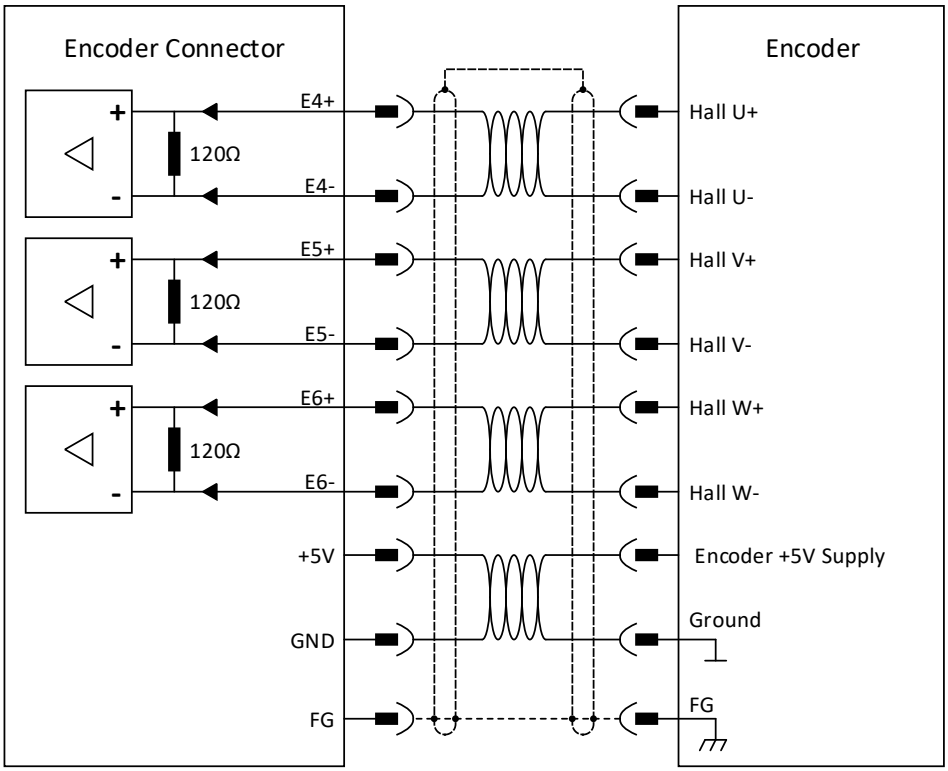
4.5. Encoder Feedback Connector Pinouts

Pin	Signal	Function
1	E1-	Encoder input channel 1-
2	E1+	Encoder input channel 1+
3	E2-	Encoder input channel 2-
4	E2+	Encoder input channel 2+
5	E3-	Encoder input channel 3-
6	E3+	Encoder input channel 3+
7	E4-	Encoder input channel 4-
8	E4+	Encoder input channel 4+
9	E5-	Encoder input channel 5-
10	E5+	Encoder input channel 5+
11	E6-	Encoder input channel 6-
12	E6+	Encoder input channel 6+
13	GND	Power ground
14	PWR	Encoder power supply
15	FG	Frame ground
16	RST	Encoder reset (Option)
	 Molex 5016461600	

4.5.1. Incremental Encoder



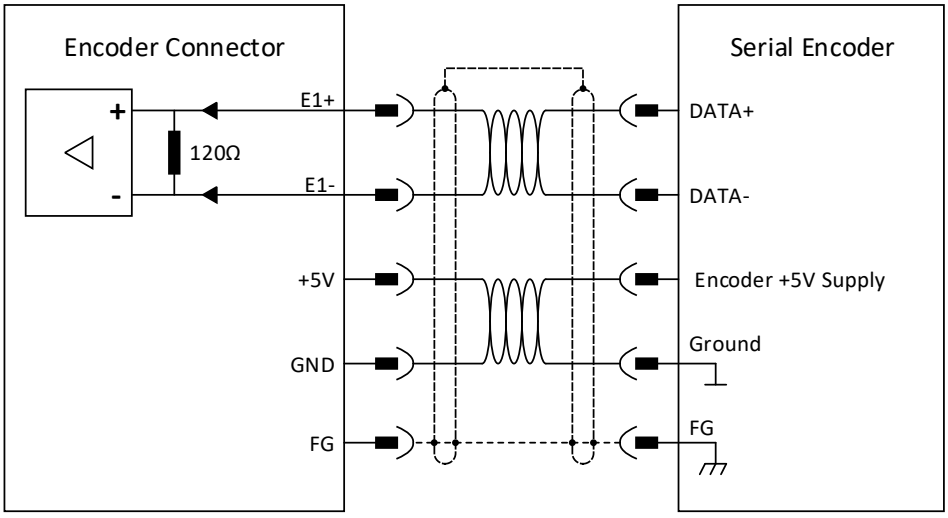
4.5.2. Hall Sensor



4.5.3. Serial Encoder

nEXT1 Servo Driver support the following type of serial encoder:

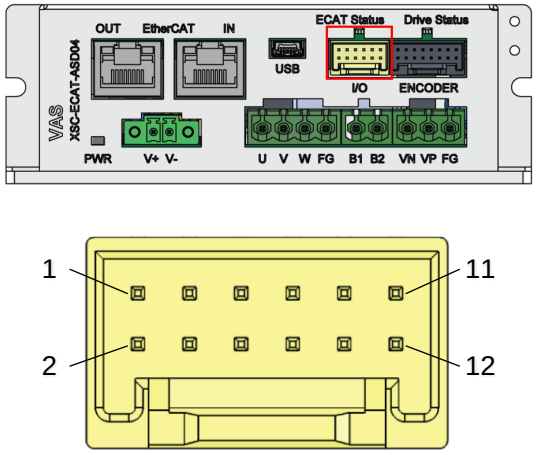
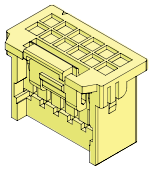
- Tamagawa serial encoder.
- Panasonic minas A4, A5, A6.
- Yaskawa Sigma II, IV, VII.



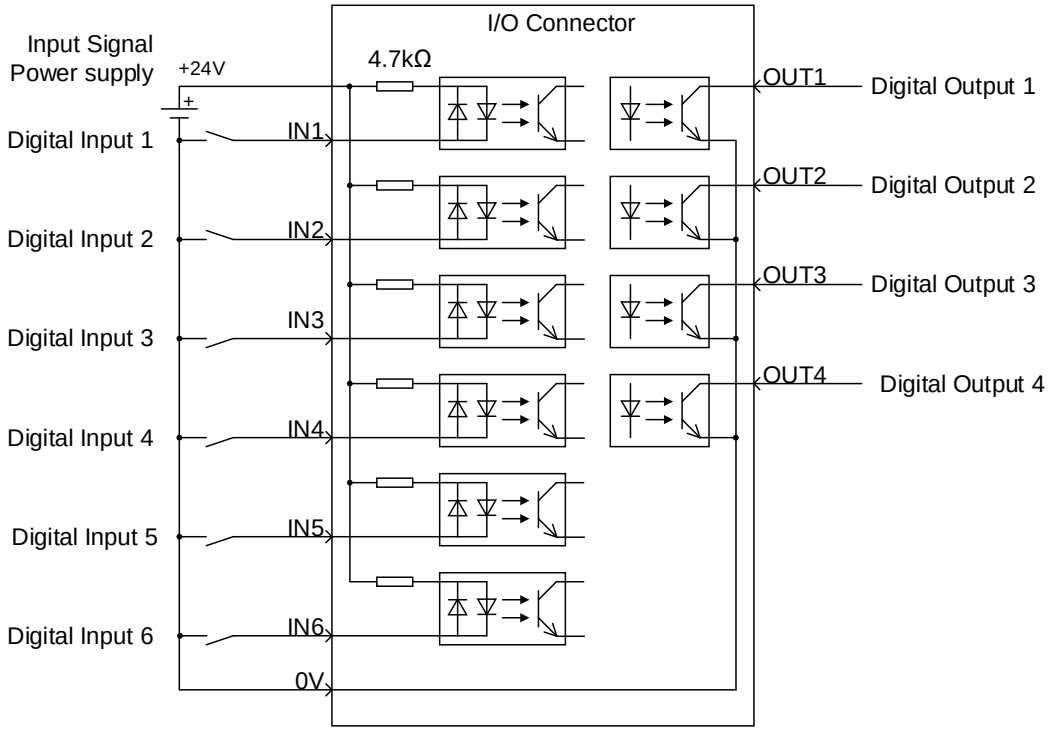
4.6. Digital I/O Connector Pinouts

4.6.1. I/O Signal Connector Pin Arrangement

The following table gives the pin numbers, names, and functions the I/O signal pins for the default settings.

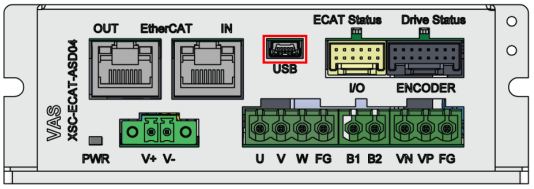
Pin	Signal	Function
1	IN1	Digital Input 1
2	IN2	Digital Input 2
3	OUT1	Digital Output 1
4	IN3	Digital Input 3
5	OUT2	Digital Output 2
6	IN4	Digital Input 4
7	OUT3	Digital Output 3
8	IN5	Digital Input 5
9	OUT4	Digital Output 4
10	IN6	Digital Input 6
11	V+	Positive Power supply
12	V-	Power supply return
	 Molex 5016461200	

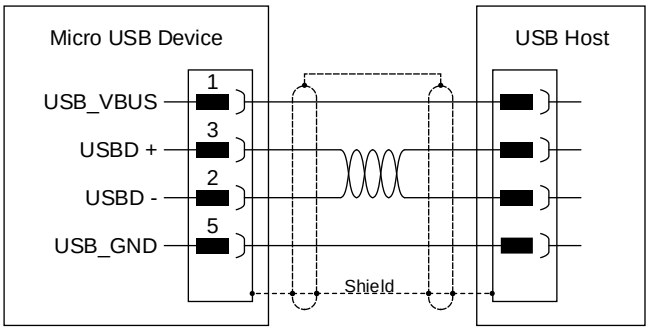
4.6.2. I/O Signal Wiring Examples



4.7. USB Mini 2.0

The following table gives the pin numbers, names, and functions the USB mini connector

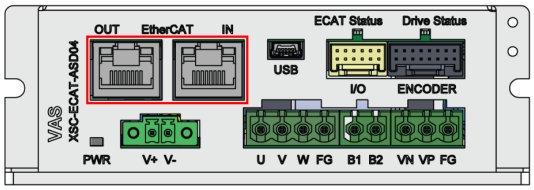
Pin	Signal	Function
1	VBUS	USB VBUS 5V
2	D-	USB_N line
3	D+	USB_P line
5	GND	USB ground return
		USB Mini Plug



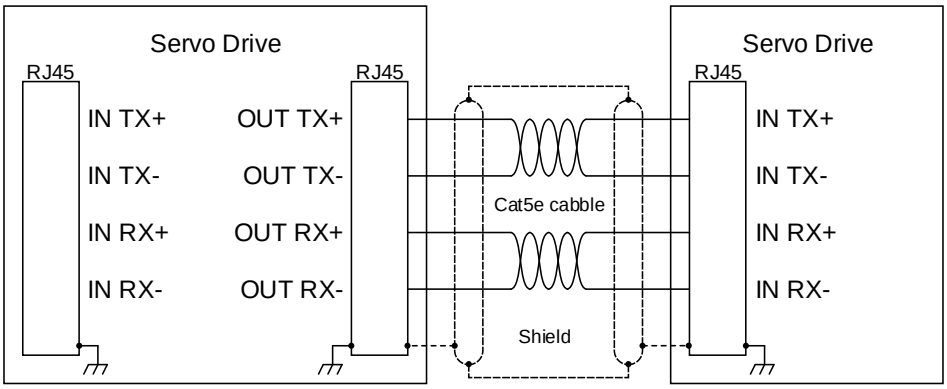
USB Connection Diagram

4.8. EtherCAT Communication

4.8.1. EtherCAT In/Out Connector Pin Assignments

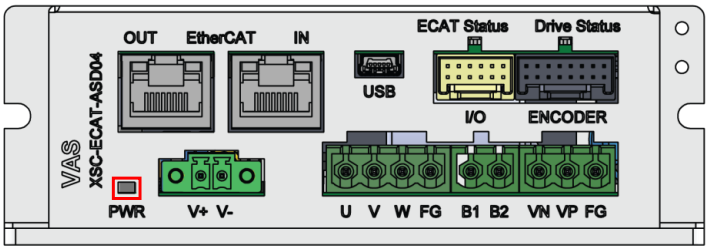
Pin	Signal	Function
1	TX+	Send data
2	TX-	
3	RX+	Receive data
4,5	N/A	-
6	RX-	Receive data
7, 8	N/A	-
		Minimum require: Standard Ethernet CAT5E Cable

4.8.2. EtherCAT Wiring

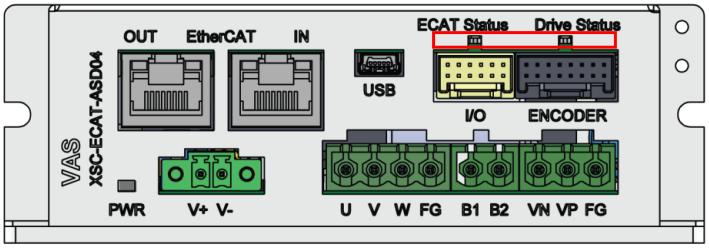


4.9. Servo Driver indicator

Power supply indicator



Drive Status indicator



The Drive status indicator is a single red/green dual bi-colored LED, the green LED indicator Servo is ON and the red LED indicator an Alarm Occurs and the servo is OFF.

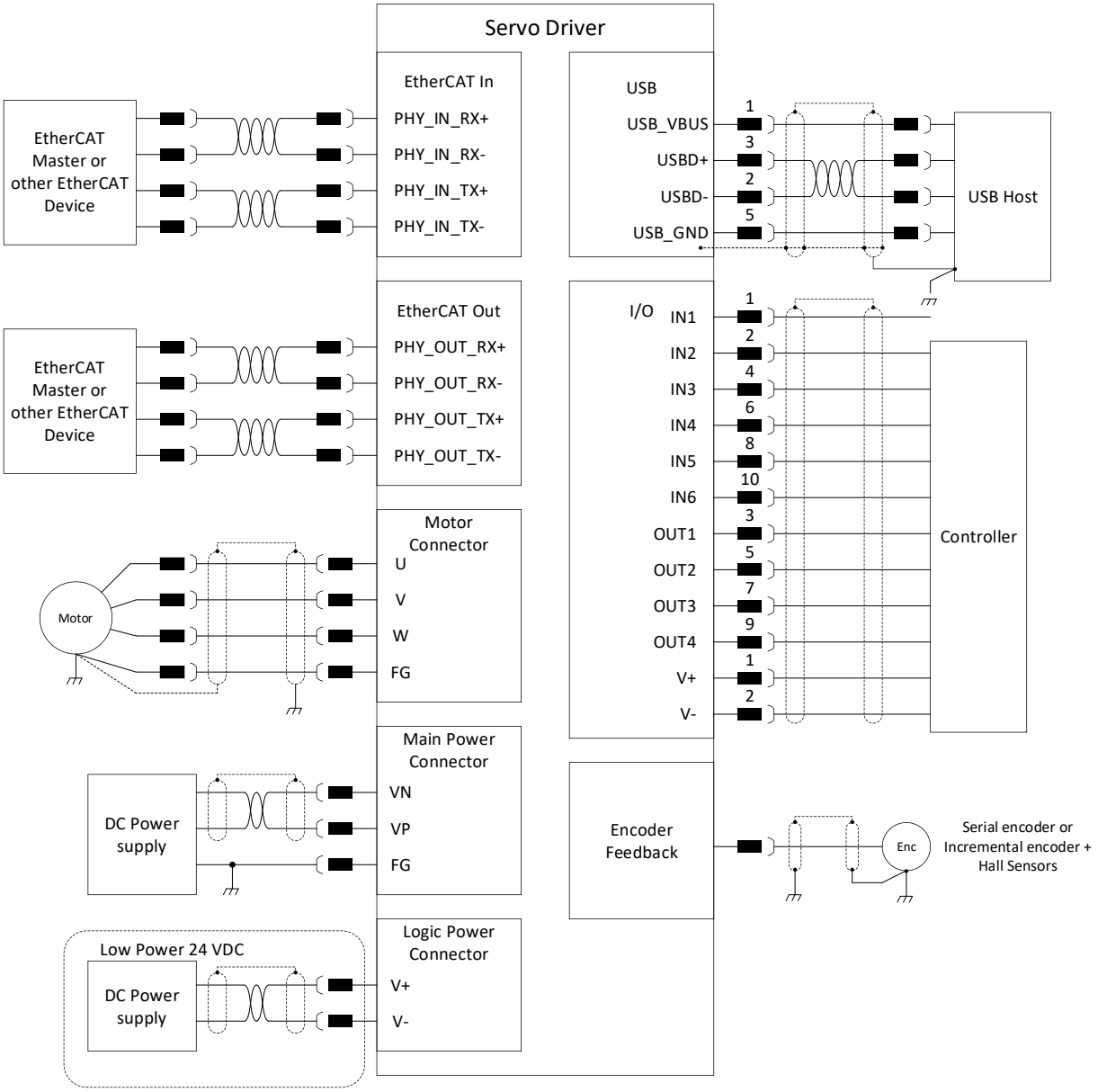
Name	Color	State	Contents
SERVO	Green	Off	Servo motor is OFF
		On	Servo motor is ON
ERROR	Red	Off	No Error
		On	Error occurred

EtherCAT Status indicator

The EtherCAT status indicator is a single red/green dual bi-colored LED that combines the green RUN indicator and the red ERROR indicator of the EtherCAT state machine.

Name	Color	State	Contents
RUN	Green	Off	Device is in INIT state
		Blinking	Device is in PREOP state
		Single Flash	Device is in SAFEOP state
		On	Device is in OP state
ERROR	Red	Off	No Error
		Toggle	EtherCAT Error occurred

4.10. Basic Wiring Diagram



5. Basic Functions That Require Setting before Operation

5.1. Manipulating Servo Driver Parameters

5.1.1. Classifications of Servo Driver Parameters

There are the following two types of Servo Driver parameters.

Classification	Meaning
Driver Parameters	Parameters for the basic settings that are required for operation and adjust servo performance
Motor Parameters	Parameters that are used to setting and tuning the servo motor

5.1.2. Setting Servo Driver Parameters

Setting Servo Driver Parameters with nEXT Configurator

You can use the **nEXT Configurator software** to set the Servo Driver parameters.

Refer to the following sections **nEXT Configurator Software** for details.

Setting Servo Driver Parameters with EtherCAT (CoE) Communications

You can set objects 2000h to 26FFh with EtherCAT(CoE) communications to set the Servo Driver parameters

When you use EtherCAT (CoE) communications objects, you must write the Servo Driver parameters to non-volatile memory.

To write the Servo Driver parameters to non-volatile memory, set the store parameters (2700h) object.

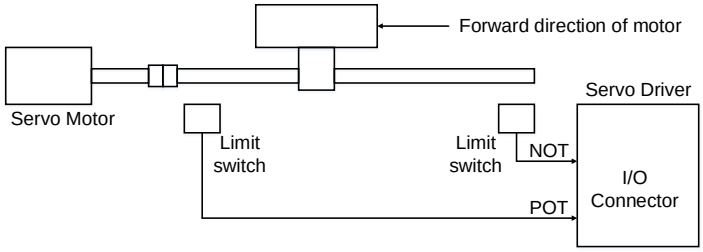
5.2. Limit and Related Settings

Limit is a function of the Servo Driver that forces the Servomotor to stop in response to a signal input from a limit switch that is activated when a moving part of the machine exceeds the safe range of movement.

The Limit signals include the POT (Forward Drive Prohibit) and the NOT (Reverse Drive Prohibit) signals.

You use the POT and NOT signals to stop the machine by installing limit switches at the positions where you want to stop the machine that is operated by the Servomotor.

A Servo Driver wiring example is provided below.



5.2.1. Limit Signals

The limit signals include the POT (Forward Drive Prohibit) and the NOT (Reverse Drive Prohibit) signals.

Type	Signal	Signal Status	Allocated value
Input	POT	ON	Forward drive is enabled (actual operation).
		OFF	Forward drive is prohibited (forward limit).
	NOT	ON	Reverse drive is enabled (actual operation).
		OFF	Reverse drive is prohibited (reverse limit).

You do not need to wire the limit input signals if you are not going to use the limit function

You can use **nEXT Configurator** to allocate the POT and NOT signal to I/O connector pins. Refer to the following sections for details.

- ***Connecting I/O Signals***

5.2.2. Motor Stopping Method for Limit function

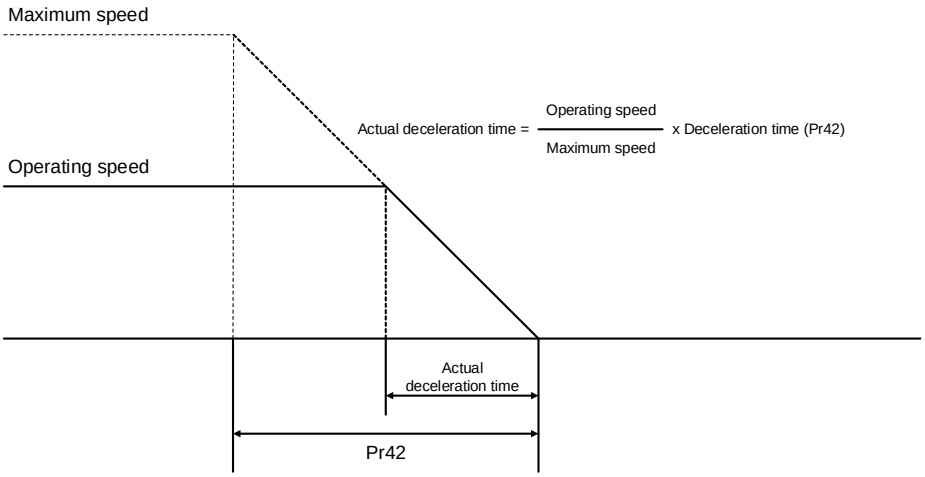
Stopping the Servomotor by Setting the Deceleration Time

To specify the Servomotor deceleration time and use it to stop the Servomotor, set Pr42 (Deceleration Time for Servo OFF and Forced Stops).

Pr42 (230Ah)	Deceleration Time for Servo OFF and Forced Stops			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to 10000	1 ms	0	Immediately

If you set Pr42 to 0, the Servomotor will be stopped with a zero speed.

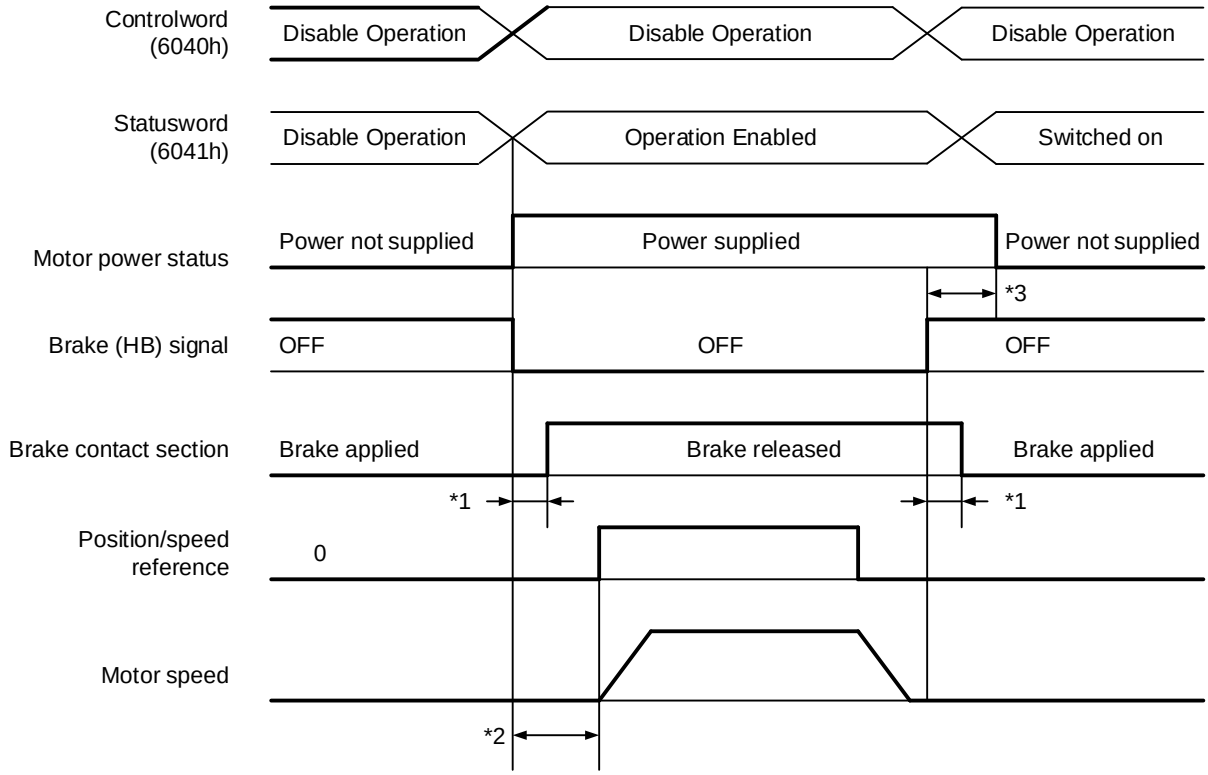
The deceleration time that you set in Pr42 is the time to decelerate the Servomotor from the maximum motor speed.



5.3. Holding Brake

5.3.1. Brake Operating Sequence

You must consider the brake release delay time and the brake operation delay time to determine the brake operation timing, as described below.



*1. The brake delay times is used for servomotors with Holding Brakes when the power supply is switched on the DC side. You must evaluate the actual brake delay times on the actual equipment before using the application.

*2. Before you output a reference from the host controller to the Servo Driver, wait for at least 50 ms plus the brake release delay time after you send the SV_ON command.

3. Use the following parameters to set the timing of when the brake will operate and when the servo will be turned OFF.

- Pr64 (Brake Reference-Servo OFF Delay Time), Pr65 (Brake Reference Output Speed Level), and Pr66 (Servo OFF-Brake Reference Waiting Time).

You can use **nEXT Configurator** to allocate Holding Brake (HB) signal to I/O connector. Refer to the following sections for details.

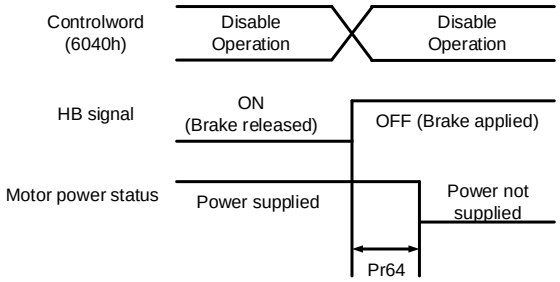
- ***Connecting I/O Signals***

5.3.2. Output Timing of /BK (Brake) Signal When the Servomotor Is Stopped

When the Servomotor is stopped, the /BK signal turns OFF as soon as the Servo OFF command (Disable Operation command) is received. Use the servo OFF delay time (Pr64) to change the timing to turn OFF power supply to the motor after the Servo OFF command (Disable Operation command) is input.

Pr64 (2506h)	Brake Reference-Servo OFF Delay Time			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to 50	10 ms	0	Immediately

- When the Servomotor is used to control a vertical axis, the machine moving part may move slightly due to gravity or an external force. You can eliminate this slight motion by setting the servo OFF delay time (Pn506) so that power supply to the motor is stopped after the brake is applied.
- This parameter sets the timing of stopping power supply to the Servomotor while the Servomotor is stopped.



5.3.3. Output Timing of /BK (Brake) Signal When the Servomotor Is Operating

If an alarm occurs while the Servomotor is operating, the Servomotor will start stopping and the HB signal will be turned OFF. You can adjust the timing of HB signal output by setting the brake reference output speed level (Pr65) and the servo OFF-brake reference waiting time (Pr66).

Pr65 (2507h)	Brake Reference Output Speed Level			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to Maxspeed	RPM	100	Immediately
Pr66 (2508h)	Servo OFF-Brake Reference Waiting Time			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	10 to 100	10 ms	50	Immediately

5.4. Motor Overload Detection Level

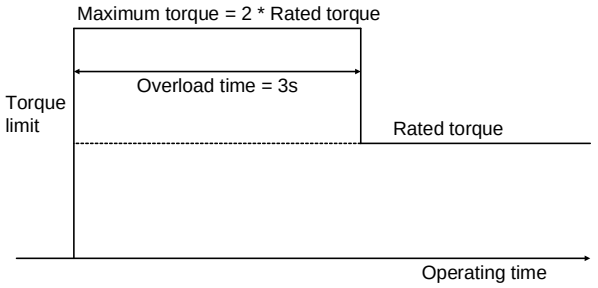
The motor overload detection level is the threshold used to detect overload alarms and overload warnings when the Servomotor is subjected to a continuous load that exceeds the Servomotor ratings.

It is designed to prevent Servomotor overheating during the work.

You can change the detection timing for FF0Ch alarms (Continuous Overload). You cannot change the detection level for FF0Bh alarms (Instantaneous Overload).

5.4.1. Detection Timing for Overload Alarms

The nEXT1 Servo Driver has built-in overload protection function, which enables servo motor to work at maximum 200% of rated torque within 3s.



If Servomotor heat dissipation is insufficient (e.g., if the heat sink is too small), you can lower the overload alarm detection level to help prevent overheating by setting torque limits. Refer to the following sections for details.

- ***Selecting Torque Limits***

5.5. Setting Unit Systems

You can set the Servo Driver reference units with EtherCAT (CoE) communications. You can set the following four reference units with EtherCAT communications.

- Position reference unit

The setting procedures are given below.

5.5.1. Setting the Position Reference Unit

Set the position reference unit in position user unit (2701h). The position reference unit setting will be used for the electronic gear ratio setting.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
2701h	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1073741823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1073741823 (default: 1)	Yes

You can set the position reference unit in ASD configurator software by setting the Driver parameter **Pr38**, **Pr39**. Refer to the following sections for details.

- ***Setting Parameters***

5.6. Setting the Regenerative Resistor Capacity

The regenerative resistor consumes regenerative energy that is generated by the Servomotor, e.g., when the Servomotor decelerates.

If an External Regenerative Resistor is connected, you must set Pr72 (Regenerative Resistor Value) and Pr73 (Regenerative Resistor Capacity).

Pr72 (2600h)	Regenerative Resistor Value			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to 65535	0.1Ω	0	Immediately
Pr73 (2601h)	Regenerative Resistor Capacity			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	-	1Watt	0	Immediately

Set the regenerative resistor capacity to a value that is consistent with the allowable capacity of the External Regenerative Resistor. The setting depends on the cooling conditions of the External Regenerative Resistor.

- For self-cooling (natural convection cooling): Set the parameter to a maximum 20% of the capacity (W) of the actually installed regenerative resistor.
- For forced-air cooling: Set the parameter to a maximum 50% of the capacity (W) of the actually installed regenerative resistor.

6. Application Function

6.1. I/O Signal Allocations

Functions are allocated to the pins on the I/O signal connector in advance. You can change the allocations and the polarity for some of the connector pins. Function allocations and polarity settings are made with parameters.

This section describes the I/O signal allocations.

6.1.1. Input Signal Allocations

The input signals that you can allocate to the pin on the I/O signal connector and the parameters are given in the following table.

Input Signal	Name	Allocated value
POT	Forward Drive Prohibit Input signal	1
NOT	Reverse Drive Prohibit Input signal	2
HOME	Home signal	3
TP1	Touch Probe 2 Input signal	4
TP2	Touch Probe 2 Input signal	5
DI1	General Input 1	6
DI2	General Input 2	7

The input polarity of each signal is assign the value: high (0) and low (1)

Parameter Settings, Allocated Pins, and Polarities

You can allocate input signal by setting parameter Digital Input x Signal Allocation (x = 1 → 6) Pr74 to Pr79. The setting value of Pr74 to Pr79 are given in the following format:

Pr74 = (Polarity << 8) | Allocated value

Example of Changing Input Signal Allocations

The following example shows reversing the POT (Forward Drive Prohibit) signal allocated to Digital Input 1 and the HOME (Home signal) signal allocated to Digital Input 2.

- Digital Input 1 signal Allocation (Pr74) = 257
- Digital Input 2 signal Allocation (Pr75) = 3

You can use **nEXT Configurator** to Setting Input Signal Allocations. Refer to the following sections for details.

- ***Connecting I/O Signals***

6.1.2. Output Signal Allocations

You can allocate the desired output signals to pins 1, 2, and 23 to 26 on the I/O signal connector. The output signals that you can allocate to the pin on the I/O signal connector and the parameters are given in the following table.

Output Signal	Name	Allocation value
ALM	Servo Alarm Output signal	1
COIN	Positioning Completion Output signal	2
TGON	Rotation Detection Output signal	3
SRDY	Servo Ready Output signal	4
CLT	Torque Limit Detection Output signal	5
VLT	Speed Limit Detection Output signal	6
HB	Holding Brake Output Signal	7
DO1	General Output 1	8
DO2	General Output 2	9
DO3	General Output 3	10

Parameter Settings

You can allocate input signal by setting parameter Digital Output x Signal Allocation (x = 1 → 4) Pr80 to Pr83. The setting value of Pr83 to Pr83 are given in the following format:

Pr80 = Allocated value

Example of Changing Input Signal Allocations

The following example shows reversing the COIN (Positioning Completion Output) signal allocated to Digital Output 1 and the HB (Holding Brake Output) signal allocated to Digital Output 2.

- Digital Output 1 signal Allocation (Pr80) = 2
- Digital Output 2 signal Allocation (Pr81) = 7

You can use **nEXT Configurator** to Setting Input Signal Allocations. Refer to the following sections for details.

- ***Connecting I/O Signals***

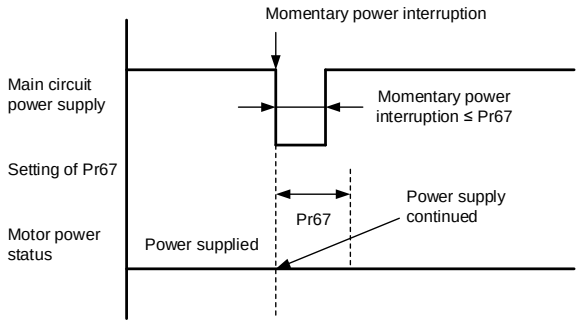
6.2. Operation for Momentary Power Interruptions

Even if the main power supply to the Servo Driver is interrupted momentarily, power supply to the motor (servo ON status) will be maintained for the time set in Pr67 (Momentary Power Interruption Hold Time).

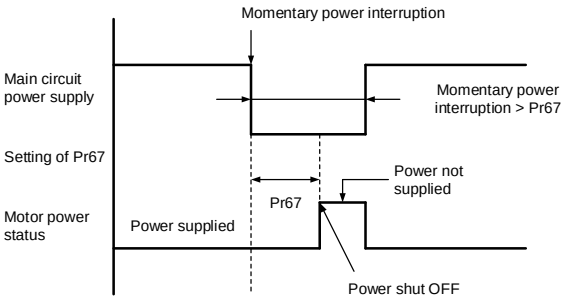
Pr67 (2509h)	Momentary Power Interruption Hold Time			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	20 to 50000	1 ms	20	Immediately

If the momentary power interruption time is equal to or less than the setting of Pr67, power supply to the motor will be continued. If it is longer than the setting, power supply to the motor will be stopped. Power will be supplied to the motor again when the main circuit power supply recovers.

Setting of Pr67 ≥ Momentary power interruption time



Setting of Pr67 < Momentary power interruption time



Information

1. If the momentary power interruption time exceeds the setting of Pn67, the S-RDY (Servo Ready) signal will turn OFF.
2. The holding time of the Servo Driver control power supply is approximately 100 ms. If control operations become impossible during a momentary power interruption of the control power supply, the setting of Pn67 will be ignored and the same operation will be performed as for when the power supply is turned OFF normally.

6.3. Selecting Torque Limits

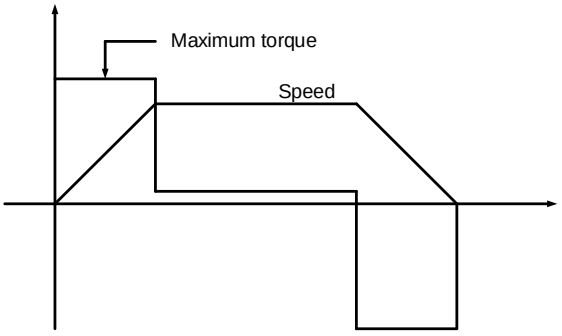
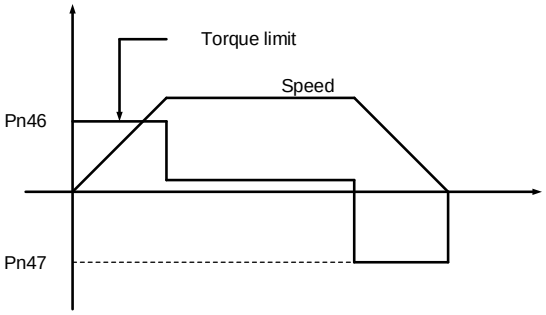
You can limit the torque that is output by the Servomotor, the maximum output torque will always be limited to the specified forward torque limit (Pr46) and reverse torque limit (Pr47).

Setting the Torque Limits

Pr72 (2403h)	Forward Torque Limit			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to 300	1%	200	Immediately
Pr73 (2404h)	Reverse Torque Limit			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to 300	1%	200	Immediately

* Set a percentage of the rated motor torque.

Note: If the setting of Pr46 or Pr47 is too low, the torque may be insufficient for acceleration or deceleration of the Servomotor.

Without Internal Torque Limits (Output to the maximum torque is possible)	**With Internal Torque Limits**
	

7. Trial Operation and Actual Operation

7.1. Flow of Trial Operation

The procedure for trial operation is given below.

- **Preparation for Trial Operation**

Step	Meaning	Reference
1	**Installation** Install the Servomotor and Servo Driver according to the installation conditions. First, operation is checked with no load. Do not connect the Servomotor to the machine.	*Chapter 3 Servo Driver Installation*
2	**Wiring and Connections** Wire and connect the Servo Driver. First, Servomotor operation is checked without a load.	*Chapter 4 Wiring and Connecting Servo Driver*
3	**Confirmations before Trial Operation**	*7.2.Inspections and Confirmations before Trial Operation*
4	**Power ON**	-

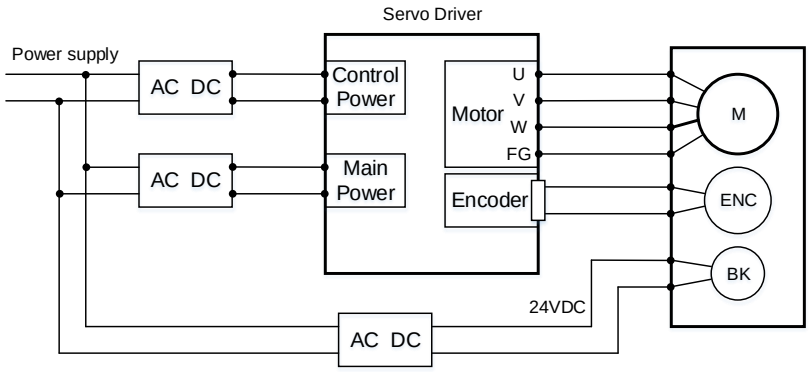
Use the following procedure to execute current loop tuning program.

1. Click to **Tuning** in toolbar and choose **Motor Configuration** of the **nEXT Configurator software**.

To ensure safe and correct trial operation, check the following items before you start trial operation.

- Make sure that the Servo Driver and Servomotor are installed, wired, and connected correctly.
- Make sure that the correct power supply voltage is supplied to the Servo Driver.
- Make sure that there are no loose parts in the Servomotor mounting.
- If you are using a Servomotor with a Holding Brake, make sure that the brake is released in advance. To release the brake, you must apply the specified voltage to the brake.

A circuit example for trial operation is provided below.



7.2. Trial Operation for the Servomotor without a Load

You use jogging for trial operation of the Servomotor without a load.

Jogging is used to check the operation of the Servomotor without connecting the Servo Driver to the host controller. The Servomotor is moved at the preset jogging speed.

Caution

- During jogging, the limit function is disabled. Consider the range of motion of your machine when you jog the Servomotor.

Preparations

Confirm the following conditions before you jog the Servomotor.

- The main circuit power supply must be ON.
- There must be no alarms.
- The servo must be OFF.
- The jogging speed must be set considering the operating range of the machine.

The jogging speed is set with the following parameters.

Pr40 (2305h)	Soft Start Acceleration/Deceleration Time			
	Setting Range	**Setting Unit**	**Default setting**	**When Enabled**
	0 to 10000	1 ms	0	Immediately

You can use **nEXT Configurator** to operator the Jogging program. Refer to the following sections for details.

- ***Jogging the Servomotor to Test Operation***

7.3. Trial Operation with the Servomotor Connected to the Machine

This section provides the procedure for trial operation with both the machine and Servomotor.

Precautions

If you will use a brake, observe the following precautions during trial operation.

- Before you check the operation of the brake, implement measures to prevent vibration from being caused by the machine falling due to gravity or an external force.
- First check the Servomotor operation and brake operation with the Servomotor uncoupled from the machine. If no problems are found, connect the Servomotor to the machine and perform trial operation again.

Control the operation of the brake with the Holding Brake (HB) signal output from the Servo Driver. Refer to the following sections for information on wiring and the related parameter settings.

- ***Holding Brake***
- ***Connecting I/O Signals***

Preparations

Confirm the following items before you perform the trial operation procedure for both the machine and Servomotor.

- Make sure that the Servo Driver is connected correctly to both the host controller and the peripheral devices.
- Limit wiring
- Brake wiring
- Emergency stop circuit wiring
- Host controller wiring

Operating Procedure

1. Enable the limit signals.
   - ***Input Signal Allocations***
2. Make the settings for the protective functions, such as the limit, and the brake.
   - ***Limit and Related Settings***
   - ***Holding Brake***
3. Turn OFF the power supplies to the Servo Driver

   The control power supply and main circuit power supply will turn OFF

4. Couple the Servomotor to the machine.
5. Turn ON the power supplies to the machine and host controller and turn ON the control power supply and main circuit power supply to the Servo Driver.
6. Check the protective functions, such the brake, to confirm that they operate correctly.
7. Perform trial operation
8. If necessary, adjust the servo gain to improve the Servomotor response characteristics.

   The Servomotor and machine may not be broken in completely for the trial operation. Therefore, let the system run for a sufficient amount of time to ensure that it is properly broken in.

9. For future maintenance, save the parameter settings with one of the following methods.
   - Use the **nEXT Configurator** to save the parameters as a file.
   - Record the settings manually.

This concludes the procedure for trial operation with both the machine and Servomotor.

7.4. Convenient Function to Use during Trial Operation

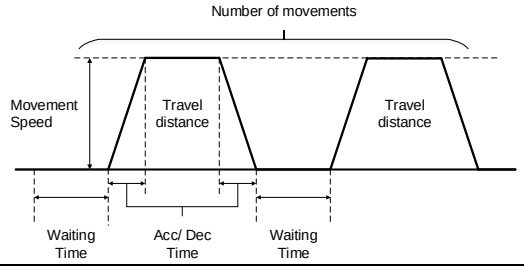
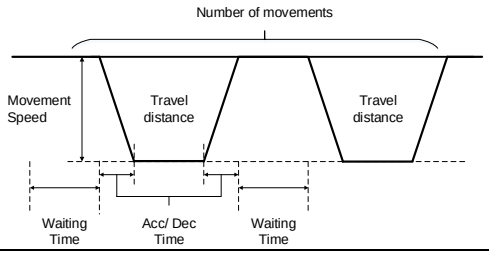
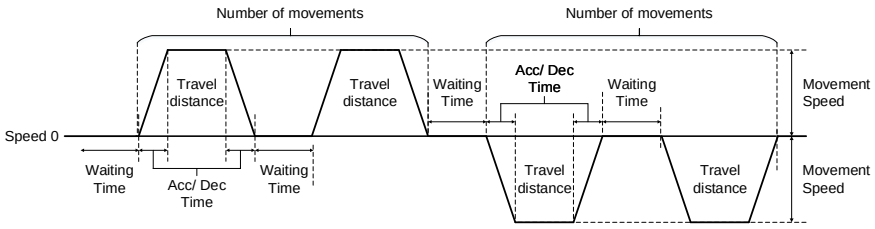
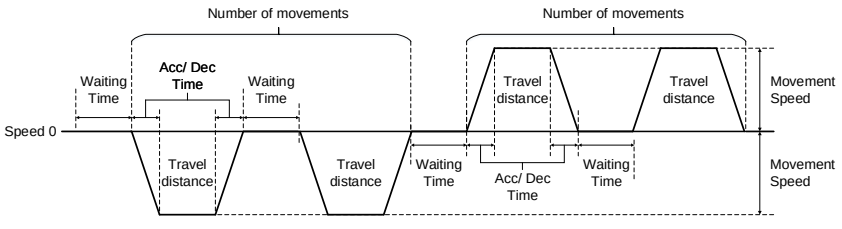
This section describes some convenient operations that you can use during trial operation. Use them as required.

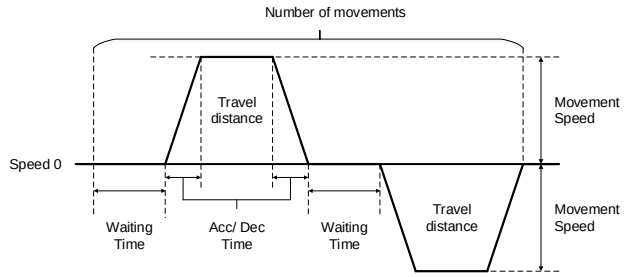
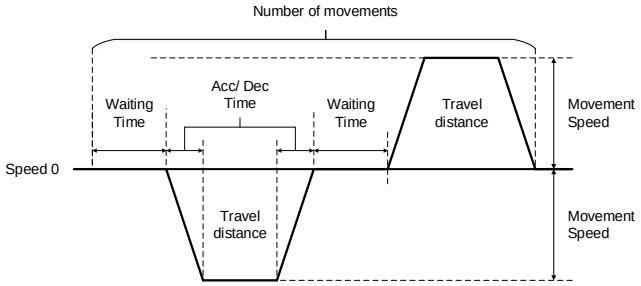
Program Jogging

You can use program jogging to perform continuous operation with a preset operation pattern, travel distance, movement speed, acceleration/deceleration time, waiting time, and number of movements.

You can use this operation when you set up the system in the same way as for normal jogging to move the Servomotor without connecting it to the host controller in order to check Servomotor operation and execute simple positioning operations.

Program Jogging Operation Pattern

Value	Setting	Operation Pattern
0	(Waiting time → Forward travel distance) x Number of movements	
1	(Waiting time → Reverse travel distance) x Number of movements	
2	(Waiting time → Forward travel distance) x Number of movements → (Waiting time → Reverse travel distance) x Number of movements	
3	(Waiting time → Reverse travel distance) x Number of movements → (Waiting time → Forward travel distance) x Number of movements	

Value	Setting	Operation Pattern
4	(Waiting time → Forward travel distance → Waiting time → Reverse travel distance) x Number of movements	
5	(Waiting time → Reverse travel distance → Waiting time → Forward travel distance) x Number of movements	

You can use **nEXT Configurator** to operator the Jogging program. Refer to the following sections for details.

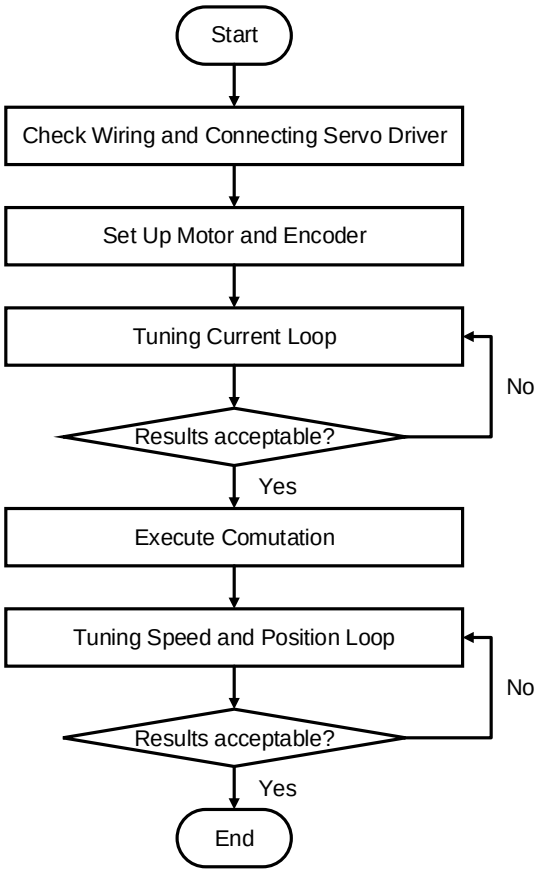
- ***Perform Trial Operation with a Program***

8. Tuning

8.1. Overview and Flow of Tuning

Tuning is performed to optimize response by adjusting the servo gains in the Servo Driver. The servo gains are set using a combination of parameters, such as parameters for the current loop gain, speed loop gain, position loop gain and filters. These parameters influence each other, so you must consider the balance between them.

The basic tuning procedure is shown in the following flowchart. Make suitable adjustments considering the conditions and operating requirements of your machine.



8.1.1. Tuning Functions

The following table provides an overview of the tuning functions.

Tuning Function	Outline	Reference
Set up motor and encoder	This step requires the user to enter the necessary parameters of the motor, this step is required before proceeding to the next steps.	Configuring the Servo Motor
Tuning Current Loop	The following parameters are adjusted with the internal current reference in the Servo Driver during operation. You can adjust the servo gains to adjust the response. • Current Loop Gain	Tuning Current Loop
Execute commutation	This automatic adjustment function is designed to determine motor phase and calculate some motor parameters.	Execute Commutation
Tuning Speed and Position Loop	The following parameters are adjusted with the position reference or speed reference input from the host controller when the machine is in operation. You can adjust the servo gains to adjust the response. • Gains (position loop gain and speed loop gain) • Filters (torque reference filter and notch filters)	Tuning Speed and Position Loop

8.2. Monitoring Methods

You can use the data tracing function of the **nEXT Configurator** for monitoring. If you perform manual tuning, always use the above functions to monitor the machine operating status and Servo Driver signal waveform while you adjust the servo gains.

Check the adjustment results with the following response waveforms.

- Current Control

Item	Unit
Current Reference	mA
Current Feedback	mA

- Position Control

Item	Unit
Torque reference	%
Feedback speed	RPM
Position reference speed	RPM
Position deviation	Reference units

- Speed Control

Item	Unit
Torque reference	%
Feedback speed	RPM
Reference speed	RPM

8.3. Precautions to Ensure Safe Tuning

Perform the following settings in a way that is suitable for tuning.

8.3.1. Limit Settings

Limit settings are made to force the Servomotor to stop for a signal input from a limit switch when a moving part of the machine exceeds the safe movement range.

Refer to the following section for details.

- ***Limit and Related Settings***

8.3.2. Torque Limit Settings

You can limit the torque that is output by the Servomotor based on calculations of the torque required for machine operation. You can use torque limits to reduce the amount of shock applied to the machine when problems occur, such as collisions or interference. If the torque limit is lower than the torque that is required for operation, overshooting or vibration may occur.

Refer to the following section for details.

- ***Selecting Torque Limits***

8.3.3. Setting the Position Deviation Overflow Alarm Level

The position deviation overflow alarm is a protective function that is enabled when the Servo Driver is used in position control.

If the alarm level is set to a suitable value, the Servo Driver will detect excessive position deviation and will stop the Servomotor if the Servomotor operation does not agree with the reference.

The position deviation is the difference between the position reference value and the actual position.

You can calculate the Position Deviation Overflow Alarm Level (**Pr68**) [setting unit: position units] with the following formula.

$$\text{Pr68} > \text{maximum motor speed} \times \frac{\text{Encoder resolution}}{100 \times \text{Pr04}} \times \frac{\text{Denominator}^{*1}}{\text{Numerator}} \times (1.2 \text{ to } 2)^{*2}$$

*1. Refer to the following section for details.

- ***Setting Unit Systems***

*2. The underlined coefficient "× (1.2 to 2)" adds a margin to prevent an FF11h alarm (Position Deviation Overflow) from occurring too frequently

If you set a value that satisfies the formula, an FF11h alarm (Position Deviation Overflow) should not occur during normal operation.

If the Servomotor operation does not agree with the reference, position deviation will occur, an error will be detected, and the Servomotor will stop.

The following calculation example uses a Rotary Servomotor with a maximum motor speed of 5000 and an encoder resolution of 1048576 (20 bits). Pr04 is set to 100. Denominator / Numerator = 1 / 1

Pr68 = 5000 x 1048576 / 100 x 100 x 1/1 x 2 = 1048576

If the acceleration/deceleration rate required for the position reference exceeds the tracking capacity of the Servomotor, the tracking delay will increase and the position deviation will no longer satisfy the above formulas. If this occurs, lower the acceleration/deceleration rate so that the Servomotor can follow the position reference or increase the position deviation overflow alarm level.

Related Parameters

Pr68 (2520h)	Position Deviation Overflow Alarm Level			
	Setting Range	Setting Unit	Default Setting	When Enabled
	1 to 1,073,741,823	1 reference unit	-	Immediately

Related Alarms

Alarm Number	Alarm Name	Alarm Meaning
FF11h	Position Deviation Overflow	The setting of Position Deviation Overflow Alarm Level Pr68 (2520h) was exceeded by the position deviation while the servo was ON.

8.3.4. Setting the Position Deviation Overflow Alarm Level at Servo ON

If the servo is turned ON when there is a large position deviation, the Servomotor will attempt to return to the original position to bring the position deviation to 0, which may create a hazardous situation. To prevent this, you can set a position deviation overflow alarm level at servo ON to restrict operation.

The related parameters and alarms are given in the following tables.

Related Parameters

Pr70 (2526h)	Position Deviation Overflow Alarm Level at Servo ON			
	Setting Range	Setting Unit	Default Setting	When Enabled
	1 to 1,073,741,823	1 reference unit	-	Immediately

Related Alarms

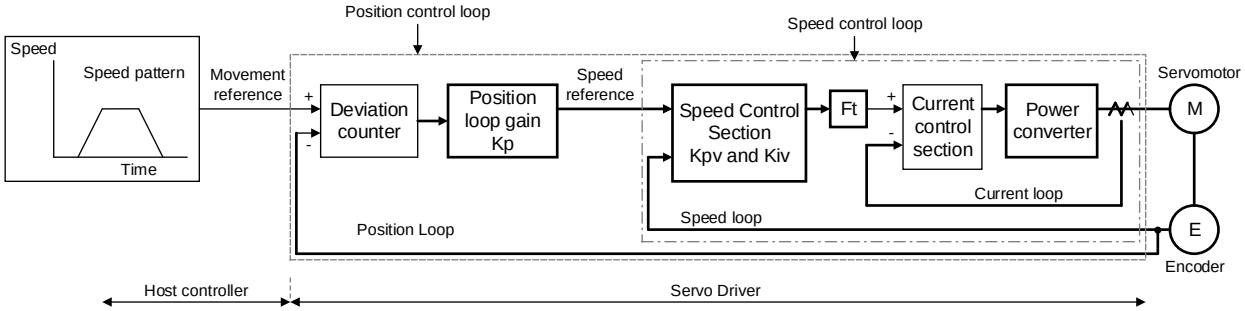
Alarm Number	Alarm Name	Alarm Meaning
FF12h	Position Deviation Overflow Alarm at Servo ON	This alarm occurs if Servo ON command is executed after the position deviation exceeded the setting of Position Deviation Overflow Alarm Level Pr70 (2526h) at Servo ON while the servo was OFF.

Refer to the following section for information on troubleshooting alarms.

- ***Resetting Alarms***

8.4. Manual Tuning

Servo Gains



Kp: Position loop gain (Pr04)

Kpv: Speed loop gain (Pr02)

Kiv: Speed loop integral (Pr03)

Ft: First stage first torque filter frequency (Pr44)

In order to manually tune the servo gains, you must understand the configuration and characteristic of the Servo Driver and adjust the servo gains individually. In most cases, if you greatly change any one parameter, you must adjust the other parameters again. To check the response characteristic, you must prepare a measuring instrument to monitor the output waveforms from the analog monitor.

The Servo Driver has three feedback systems (the position loop, speed loop, and current loop), and the response characteristic must be increased more with the inner loops. If this relationship is not maintained, the response characteristic will suffer and vibration will occur more easily.

You can use manual tuning to set the servo gains in the Servo Driver to increase the response characteristic of the Servo Driver. For example, you can reduce the positioning time for position control. You can monitor the servo gains and closed loop response in **nEXT Configurator**. Refer to the following sections for details.

- ***Monitoring machine Operation Status and Signal Waveforms***

Adjusted Servo Gains

You can set the following gains to adjust the response characteristic of the Servo Driver.

- Pr02: Speed Loop Gain
- Pr03: Speed Loop Integral Gain
- Pr04: Position Loop Gain
- Pr44: First Stage First Torque Reference Filter Frequency

♦ Position Loop Gain

The position loop gain determines the response characteristic of the position loop in the Servo Driver.

If you can increase the setting of the position loop gain, the response characteristic will improve and the positioning time will be shortened. However, you normally cannot increase the position loop gain higher than the inherit vibration frequency of the machine system. Therefore, to increase the setting of the position loop gain, you must increase the rigidity of the machine to increase the inherit vibration frequency of the machine.

Pr04 (2102h)	Position Loop Gain			
	Setting Range	Setting Unit	Default Setting	When Enabled
	10 to 1000	-	100	Immediately

♦ Speed Loop Gain

This parameter determines the response characteristic of the speed loop. If the response characteristic of the speed loop is low, it becomes a delay factor for the position loop located outside of the speed loop. This will result in overshooting and vibration in the speed reference. Therefore, setting the speed loop gain as high as possible within the range that will not cause the machine system to vibrate will produce a stable servo system with a good response characteristic.

Pr04 (2102h)	Speed Loop Gain			
	Setting Range	Setting Unit	Default Setting	When Enabled
	10 to 1000	-	100	Immediately

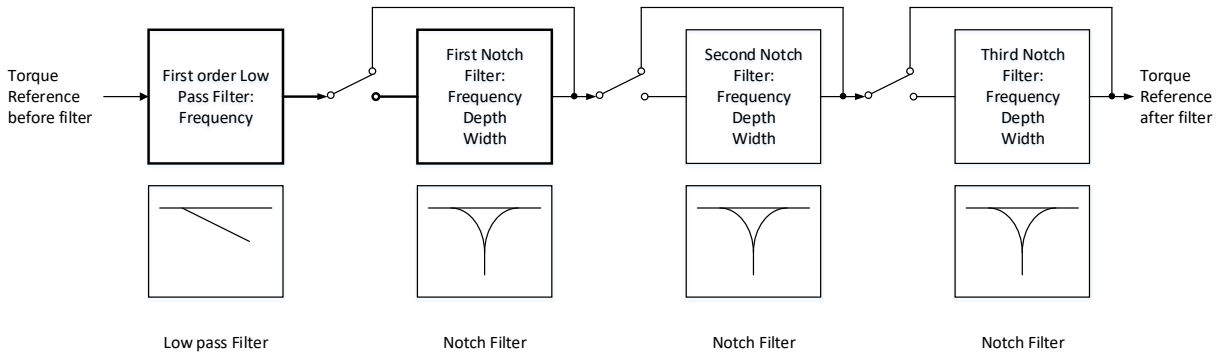
♦ Speed Loop Integral Gain

To enable response to even small inputs, the speed loop has an integral element. The integral element becomes a delay factor in the servo system. If the Integral gain is set too low, overshooting will occur, positioning settling time will increase, and the response characteristic will suffer.

Pr04 (2102h)	Speed Loop Gain			
	Setting Range	Setting Unit	Default Setting	When Enabled
	10 to 1000	-	100	Immediately

♦ Torque Reference Filter

As shown in the following diagram, the torque reference filter contains a first order lag filter and notch filters arranged in series, and each filter operates independently.



Torque Reference Low Pass Filter

If you suspect that machine vibration is being caused by the Servo Driver, try adjusting the torque reference filter time constant. This may stop the vibration. The lower the value, the better the control response characteristic will be, but there may be a limit depending on the machine conditions.

Pr17	First Stage Torque Reference Filter Frequency			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 5000	1Hz	0	Immediately

Notch Filters

The notch filter can eliminate specific frequency elements generated by the vibration of sources such as resonance of the shaft of a ball screw.

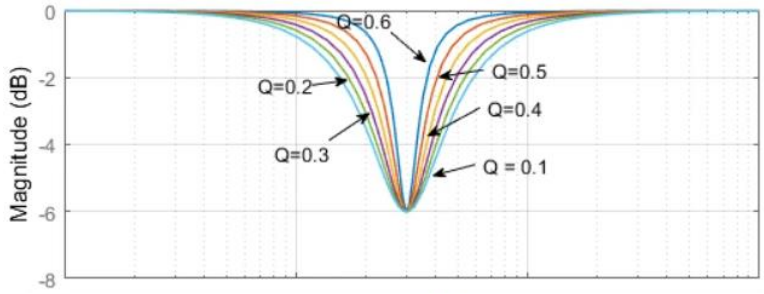
The notch filter puts a notch in the gain curve at the specific vibration frequency (called the notch frequency). The frequency components near the notch frequency can be reduced or removed with a notch filter.

Notch filters are set with three parameters for the notch filter frequency, notch filter Q value, and notch filter depth. This section describes the notch filter Q value and notch filter depth.

- **Notch filter Q Value**

The setting of the notch filter Q value determines the width of the frequencies that are filtered for the notch filter frequency. The width of the notch changes with the notch filter Q value. The larger the notch filter Q value is, the steeper the notch is and the narrower the width of frequencies that are filtered is.

The notch filter frequency characteristics for different notch filter Q values are shown below.



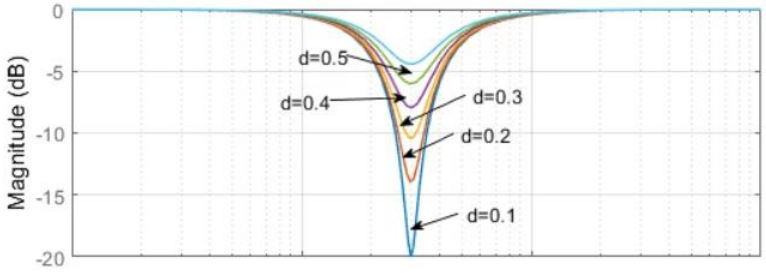
Note: The above notch filter frequency characteristics are based on calculated values and may be different from actual characteristics.

♦ Notch filter Depth

The setting of the notch filter depth determines the depth of the frequencies that are filtered for the notch filter frequency. The depth of the notch changes with the notch filter depth. The smaller the notch filter depth is, the deeper the notch is, increasing the effect of vibration suppression. However, if the value is too small, vibration can actually increase.

The notch filter is disabled if the notch filter depth is set to 1

The notch filter frequency characteristics for different notch filter depths are shown below.



Note: The above notch filter frequency characteristics are based on calculated values and may be different from actual characteristics.

You can enable or disable the notch filter with Driver Parameters Pr51, Pr55 and Pr59

Parameter		Meaning	When Enabled
Pr51	0	Disable first state notch filter	Immediately
	1	Enable first state notch filter	
Pr55	0	Disable second state notch filter	
	1	Enable second state notch filter	
Pr59	0	Disable third state notch filter	
	1	Enable third state notch filter	

Set the machine vibration frequencies in the notch filter parameters.

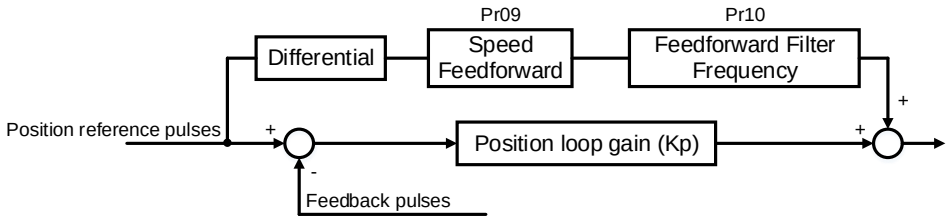
Pr52	First Stage Notch Filter Frequency			
	Setting Range	Setting Unit	Default Setting	When Enabled
	50 to 5000	1Hz	5000	Immediately
Pr53	First Stage Notch Filter Q value			
	Setting Range	Setting Unit	Default Setting	When Enabled
	50 to 1000	0.01	70	Immediately
Pr54	First Stage Notch Filter Depth			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 1000	0.001	0	Immediately
Pr56	Second Stage Notch Filter Frequency			
	Setting Range	Setting Unit	Default Setting	When Enabled
	50 to 5000	1Hz	5000	Immediately
Pr57	Second Stage Notch Filter Q value			
	Setting Range	Setting Unit	Default Setting	When Enabled
	50 to 1000	0.01	70	Immediately
Pr58	Second Stage Notch Filter Depth			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 1000	0.001	0	Immediately
Pr60	Third Stage Notch Filter Frequency			
	Setting Range	Setting Unit	Default Setting	When Enabled
	50 to 5000	1Hz	5000	Immediately
Pr61	Third Stage Notch Filter Q value			
	Setting Range	Setting Unit	Default Setting	When Enabled
	50 to 1000	0.01	70	Immediately
Pr62	Second Stage Notch Filter Depth			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 1000	0.001	0	Immediately

8.5. Additional Adjustment Functions

This section describes the functions that you can use to make adjustments after you perform tuning procedure.

8.5.1. Speed Feedforward

The feedforward function applies feedforward compensation to position control to shorten the positioning time.



Pr09 (2107h)	Speed Feedforward			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 100	1%	0	Immediately
Pr10 (2108h)	Speed Feedforward Filter Frequency			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 5000	1Hz	0	Immediately

8.5.2. Speed Feedback Filter

You can set a first order lag filter for the speed feedback in the speed loop. This ensures smooth changes in the feedback speed to reduce vibration. If a large value is set, it will increase the delay and make response slower.

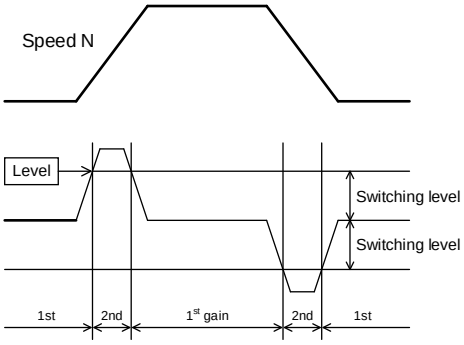
Pr41 (2308h)	Speed Feedback Filter Frequency			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 5000	1Hz	2000	Immediately

8.5.3. Gain Switching

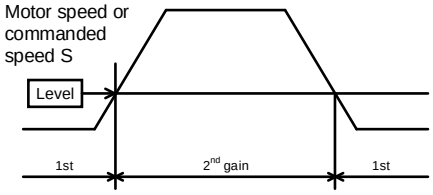
You can use gain switching to shorten the positioning time by increasing the gains during positioning and suppressing vibration by decreasing the gains while stopping.

Gain switching selection

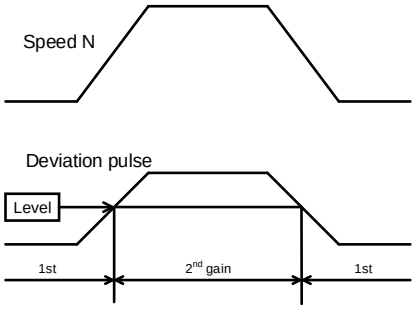
Gain switching based on Torque Reference Level



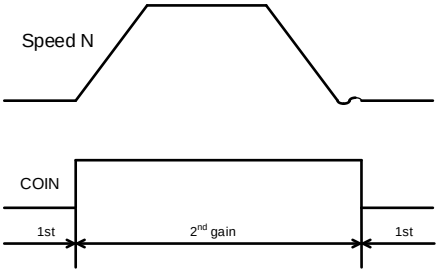
Gain switching based on Position Speed Reference Level



Gain switching based on Position Deviation Level



Gain switching based on Position Complete signal (COIN)



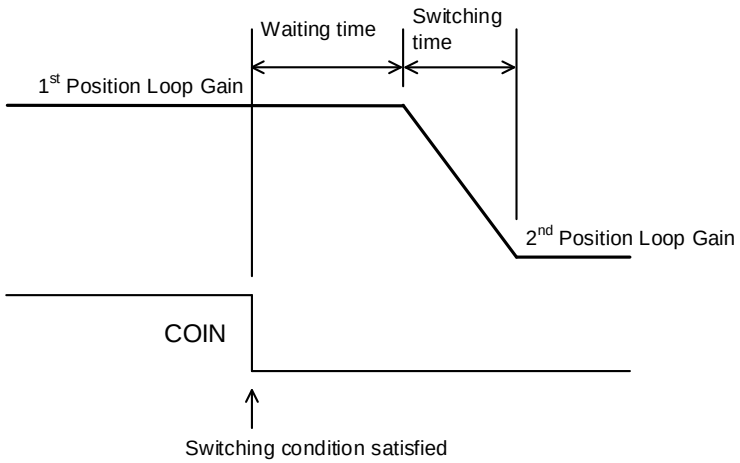
Gain Switching Selections

Driver Parameter		Function	When Enabled
Pr13 (210Bh)	0	Fixed to First gain	Immediately
	1	Fixed to Second gain	
	2	Use the internal torque reference as the condition	
	3	Use the speed reference as the condition	
	4	Use the position deviation error as the condition	
	5	Use the position complete as the condition	

Gain Switching Combinations

Select Gains	Speed Loop Gain	Speed Loop Integral Gain	Position Loop Gain	Torque Reference Filter
Gain Settings 1	Speed Loop Proportional Gain (Pr02)	Speed Loop Integral Gain (Pr03)	Position Loop Gain (Pr04)	First State First Torque Reference Filter Frequency (Pr44)
Gain Settings 2	Second Speed Loop Proportional Gain (Pr06)	Second Speed Loop Integral Gain (Pr07)	Second Position Loop Gain (Pr08)	First State Second Torque Reference Filter Frequency (Pr45)

Relationship between the Waiting Times and Switching Times for Gain Switching



Parameters Related to Automatic Gain Switching

Pr17 (2131h)	Gain Switching Time 1			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 65535	1ms	0	Immediately
Pr18 (2132h)	Gain Switching Time 2			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 65535	1ms	0	Immediately
Pr19 (2135h)	Gain Switching Waiting Time 1			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 65535	1ms	0	Immediately
Pr20 (2136h)	Gain Switching Waiting Time 2			
	Setting Range	Setting Unit	Default Setting	When Enabled
	0 to 65535	1ms	0	Immediately

8.3. Diagnostic Tools

8.5.4. Mechanical Analysis

Overview

You can connect the Servo Driver to a computer to measure the frequency characteristics of the machine. This allows you to measure the frequency characteristics of the machine without using a measuring instrument.

The Servomotor is used to cause machine vibration and then the speed frequency characteristics for the motor torque are measured. The measured frequency characteristics can be used to determine the machine resonance.

You determine the machine resonance for use in servo tuning and as reference for considering changes to the machine. The performance of the servo cannot be completely utilized depending on the rigidity of the machine. You may need to consider making changes to the machine.

The information can also be used as reference for servo tuning to help you adjust parameters, such as the servo rigidity and torque filter time constant.

You can also use the information to set parameters, such as the notch filters.

You can use **nEXT Configurator** to execute this function. Refer to the following sections for details.

- ***Displaying Machine Frequency Characteristics on a Graph***

9. EtherCAT Communications

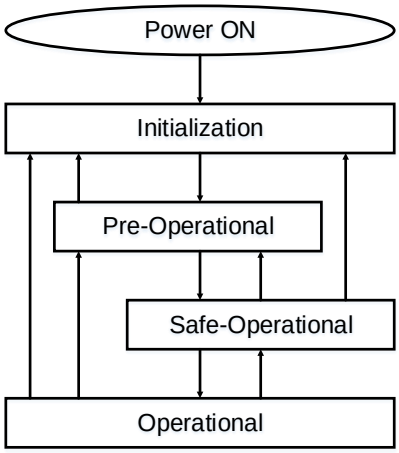
9.1. EtherCAT Slave Information

You can use an EtherCAT slave information file (ESI) to configure the EtherCAT master.

The ESI file contains general information on EtherCAT communications settings that are related to the Servo Driver settings.

9.2. EtherCAT State Machine

The EtherCAT state machine is used to manage the communications states between the master and slave applications when EtherCAT communications are started and during operation, as shown in the following figure. Normally, the state changes for requests from the master.

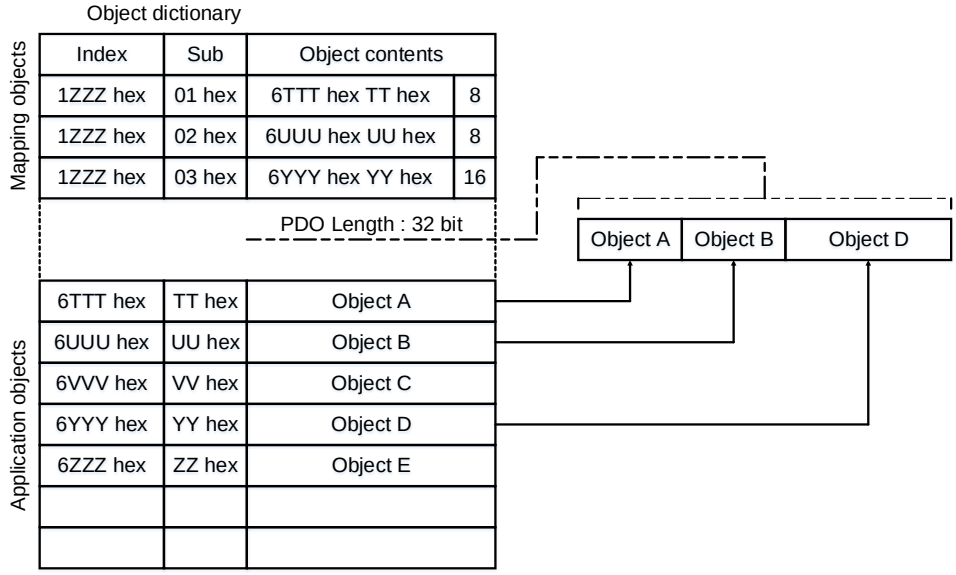


State	Description
INIT	• Mailbox communications are not possible. • Process data communications are not possible.
INIT => PRE-OP	• The master sets the DL address and Sync Manager channels for mailbox communications. • The master initializes DC clock synchronization. • The master requests the Pre-Operational state. • The master sets the AL control register. • The slaves check whether the mailbox was initialized correctly.
PRE-OPERATIONAL (PREOP)	• Mailbox communications are possible. • Process data communications are not possible.
PREOP => SAFEOP	• The master sets the Sync Manager channels and FMMU channels for process data. • The master uses SDOs to set the PDO mappings and the Sync Manager PDO Assignment parameters. • The master requests the Safe-Operational state. • The slaves check whether the Sync Manager channels for process data communications and, if required, the distributed clock settings are correct.
SAFE-OPERATIONAL (SAFEOP)	• Mailbox communications are possible. • Process data communications are possible. However, only the input data is valid. The output data is still not valid.
SAFEOP => OP	• The master sends valid output data. • The master requests the Operational state.
OPERATIONAL (OP)	• Mailbox communications are possible. • Process data communications are possible.

9.3. PDO Mappings

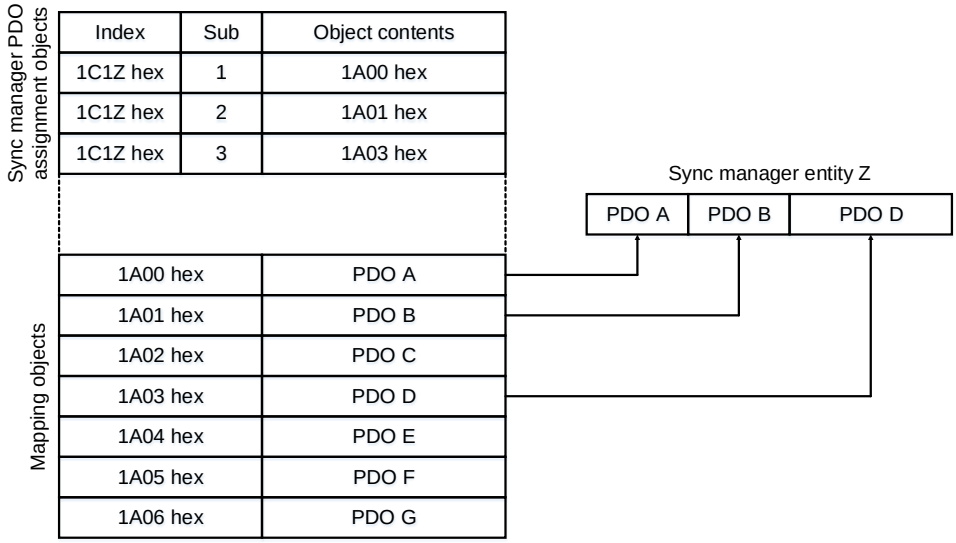
The process data that is used in process data communications is defined in the PDO mappings. PDO mappings are definitions of the applications objects that are sent with PDOs. The PDO mapping tables are in indexes 1600h to 1603h for the RxPDOs and indexes 1A00h to 1A03h for the TxPDOs in the object dictionary.

The following figure shows an example of PDO mappings.



In addition to the above PDO mappings, PDOs have to be assigned to the Sync Managers to exchange EtherCAT process data. The Sync Manager PDO assignment objects (1C12h and 1C13h) establish the relationship between these PDOs and the Sync Managers.

The following figure shows an example of a Sync Manager and the PDO mappings.



9.3.1. Default PDO mappings

The following table shows the default PDO mappings for the Servo Driver.

The defaults are defined in the EtherCAT slave information file (ESI).

- First PDO Mapping (Position, Torque Limit, and Touch Probe)

RxPDO (1600h)	Controlword (6040h)	Target position (607Ah)	Target velocity (60FFh)	Target torque (6071h)	Digital outputs (60FEh)	Touch probe function (60B8h)

TxPDO (1A00h)	Statusword (6041h)	Position actual value (6064h)	Torque actual value (6077h)	Following error actual value (60F4h)	Touch probe status (60B9h)	Touch probe 1 position (60BAh)	Touch probe 2 position (60BCh)	Digital inputs (60FDh)

- Second PDO Mapping (Cyclic Synchronous Position): Default PDO Assignments

RxPDO (1601h)	Controlword (6040h)	Target position (607Ah)	Digital outputs (60FEh)	Touch probe function (60B8h)

TxPDO (1A01h)	Statusword (6041h)	Position actual value (6064h)	Touch probe status (60B9h)	Touch probe 1 position (60BAh)	Touch probe 2 position (60BCh)	Digital inputs (60FDh)

Third PDO Mapping (Cyclic Synchronous Velocity)

RxPDO (1602h)	Controlword (6040h)	Target velocity (60FFh)	Digital outputs (60FEh)

TxPDO (1A02)	Statusword (6041h)	Position actual value (6064h)	Digital inputs (60FDh)

9.4. Synchronization with Distributed Clocks

The synchronization of EtherCAT communications is based on a mechanism called a distributed clock. With the distributed clock, all devices are synchronized with each other by sharing the same reference clock. The slave devices synchronize the internal applications to the Sync0 events that are generated according to the reference clock.

You can use the following synchronization modes with EtherCAT (CoE). You can change the synchronization mode in the Sync Control registers (ESC registers 0x980 and 0x981).

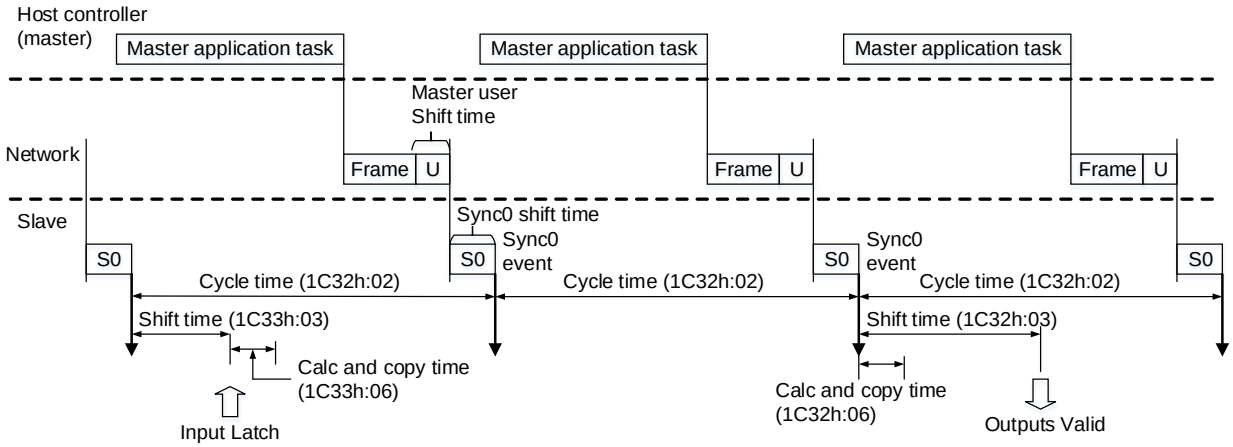
- Free-Run (ESC register 0x980 = 0x0000)

In Free-Run mode, the local cycle is independent from the communications cycle and master cycle.

- DC Mode (ESC register 0x980 = 0x0300)

In this mode, the Servo Driver is synchronized with the host controller (master) on the Sync0 event.

The following figure gives a timing chart for DC synchronization.



Index	Sub-Index	Name	Access	PDO Mapping	Data Type	Description
1C32h	Sync Manager channel 2 (process data output) synchronization					
	1	Synchronization type	RO	No	UINT	Current status of DC mode 0: Free-run 1: DC mode (synchronous with Sync0)
	2	Cycle time	RO	No	UDINT	Sync0 event cycle [ns] (The value is set by the master via an ESC register) Range: 500000 x n (n = 1 to 8)[ns]
	3	Shift time	RO	No	UDINT	The time between the Sync0 event and Outputs Valid (the time from Sync0 until the output is input to the Servo Driver).
	4	Calc and copy time	RO	No	UDINT	The time from the Sync0 event until the output data from Sync Manager 2 is read.
1C33h	Sync Manager channel 3 (process data input) synchronization					
	3	Shift time	RW	No	UDINT	500000 x n (n = 1 to 8)[ns] Range: 0 to (Sync0 event cycle - 500000)[ns] The time between the Sync0 event and Inputs Latch.
	6	Calc and copy time	RO	No	UDINT	The time for copying the input process data to the Sync Manager 3 area.

9.5. Emergency Messages

Emergency messages are triggered by alarms and warnings detected within the Servo Driver. They are sent via the mailbox interface.

An emergency message consists of eight bytes of data as shown in the following table.

Byte	0	1	2	3	4	5	6	7
Description	Emergency error code (FF00h)*1		Error register (object 0x1001)	Reversed	Manufacturer-specific error field			
					Servo Driver alarm/warning code*2		Reversed	

Example Emergency message:

Emergency message	Meaning
FF00,08,00 16 FF 00 00	Error occurs Fault code: FF16h → Encoder Communication Error
FF00,08,00 08 FF 00 00	Error occurs Fault code: FF08h → Main Under Voltage

*1: The manufacturer-specific error code is always FF00h.

*2: For details on Servo Driver alarms, refer to troubleshooting alarm on part 12.1.

10. CiA402 Drive Profile

10.1. Device control

You use the controlword (6040h) to execute device control for the Servo Driver according to the following state transitions. You can use the statusword (6041h) to monitor the device status of the Servo Driver.

10.1.1. State Machine Control Commands

Command	Bits in Controlword (6040h)				
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0
Shutdown	0	-	1	1	0
Switch ON	0	0	1	1	1
Switch ON + enable Operation	0	1	1	1	1
Disable Voltage	0	-	-	0	-
Quick Stop	0	-	0	1	-
Disable Operation	0	0	0	1	1
Enable Operation	0	1	1	1	1
Fault Reset	0 → 1	-	-	-	-

10.1.2. Bits in Statusword (6041h)

Bit	Data Description	Remarks
0	Ready to Switch ON	
1	Switch ON	
2	Operation Enabled	
3	Fault	
4	Voltage Enabled	
5	Quick Stop	
6	Switch ON Disabled	
7	Warning	
8	Active Mode Stop	
9	Remote	
10	Target Reached	
11	Internal Limit Active	
12	Operation Mode Specific	
13		
14	Torque Limit Active	
15	Safety Active	

10.1.3. Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
0x6040	0	Controlword	RW	Yes	-	UINT
0x6041	0	Statusword	RO	Yes	-	UINT
0x605A	0	Quick stop option code	RW	No	-	INT
0x605B	0	Shutdown option code	RW	No	-	INT
0x605C	0	Disable operation option code	RW	No	-	INT
0x605D	0	Halt option code	RW	No	-	INT
0x605E	0	Fault reaction option code	RW	No	-	INT

10.2. Modes of Operation

The Servo Driver supports the following modes of operation.

- Cyclic Sync Position Mode
- Homing Mode

10.2.1. Related Objects

Index	Subindex	Name	Access	PDO mapping	Unit	Data Type
0x6060	0	Modes of operation	RW	Yes	-	SINT
0x6061	0	Modes of operation display	RO	Yes	-	SINT
0x6502	0	Supported drive modes	RO	No	-	UDINT

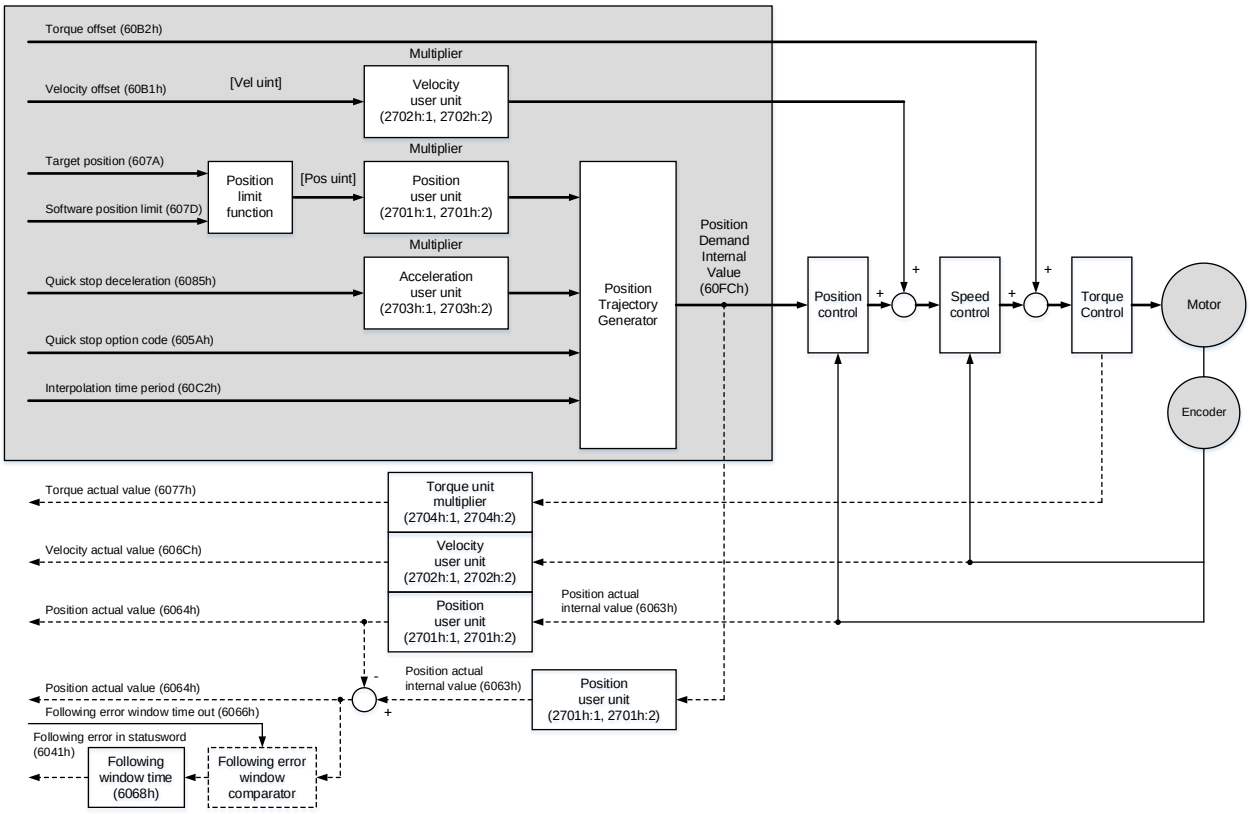
10.3. Position Control Modes

10.3.1. Cyclic Synchronous Position Mode

The Cyclic Synchronous Position Mode is used for the interpolated positioning in the same way as the Interpolated Position Mode. In this mode, speed and torque compensations can be specified by the master to enable speed and torque feedforward.

The interpolation time period defines the interval at which the Target Position is updated. Interpolation is performed in the Servo Driver according to this setting. The target position is interpreted as an absolute value.

The following figure shows the block diagram for the Cyclic Synchronous Position Mode.

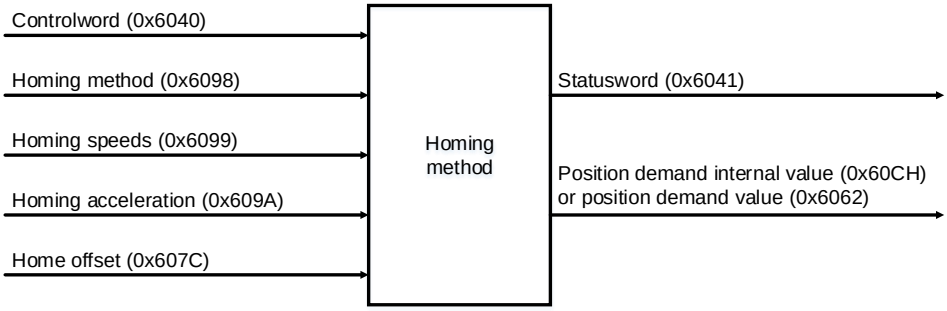


Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
607Ah	0	Target position	RW	Yes	Pos. unit	UINT
607Dh	Software position limit					
	1	Min position limit	RW	No	Pos. unit	DINT
	2	Max position limit	RW	No	Pos. unit	DINT
6084h	0	Profile deceleration	RW	No	Acc. unit	UDINT
6085h	0	Quick stop deceleration	RO	Yes	Acc. unit	DUINT
60B1h	0	Velocity offset	RW	Yes	Vel. unit	UDINT
60B2h	0	Torque offset	RW	Yes	Trq. unit	INT
60C2h	Interpolation time period					
	1	Interpolation time period value	RO	No	-	USINT
	2	Interpolation time index	RO	No	-	SINT

10.4. Homing

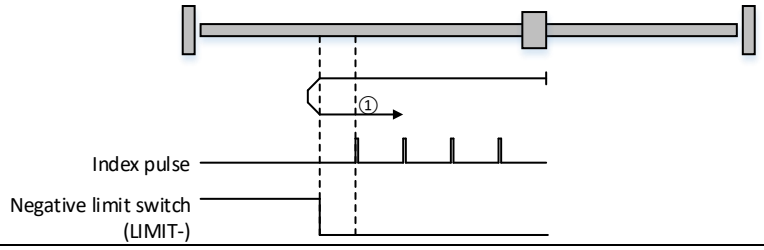
The following figure shows the relationship between the input objects and the output objects in the Homing Mode. You can specify the speeds, acceleration rate, and homing method. You can also use home offset to offset zero in the user coordinate system from the home position.

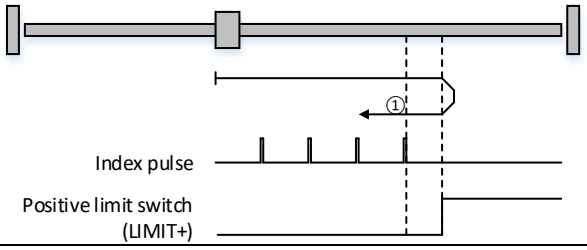
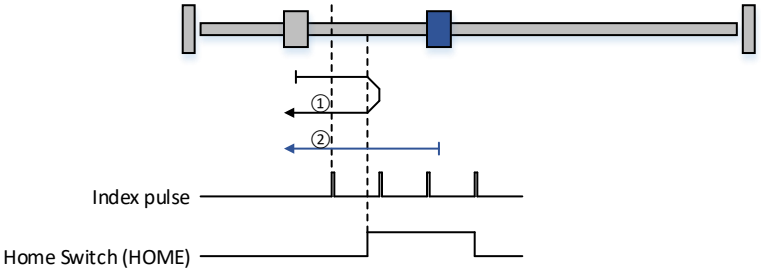
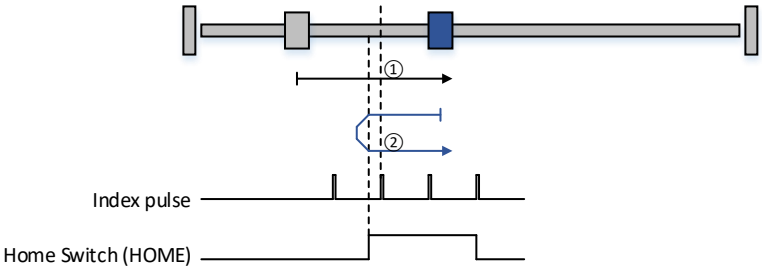
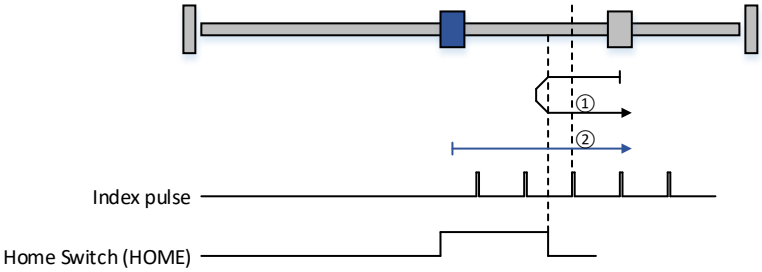
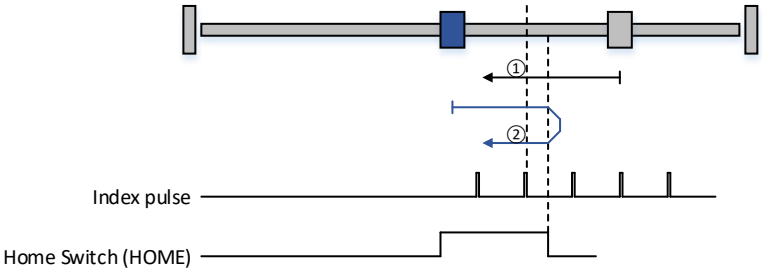


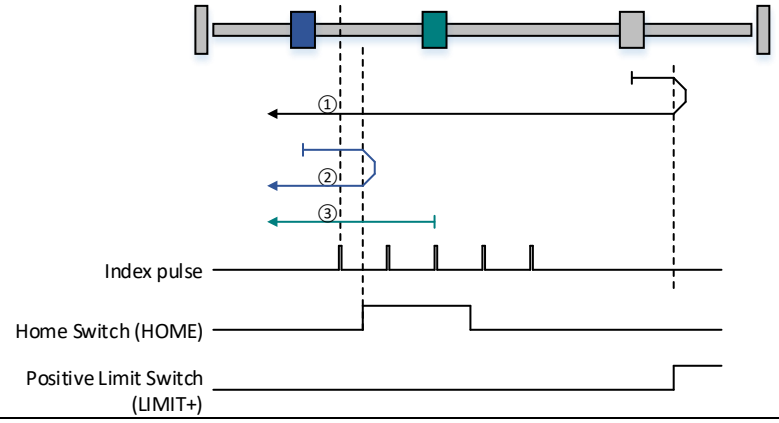
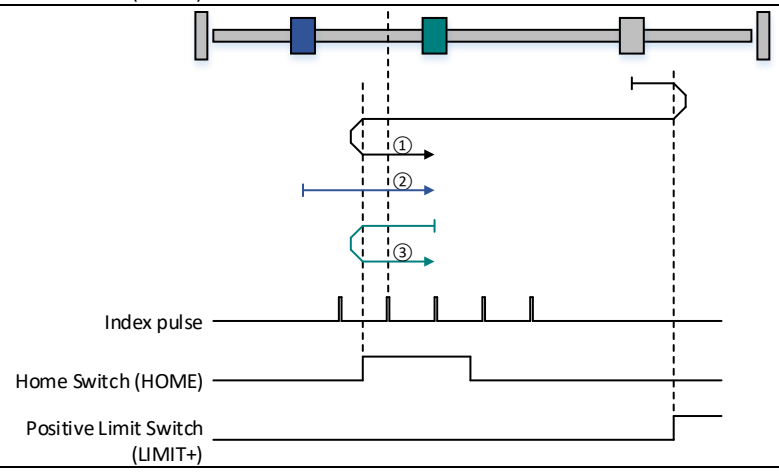
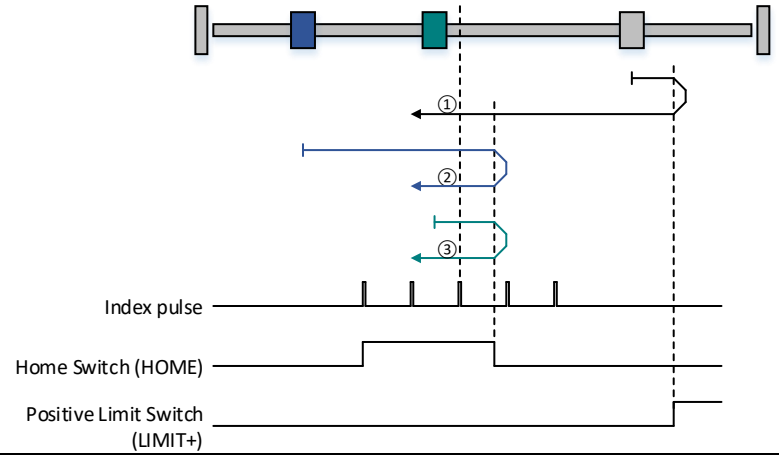
10.4.1. Related Objects

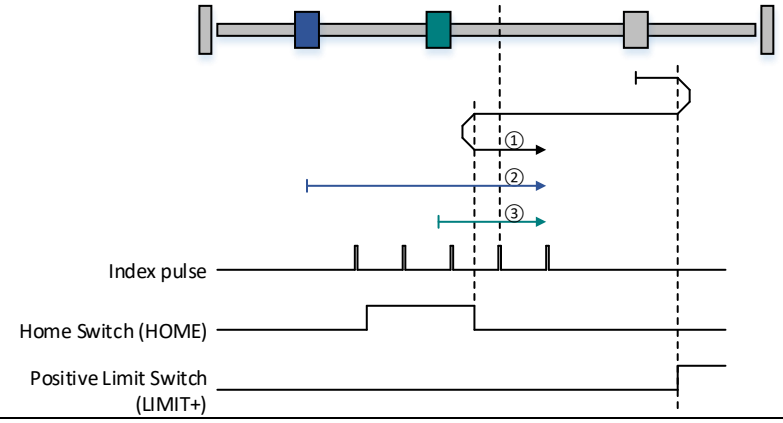
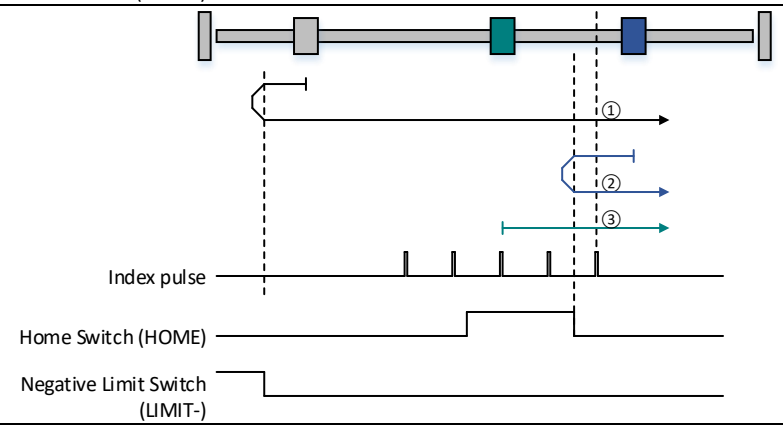
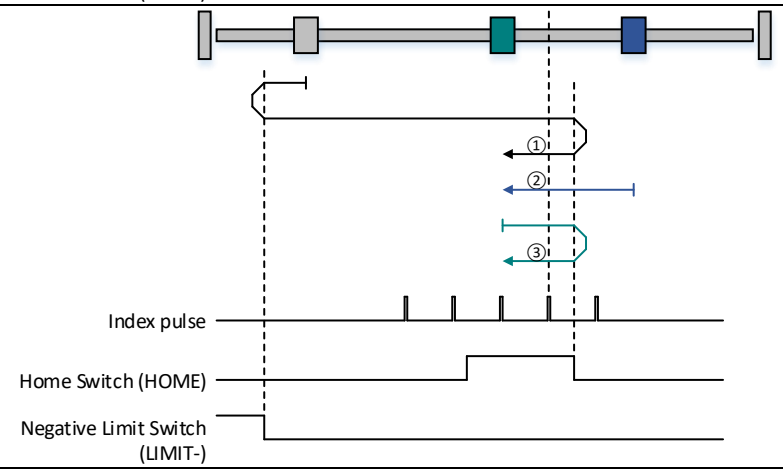
Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6040h	0	Controlword	RW	Yes	-	UINT
6041h	0	Statusword	RO	Yes	-	UINT
607Ch	0	Home offset	RW	No	Pos.Unit	DINT
6098h	0	Homing method	RO	Yes	-	SINT
6099h	Homing speeds					
	1	Speed during search for switch	RW	Yes	Vel. unit	UDINT
	2	Speed during search for zero	RW	Yes	Vel. unit	UDINT
609Ah	0	Homing acceleration	RW	Yes	Acc. unit	UDINT

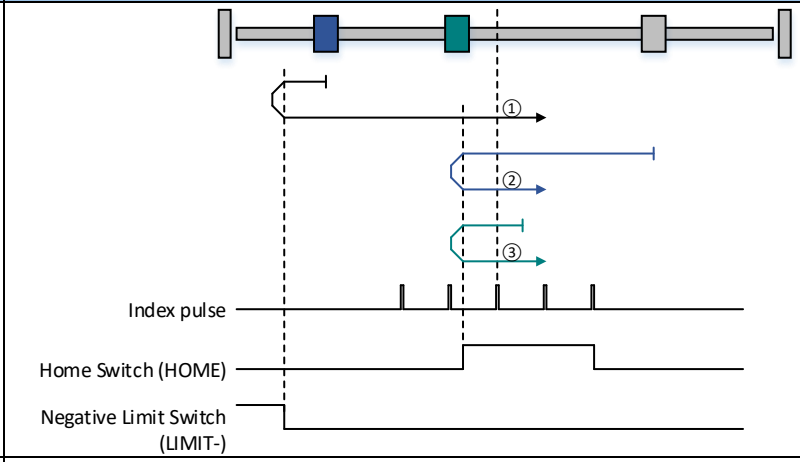
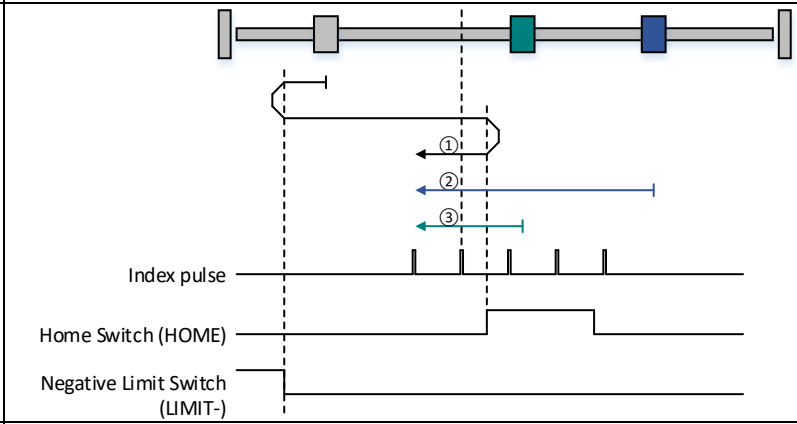
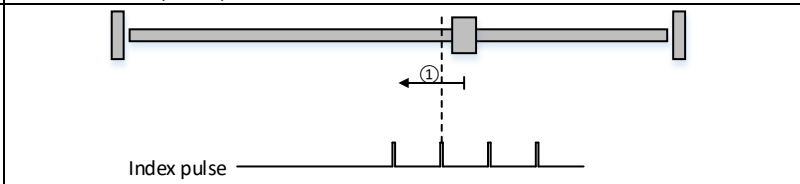
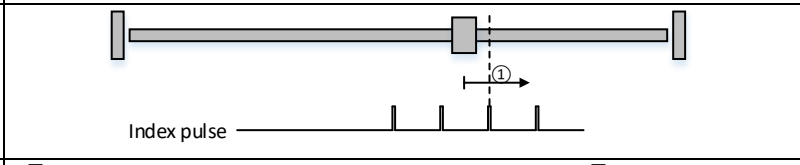
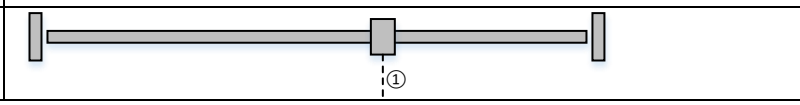
10.4.2. Homing Method (0x6098)

Value	Definition	Description
0	-	No homing (Default setting)
1	Homing with the negative limit switch input (LIMIT+) signal and index pulse	With this method, homing starts in the negative direction if the negative limit switch is inactive. The home position is the first index pulse that is detected after the negative limit switch becomes inactive. 
2	Homing with the positive limit switch input (LIMIT+) signal and index pulse	With this method, homing starts in the positive direction if the positive limit switch is inactive. The home position is the first index pulse that is detected after the positive limit switch becomes inactive.

Value	Definition	Description
		
3	Homing with the home switch input (HOME) signal and index pulse	
4	Homing with the home switch input (HOME) signal and index pulse	
5	Homing with the home switch input (HOME) signal and index pulse	
6	Homing with the home switch input (HOME) signal and index pulse	

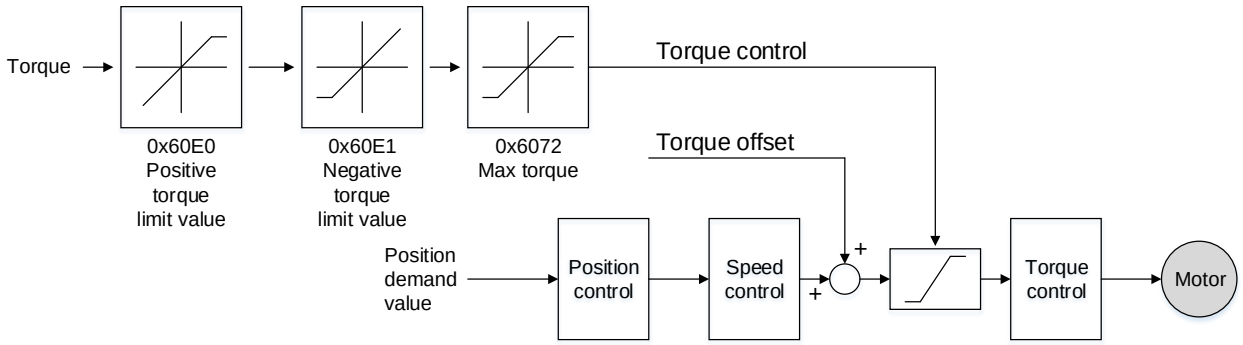
Value	Definition	Description
7	Homing with the home switch input (HOME) signal, the positive limit switch input (LIMIT+) signal and index pulse	
8	Homing with the home switch input (HOME) signal, the positive limit switch input (LIMIT+) signal and index pulse	
9	Homing with the home switch input (HOME) signal, the positive limit switch input (LIMIT+) signal and index pulse	

Value	Definition	Description
10	Homing with the home switch input (HOME) signal, the positive limit switch input (LIMIT+) signal and index pulse	
11	Homing with the home switch input (HOME) signal, the negative limit switch input (LIMIT-) signal and index pulse	
12	Homing with the home switch input (HOME) signal, the negative limit switch input (LIMIT-) signal and index pulse	

Value	Definition	Description
13	Homing with the home switch input (HOME) signal, the negative limit switch input (LIMIT-) signal and index pulse	
14	Homing with the home switch input (HOME) signal, the negative limit switch input (LIMIT-) signal and index pulse	
33	Homing with the index pulse	
34	Homing with the index pulse	
35	Homing in current actual position	

10.5. Torque Limits

The following figure shows the block diagram for the torque limits. The torque is limited by the lowest limit value.



Related Objects

Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
6072h	0	Max torque	RW	Yes	Trq.unit	UINT
60E0h	0	Positive torque limit value	RW	Yes	Trq.unit	UINT
60E1h	0	Negative torque limit value	RW	Yes	Trq.unit	UINT

10.6. Digital I/O Signals

The digital inputs and digital outputs are used to control the I/O signals of the CN1 connector on the Servo Driver.

Index	SubIndex	Name	Access	PDO Mapping	Unit	Data Type
60FDh	0	Digital inputs	RO	Yes	-	UDINT
60FEh	Digital outputs					
	1	Physical outputs	RW	Yes	-	UDINT
	2	Bit mask	RW	No	-	UDINT

10.7. Touch Probe

You can latch the feedback position with the following trigger events.

- Trigger with probe 1 input (Probe 1 Latch Input (/Probe1) signal)
- Trigger with probe 2 input (Probe 2 Latch Input (/Probe2) signal)
- Trigger with encoder zero signal (phase C)

The following two touch probe latches can be used at the same time.

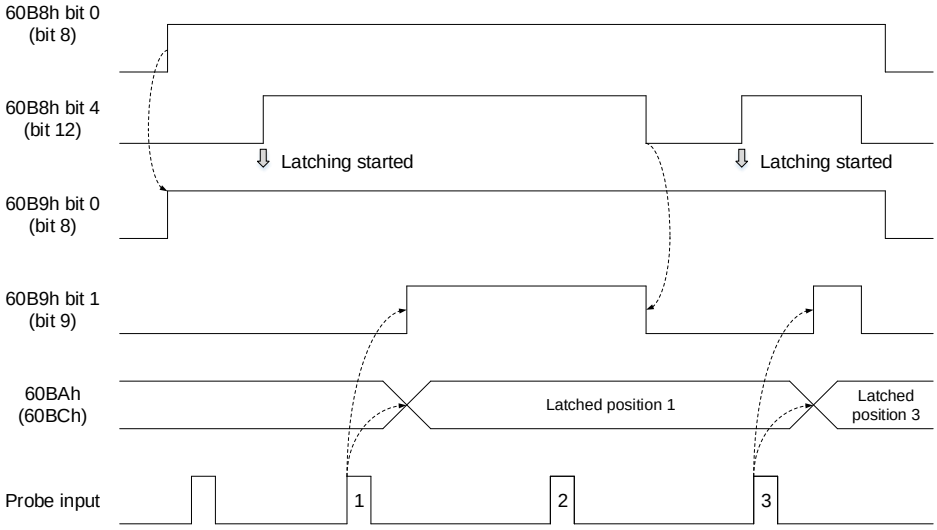
- Touch Probe 1 Latch
  - Latch control object: 60B8h (bits 0 to 7)
  - Latch status object: 60B9h (bits 0 to 7)
  - The latched position is always stored in touch probe 1 position value (60BAh).
  - Trigger signal: Encoder zero signal or /Probe1 signal
- Touch Probe 2 Latch
  - Latch control object: 60B8h (bits 8 to 15)
  - Latch status object: 60B9h (bits 8 to 15)
  - The latched position is always stored in touch probe 2 position value (60BCh).
  - Trigger signal: /Probe2 signal

10.7.1. Related Objects

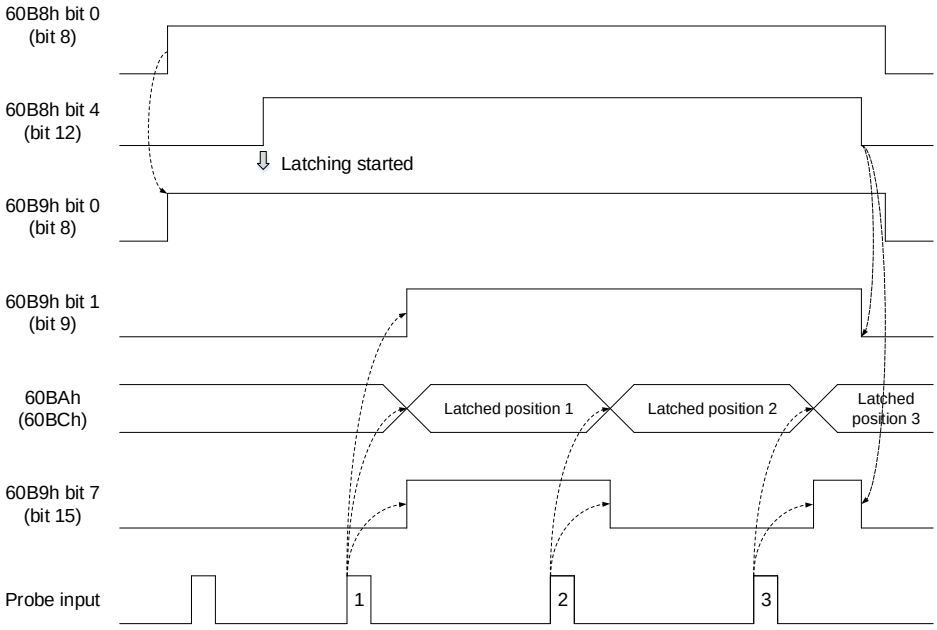
Index	Subindex	Name	Access	PDO Mapping	Unit	Data Type
60B8h	0	Touch probe function	RW	Yes	-	UINT
60B9h	0	Touch probe status	RO	Yes	-	UINT
60Bah	0	Touch probe 1 position value	RO	Yes	Pos.unit	DINT
60BCh	0	Touch probe 2 position value	RO	Yes	Pos.unit	DINT

10.7.2. Example of Execution Procedure for a Touch Probe

- Single Trigger Mode (60B8h bit 1 = 0 or bit 9 = 0)



- Continuous Trigger Mode (60B8h bit 1 = 1 or bit 9 = 1)



11. Object Dictionary

11.1. Object Dictionary List

The following table lists the dictionary objects.

Function Classification	Object Name	Index	Refer to
General Objects	Device type	1000h	13.2
	Error register	1001h	13.2
	Manufacturer device name	1008h	13.2
	Manufacturer software version	100Ah	13.2
	Store parameters	1010h	13.2
	Restore default parameters	1011h	13.2
	Identity object	1018h	13.2
PDO Mapping Objects	Receive PDO mapping	1600h to 1602h	13.3
	Transmit PDO mapping	1A00h to 1A02h	13.3
Sync Manager Communication Objects	Sync manager communication type	1C00h	13.4
	Sync manager PDO assignment	1C12h and 1C13h	13.4
	Sync manager synchronization	1C32h and 1C33h	13.4
	Sync error setting	10F1h	13.4
Manufacturer Specific Objects	Servo Driver parameters	2000h to 26FFh	13.5
	User parameter configuration	2700h	13.5
	Position user unit	2701h	13.5
	Velocity user unit	2702h	13.5
	Acceleration user unit	2703h	13.5
Device Control	Error code	603Fh	13.6
	Controlword	6040h	13.6
	Statusword	6041h	13.6
	Quick stop option code	605Ah	13.6
	Shutdown option code	605Bh	13.6
	Disable operation option code	605Ch	13.6
	Fault reaction option code	605Eh	13.6
	Modes of operation	6060h	13.6
	Modes of operation display	6061h	13.6
	Supported drive modes	6502h	13.6
Homing Mode	Home offset	607Ch	13.7
	Homing method	6098h	13.7
	Homing speeds	6099h	13.7
	Homing acceleration	609Ah	13.7
Position Control Function	Position demand value	6062h	13.8
	Position actual internal value	6063h	13.8
	Position actual value	6064h	13.8
	Position demand internal value	60FCh	13.8

Function Classification	Object Name	Index	Refer to
	Following error window	6065h	13.8
	Following error time out	6066h	13.8
	Following error actual value	60F4h	13.8
	Position window	6067h	13.8
	Position window time	6068h	13.8
Torque Limit Function	Max torque	6072h	13.9
	Positive torque limit value	60E0h	13.9
	Negative torque limit value	60E1h	13.9
Touch Probe Function	Touch probe function	60B8h	13.10
	Touch probe status	60B9h	13.10
	Touch probe 1 position value	60Bah	13.10
	Touch probe 2 position value	60BCh	13.10
Digital Inputs/Outputs	Digital inputs	60FDh	13.11
	Digital outputs	60FEh	13.11

11.2. General Objects

Device type (1000h)

This object contains the device type and functionality.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1000h	0	Device type	UDINT	RO	No	00010000h	No

Error register (1001h)

This object contains the error status of the device. The value of this object is stored as part of an emergency message.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1001h	0	Error register	USINT	RO	No	00h	No

Data Description

Bit	Data	Description
0	Generic error	0: No error, 1: error
1 to 7	Reversed	0: Always 0

Device name (1008h)

This object contains the Servo Driver model name.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1008h	0	Device name	STRING	RO	No	00h	No

Manufacturer hardware version (1009h)

The object contains the hardware version of the Servo Driver

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1009h	0	Manufacturer hardware version	STRING	RO	No	00h	No

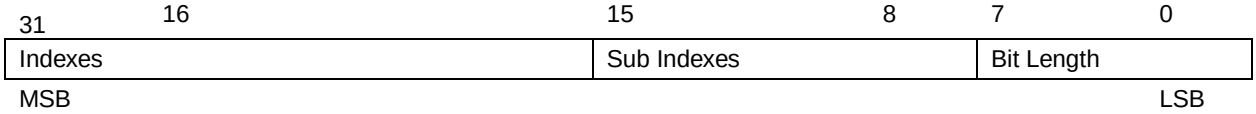
Manufacturer software version (100Ah)

The object contains the software version of the Servo Driver

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
100Ah	0	Manufacturer software version	STRING	RO	No	00	No

11.3. PDO Mapping Objects

Indexes 1600 hex to 17FF hex are used for Receive PDO mapping, and indexes 1A00 hex to 1BFF hex are used for Transmit PDO mapping. Sub-indexes after sub-index 1 provide information about the application object being mapped.



Bits 0 to 7 : Bit length of the mapped object.

(For example, for 32 bits, 20 hex is given.)

Bits 8 to 15 : Sub-index of the mapped object.

Bits 16 to 31 : Index of the mapped object.

The following indexes describes the specific objects by Slave Unit types

Receive PDO Mapping (1600h to 1602h)

- First Receive PDO Mapping

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1600h	0	Number of objects	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to FFFFFFFFh (default: 60400010h)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to FFFFFFFFh (default: 0x607A0020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to FFFFFFFFh (default: 60FF0020h)	Yes
	4	Mapping entry 4	UDINT	RW	No	0 to FFFFFFFFh (default: 60710010h)	Yes
	5	Mapping entry 5	UDINT	RW	No	0 to FFFFFFFFh (default: 60FE0020h)	Yes
	6	Mapping entry 6	UDINT	RW	No	0 to FFFFFFFFh (default: 60B80010h)	Yes
	7 to 8	Mapping entry 7 to Mapping entry 8	UDINT	RW	No	0 to FFFFFFFFh (default: 0)	Yes

- Second Receive PDO Mapping

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1601h	0	Number of objects	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to FFFFFFFFh (default: 60400010h)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to FFFFFFFFh (default: 0x607A0020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to FFFFFFFFh (default: 60FE0020h)	Yes
	4	Mapping entry 4	UDINT	RW	No	0 to FFFFFFFFh (default: 60B80010h)	Yes
	5 to 8	Mapping entry 5 to Mapping entry 8	UDINT	RW	No	0 to FFFFFFFFh (default: 0)	Yes

- Third Receive PDO Mapping

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1602h	0	Number of objects	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to FFFFFFFFh (default: 60400010h)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to FFFFFFFFh (default: 0x60FF0020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to FFFFFFFFh (default: 60FE0020h)	Yes
	4 to 8	Mapping entry 4 to Mapping entry 8	UDINT	RW	No	0 to FFFFFFFFh (default: 0)	Yes

Transmit PDO Mapping (1A00h to 1A02h)

- First Transmit PDO Mapping

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1A00h	0	Number of objects	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to FFFFFFFFh (default: 60410010h)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to FFFFFFFFh (default: 0x60640020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to FFFFFFFFh (default: 60770020h)	Yes
	4	Mapping entry 4	UDINT	RW	No	0 to FFFFFFFFh (default: 60F40020h)	Yes
	5	Mapping entry 5	UDINT	RW	No	0 to FFFFFFFFh (default: 60B90010h)	Yes
	6	Mapping entry 4	UDINT	RW	No	0 to FFFFFFFFh (default: 60BA0020h)	Yes
	7	Mapping entry 5	UDINT	RW	No	0 to FFFFFFFFh (default: 60BC0020h)	Yes
	8	Mapping entry 8	UDINT	RW	No	0 to FFFFFFFFh (default: 60FD0020h)	Yes

- Second Transmit PDO Mapping

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1A01h	0	Number of objects	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to FFFFFFFFh (default: 60410010h)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to FFFFFFFFh (default: 0x60640020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to FFFFFFFFh (default: 60B90010h)	Yes
	4	Mapping entry 4	UDINT	RW	No	0 to FFFFFFFFh (default: 60BA0020h)	Yes
	5	Mapping entry 5	UDINT	RW	No	0 to FFFFFFFFh (default: 60BC0020h)	Yes
	6	Mapping entry 4	UDINT	RW	No	0 to FFFFFFFFh (default: 60FD0020h)	Yes
	7 to 8	Mapping entry 7 to 8	UDINT	RW	No	0 to FFFFFFFFh (default: 0)	Yes

- Third Transmit PDO Mapping

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1A02h	0	Number of objects	USINT	RW	No	0 to 8 (default: 8)	Yes
	1	Mapping entry 1	UDINT	RW	No	0 to FFFFFFFFh (default: 60410010h)	Yes
	2	Mapping entry 2	UDINT	RW	No	0 to FFFFFFFFh (default: 0x60640020)	Yes
	3	Mapping entry 3	UDINT	RW	No	0 to FFFFFFFFh (default: 60FD0020h)	Yes
	4 to 8	Mapping entry 4 to Mapping entry 8	UDINT	RW	No	0 to FFFFFFFFh (default: 0)	Yes

11.4. Sync Manager Communication Objects

Sync manager communication type (1C00h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C00h	0	Number of used Sync Manager channels	USINT	RO	No	04h	Yes
	1	Communication type sync manager 0	USINT	RO	No	1: Mailbox reception (master to slave)	Yes
	2	Communication type sync manager 1	USINT	RO	No	2: Mailbox send (slave to master)	Yes
	3	Communication type sync manager 2	USINT	RO	No	3: Process data output (master to slave)	Yes
	4	Communication type sync manager 3	USINT	RO	No	4: Process data input (slave to master)	Yes

Sync manager PDO assignment (1C12h and 1C13h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C12h	0	Number of objects	USINT	RW	No	0 to 2 (default: 1)	Yes
	1	Index of assigned RxPDO 1	UINT	RW	No	1600h to 1602h (default: 1601h)	Yes
	2	Index of assigned RxPDO 2	UINT	RW	No	1600h to 1602h (default: 0)	Yes
1C13h	0	Number of objects	USINT	RW	No	0 to 2 (default: 1)	Yes
	1	Index of assigned TxPDO 1	UINT	RW	No	1A00h to 1A02h (default: 1A01h)	Yes
	2	Index of assigned TxPDO 2	UINT	RW	No	1A00h to 1A02h (default: 0)	Yes

Sync Manager Synchronization (1C32h and 1C33h)

- Sync Manager 2 (Process Data Output) Synchronization

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C32h	0	Number of synchronization parameters	USINT	RO	No	20h	No
	1	Synchronization type	UINT	RW	No	0: Free-Run 2: DC Sync0	No
	2	Cycle time	UDINT	RO	No	Sync0 event cycle [ns]	No
	4	Synchronization types supported	UINT	RO	No	40300208h	No
	5	Minimum cycle time	UDINT	RO	No	150000 [ns]	No
	6	Calc and copy time	UDINT	RO	No	0 [ns]	No
	8	Get cycle time	UINT	RW	No		No
	9	Delay time	UDINT	RO	No	0 [ns]	No
	10	Sync0 cycle time	UDINT	RW	No	Same as 1C32h:02	No
	11	SM-Event Missed	UINT	RO	No		No
	12	Cycle Time Too Small	UINT	RO	No		No
	31	Sync Error	BOOL	RO	No		No

- Sync Manager 3 (Process Data Input) Synchronization

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
1C33h	0	Number of synchronization parameters	USINT	RO	No	20h	No
	1	Synchronization type	UINT	RW	No	Same as 1C32h:01	No
	2	Cycle time	UDINT	RO	No	Same as 1C32h:02	No
	4	Synchronization types supported	UINT	RO	No	40300208h	No
	5	Minimum cycle time	UDINT	RO	No	Same as 1C32h:05	No
	6	Calc and copy time	UDINT	RO	No	0 [ns]	No
	8	Get cycle time	UINT	RW	No		No
	9	Delay time	UDINT	RO	No	0 [ns]	No
	10	Sync0 cycle time	UDINT	RW	No	Same as 1C32h:10	No
	11	SM-Event Missed	UINT	RO	No		No
	12	Cycle Time Too Small	UINT	RO	No		No
	31	Sync Error	BOOL	RO	No		No

Sync error setting (10F1h)

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
10F1h	0	Number of objects	USINT	RO	No	02h	No
	1	Local error Reaction	UDINT	RW	No	01h	No
	2	Sync Error Counter Limit	UINT	RW	No	04h	Yes

11.5. Manufacturer-Specific Objects

Servo Driver Parameters (2000h to 26FFh)

Objects 2000h to 26FFh are mapped to Servo Driver parameters

User Parameter Configuration (2700h)

Index	Subin -dex	Name	Data type	Acces s	PDO Mapping	Value	Saving to EEPROM
2700h	0	User parameter configuration	UDINT	RW	No	0 to FFFFFFFFh (default:0)	No

This object enables all user parameter settings and initializes all of the position data

If you change any of the following objects and restart operation without turning the power supply OFF and then ON again, you must execute this object to enable the new settings.

- Objects 2701h, 2702h, and 2703h
- Servo Driver parameters that require that the power supply be turned OFF and ON again to enable changes to the parameter settings

- **Procedure**
  1. Change the Servo Driver to the Switch ON Disabled state.
  2. Set the new parameter settings.
  3. Set user parameter configuration (2700h) to 1. The parameter settings will be enabled. After execution, object 2700h will automatically be reset to 0.

Position User Unit (2701h)

This object sets the user-defined position reference unit (Pos. unit).

The user-defined position reference unit is calculated with the following formula.

1 [Pos. unit] = (Numerator/Denominator) [inc]

Index	Subin -dex	Name	Data type	Acces s	PDO Mapping	Value	Saving to EEPROM
2701h	0	Number of entries	USINT	RO	No	2	No
	1	Numerator	UDINT	RW	No	1 to 1073741823 (default: 1)	Yes
	2	Denominator	UDINT	RW	No	1 to 1073741823 (default: 1)	Yes

Setting range: 1/4,096 < Numerator/Denominator < 65,536

(Alarm FF03h will be detected if the setting exceeds the setting range.)

11.6. Device Control

Error Code (603Fh)

This object provides the Servo Driver alarm/warning code of the last error that occurred.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
603Fh	0	Error code	UINT	RO	No	0	No

Controlword (6040h)

This object controls the device and operation mode.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6040h	0	Controlword	UINT	RW	Yes	0 to FFFFh (default: 0)	No

- Controlword Bits

Bit	Function	Description
0	Switch on	Refer to Detail on Bits 0 to 3
1	Enable voltage	
2	Quick stop	
3	Enable Operation	
4 to 6	Operation mode specific	Refer to Detail on Bits 4 to 9
7	Fault reset	0 → 1: Alarm/warning reset
8	Halt	Refer to Detail on Bits 4 to 9
9	Operation mode specific	
10	Reserved	-
11	Positive torque limit	0: Disables torque limit parameter (object 2404h) 1: Enables torque limit parameter (object 2404h)
12	Negative torque limit	0: Disables torque limit parameter (object 2405h) 1: Enables torque limit parameter (object 2405h)
13 to 15	Reserved	-

- Detail on Bits 0 to 3

Bits 0 to 3: These bits function as the control command for the Servo Driver's state.

Command	Controlword Bits				
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0
Shutdown	0	X	1	1	0
Switch on	0	0	1	1	1
Switch on + Enable operation	0	1	1	1	1
Disable voltage	0	X	X	0	X
Quick stop	0	X	0	1	X
Disable operation	0	0	1	1	1
Enable operation	0	1	1	1	1

- Details on Bits 4 to 9

Bits 4, 5, 6, 8, and 9: Homing Mode

Bit	Function	Value	Description
4	Homing operation start	0	Does not start homing
		1	Start or continuous homing
5	-	0	Reserved.
6	-	0	Reserved.
8	Halt	0	Enables bit 4
		1	Stop the axis according to halt option code (605Dh)
9	-	0	Reserved.

Bits 4, 5, 6, 8, and 9: Cyclic Synchronous Position Mode

Bit	Function	Value	Description
4	-	0	Reserved.
5	-	0	Reserved.
6	-	0	Reserved.
8	Halt	0	Executes or continues operation.
		1	Stop the axis according to halt option code (605Dh)
9	-	0	Reserved.

Statusword (6041h)

Statusword contains the bits that give the current state of the Servo Driver and the operating state of the operation mode.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6041h	0	Statusword	UINT	RO	Yes	0	No

- Controlword Bits

Bit	State	Description
0	Ready to switch on	Refer to Detail on Bits 0 to 7
1	Switched on	
2	Operation enabled	
3	Fault	
4	Voltage enabled	
5	Quick stop	
6	Switch on disabled	
7	Warning	
8	Active mode stop	1: Active mode function execution is in progress
9	Remote	*Controlword* (6040h) is being processed
10	Operation mode specific	Refer to Details on Bits 10, 12 and 13.
11	Internal limit value	Refer to Details on Bit 11.
12, 13	Operation mode specific	Refer to Details on Bit 10, 12 and 13.
14	Torque limit active	0: Torque limit is disabled 1: Torque limit is enabled.
15	Reserved	-

- Detail on Bits 0 to 7

Bits 0 to 7: Current State of Servo Driver

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Servo Driver State
X	0	X	X	0	0	0	0	Not ready to switch on
X	1	X	X	0	0	0	0	Switch on disabled
X	0	1	X	0	0	0	1	Ready to switch on
X	0	1	X	0	0	1	1	Switched on
X	0	1	X	0	1	1	1	Operation enabled
X	0	0	X	0	1	1	1	Quick stop active
X	0	X	X	1	1	1	1	Fault reaction active
X	0	X	X	1	0	0	0	Fault
X	X	X	1	X	X	X	X	Main power on
1	X	X	X	X	X	X	X	Warning occurred

- Details on Bit 11

Bit 11: Internal limit active

The internal limit is activated in the following cases:

- The target position was limited by a software limit.
- The N-OT or P-OT signal was activated.
- The interpolation speed was exceeded in Cyclic Position Mode.

- Details on Bits 10, 12, and 13

Bits 10, 12, and 13: Homing Mode

Bit 13	Bit 12	Bit 10	Description
Homing error	Homing attained	Target reached	
0	0	0	Homing is in progress
0	0	1	Homing was interrupted or has not yet started
0	1	0	Home has been defined, but the operation is still in progress
0	1	1	Homing was completed normally
1	0	0	A homing error occurred and the speed is not 0.
1	0	1	A homing error occurred and the speed is 0.

Bits 10, 12, and 13: Cyclic Synchronous Position Mode

Bit	State	Value	Description
10	Target reached	0	The target position has not been reached.
		1	The target position was reached.
12	Target value ignored	0	The target value position was ignored.
		1	The target value will be used as the input to the position control loop.
13	Following error	0	There is no following error.
		1	A following error occurred.

Quick Stop Option Code (605Ah)

This object determines what operation will be performed if a Quick Stop is executed.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
605Ah	0	Quick stop option code	INT	RW	No	0 to 3 (default: 2)	Yes

- Data Description

Value	Description
0	Disables the Servo Driver (moves to the Switch ON Disabled state).
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the switch ON Disabled state.
2	Decelerates at the deceleration rate for a quick stop and moves to the Switch ON Disables state.
3	Decelerates at the torque limit and moves to the Switch IN Disabled state.

Shutdown Option Code (605Bh)

This object defines the operation that is performed if there is a move from Operation Enable state to Ready to Switch ON state.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
605Bh	0	Shutdown option code	INT	RW	No	0 to 1 (default: 0)	Yes

- Data Description

Value	Description
0	Disables the Servo Driver (moves to the Switch ON Disabled state).
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Switch ON Disabled state

Disable Operation Option Code (605Ch)

This object defines the operation that is performed if there is a move from Operation Enable state to Switched ON state.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
605Ch	0	Disable operation option code	INT	RW	No	0 to 1 (default: 1)	Yes

- Data Description

Value	Description
0	Disables the Servo Driver (moves to the Switch ON Disabled state).
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Switch ON Disabled state

Halt Option Code (605Dh)

This object defines the operation that is performed if bit 8 (Halt) in *controlword* is active.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
605Dh	0	Halt option code	INT	RW	No	0 to 3 (default: 1)	Yes

- Data Description

Value	Description
1	Decelerates at the deceleration rate for decelerating to a stop and moves to the Operation Enabled state.
2	Decelerates at the deceleration rate for a quick stop and moves to the Operation Enabled state.
3	Decelerates at the torque limit and moves to the Operation Enabled state.

Fault Reaction Option Code (605Eh)

This object defines the operation that is performed when an alarm is detected in the Servo Driver system.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
605Dh	0	Fault reaction option code	INT	RW	No	0	Yes

- Data Description

Value	Description
0	Disables the Servo Driver. (Turn OFF the servo.)

Modes of Operation (6060h)

This object is used to select the operation mode. The Servo Driver gives the actual operation mode in the modes of operation display object.

- Data Description

Value	Description
0	There is no mode change or no mode assigned.
6	Homing Mode
8	Cyclic Sync Position Mode
Other value	Reserved (continue previous mode).

Modes of Operation Display (6061h)

This object gives the current mode of operation.

The values that are returned are the same as the object codes for *modes of operation* (6060h).

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6061h	0	Modes of operation display	SINT	RO	Yes	-	No

Supported Drive Modes (6502h)

This object gives the operation modes that are supported by the device.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6502h	0	Supported drive modes	UDINT	RO	no	-	No

- Data Description

Value	Description	Definition
0	Pp (Profile position mode)	0: Not supported
1	Vl (Velocity mode)	0: Not supported
2	Pv (Profile velocity mode)	0: Not supported
3	Tq (Torque profile mode)	0: Not supported
4	Reserved.	0
5	Hm (Homing mode)	1: Supported
6	Ip (Interpolated position mode)	0: Not supported
7	Csp (Cyclic sync position mode)	1: Supported
8	Csv (Cyclic sync velocity mode)	0: Not supported
9	Cst (Cyclic sync torque mode)	0: Not supported
10 to 31	Reserved	0

11.7. Homing Mode

Home Offset (607Ch)

This object contains the offset between the zero position for the application and the machine home position (found during homing).

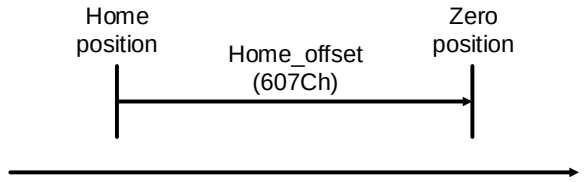
Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
607Ch	0	Home offset	DINT	RW	No	-536870912 to 536870911 (default: 0) [Pos. unit]	Yes

- Incremental Encoder

The machine home position is found during homing. After homing is completed, the zero position is offset from the home position by adding the home offset to the home position.

- Absolute Encoder

If an absolute encoder is connected to the Servo Driver, the home offset is added to the encoder absolute position when the power supply to the Servo Driver is turned ON.



Homing Method (6098h)

This object specifies the homing method. Refer to the following section for details on the operations that are performed.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6098h	0	Home method	SINT	RW	Yes	0 to 35 (default: 0)	Yes

- Data Description

Value	Description
0	Homing is disabled
1	Homing with the negative limit switch and index pulse
2	Homing with the positive limit switch and index pulse
3 to 14	Homing with the home switch and index pulse
33 or 34	Homing with index pulse
35	Homing with the current position

Homing Speeds (6099h)

This object defines the speeds that are used during homing. The speeds are given in user speed reference units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6099h	0	Number of entries	USINT	RO	No	2	No
	1	Speed during search for switch	UDINT	RW	Yes	0 to 4294967295 (default: 500000) [Vel. unit]	Yes
	2	Speed during search for zero	UDINT	RW	Yes	0 to 4294967295 (default: 500000) [Vel. unit]	Yes

Homing Acceleration (609Ah)

This object defines the acceleration that is used during homing. The rate is given in user acceleration reference units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
609Ah	0	Homing acceleration	UDINT	RW	Yes	0 to 4294967295 (default: 1000) [Acc. unit]	Yes

11.8. Position Control Function

Position Demand Value (6062h)

This object specifies the current reference position in user position reference units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6062h	0	Position demand value	DINT	RO	Yes	[Pos. unit]	No

Position Actual Internal Value (6063h)

This object gives the current feedback position in encoder pulse units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6063h	0	Position actual internal value	DINT	RO	Yes	[inc]	No

Position Actual Value (6064h)

This object gives the current feedback position in user position reference units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6064h	0	Position actual value	DINT	RO	Yes	[Pos. unit]	No

Position Demand Internal Value (60FCh)

This object gives the output of the trajectory generator during position control (the position that is input to the position loop). The value is given in encoder pulses.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60FCh	0	Position demand internal value	DINT	RO	Yes	[inc]	No

Following Error Window (6065h)

This object defines the detection range for the following error (bit 13 of statusword).

If the position deviation exceeds the following error window for the following error time out (6066h), bit 13 in statusword changes to 1 to indicate following error. A following error can occur when the Servo Driver is blocked, when the profile speed is too high, or when the gain settings are not correct.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6065h	0	Following error window	UDINT	RW	Yes	0 to 1073741823 (default: 5,242,880) [Pos. unit]	Yes

Following Error Time Out (6066h)

If the position deviation exceeds the following error window for the time specified in this object, bit 13 in statusword changes to 1 to indicate following error.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6066h	0	Following error time out	UINT	RW	No	0 to 65535 (default: 0) [ms]	Yes

Following Error Actual Value (60F4h)

This object provides the current following error.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60F4h	0	Following error actual value	DINT	RO	Yes	[Pos. unit]	No

Position Window (6067h)

This object defines the positioning completed width for the target position. When the Servo Driver has completed outputting the reference to the target position and the time specified in position window time (6068h) has passed after the distance between the target position and the position actual value is within the value of this object, bit 10 (target reached) in statusword changes to 1.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6067h	0	Position window	UDINT	RW	No	0 to 1073741823 (default: 30) [Pos. unit]	Yes

Position Window Time (6068h)

When the Servo Driver has completed outputting the reference to the target position and the time specified in this object has passed after the distance between the target position and the position actual value is within the position window (6067h), bit 10 (target reached) in statusword changes to 1.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6068h	0	Position window time	UINT	RW	No	0 to 65535 (default: 0) [ms]	Yes

11.9. Torque Limit Function

Max torque (6072h)

This object sets the maximum output torque for the motor in user-defined torque reference units.

The maximum motor torque is automatically set in this object in units of 0.1% of the motor rated torque when the power is turned ON.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
6072h	0	Max torque	UINT	RW	Yes	0 to 65535 (default: maximum motor torque) [Trq. unit]	Yes

Positive Torque Limit Value (60E0h)

This object sets the positive torque limit in user-defined torque reference units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60E0h	0	Positive torque limit value	UINT	RW	Yes	0 to 65535 (default: 2000) [Trq. unit]	Yes

Negative Torque Limit Value (60E1h)

This object sets the negative torque limit in user-defined torque reference units.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60E1h	0	Negative torque limit value	UINT	RW	Yes	0 to 65535 (default: 2000) [Trq. unit]	Yes

11.10. Touch Probe Function

Touch Probe Function (60B8h)

This object sets the touch probes

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60B8h	0	Touch probe function	UINT	RW	Yes	0 to FFFFh (default: 0)	No

- Data Description

Bit	Value	Description
0	0	Disable touch probe 1
	1	Enable touch probe 1
1	0	Single Trigger Mode (Latches the position at the first trigger event)
	1	Continuous Trigger Mode (Latches the position every trigger event)
2	0	Triggers on probe 1 input
	1	Trigger on encoder zero signal (phase Z)
3	-	Reserved
4	0	Stops sampling at touch probe 1
	1	Start sampling at touch probe 1
5 to 7	-	Reserved
8	0	Disable touch probe 2
	1	Enable touch probe 2
9	0	Single Trigger Mode (Latches the position at the first trigger event)
	1	Continuous Trigger Mode (Latches the position every trigger event)
10	0	Triggers on probe 2 input
	1	Trigger on encoder zero signal (phase Z)
11	-	Reserved
12	0	Stops sampling at touch probe 2
	1	Start sampling at touch probe 2
13 to 15	-	Reserved

Touch Probe Status (60B9h)

This object gives the status of the touch probes.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60B9h	0	Touch probe status	UINT	RO	Yes	-	No

- Data Description

Bit	Value	Description
0	0	Touch probe 1 is disabled.
	1	Touch probe 1 is enabled.
1	0	No latched position is stored for touch probe 1
	1	A latch position is stored for touch probe 1
2 to 6	-	Reserved
7	0 or 1	Saving the latched position for Continuous Trigger Mode for touch probe 1 was completed. * (Status toggles every time a position is latched.)
8	0	Touch probe 2 is disabled.
	1	Touch probe 2 is enabled.
9	0	
	1	
10 to 14	-	Reserved
15	1	Saving the latched position for Continuous Trigger Mode for touch probe 2 was completed. * (Status toggles every time a position is latched.)

* If the continuous latch is enabled (60B8h bit 1 = 1 or bit 9 = 1), bit 7 or bit 15 of object 60B9h is toggled every time the latched position is updated.

Touch Probe 1 Position Value (60BAh)

This object gives the latched position for touch probe 1. The value is given in user position units (Pos. unit).

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60BAh	0	Touch probe 1 position value	DINT	RO	Yes	[Pos. unit]	No

Touch Probe 2 Position Value (60BCh)

This object gives the latched position for touch probe 1. The value is given in user position units (Pos. unit).

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60BCh	0	Touch probe 2 position value	DINT	RO	Yes	[Pos. unit]	No

11.11. Digital Inputs/Outputs

Digital Inputs (60FDh)

This object gives the status of the digital inputs to CN1 on the Servo Driver

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60FDh	0	Digital inputs	UDINT	RO	Yes	-	No

- Data Description

Bit	Signal	Description
0	DI0	0: OFF, 1: ON
1	DI1	0: OFF, 1: ON
2	DI2	0: OFF, 1: ON
3	DI3	0: OFF, 1: ON
4	DI4	0: OFF, 1: ON
5	DI5	0: OFF, 1: ON
6 to 31	-	Reserved

Digital Outputs (60FEh)

This object controls the status of the general-purpose output signals (SO1 to SO3) from CN2 on the Servo Driver.

Index	Subin -dex	Name	Data type	Access	PDO Mapping	Value	Saving to EEPROM
60FDh	0	Number of entries	USINT	RO	No	-	No
	1	Physical outputs*1	UDINT	RW	Yes	0 to FFFFFFFFh (default: 0)	No
	2	Bit mask*2	UDINT	RW	No	0 to FFFFFFFFh (default: 0Fh)	Yes

*1. Data Description of Physical Outputs:

Bit	Signal	Description
0	OUT1	0: OFF, 1: ON
1	OUT2	0: OFF, 1: ON
2	OUT3	0: OFF, 1: ON
3	OUT4	0: OFF, 1: ON
3 to 31	-	Reserved

*2. Data Description of Bit Masks:

Bit	Signal	Description
0	OUT1	0: Disables physical output 1: Enables physical output
1	OUT2	0: Disables physical output 1: Enables physical output
2	OUT3	0: Disables physical output 1: Enables physical output
3	OUT4	0: Disables physical output 1: Enables physical output
4 to 31	-	Reserved

12. Maintenance

12.1. Alarm Displays

If an error occurs in the Servo Driver, a Red LED in Driver Status will be turn ON. This section provides a list of the alarms that may occur and the causes of and corrections for those alarms

12.1.1. List of Alarms

The following alarm tables gives the alarm name, alarm meaning, and alarm reset possibility in order of the alarm codes.

Alarm Reset Possibility

Yes: You can use an alarm reset to clear the alarm. However, this assumes that the cause of the alarm has been removed.

No: You cannot clear the alarm.

List of Alarms

Alarm Code	Alarm Name	Descriptions	Alarm Reset Possible?
FF01h	Parameter Checksum Error	There is an error in the parameter data in the Servo Driver.	No
FF02h	Driver initialization failed	Initialization failed when the power supply was turned ON.	No
FF03h	Parameter Setting Error	A parameter setting is outside of the setting range.	Yes
FF04h	Invalid Servo ON Command Alarm	The Servo ON command (Enable Operation command) was sent from the host controller after a utility function that turns ON the Servomotor was executed.	Yes
FF05h	Overcurrent Detected	An overcurrent flowed through the power transformer or the heat sink overheated.	Yes
FF06h	IPM Error Protection	An Error occurred in Intelligent Power Module	Yes
FF07h	Main Over voltage	The main circuit DC voltage is too high.	Yes
FF08h	Main Under voltage	The main circuit DC voltage is too low.	Yes
FF09h	Motor Over Speed	The motor exceeded the maximum speed.	Yes
FF0Ah	Maximum Speed Setting Error	The setting of Maximum Motor Speed is greater than the maximum speed	Yes
FF0Bh	Instantaneous Overload	The Servomotor was operating for several seconds to several tens of seconds under a torque that largely exceeded the rating.	Yes
FF0Ch	Continuous Overload	The Servomotor was operating continuously under a torque that exceeded the rating.	Yes
FF0Dh	Internal Temperature Sensor Error	The surrounding temperature of the control PCB is abnormal.	Yes
FF0Eh	Servo Driver Built-in Fan Stopped	The fan inside the Servo Driver stopped	No
FF0Fh	Overheat Alarm	The input voltage (temperature) for the overheat protection input (TH) signal exceeded the setting of Pn61B (261Bh) (Overheat Alarm Level).	Yes
FF10h	Servomotor Out of Control	The Servomotor ran out of control.	Yes
FF11h	Position Deviation Overflow	The setting of Position Deviation Overflow Alarm Level (2520h) was exceeded by the position deviation while the servo was ON.	Yes

Alarm Code	Alarm Name	Descriptions	Alarm Reset Possible?
FF12h	Position Deviation Overflow Alarm at Servo ON	The servo was turned ON after the position deviation exceeded the setting of Position Deviation Overflow Alarm Level at Servo ON while the servo was OFF.	Yes
FF13h	Current Detection Error 1	The Current detection circuit for phase U is faulty	No
FF14h	Current Detection Error 2	The Current detection circuit for phase V is faulty	No
FF15h	Control Voltage Fault	The control voltage is Fault	No
FF16h	Encoder Communication Error	Communications between the encoder and Servo Driver is not possible.	Yes
FF17h	Encoder Overspeed (Detected at the encoder when the control power supply is turned ON.)	The encoder was operating at high speed when the power was turned ON.	No
FF18h	Encoder Full Absolute Status		
FF19h	Encoder Counting Error		
FF1Ah	Encoder Counter Overflow		
FF1Bh	Encoder Over Heat	The internal temperature of encoder is too high.	No
FF1Ch	Encoder Backup Alarm (Detected at the encoder, but only when an absolute encoder is used.)	The power supplies to the encoder all failed and the position data was lost.	No
FF1Dh	Encoder Battery Error		
FF1Eh	Encoder Battery Alarm (The absolute encoder battery voltage was lower than the specified level.)	The battery voltage was lower than the specified level after the control power supply was turned ON.	No
FF1Fh	Software Error	An error occurs in communication between Servo Driver and Software	Yes
FF20h	ESM requirements during operation error protection	When a PDS state was "Operation enabled" or "Quick stop active", the transition command to other ESM state was received	Yes
FF20h	EtherCAT DC Synchronization Error	The Servo Driver and Sync0 events cannot be synchronized.	Yes
FF21h	EtherCAT State Error	The EtherCAT AL does not move to the Operational state when the DS402 drive is in Operation Enabled state.	Yes
FF22h	EtherCAT Output Data Synchronization Error	The process data reception events and Sync0 events cannot be synchronized. (Process data communications failed.)	Yes
FF23h	EtherCAT Internal Synchronization Error 1	A synchronization error occurred during Ether- CAT communications with the Servo Driver.	Yes
FF24h	EtherCAT Module Interface Communications Data Error	There is an error in the communications data between the Servo Driver and the EtherCAT Module.	Yes

12.1.2. Troubleshooting Alarms

The causes of and corrections for the alarms are given in the following table. Contact us if you cannot solve a problem with the correction given in the table.

Error Code: Error Name	Possible Cause	Confirmation	Correction
FF01h: Parameter Checksum Error: (There is an error in the parameter data in the Servo Driver.)	The power supply voltage suddenly dropped	Measure the control power supply voltage	Set the power supply voltage within the specified range, and initialize the parameter settings.
	The power supply was shut OFF while writing parameter settings	-	Initialize the parameter settings and then set the parameters again.
	A malfunction was caused by noise from the main DC power supply, ground, static electricity, or other source.	Turn the control power supply to the Servo Driver OFF and ON again. If the alarm still occurs, noise may be the cause.	Implement countermeasures against noise.
	Gas, water drops, or cutting oil entered the Servo Driver and caused failure of the internal components.	Check the installation conditions.	The Servo Driver may be faulty. Replace the Servo Driver.
	A failure occurred in the Servo Driver.	Turn the power supply to the Servo Driver OFF and ON again. If the alarm still occurs, the Servo Driver may have failed.	The Servo Driver may be faulty. Replace the Servo Driver.
FF03h: Parameter Setting Error (A parameter setting is outside of the setting range.)	A malfunction was caused by noise or not stable	Turn the control power supply to the Servo Driver OFF and ON again. If the alarm still occurs, noise may be the cause.	Implement countermeasures against noise.
	A failure occurred in the Servo Driver.	Turn the power supply to the Servo Driver OFF and ON again. If the alarm still occurs, the Servo Driver may have failed.	The Servo Driver may be faulty. Replace the Servo Driver.
	The position unit is outside of the setting range.	Make sure it is within the following range. 1/4,096 < Numerator (2701h: 1)/Denominator (2701h: 2) < 65,536	Correct the setting of position user unit (2701h).
	The speed unit is outside of the setting range.	Make sure it is within the following range. 1/128 ≤ Numerator (2702h: 1)/Denominator (2702h: 2) ≤ 8,388,608	Correct the setting of velocity user unit (2702h).
	The acceleration unit is outside of the setting range.	Make sure it is within the following range. 1/128 ≤ Numerator (2703h: 1)/Denominator (2703h: 2) ≤ 262,144	Correct the setting of acceleration user unit (2703h).
	Another parameter setting is outside of the setting range.	Check the setting ranges of the parameters that have been changed.	Set the parameters to values within the setting ranges.

Error Code: Error Name	Possible Cause	Confirmation	Correction
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
FF04h: Invalid Servo ON Command Alarm	The Servo ON command (Enable Operation command) was sent from the host controller after a utility function that turns ON the Servomotor was executed	-	Turn the power supply to the Servo Driver OFF and ON again. Or, execute a software reset.
FF05h: Overcurrent Detected (An overcurrent flowed through the power transformer or the heat sink overheated.)	The Main Circuit Cable is not wired correctly or there is faulty contact.	Check the wiring.	Correct the wiring.
	There is a short-circuit or ground fault in a Main Circuit Cable.	Check for short-circuits across Servomotor phases U, V, and W, or between the ground and Servomotor phases U, V, and W.	The cable may be short-circuited. Replace the cable.
	There is a short circuit or ground fault inside the Servomotor.	Check for short-circuits across the Servomotor connection terminals U, V and W on Servo Driver, or between the ground and terminals U, V, or W.	The Servo Driver may be faulty. Replace the Servo Driver.
	A heavy load was applied while the Servomotor was stopped or running at a low speed.	Check to see if the operating conditions exceed Servo Driver specifications.	Reduce the load applied to the Servomotor. Or, increase the operating speed.
	A malfunction was caused by noise.	Improve the noise environment, e.g. by improving the wiring or installation conditions, and check to see if the alarm still occurs.	Implement countermeasures against noise, such as correct wiring of the FG. Use an FG wire size equivalent to the Servo Driver's main circuit wire size.
	A failure occurred in the Servo Driver.	-	Turn the power supply to the Servo Driver OFF and ON again. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.
FF06h: IPM Fault Protection			
FF07h: Main Overvoltage (Detected in the main circuit power supply section of the Servo Driver.)	The DC power supply voltage exceeded the specified range.	Measure the power supply voltage.	Set the DC power supply voltage within the specified range.
	The power supply is not stable or was influenced by a lightning surge.	Measure the power supply voltage.	Improve the power supply conditions, install a surge absorber, and then turn the power supply OFF and ON again. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.

Error Code: Error Name	Possible Cause	Confirmation	Correction
	The voltage for DC power supply was too high during acceleration or deceleration.	Check the power supply voltage and the speed and torque during operation.	Set the DC power supply voltage within the specified range.
	A failure occurred in the Servo Driver.	-	While the main circuit power supply is OFF, turn the control power supply to the Servo Driver OFF and ON again. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.
FF08h: Main Undervoltage (Detected in the main circuit power supply section of the Servo Driver.)	The power supply voltage went below the specified range.	Measure the power supply voltage.	Set the power supply voltage within the specified range.
	The power supply voltage dropped during operation.	Measure the power supply voltage.	Increase the power supply capacity.
	The Servo Driver fuse is blown out.	-	Replace the Servo Driver.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
FF09h: Motor Overspeed (The motor exceeded the maximum speed.)	The order of phases U, V, and W in the motor wiring is not correct.	Check the wiring of the Servomotor.	Make sure that the Servomotor is correctly wired.
	A reference value that exceeded the overspeed detection level was input.	Check the input reference.	Reduce the reference value. Or, adjust the gain.
	The motor exceeded the maximum speed.	Check the waveform of the motor speed.	Reduce the speed reference input gain and adjust the servo gain. Or, reconsider the operating conditions.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
FF0A: Maximum Speed Setting Error			
FF0Bh: Instantaneous Overload FF0Ch: Continuous Overload	The wiring is not correct or there is a faulty contact in the motor or encoder wiring.	Check the wiring.	Make sure that the Servomotor and encoder are correctly wired.
	Operation was performed that exceeded the overload protection characteristics.	Check the motor overload characteristics and Run command.	Reconsider the load and operating conditions. Or, increase the motor capacity.
	An excessive load was applied during operation because the Servomotor was not driven due to mechanical problems.	Check the operation reference and motor speed.	Correct the mechanical problem.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
FF0Dh:	The surrounding temperature is too high.	Check the surrounding temperature of Servo	Decrease the surrounding temperature by improving

Error Code: Error Name	Possible Cause	Confirmation	Correction
Internal Temperature Error 1 (Control Board Temperature Error)		Driver installation environment.	the Servo Driver installation conditions.
	An overload alarm was reset by turning OFF the power supply too many times.	Check the alarm display to see if there is an overload alarm.	Change the method for resetting the alarm.
	The Servo Driver installation orientation is not correct or there is insufficient space around the Servo Driver.	Check the Servo Driver installation conditions.	Install the Servo Driver according to specifications.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
FF0Eh: Servo Driver Built-in Fan Stopped	The fan inside the Servo Driver stopped.	Check for foreign matter inside the Servo Driver	Remove foreign matter from the Servo Driver. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.
FF0Fh: Servo Driver Overheat	The surrounding temperature is too high.	Check the surrounding temperature using a thermostat.	Lower the surrounding temperature by improving the installation conditions of the machine.
	Operation was performed under an excessive load.	Check the load during operation.	Reconsider the load and operating conditions.
	The Servo Driver installation orientation is not correct or there is insufficient space around the Servo Driver.	Check the Servo Driver installation conditions.	Install the Servo Driver according to specifications.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
FF10h: Servomotor Out of Control (Detected when the servo is turned ON.)	The order of phases U, V, and W in the motor wiring is not correct.	Check the Servomotor wiring.	Make sure that the Servomotor is correctly wired.
	A failure occurred in the encoder.	-	If the motor wiring is correct and an alarm still occurs after turning the power supply OFF and ON again, the Servomotor may be faulty. Replace the Servomotor.
	A failure occurred in the Servo Driver.	-	Turn the power supply to the Servo Driver OFF and ON again. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.
FF11h: Position Deviation Overflow (The setting of Position Error Alarm Level was exceeded by the position deviation while the servo was ON.)	The Servomotor U, V, and W wiring is not correct.	Check the wiring of the Servomotor's Main Circuit Cables.	Make sure that there are no faulty contacts in the wiring for the Servomotor and encoder.
	The position command speed is too fast.	Reduce the position command speed and try operating the Servo Driver.	Reduce the position reference speed or the reference acceleration

Error Code: Error Name	Possible Cause	Confirmation	Correction
			rate, or reconsider the electronic gear ratio.
	The acceleration of the position reference is too high.	Reduce the reference acceleration and try operating the Servo Driver.	Reduce the acceleration of the position reference using an EtherCAT command.
	The setting of Position Deviation Overflow Alarm Level is too low for the operating conditions.	Check the setting of 2520h to see if it is appropriate.	Optimize the setting of 2520h.
	A failure occurred in the Servo Driver.	-	Turn the power supply to the Servo Driver OFF and ON again. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.
Encoder Backup Alarm (Detected at the encoder, but only when an absolute encoder is used.)	The power to the absolute encoder was turned ON for the first time.	Check to see if the power supply was turned ON for the first time.	Set up the encoder.
	The Encoder Cable was disconnected and then connected again.	Check to see if the power supply was turned ON for the first time.	Check the encoder connection and set up the encoder.
	Power is not being supplied both from the control power supply (+5 V) from the Servo Driver and from the battery power supply.	Check the encoder connector battery and the connector status.	Replace the battery or implement similar measures to supply power to the encoder, and set up the encoder.
	A failure occurred in the absolute encoder.	-	If the alarm still occurs after setting up the encoder again, replace the Servomotor.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
Encoder Battery Alarm (The absolute encoder battery voltage was lower than the specified level.)	The battery connection is faulty or a battery is not connected.	Check the battery connection.	Correct the battery connection.
	The battery voltage is lower than the specified value (2.7 V).	Measure the battery voltage.	Replace the battery.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.
Encoder Overspeed (Detected at the encoder when the control power supply is turned ON.)	The Servomotor speed exceeded the specified value when the control power supply was turned ON.	Check the motor speed when the power supply is turned ON.	Reduce the Servomotor speed and turn ON the control power supply.
	A failure occurred in the encoder.	-	Turn the power supply to the Servo Driver OFF and ON again. If an alarm still occurs, the Servomotor encoder may be faulty. Replace the Servomotor.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.

Error Code: Error Name	Possible Cause	Confirmation	Correction
EtherCAT DC Synchronization Error	The synchronization timing (Sync0) for EtherCAT communications fluctuated.	-	Turn the power supply OFF and ON again and reestablish communications.
EtherCAT State Error	The EtherCAT communications state left the Operational state during motor operation.	-	Reset the alarm and then re-establish communications.
EtherCAT Output Data Synchronization Error	Noise caused an error in EtherCAT communications.	-	Check the EtherCAT wiring and implement noise countermeasures.
	The controller did not update the process data during the fixed period.	Check the process data specified by the controller.	Correct the controller so that the process data is updated during the fixed period.
	The EtherCAT Communications Cable or connector wiring is faulty.	Check the EtherCAT Communications Cable and connector wiring.	Wire the connections correctly.
EtherCAT Internal Synchronization Error 1	The EtherCAT transmission cycle fluctuated.	-	Remove the cause of transmission cycle fluctuation at the host controller.
	A failure occurred in the Servo Driver.	-	Turn the power supply to the Servo Driver OFF and ON again. If an alarm still occurs, the Servo Driver may be faulty. Replace the Servo Driver.
EtherCAT Module Interface Communications Data Error	Noise caused an error in communications between the Servo Driver and EtherCAT Network Module.	-	Implement countermeasures against noise.
	A failure occurred in the Servo Driver.	-	The Servo Driver may be faulty. Replace the Servo Driver.

12.1.3. Resetting Alarms

If there is an alarm occurs, use one of the following methods to reset the alarm after eliminating the cause of the alarm.

Clearing Alarms with the Fault Reset Command

Execute the Fault Reset command to clear alarms.

Refer to the following section for details on the Fault Reset command.

- ***Controlword Bits on Section 10.1***

Clearing Alarms by nEXT Configurator software

Refer to the following section for details.

- ***Troubleshooting***

13. nEXT Configurator Software

13.1. Introduction to nEXT Configurator software

13.1.1. Features and Specifications

The **nEXT Configurator** Tool is used to setup and optimally tune the nEXT1 Servo Driver

You can use **nEXT Configurator** for the following tasks.

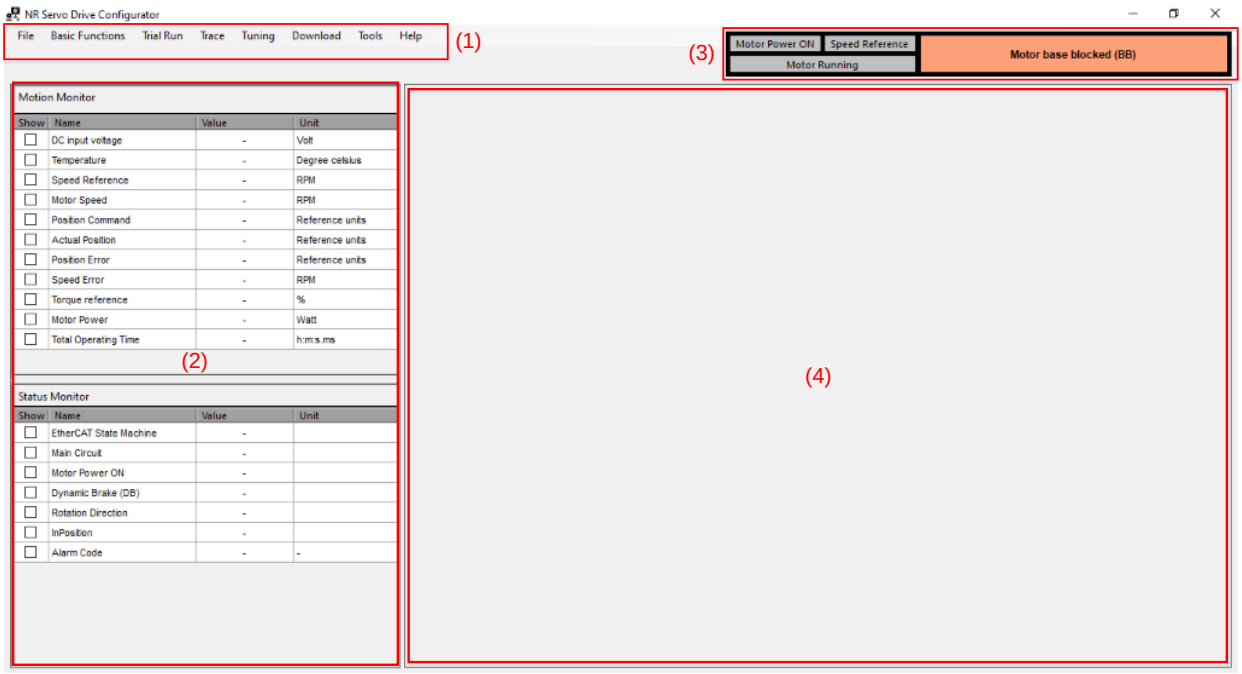
- Make settings for Servo Driver, such as parameter setting and encoder settings.
- Perform trial operation
- Tuning Servo Driver
- Monitor product information, Servo Driver status and other information
- Perform troubleshooting, such as checking and clearing alarms

13.1.2. Name of Window parts

This section gives the names of the parts of the main **nEXT Configurator** window and describes the parts.

Main Window

The names parts of the main **nEXT Configurator** window are given below.



No.	Item	Description
(1)	Toolbar	
(2)	Monitor Area	Monitor Servo Driver status
(3)	Status Area	Display Servo Driver status
(4)	Function Display Area	Display the operating pane for **nEXT Configurator** functions

13.2. Starting nEXT Configurator

The **nEXT Configurator** can working in Online and Offline mode.

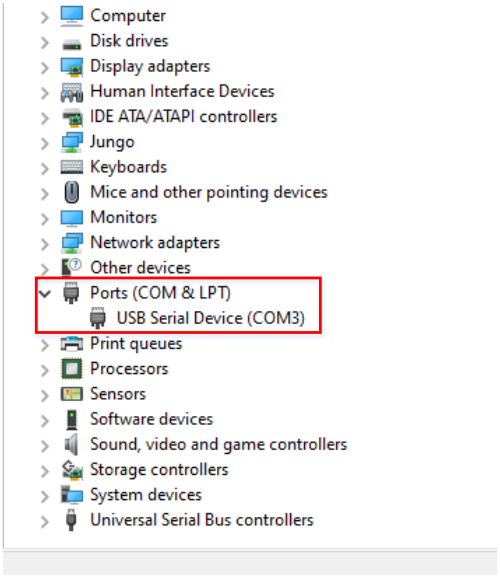
- With Online mode, the Servo Driver interface with software via USB
- With Offline mode, there is no connection to Servo Driver, so the functions that you can use are restricted. The function that you cannot use will be grayed out in the toolbar.

The computer and Servo Driver are connected directly with a USB cable.

Use the following procedure to connect the computer to the Servo Driver directly.

1. The computer and Servo Driver are connected with Mini USB cable

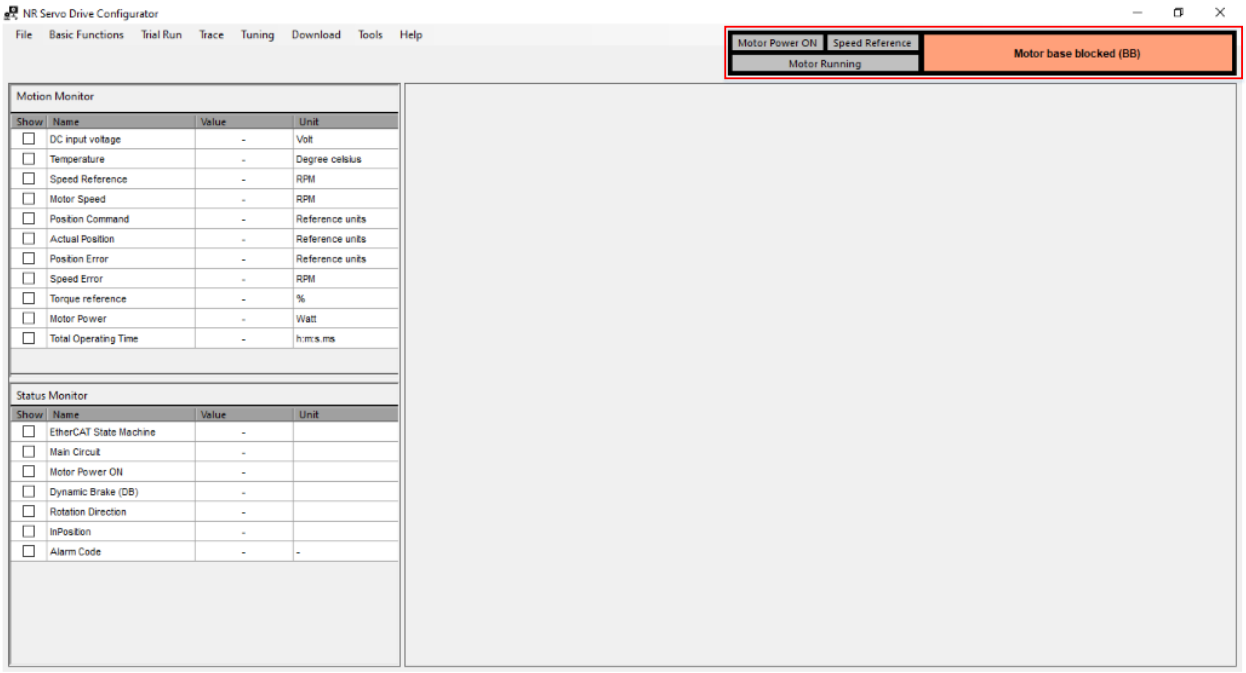
If the connect success, the device is displayed in the COM port list.



2. Start **nEXT Configurator.exe**

The **nEXT Configurator** will start, the connection is automatically established. If not, click **File → Connect** to start establish connection.

If the connection successfully, the status area will display "**Motor base blocked (BB)**"

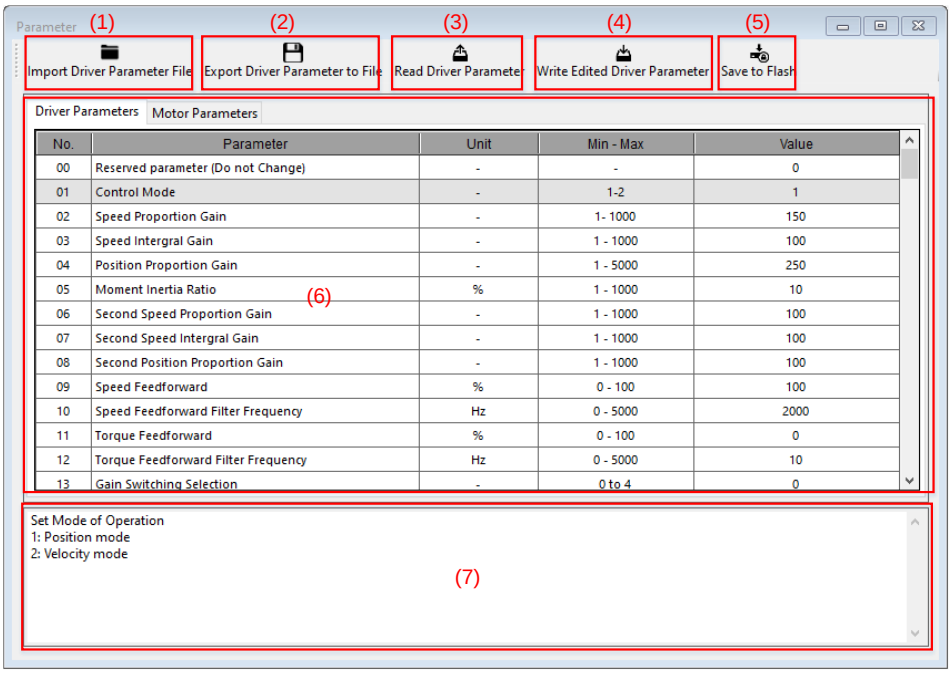


13.3. Setting Up Servo Driver

The procedures for the basic settings that are required to use a servo system are given.

13.3.1. Setting Parameters

You can edit the parameters that are set in the Servo Driver from the Edit Parameters Window. You can save the edited parameters in a project file or you can write them to file.



No.	Item	Description	Reference
(1)	File Import	The parameters are read from a Driver Parameter file (.txt) or Motor Parameter file (.sys) and displayed in the Edit Parameters Window	Reading Parameters from File
(2)	File Export	The parameters in the Edit Parameters Window are written to a Driver Parameter file (.txt) or Motor Parameter (.sys) file	Writing Parameters to File
(3)	Read from Servo Driver	The setting of all of the parameters are read from the Servo Driver and applied to displayed parameters	Reading All Parameters from Servo Driver
(4)	Write to Servo Driver	The settings of the parameters that were edited in the Edit Parameters Window are written to Servo Driver.	Write Edited Parameters to the Servo Driver
(5)	Save to Flash	All the parameter written to Servo Driver are saved in flash memory.	Saving Parameters Written to Servo Driver to Flash Memory
(6)	Parameter List	The parameter names are displayed along with the settings value for the Servo Driver.	Parameter List
(7)	Description of Parameter	Describe the value of each parameter selected in the Edit Parameters Window	-

♦ Parameter List

(1)

Driver Parameters | Motor Parameters

No.	Parameter	Unit	Min - Max	Value
00	Reserved parameter (Do not Change)	-	-	0
01	Control Mode	-	1-2	1
02	Speed Proportion Gain	-	1- 1000	100
03	Speed Intergral Gain	-	1 - 1000	100
04	Position Proportion Gain	-	1 - 5000	100
05	Moment Inertia Ratio	%	1 - 1000	10
06	Second Speed Proportion Gain	-	1 - 1000	100
07	Second Speed Intergral Gain	-	1 - 1000	100
08	Second Position Proportion Gain	-	1 - 1000	100
09	Speed Feedforward	%	0 - 100	100
10	Speed Feedforward Filter Frequency	Hz	0 - 5000	2000
11	Torque Feedforward	%	0 - 100	0
12	Torque Feedforward Filter Frequency	Hz	0 - 5000	10
13	Gain Switching Selection	-	0 to 4	0
14	Gain Switching Level for Torque Reference	%	0 - 300	100
15	Gain Switching Level for Speed Reference	RPM	0 - MaxSpeed	1000

(2) (3) (4) (5) (6)

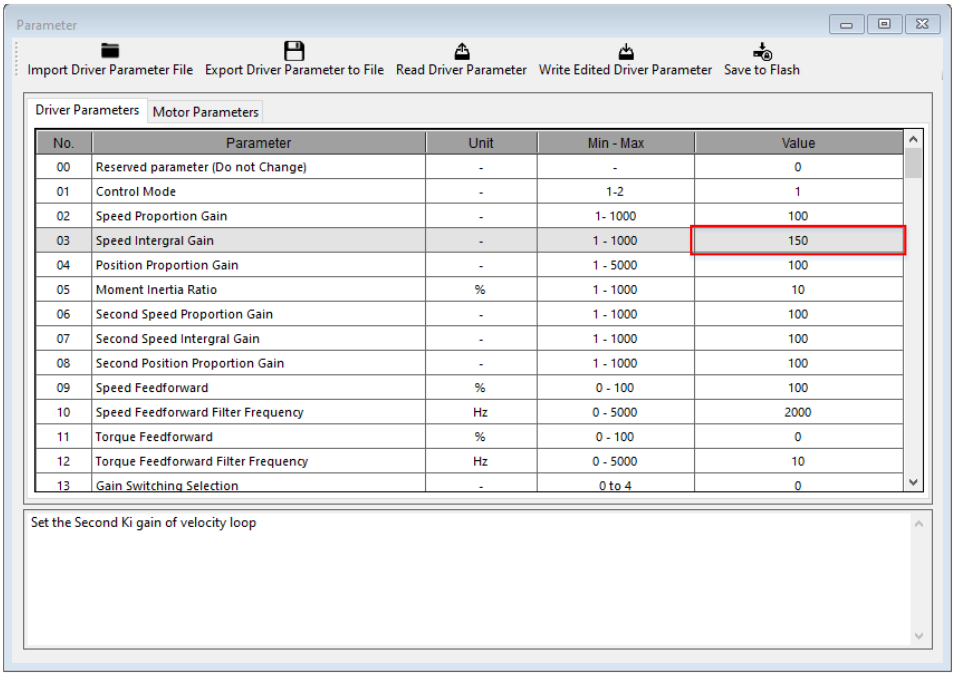
No.	Item	Description
(1)	Parameter tab	The parameter numbers are displayed. There are include 2 type of parameter: • Driver Parameter • Motor Parameter
(2)	Parameter number	The parameter numbers are displayed. The Driver Parameter is defined as **PrXXX** (XXX: parameter number)
(3)	Parameter name	The parameter names are displayed.
(4)	Unit	This is the minimum unit (setting increment) that you can set for the parameter. For parameters that do not have units, “-” is displayed.
(5)	Min-Max value	This is the allowable range of each parameter
(6)	Parameter value	The current value of each parameter are displayed

♦ Edit Parameters

Use the following procedure to edit the parameters.

1. Select **Basic function → Edit Parameters** in the toolbar.
   The Edit Parameters Window will be displayed.

2. Click the cell of the parameter to change.



3. Edit the parameter
4. Press the **Enter** Key

   The background of the edited parameter cell will change to blue.

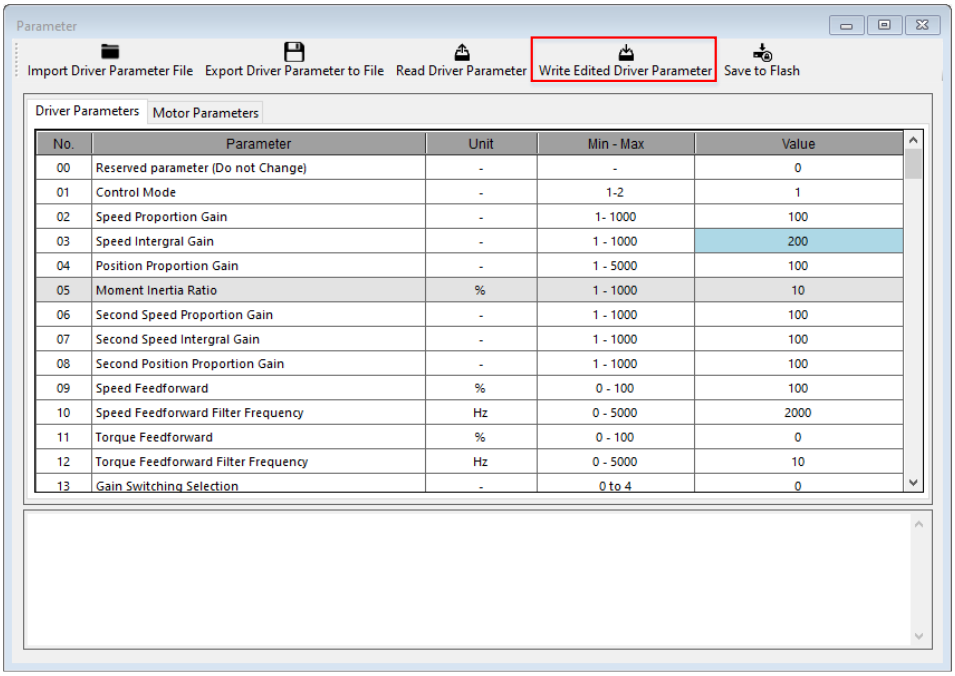
This concludes the procedure to edit the parameters.

♦ Write Edited Parameters to the Servo Driver

The settings of the parameters that were edited (i.e., blue cells) in the Edit Parameters Window are written to the Servo Driver. If there is more than one edited parameter, the settings are written to the Servo Driver for all of the edited parameters.

Use the following procedure to write the edited parameters to the Servo Driver.

1. Display the **Edit Parameters** Window and edit the parameters.
   Refer to Editing Parameters for the procedures to edit parameters.
2. Select **Write Edited Parameters**



The edited parameters are written to the Servo Driver and the cells change to white.

This concludes the procedure to write edited parameters to the Servo Driver.

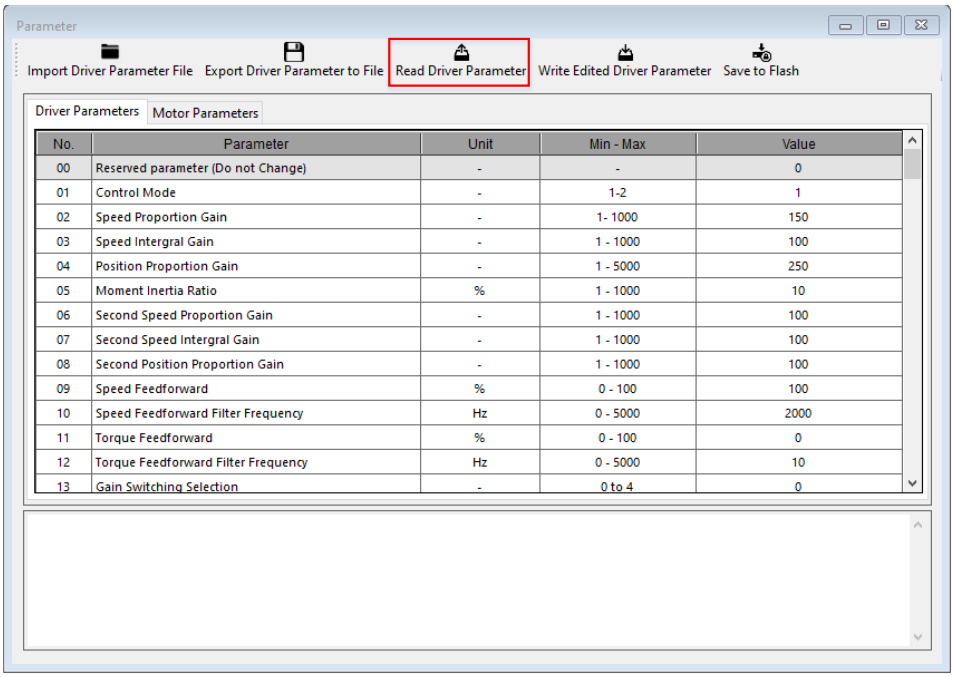
♦ Reading All Parameters from Servo Driver

Use the following procedure to write the edited parameters to the Servo Driver.

1. Open the **Edit Parameters** Window
2. Select **Read Parameter** button

If the Driver Parameters tab is selected, the Read button will be displayed **Read Driver Parameter File**

If the Motor Parameters tab is selected, the Read button will be displayed **Read Motor Parameter File**



This concludes the procedure to read all of the parameters from the Servo Driver.

♦ Reading Parameters from File

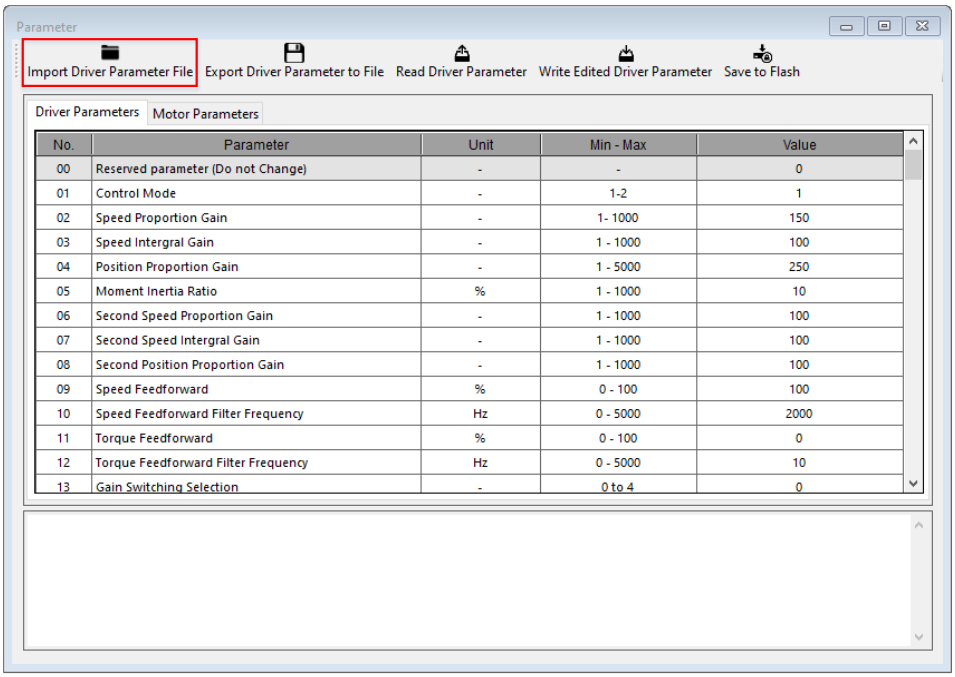
The Driver parameters are read from a Driver Parameter file (.txt) and Motor parameters are read from a Motor Parameter (.sys) file.

Use the following procedure to read the parameters from file.

1. Open the **Edit Parameters** Window
2. Select **Import** button

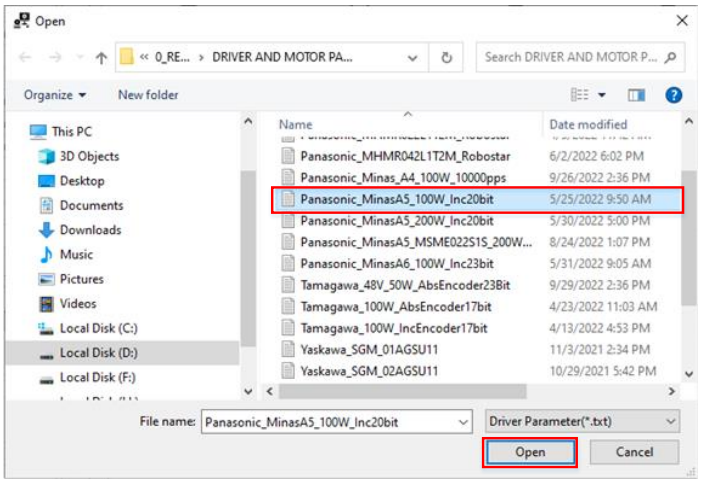
If the Driver Parameters tab is selected, the import button will be displayed **Import Driver Parameter File**

If the Motor Parameters tab is selected, the import button will be displayed **Import Motor Parameter File**

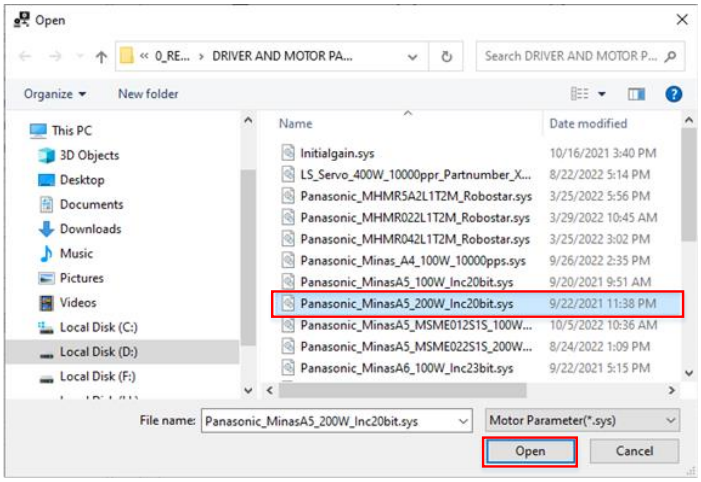


No.	Parameter	Unit	Min - Max	Value
00	Reserved parameter (Do not Change)	-	-	0
01	Control Mode	-	1-2	1
02	Speed Proportion Gain	-	1- 1000	150
03	Speed Intergral Gain	-	1 - 1000	100
04	Position Proportion Gain	-	1 - 5000	250
05	Moment Inertia Ratio	%	1 - 1000	10
06	Second Speed Proportion Gain	-	1 - 1000	100
07	Second Speed Intergral Gain	-	1 - 1000	100
08	Second Position Proportion Gain	-	1 - 1000	100
09	Speed Feedforward	%	0 - 100	100
10	Speed Feedforward Filter Frequency	Hz	0 - 5000	2000
11	Torque Feedforward	%	0 - 100	0
12	Torque Feedforward Filter Frequency	Hz	0 - 5000	10
13	Gain Switching Selection	-	0 to 4	0

3. Select the Driver parameter (.txt) file or Motor parameter (.sys) file to read and click the **Open** Button



The Driver parameters are read from the Driver parameter file (.txt) and displayed in the Edit Parameters Window.



The Motor parameters are read from the Motor Parameter file (.sys) and displayed in the Edit Parameters Window.

This concludes the procedure to read the parameters from a file.

♦ Writing Parameters to File

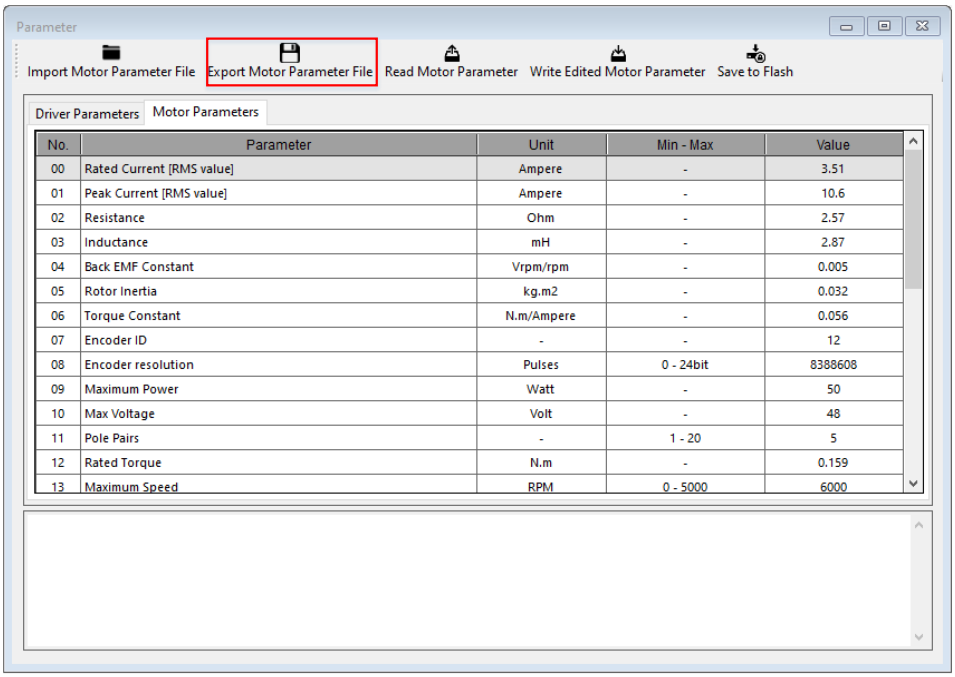
The Driver parameters edited in the Edit Parameters Window are written to a Driver Parameter file (.txt)
The Motor parameters edited in the Edit Parameters Window are written to a Motor Parameter file (.sys).

Use the following procedure to write the parameters to a file.

1. Open the **Edit Parameters** Window
2. Select **Export** button

If the Driver Parameters tab is selected, the export button will be displayed **Export Driver Parameter File**

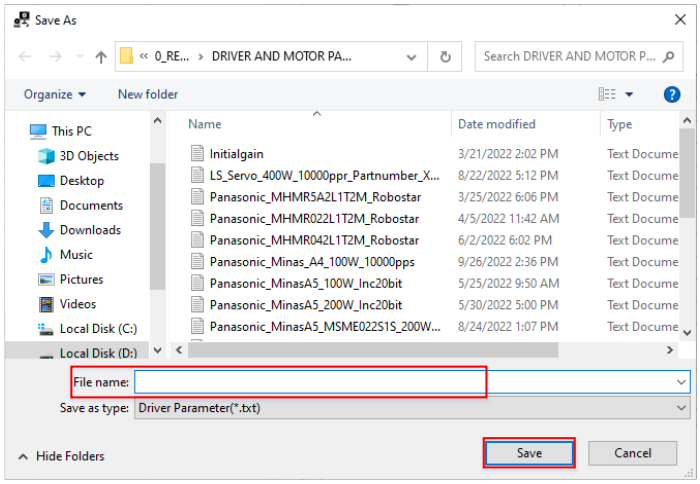
If the Motor Parameters tab is selected, the export button will be displayed **Export Motor Parameter File**



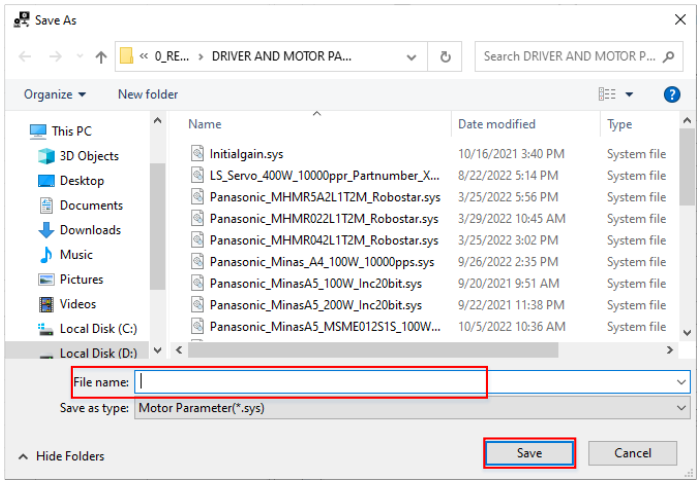
No.	Parameter	Unit	Min - Max	Value
00	Rated Current [RMS value]	Ampere	-	3.51
01	Peak Current [RMS value]	Ampere	-	10.6
02	Resistance	Ohm	-	2.57
03	Inductance	mH	-	2.87
04	Back EMF Constant	Vrpm/rpm	-	0.005
05	Rotor Inertia	kg.m2	-	0.032
06	Torque Constant	N.m/Ampere	-	0.056
07	Encoder ID	-	-	12
08	Encoder resolution	Pulses	0 - 24bit	8388608
09	Maximum Power	Watt	-	50
10	Max Voltage	Volt	-	48
11	Pole Pairs	-	1 - 20	5
12	Rated Torque	N.m	-	0.159
13	Maximum Speed	RPM	0 - 5000	6000

3. Enter the save location and the file name and click the **Save** Button

Save to Driver parameter (.txt) file



Save to Motor parameter (.sys) file



This concludes the procedure to write the parameters to a file.

♦ Saving Parameters Written to Servo Driver to Flash Memory

You must save the parameters that you edit in tables to flash memory in the Servo Driver.

Use the following procedure to save the parameters edited in tables to flash memory in the Servo Driver.

1. Open the **Edit Parameters** Window
2. Display the parameters to write to the Servo Driver.

Refer to Editing Parameters for the procedures to edit parameters.
Refer to Reading Parameters from a Parameter File for the procedure to open a parameter file.

13.3.2. Connecting I/O Signals

You can use the I/O Signal Allocation Window to allocate the input signals and output signals of the Servo Driver.

You can check the status of the I/O signals of the Servo Driver to monitor the wiring status.

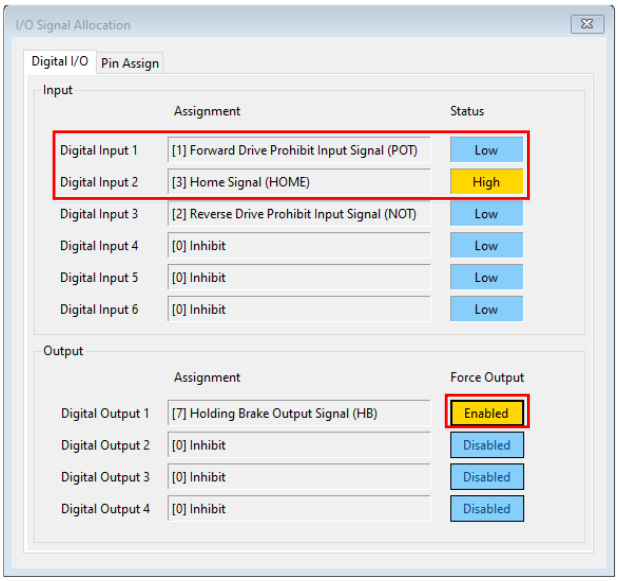
- **Checking I/O Signal Allocations**

You can check all of the allocations of the Servo Driver I/O signal connector in one window.

Use the following procedure to check the current I/O signal allocations of the Servo Driver.

1. Select **Basic Functions → I/O Signal Allocation** in the toolbar

The I/O Signal Allocation Window will be displayed



The current allocation status of Servo Driver will be displayed.

Click **Force Output** for to change level of each digital output signal.

Click **Close** to exit **I/O Signal Allocation** dialog

- **Changing I/O Signal Allocations**

Functions are allocated to the pins on the I/O signal connector of the Servo Driver in advance. You can change the allocations and the polarity for some of the connector pins.

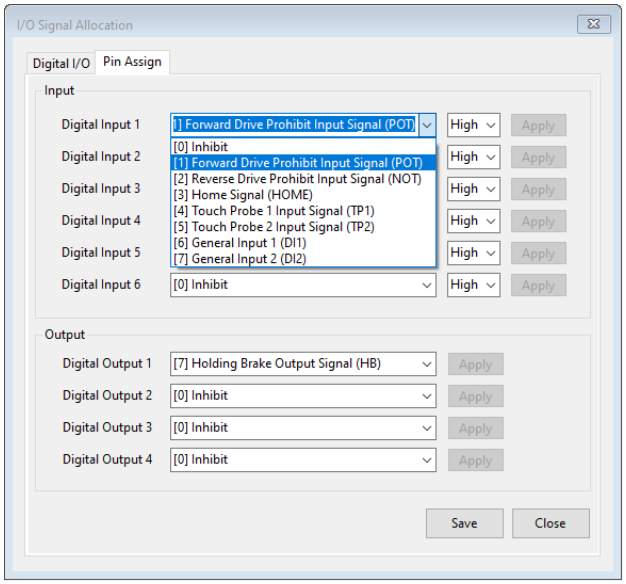
Use the following procedure to change input signal allocations.

1. Select **Basic Functions → I/O Signal Allocation** in the toolbar

The I/O Signal Allocation Window will be displayed.

2. Click to **Pin Assign** tab, and choose the cell for the pin of the input and output signal you need to change.

Click the polarity cell of the signal to change.



Click **Apply** to change the allocation

Click **Save** button to save the allocation to Servo Driver

Click **Close** button to close the I/O Signal Allocation dialog.

13.3.3. Resetting Absolute Encoder

In a system that uses an absolute encoder, the multiturn data must be reset at startup. An alarm related to the absolute encoder (FF1Ch) will occur when the absolute encoder must be reset, such as when the power supply is turned ON.

When you reset the absolute encoder, the multiturn data is reset and any alarms related to the absolute encoder are cleared.

Reset the absolute encoder in the following cases.

- When an FF1Ch alarm (Encoder Multiturn Error) occurs
- When starting the system for the first time
- When you want to reset the multiturn data in the absolute encoder
- When the Servomotor has been replaced

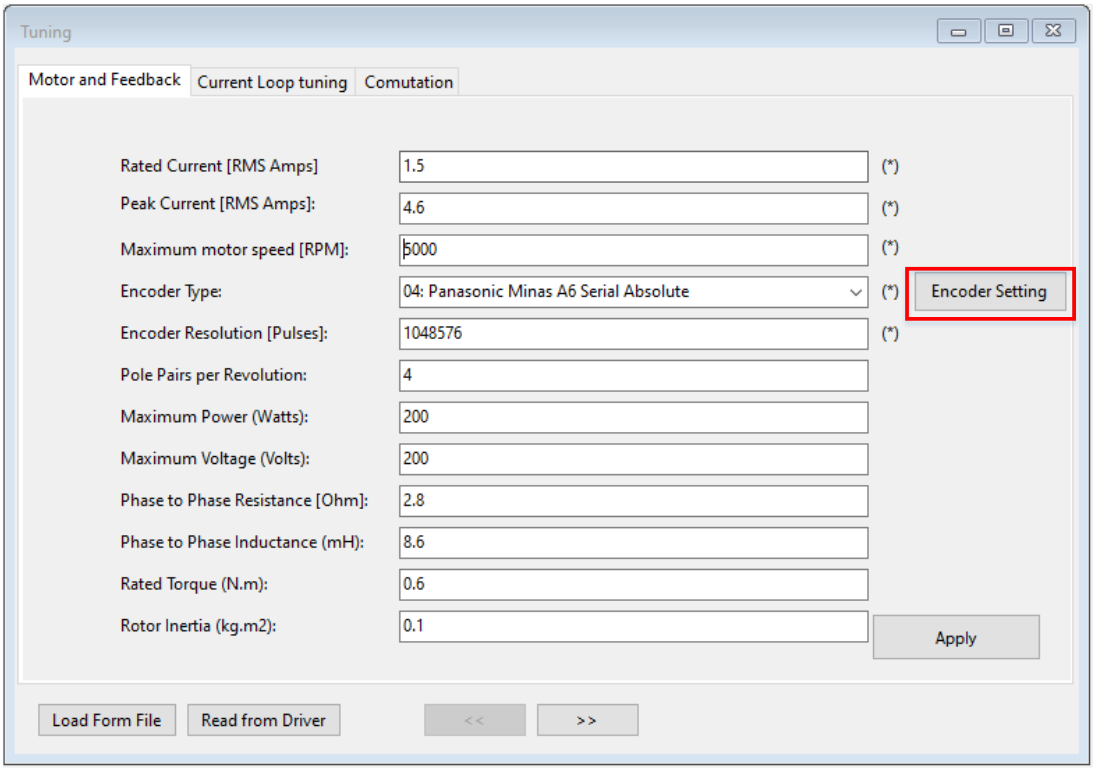
Operating Procedure

Use the following procedure to reset the absolute encoder.

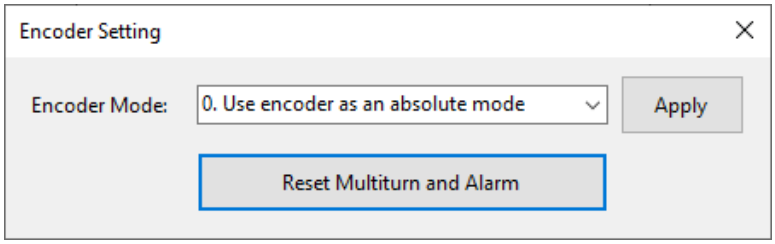
(1) Confirm that the servo is OFF.

(2) Choose **Tuning → Motor Configuration** in the Toolbar of the Main Window of the **nEXT Configurator.**

(3) Click to **Encoder Setting** button.



The Encoder Setting Dialog Box will be displayed.



(4) Click the Reset Multiturn and Alarm button.

The absolute encoder will be reset.

(5) If the Resetting Fails, click **Reset Multiturn and Alarm** button again.

This concludes the procedure to reset the absolute encoder.

13.3.4. Software Reset

You can reset the Servo Driver internally with the software. A software reset is used when resetting alarms and changing the settings of parameters that normally require turning the power supply to the Servo Driver OFF and ON again. This can be used to change those parameters without turning the power supply to the Servo Driver OFF and ON again.

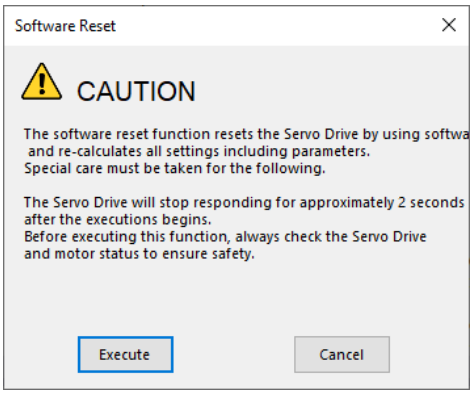
Preparations

Confirm that the following conditions are met before you perform a software reset.

- The servo must be OFF.
- The motor must be stopped.

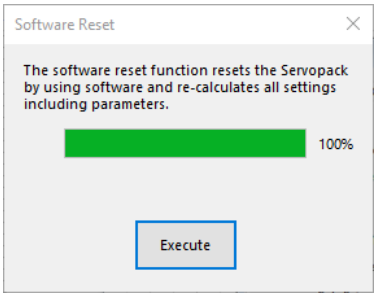
Operating Procedure

1. Click to **Basic Functions** in toolbar and choose **Software reset**

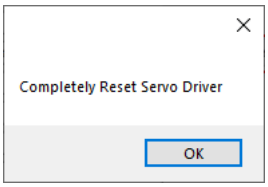


   The Software reset Dialog will be displayed.

2. Click the **Execute** Button.



   After finish reset the Servo Driver. The Complete Reset Dialog will be displayed. Click **OK** to close software program.



13.4. Perform Trial Operation

13.4.1. Introduction

You can perform trial operation by jogging the Servomotor by itself or by operating the Servomotor with a program that is set in advance. This section describes these two trial operation methods.

Jogging the Servomotor to Test Operation

This method is suitable to check the operation of the Servomotor by itself. The Servomotor will operate only while a button is clicked on the **nEXT Configurator**.

Performing Trial Operation with a Program

This method for trial operation is suitable to check operation with a program that is set for the operation pattern of your machine. The procedure for trial operation with a program is given.

13.4.2. Jogging the Servomotor to Test Operation

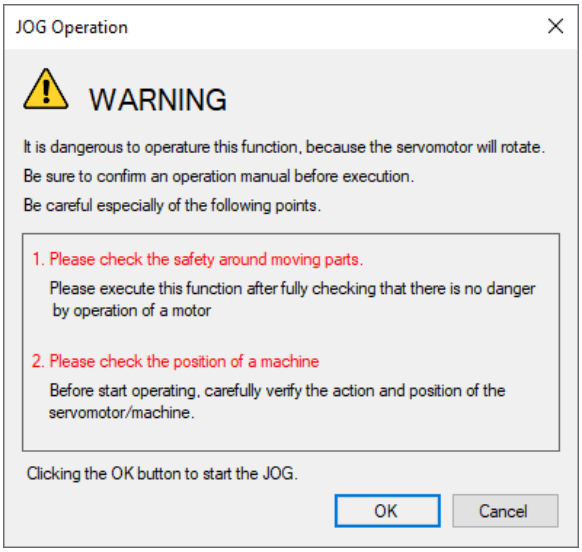
Operating Procedure

Use the following procedure to jog the motor.

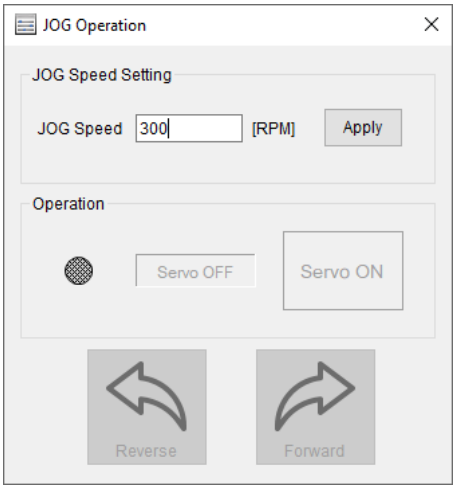
1. Click to **Trial Run** in toolbar and choose **JOG Manual** of the **nEXT Configurator software**.

The Jog Operation Dialog Box will be displayed.

2. Check the warnings and then click the OK Button.



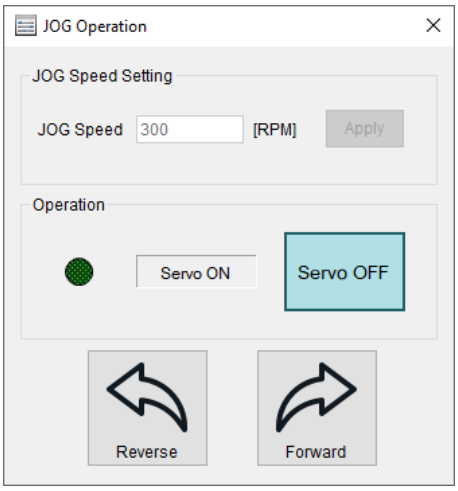
3. Check the jogging speed and then click the **Servo ON** Button.



4. The display in the Operation Area will change to **Servo ON**.

Click the Forward Button or the Reverse Button.

Jogging will be performed only while you hold down the mouse button.



After you finish jogging, turn the power supply to the Servo Driver OFF and ON again.

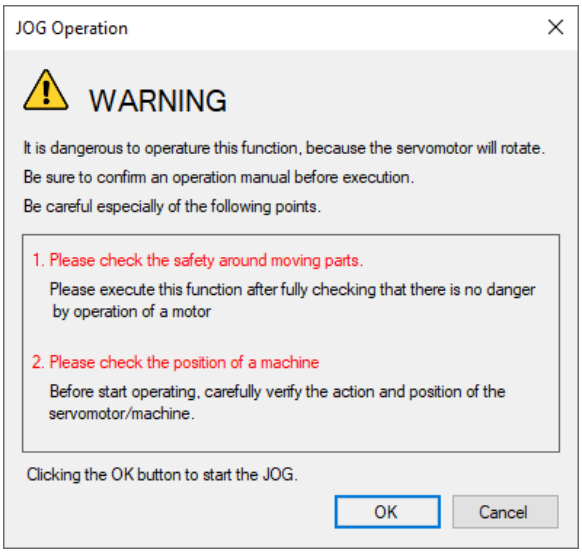
This concludes the jogging procedure.

13.4.3. Perform Trial Operation with a Program

Operating Procedure

Use the following procedure for a program jog operation.

1. Click to **Trial Run** in toolbar and choose **Program JOG Operation** of the **nEXT Configurator software**.
2. Check the warnings and then click the **OK** button.



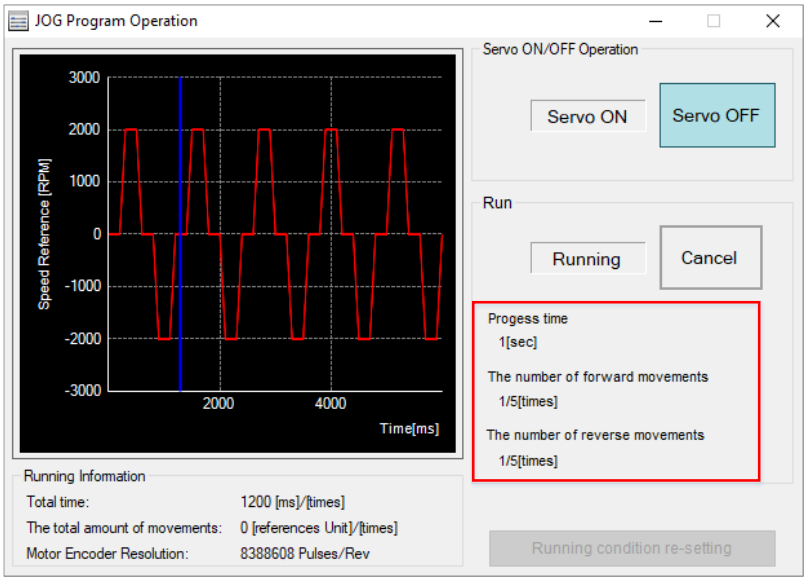
Click the **Cancel** button to cancel programmed jog operation. This Main Window will return.

3. Set the running conditions, click the **Apply** Button, and then click the **Run** button.

A graph of the operation pattern will be displayed.

4. Click the **Servo ON** button and then the **Execute** Button. The program jogging operation will be executed.

5. User can monitor some operating status while JOG Program runs.
   - Progress time
   - The number of forward movements
   - The number of reverse movements



Click **Cancel** to stop running profile and click **Servo OFF** to Stop Motor

This concludes the trial operation with a program.

13.5. Monitoring

13.5.1. Monitoring Product Information

Items That You Can Monitor

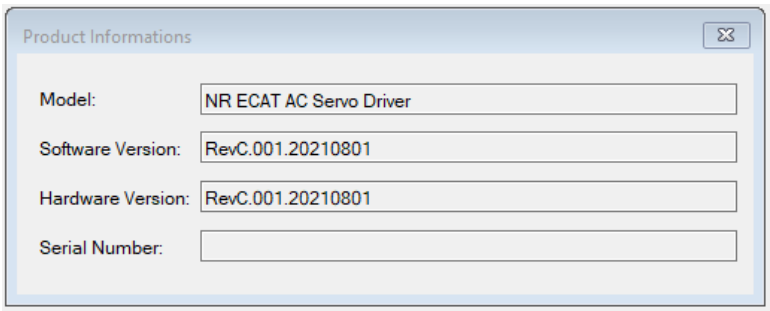
The items that you can monitor in the Product Information Window are listed below

Monitor Items	
Information on Servo Driver	• Model/Type • Serial Number • Software version (SW Ver.) • Hardware version (HW Ver.)

Operating Procedures

Use the following procedure to display the product information monitor dialog box.

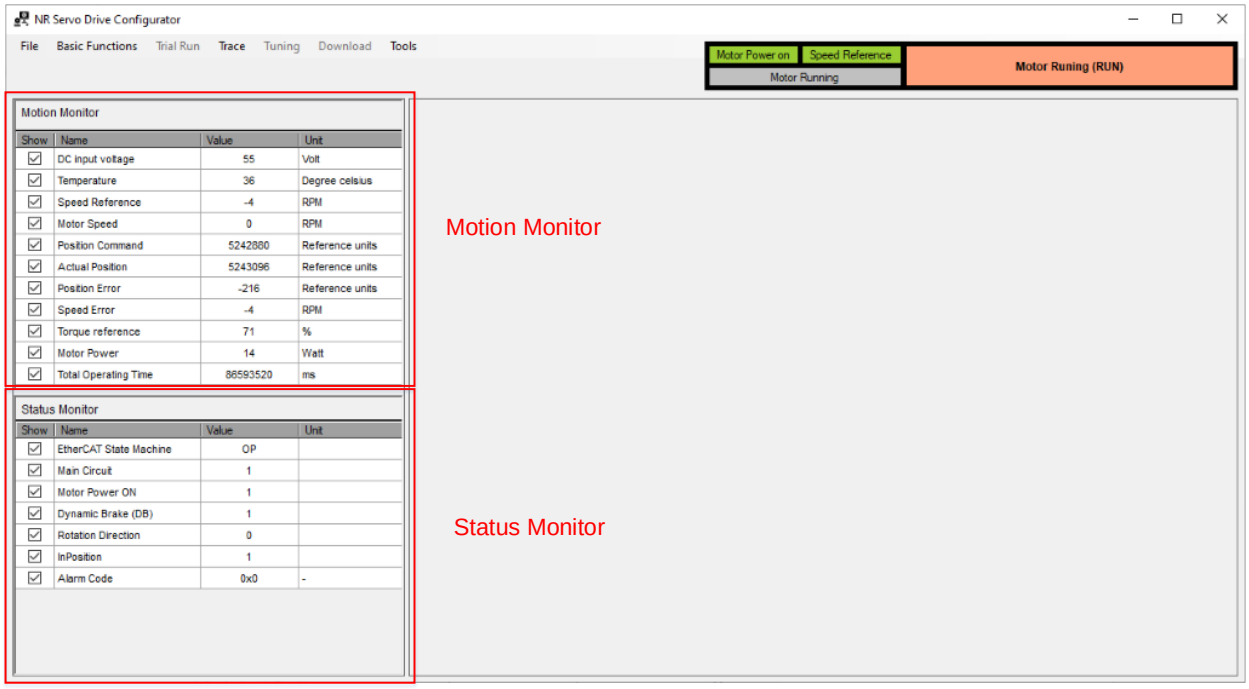
Select Read Product Information in the menu Dialog Box. The Read product information window will be displayed.



13.5.2. Monitoring Servo Driver Operation and Status

You can use the **nEXT Configurator** to monitor the operation of an online Servo Driver.

Servo Driver operation and status information will be displayed in the Motion Monitor Pane.

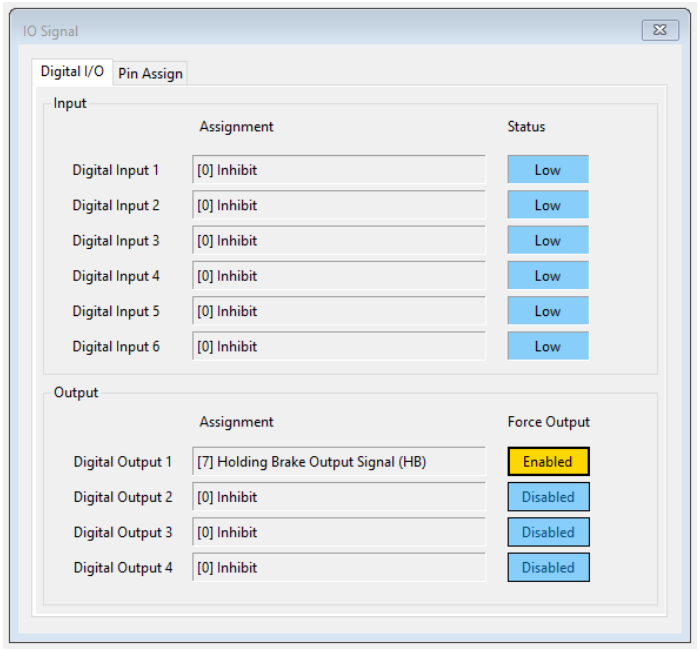


Monitor Items		Unit
Motion Monitor	Main DC Input Voltage	Volt
	Temperature	Degree Celsius
	Speed Reference	RPM
	Motor Speed	RPM
	Position Command	Reference units
	Actual position	Reference units
	Position Error	Reference units
	Speed Error	RPM
	Torque Reference	% Rated torque
	Motor Power	Watt
	Total Operating Time	h:m:s:ms
Status Monitor	EtherCAT State Machine	-
	Main Circuit	-
	Motor Power ON	-
	Dynamic Brake (DB)	-
	Rotation Direction	-
	In Position	-
	Alarm code	-

13.5.3. Monitoring Servo Driver I/O Signals

You can use the **nEXT Configurator** to monitor the I/O signals of an online Servo Driver

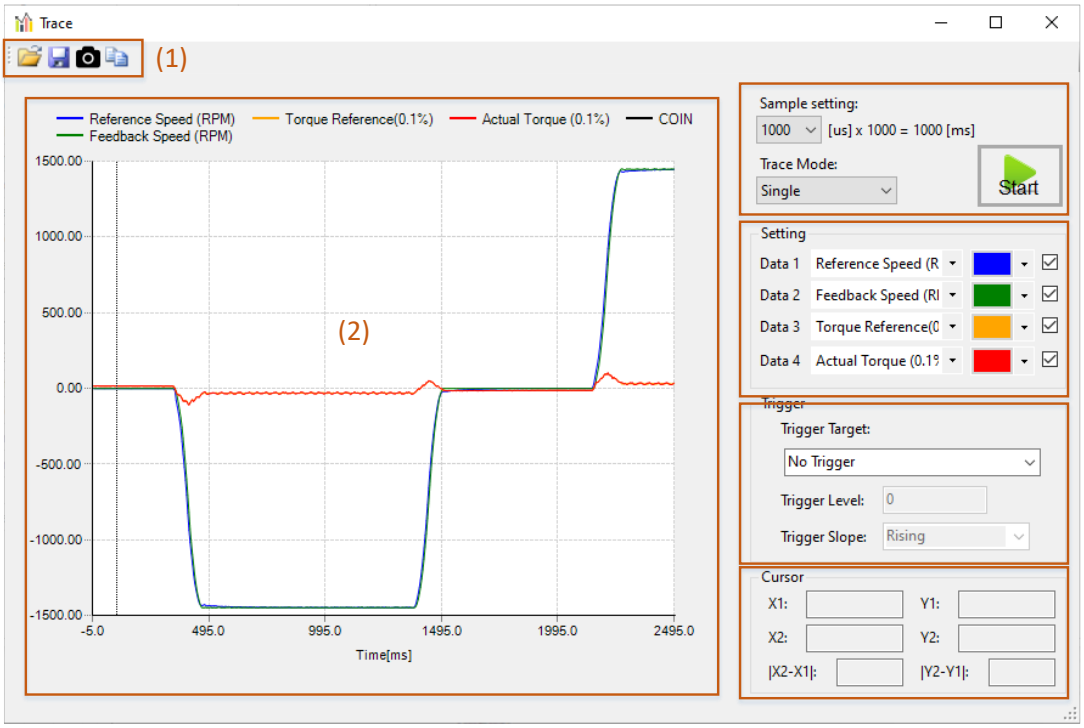
Select I/O Signal Allocation in the menu Dialog Box. The I/O Signal Allocation window will be displayed.



13.5.4. Monitoring Machine Operation Status and Signal Waveforms

You can measure Servomotor operating status and signal waveforms without using a measurement instrument. Displaying Servomotor operating status and signal waveform on a graph is call tracing. You can save the trace data on the computer and also display trace data saved on the computer.

Trace Dialog Box



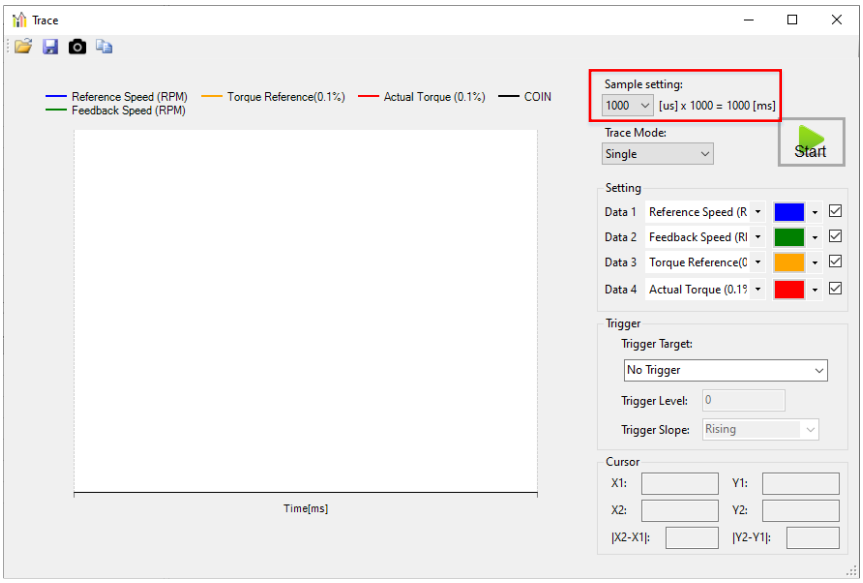
No.	Item	Description
(1)	Toolbar	The toolbar provides buttons: • **Open Button**: Load a trace data file • **Save Button**: Saves the currently displayed trace graph to a file. • **Save Image**: Saves the currently displayed trace graph to an image. • **Copy to Clipboard**: Copies the displayed trace graph to the clipboard.
(2)	Trace Graph Display Area	The trace graphs are displayed in this area.
(3)	Sample setting	Setting recording time and Trace mode
(4)	Trace Object Setting	Select the objects to trace • You can trace the following items. • Torque Reference • Actual Torque • Feedback Speed • Position Reference Speed • Position Error (Deviation) • Main Circuit DC Voltage • Drive Temperature
(5)	Trigger setting	**Trigger target**: Select the object that is to serve as the trigger for tracing You can select the following trigger targets: • Feedback speed • Torque reference • Position reference speed **Trigger Level**: Enter the reference value for detecting the trigger in the Trigger Level Box. The setting unit is the same as the unit for the selected trigger target. Trigger Slope: Enter the method for detect the trigger in the Trigger Slope box You can select the following trigger types. • Rising edge: A trigger is detected when the trigger object changes from below the trigger level to above the trigger level. • Falling edge: A trigger is detected when the trigger object changes from above the trigger level to below the trigger level. • Rising or Falling edge: A trigger is detected when the trigger object changes from below the trigger level to above the trigger level or from above the trigger level to below the trigger level.
(6)	Cursor	Right Click to Trace Graph and choose Add Cursor X or Add Cursor Y, the X or Y cursor will be displayed. You can drag the cursors to move it to check the data

♦ Preparations for Tracing

You must set the objects to trace and the trace conditions before you execute a trace.

Use the following procedure to prepare for tracing.

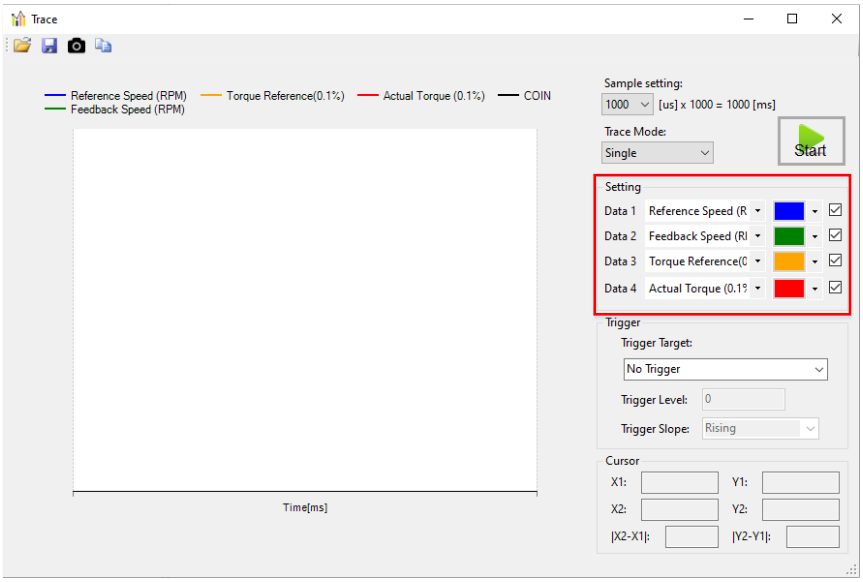
1. Select Sample setting and Trace Mode



Set the interval for obtain trace data

Example: If you set 1000, trace data is obtained every 1000ms

2. Select Trace Object

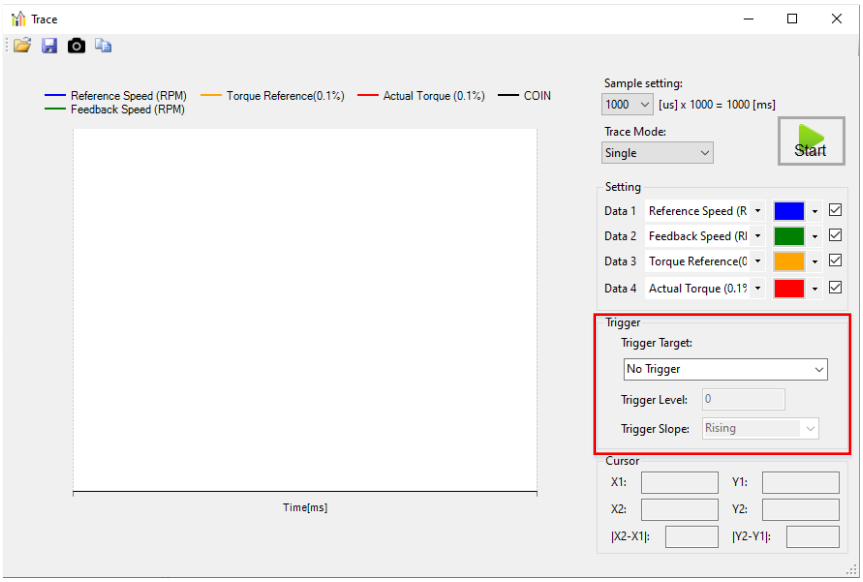


Select the objects to trace from the Data1, Data2, Data3 and Data4 Boxes. You can also set the data trace line colors.

You can select any of the following trace objects.

- Reference Speed
- Feedback speed
- Torque Reference
- Actual Torque
- Position error
- Current Phase U
- Current Phase V
- Current Phase W
- Main circuit DC power supply
- Temperature

3. Trigger setting:



Select the trigger setting from the Trigger Conditions Box.

You can select the following trigger target.

- No trigger
- Feedback Speed
- Torque Reference
- Position Reference Speed

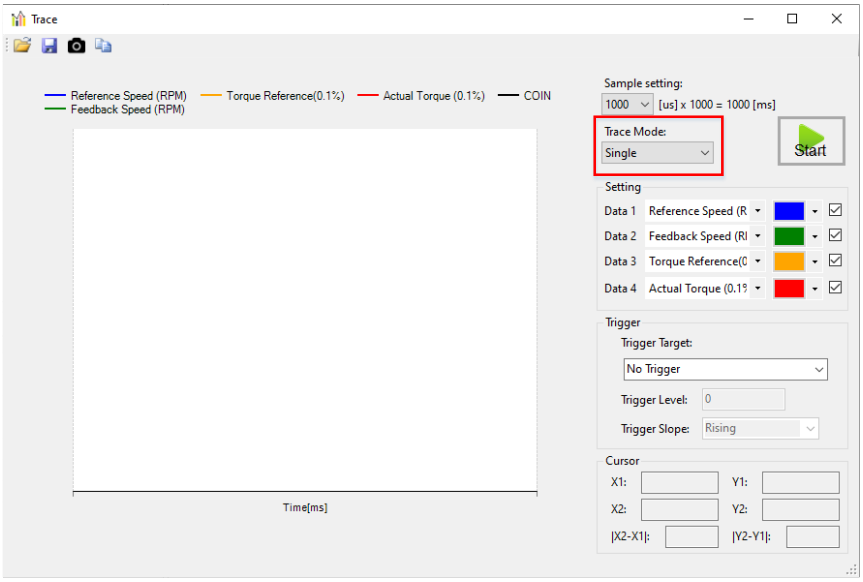
Select Trigger Level
Trigger Slope: Rising edge of Falling edge

♦ Tracing Data

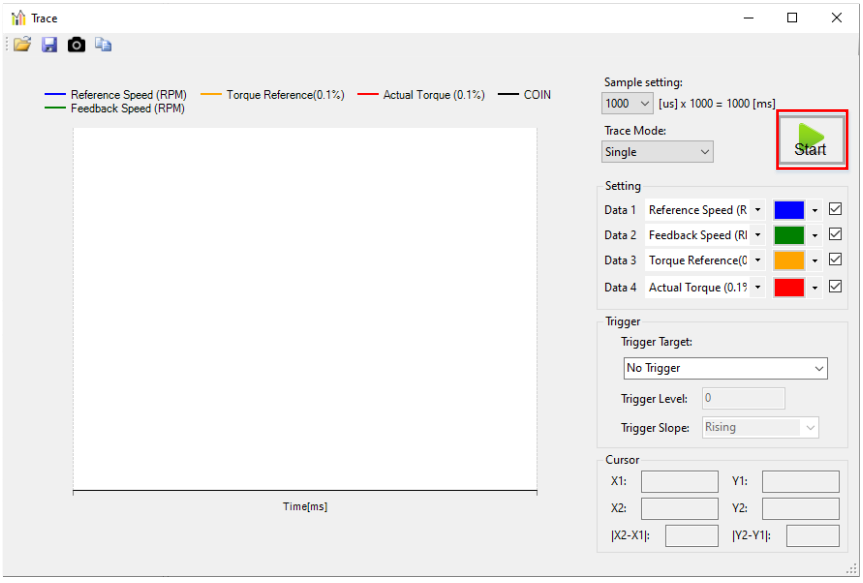
You can execute traces according to the trace settings and display the trace graphs.

Use the following procedure to trace data.

1. Select the tracing mode from the list in the **Trace Mode** Box in the Trace Dialog Box.
   - Single: When the trigger condition is met, a trace graph is executed only once and then tracing is stopped.
   - Continuous: When the trigger condition is met, the graph display is repeatedly executed automatically. Tracing is stopped when you click the **Stop** Button.



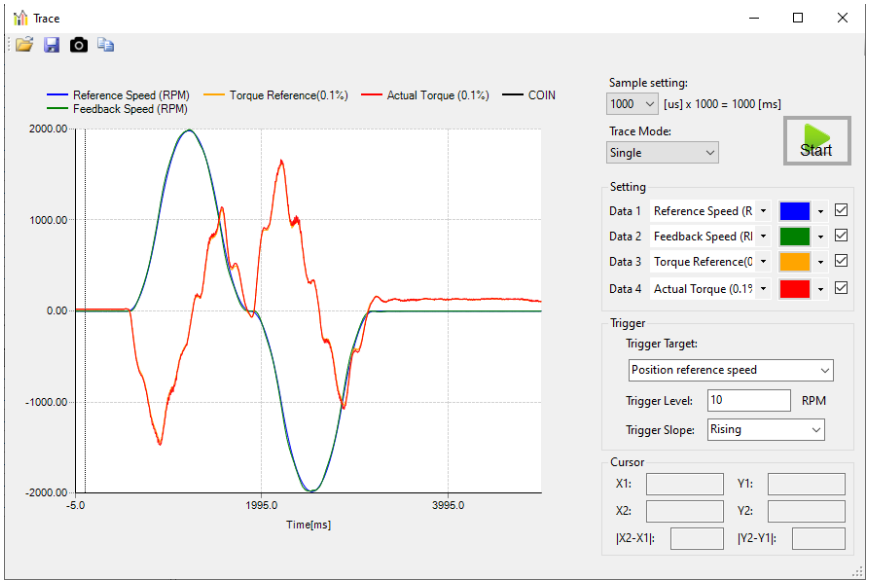
2. Click the **Start** Button



Tracing is started and the software waits for the trigger.

When the trigger condition is met, data is transferred.

When the data has been transferred, the trace graph is displayed in the Trace Dialog Box.

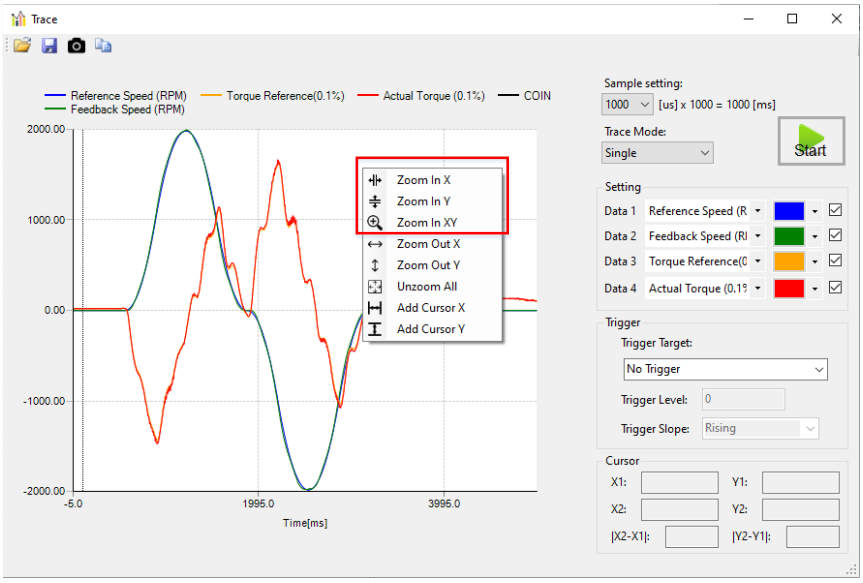


♦ Viewing Trace Graphs

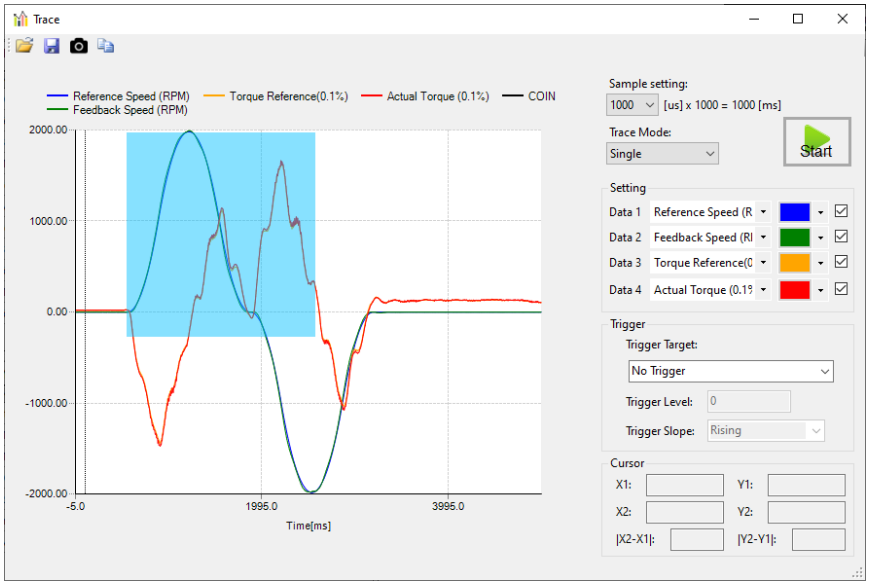
You can change the trace graph displays to make them easier to check.

Zooming Part of the Trace Graph Display

Right Click the trace graph, you can choose several option to zoom: Zoom in X, Zoom in Y, Zoom in XY



Graph Displays before Zooming

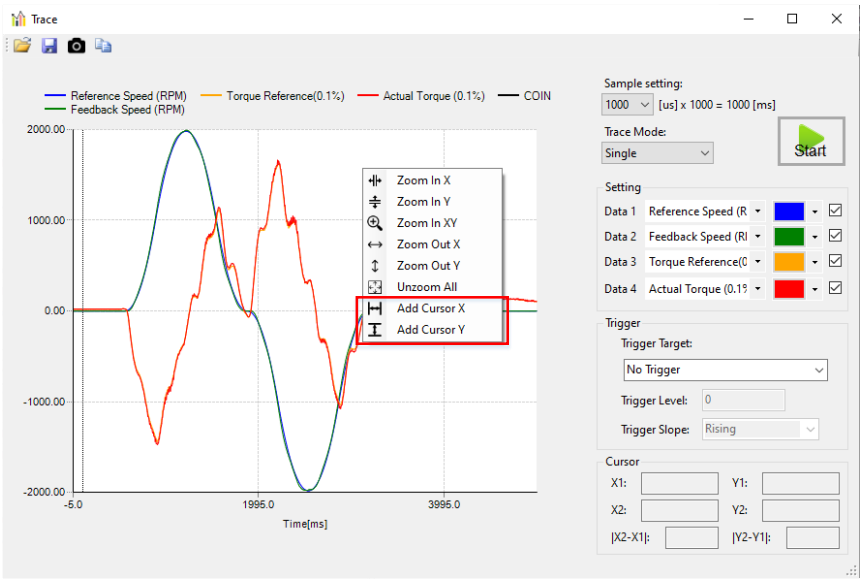


Graph Displays after Zooming

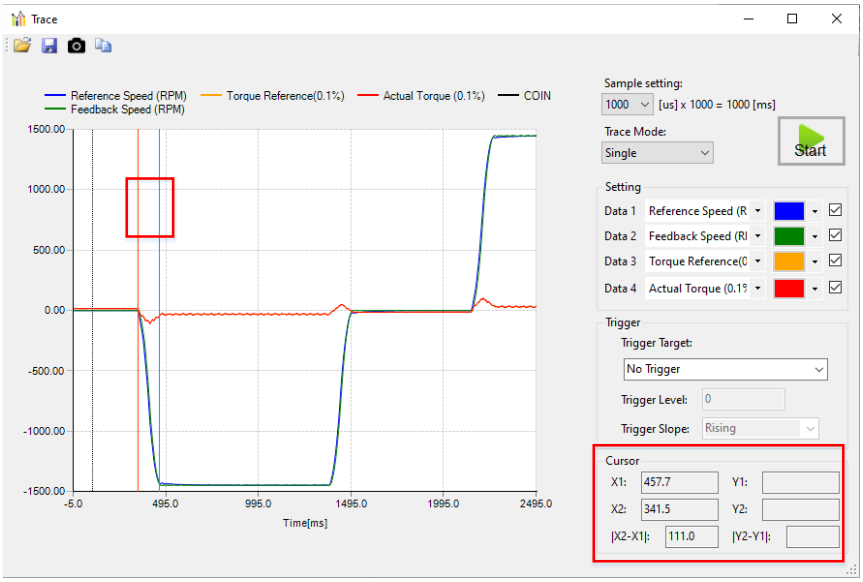
To Zoom out the graph, right click and select **Zoom out X**, **Zoom out Y** or **Unzoom All**

Displaying Graph Values with Cursors on the Axis Scale

Right Click the trace graph, you can choose Cursor option: Add Cursor X, Add Cursor Y



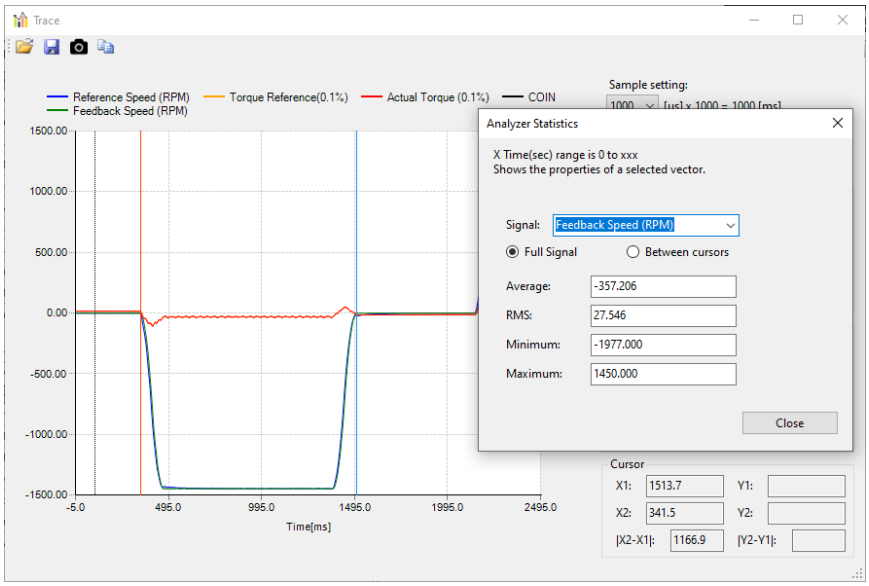
You can drag the cursor to move it and you can check the cursor data in the Cursor group box.



Display Analyzer statistics

You can use Analyzer Statistics tool to measures the minimum, maximum, average and root mean square of each signal between two X cursor shown in the graph.

1. Right click into the graph and enable cursor X
2. Move the cursor to the position you want to measure
3. Select **Tool → Analyze-Statistics** in toolbar of the main window.



The window will show the calculated value of the signal shown in the graph. Click **Close** to close the Analyzer Statistics window.

♦ Open a Trace Data File on the Computer

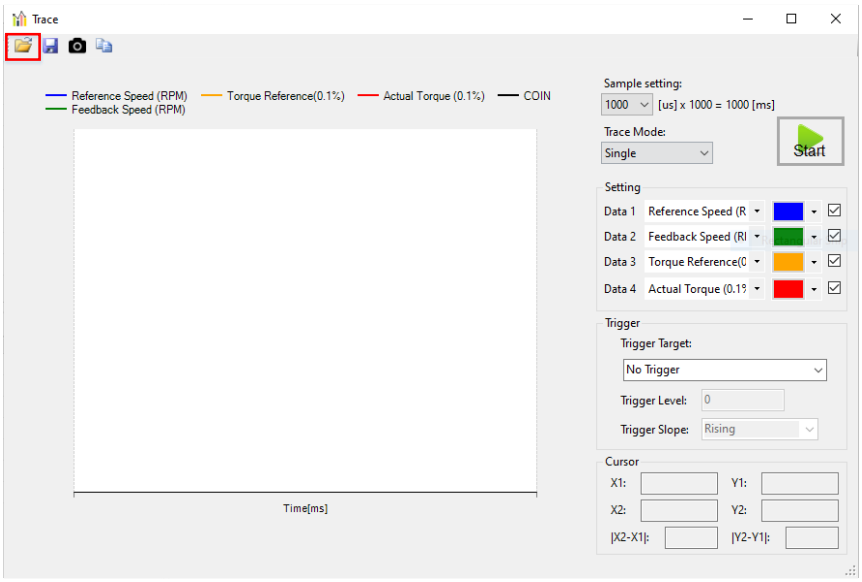
You can read data from a trace data file saved on the computer and display it on the graph in the Trace Dialog Box.

Use the following procedure to open a trace data file.

1. Select **Trace → Data Trace** in the toolbar

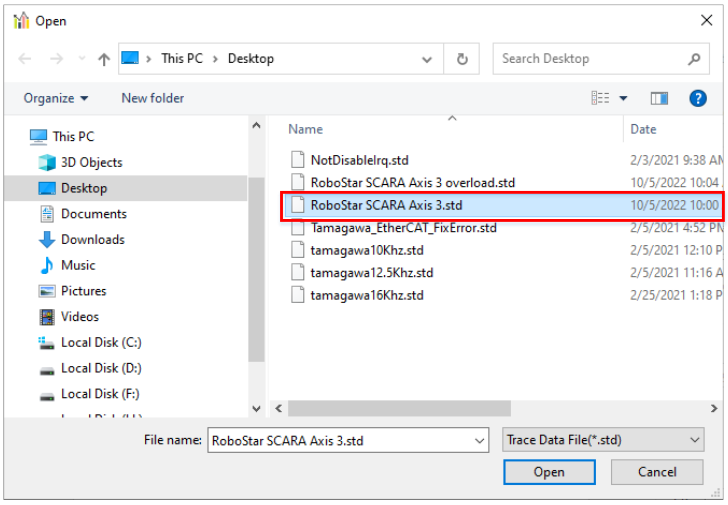
   The Trace Dialog Box will be displayed.

2. Click the Open Button.



The Open Dialog Box will be displayed.

3. Select the file to read and click the **Open** Button.



The data is read from the trace data file and displayed in the Trace Dialog Box.

This concludes the procedure to open a trace data file.

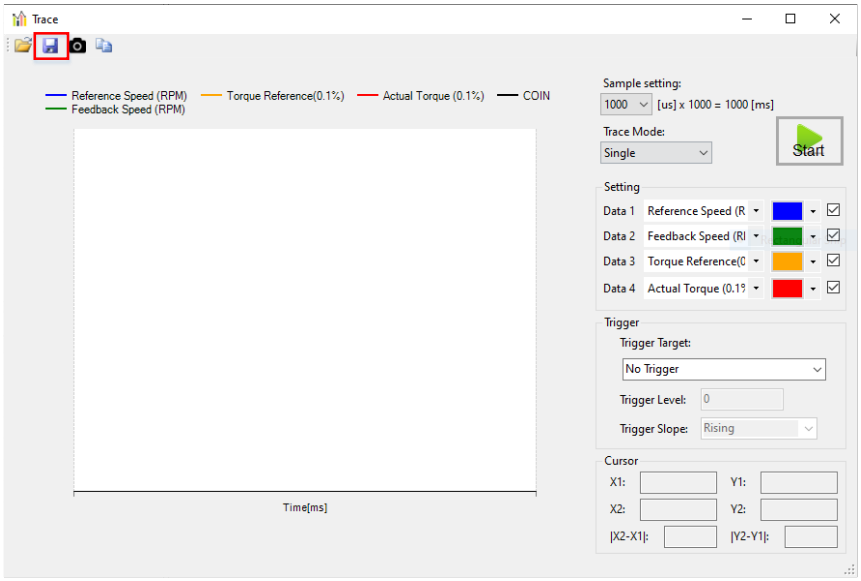
♦ Saving a Trace Data File on the Computer

You can save trace data on the computer. Use the following procedure to save data in a trace data file.

1. Use tracing to trace the machine characteristics.

   Refer to Tracing Data for detailed tracing procedures.

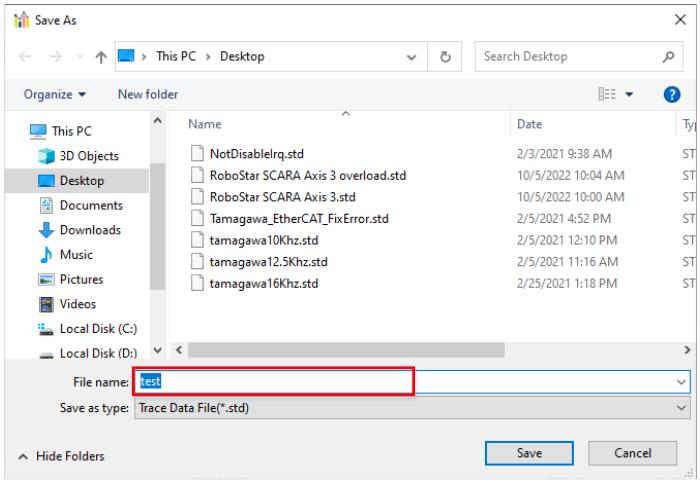
2. Click the **Save** Button.



   The Save Dialog Box will be displayed.

3. Select the location in which to save the file.

   Enter the file name



4. Click the Save Button.

   The data will be saved in a file in the specified location and the Trace Dialog Box will return.

This concludes the procedure to save data in a trace data file.

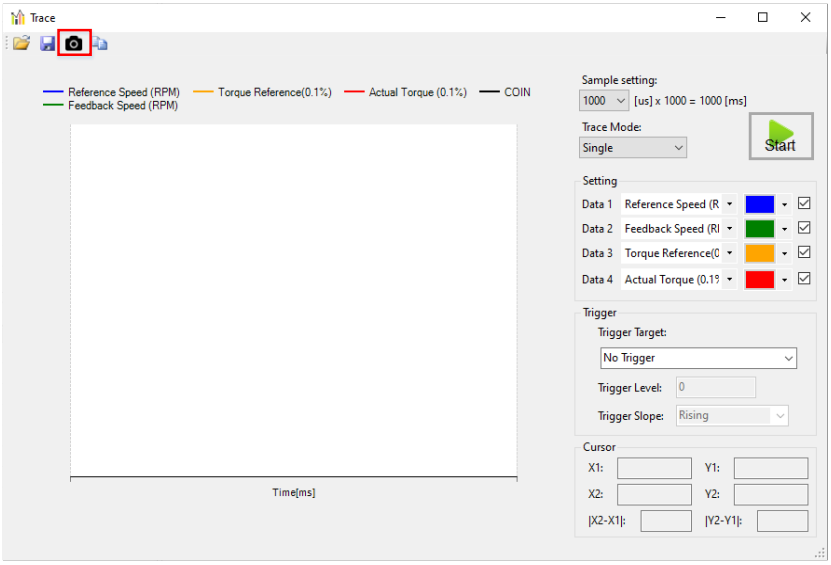
♦ Saving Trace Graph to Image

You can save trace data to image file on the computer. Use the following procedure to save trace graph in an image file.

1. Use tracing to trace the machine characteristics.

   Refer to Tracing Data for detailed tracing procedures.

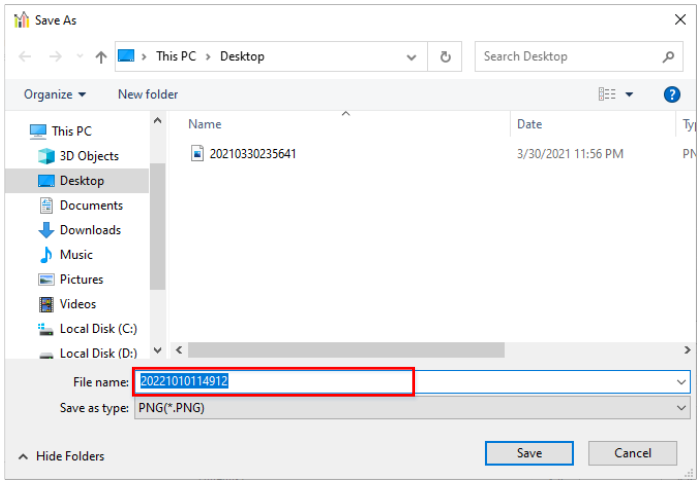
2. Click the **Save Image** Button.



The Save Dialog Box will be displayed.

3. Select the location in which to save the file.

Enter the file name



4. Click the Save Button.

The data will be saved in an image in the specified location and the Trace Dialog Box will return.

This concludes the procedure to save data in a trace data file.

♦ Copying a Trace Graph to the Clipboard

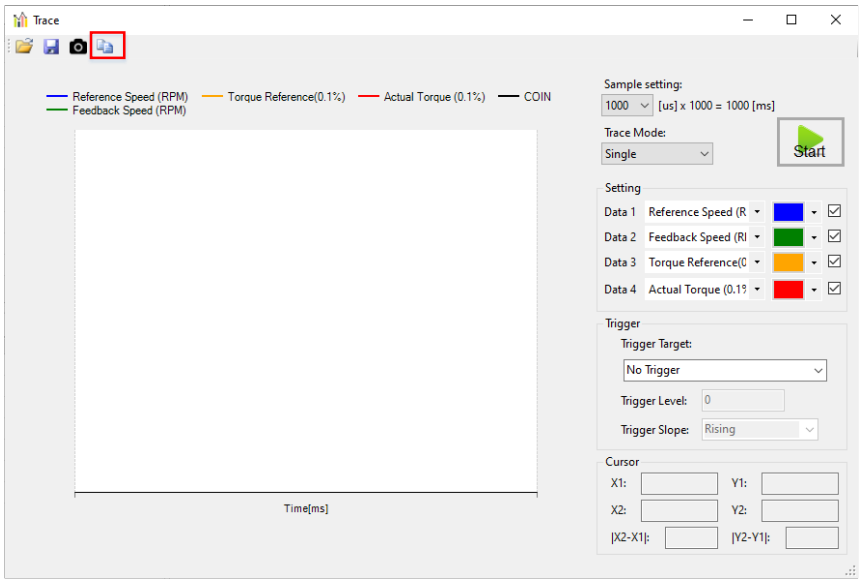
You can copy the trace graph displayed in the Trace Dialog Box to the clipboard. Copying the data to the clipboard will allow you to insert the trace graph in an MS Word or Excel file.

Use the following procedure to copy a trace graph to the clipboard.

1. Use tracing to trace the machine characteristics.

   Refer to Tracing Data for detailed tracing procedures.

2. Click the **Copy to Clipboard** Button.



This concludes the procedure to copy a trace graph to the clipboard.

13.6. Tuning

13.6.1. Configuring the Servo Motor

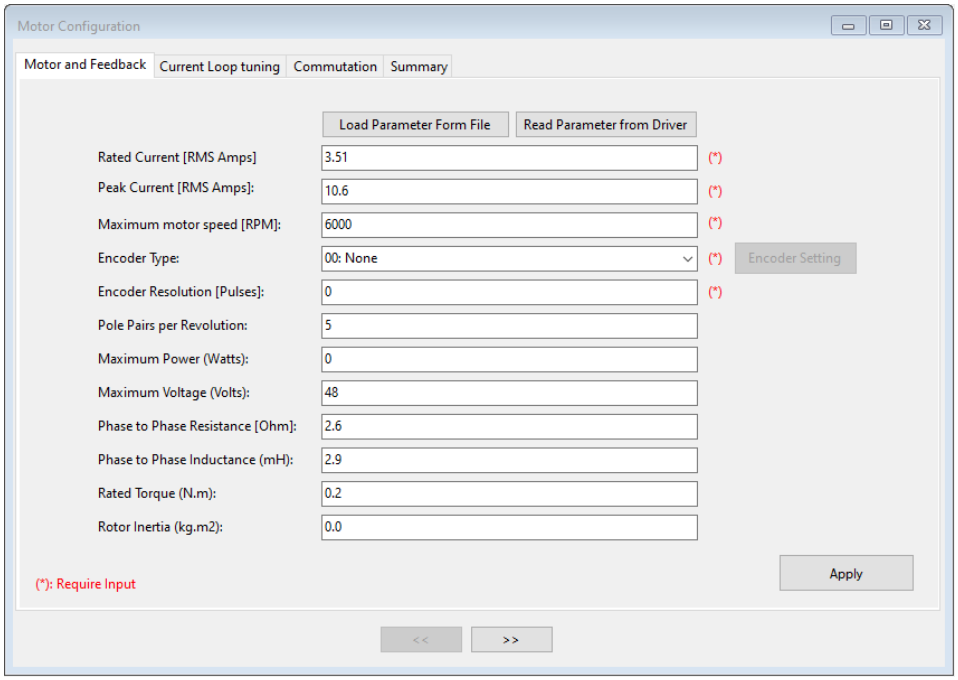
Before proceeding, you must accomplish the following actions:

- Wire the drive to the motor.
- Connect your computer to the drive.
- Use the setup software to successfully recognize the drive.

Configuration requires you to decide upon several parameters for your drive based on the requirements of your application. The drive must have information about motor parameters, scale factors, feedback devices, and limits. The setup software provides windows for you to:

- Enter the motor constants.
- Configure the primary feedback.
- Assign the user units of measurements.
- Decide which analog and digital signals will provide input and output for the drive.
- Set the limits for temperature, current, voltage, velocity and position and decide options for power-up and brake/stop behavior.
- Specify the command source.

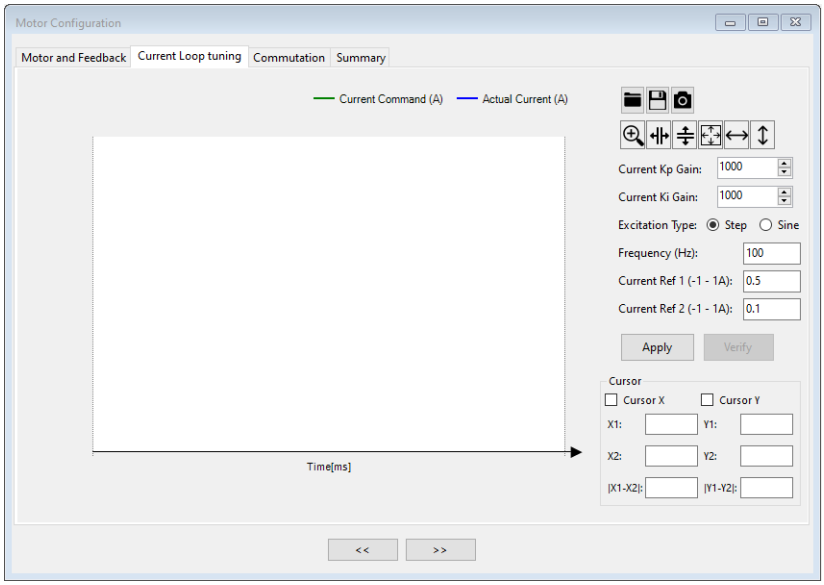
There are two type of parameters in the Servo Driver: Driver Parameters and Motor Parameters. You can save several Parameters files on your computer (they have the *.txt extension for Driver Parameter file and *.sys extension for Motor Parameter file). From your computer, a file can be downloaded to or uploaded from the drive.



13.6.2. Tuning Current Loop

Use the following procedure to execute current loop tuning program.

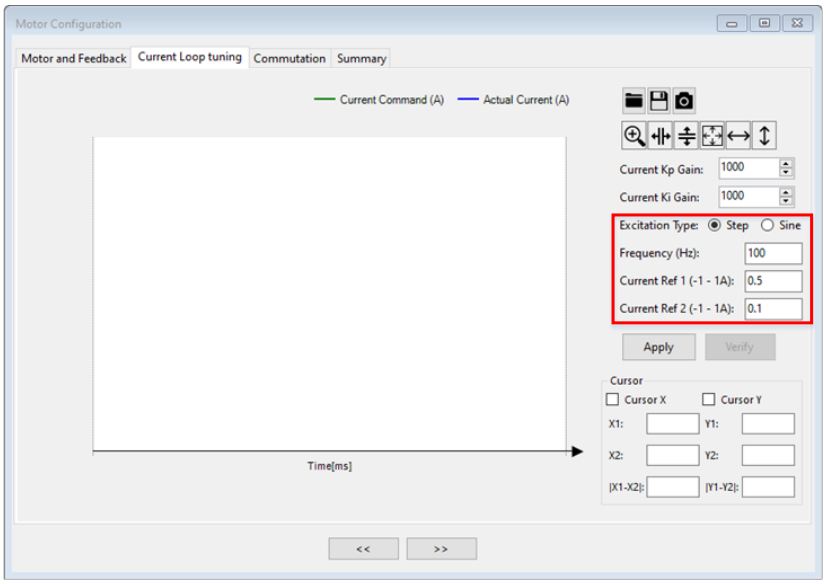
2. Click to **Tuning** in toolbar and choose **Motor Configuration** of the **nEXT Configurator software**.



The Motor Configuration Dialog Box will be displayed.

3. Click to **Current Loop tuning** tab

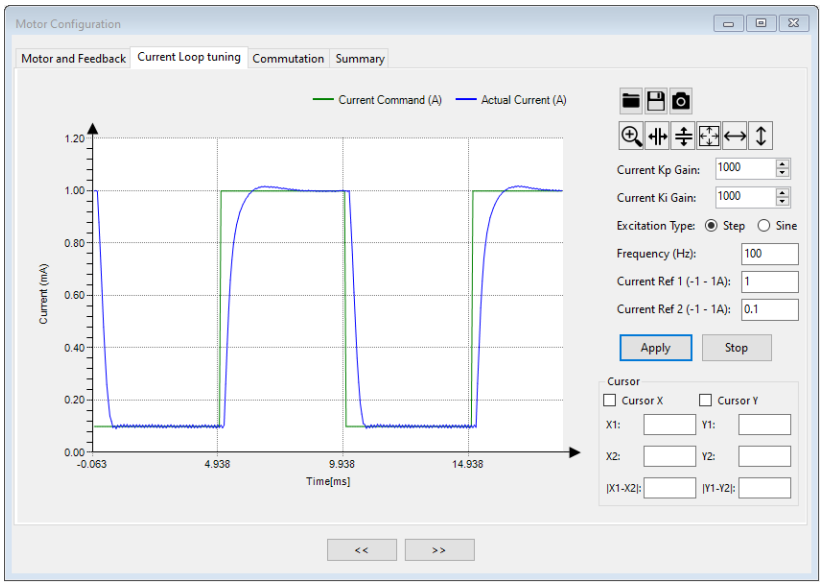
Setting the current reference by change the parameter Excitation Type, Frequency, Current Ref 1, Current Ref 2 and Click **Apply**.



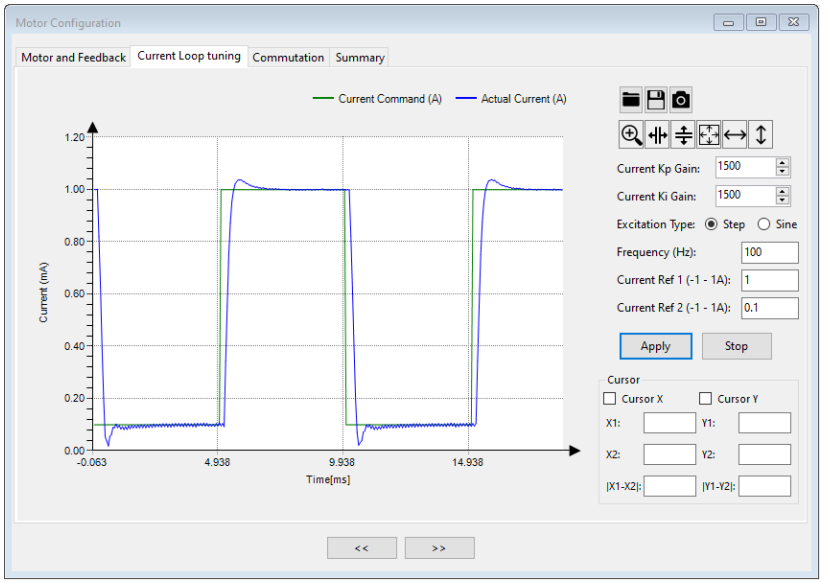
4. Click **Verify** to start current loop tuning

The response of current loop will be shown real time in the graph. Change the Current Kp gain and Current Ki gain to change the current loop response.

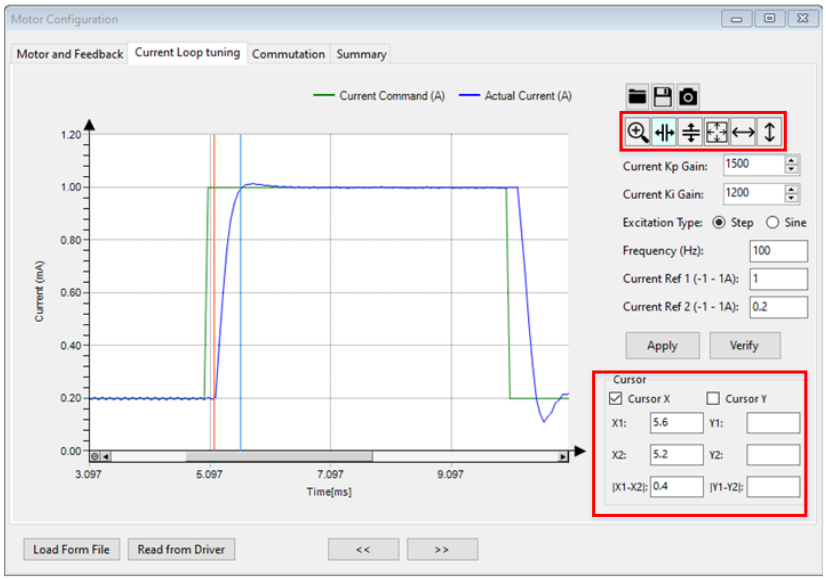
The current loop response before change PI gain



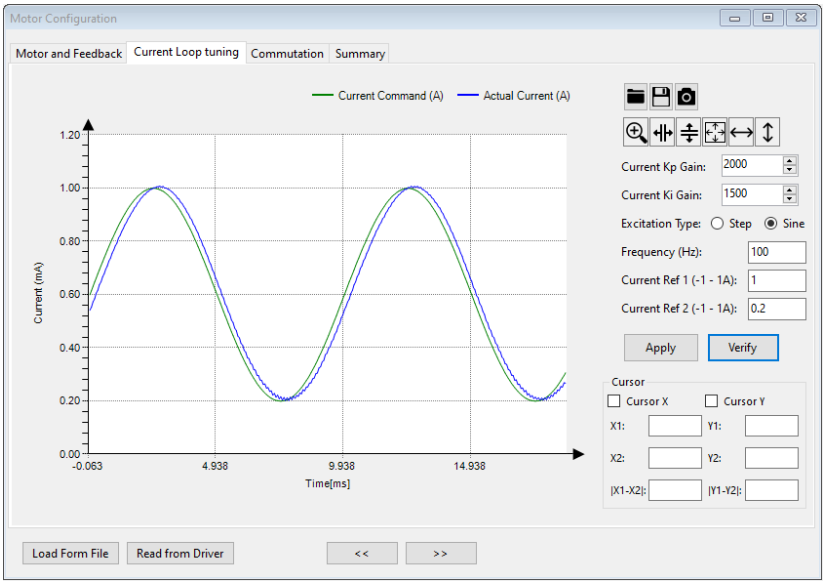
The current response after increase PI gain



You can use Zoom out and cursor to measure the response time of the signal.



You can use sine reference to measure the delay between current command and actual current.



5. If the current loop response is acceptable, click **Stop** Button to stop current loop tuning program.

This concludes the current loop tuning a program.

13.6.3. Execute Commutation

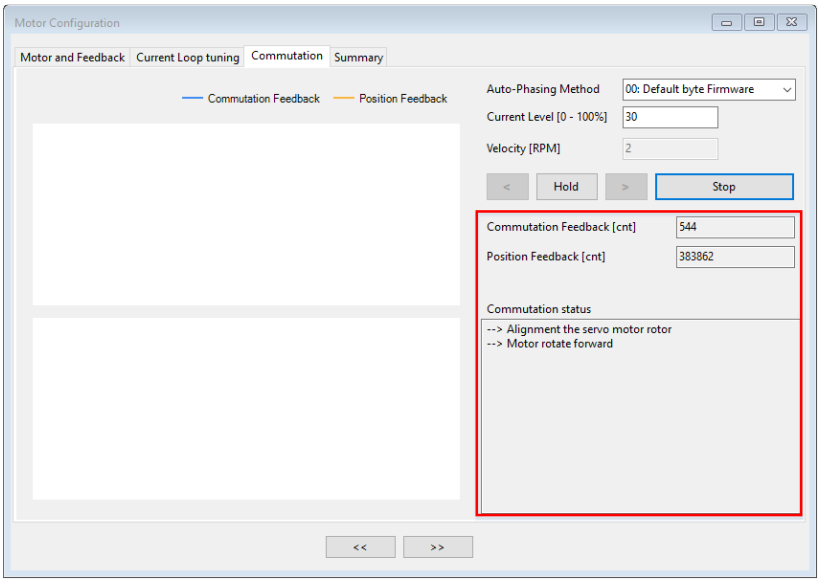
Use the following procedure to execute current loop tuning program.

1. Click to **Tuning** in toolbar and choose **Motor Configuration** of the **nEXT Configurator software**.

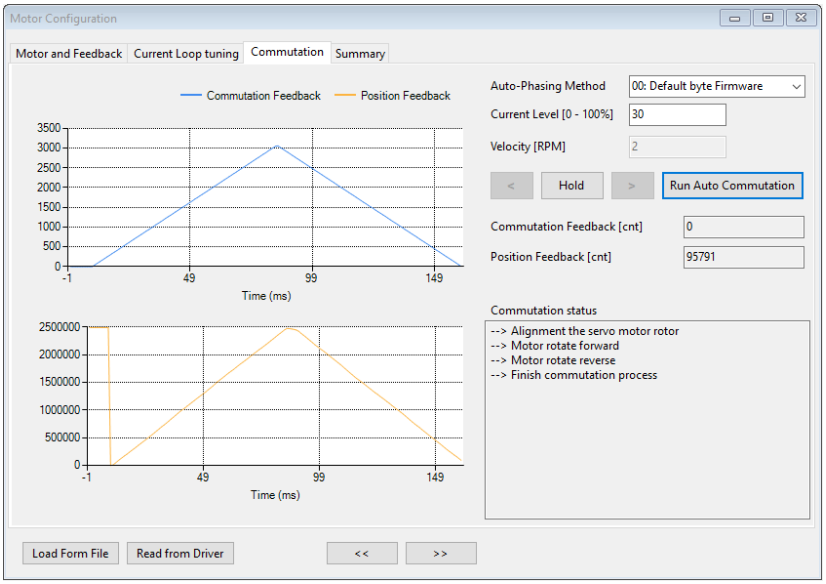
The Motor Configuration Dialog Box will be displayed.

2. Click to **Commutation** tab

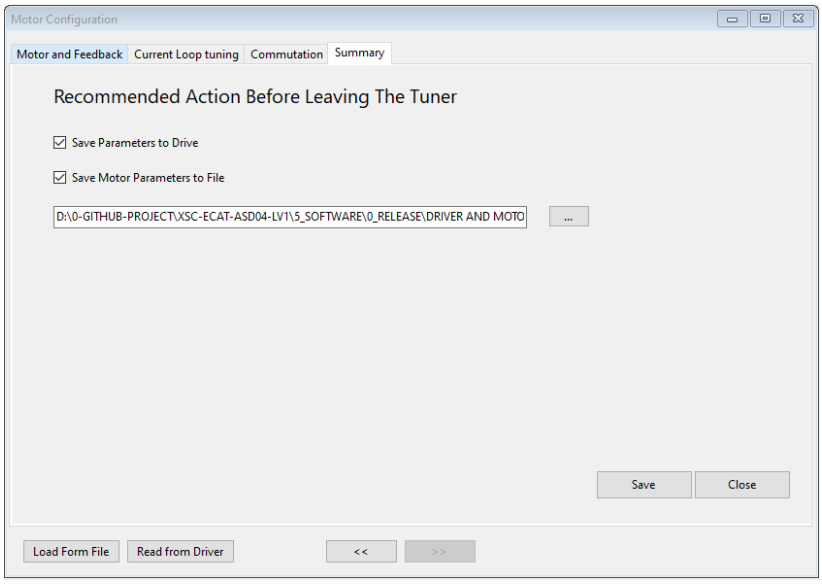
Click **Run Auto Commutation** Button to start Commutation program.



You can monitor the value of commutation feedback, and the status of commutation process



3. After the commutation program finish, click to **next** button to go to **Summary** tab



4. Click Save button and click Close button to Closed Motor Configuration program

This concludes the commutation program.

13.6.4. Tuning Speed and Position Loop

To tuning Speed and Position Loop, you need to run Trial Operation Program.

Refer to the following sections ***7-Trial Operation and Actual Operation*** for details.

You need to open Data Trace program to view Speed and Position loop response.

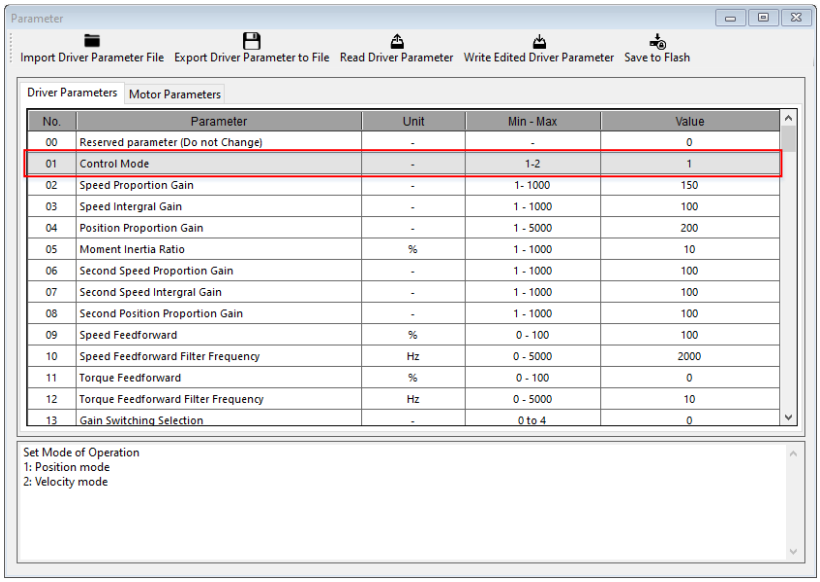
Refer to the following sections ***13.5.4-Monitoring Machine Operation Status and Signal Waveforms*** for details.

Use the following procedure to execute Speed and Position loop tuning program.

1. Click to **Basic function** in toolbar and choose **Edit Parameters** of the **nEXT Configurator software**.

   The **Edit Parameters** Dialog Box will be displayed.

   Select the control Mode by setting parameter **Pr01** in the **Edit Parameters** Window.

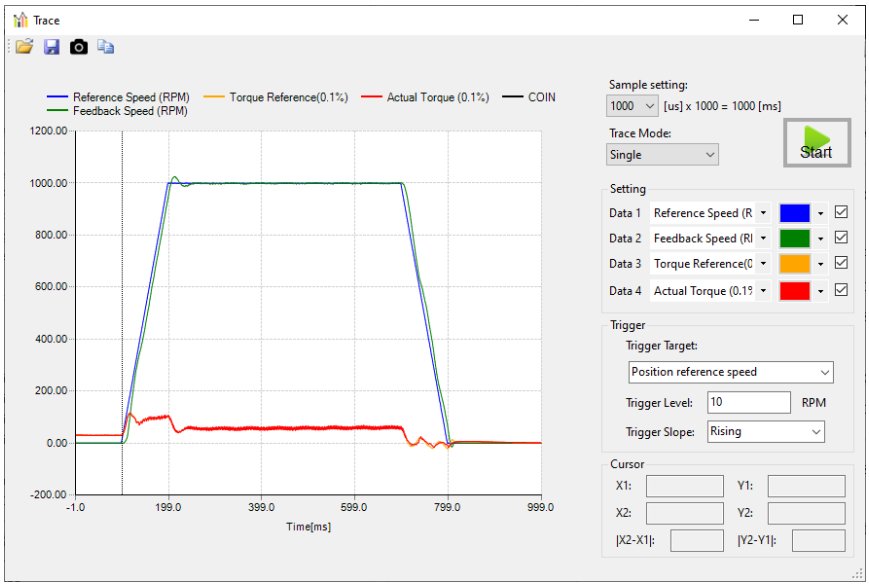


   If you want to Servo Driver working in Position mode, setting **Pr01** = 1.

   If you want to Servo Driver working in Speed mode, setting **Pr01** = 2.

2. Open **Program JOG Operation** program, setting running profile for the Servomotor.

3. Open **Data Trace** Program, select object you want to monitor
4. Execute JOG Program Function
5. Monitor the Speed response waveform, take the measurement and adjust the closed loop gain.



- To Increase the Response Speed
  - Reduce the torque reference filter time constant.
  - Increase the speed loop gain.
  - Decrease the speed loop integral time constant.
  - Increase the position loop gain.
- To Reduce Response Speed and to Stop Vibration and Overshooting
  - Reduce the position loop gain.
  - Increase the speed loop integral time constant.
  - Decrease the speed loop gain.
  - Increase the torque filter time constant.
- To Increase the Response Speed
  - Increase the position loop gain.
  - Increase Speed Feedforward.

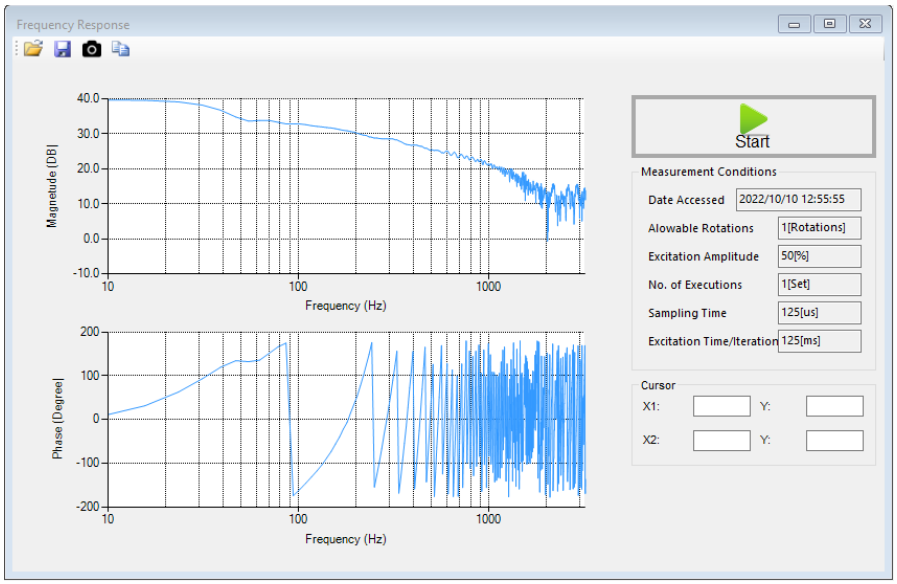
This concludes the tuning Speed and position loop.

13.6.5. Displaying Machine Frequency Characteristics on a Graph

Frequency Characteristics

The Servomotor is used to cause the machine to vibrate and the frequency characteristics from the torque to the motor speed are measured to determine the machine characteristics. For a normal machine, the resonance frequencies are clear when the frequency characteristics are plotted on graphs with the gain and phase (Bode plots). The Bode plots show the size (gain) of the response of the machine to which the torque is applied, and the phase delay (phase) in the response for each frequency. Also, the machine resonance frequency can be determined from the maximum frequency of the valleys (anti-resonance) and peaks (resonance) of the gain and the phase delay.

For a Servomotor without a load or for a rigid mechanism, the gain and phase change gradually in the Bode plots.



♦ Measure the Frequency Characteristics

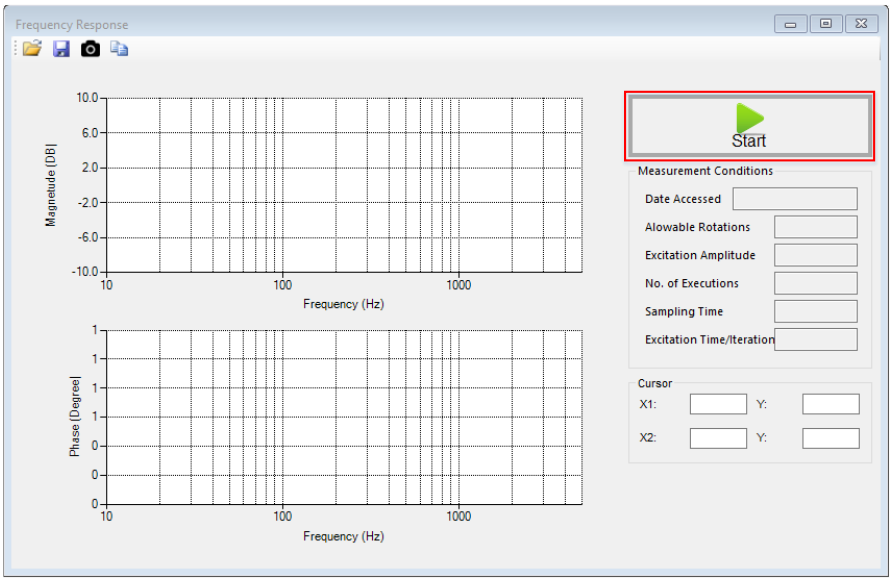
You must make preparations for measuring the frequency characteristics before you perform mechanical analysis.

Use the following procedure to prepare for measurements.

1. Select **Tuning → Mechanical Analysis** in the toolbar

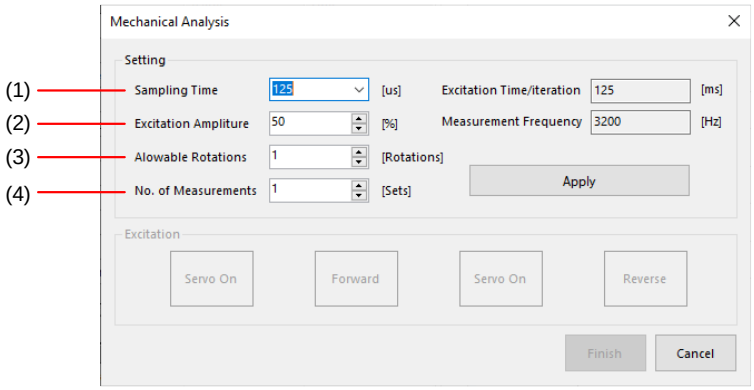
The Mechanical Analysis Dialog Box will be displayed.

2. Read the warnings and then click the OK button
3. Click **Start** button



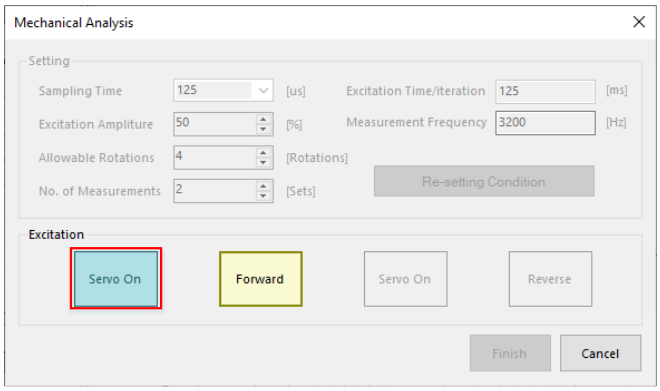
The Mechanical Analysis Dialog Box will be displayed.

4. Set the condition for the measurements

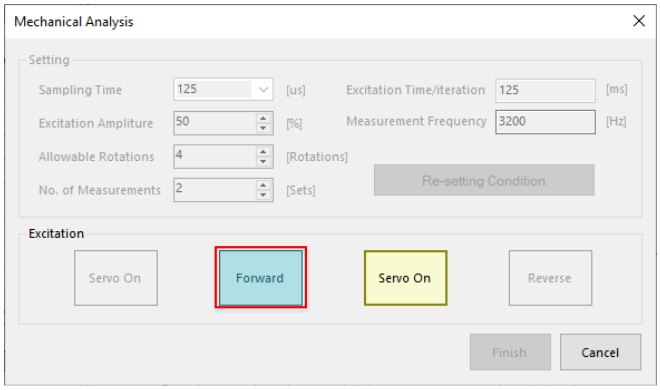


No.	Item	Description
(1)	Sampling time	Select the sampling time from the list in the box. If you set a short sampling time, measurements are possible up to high frequencies and the excitation time is shortened. However, the frequency resolution will be lower, and the measurement accuracy will be low for particularly low frequencies. The measured frequencies and excitation time are determined by the sampling time. First, set a short sampling time and use the measurement results to determine a suitable sampling time. You cannot enter values directly.
(2)	Excitation Amplitude	Set the size of the reference amplitude to excite the Servomotor as a percentage of the rated torque. The setting range is 1% to 100%. Increasing the excitation amplitude tends to produce more correct measurements, but if the excitation amplitude is too large, balance will be lost with the load moment of inertia. This will cause an alarm overload and prevent correct measurements. The excitation amplitude must be no larger than the torque limit. If the torque is restricted during excitation, correct measurements will not be possible.
(3)	Allowable Rotations	Enter the limit for the number of motor rotations (travel distance) during the measurements. The setting range is ±1 to 10 rotations. If the number of Servomotor rotations (travel distance) exceeds the allowable rotations during measurements, the Servomotor will and the measurements will stop. Set the motor rotations within the possible range of movement considering the gear ratio, e.g., the pulley diameters or ball screw pitch. If you set a small number of motor rotations, reduce the excitation width and the sampling time.
(4)	No. of Measurements	Set the number of measurements for mean processing of the measurement data. The setting range is 1 to 5 sets. One set consists of a back-and-forth operation that starts vibration or measurements from the forward side and then performs vibration and measurements from the reverse side. The larger the number of measurements, the more correct the measurement results will tend to be, but more time will be required for the measurements.

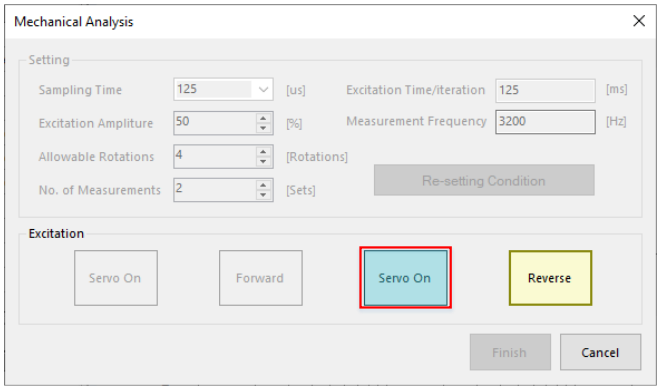
5. Click **Apply** Button
6. Click the **Servo On** Button



7. Click the Forward Button



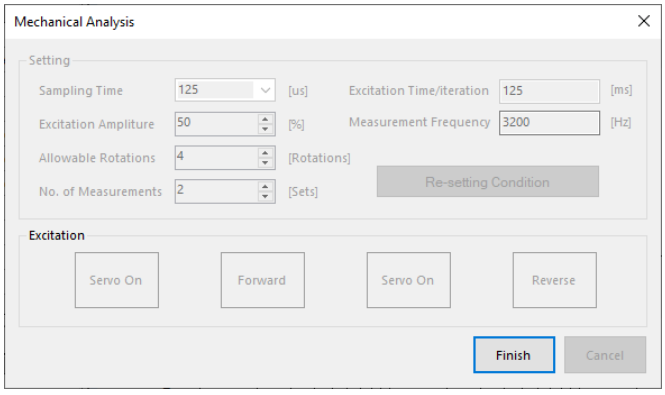
8. Click the **Servo On** Button



9. Click the Reverse Button

The Servomotor will operate in the reverse direction and measurements will be taken.

The following dialog box is displayed after the measurements have been completed.



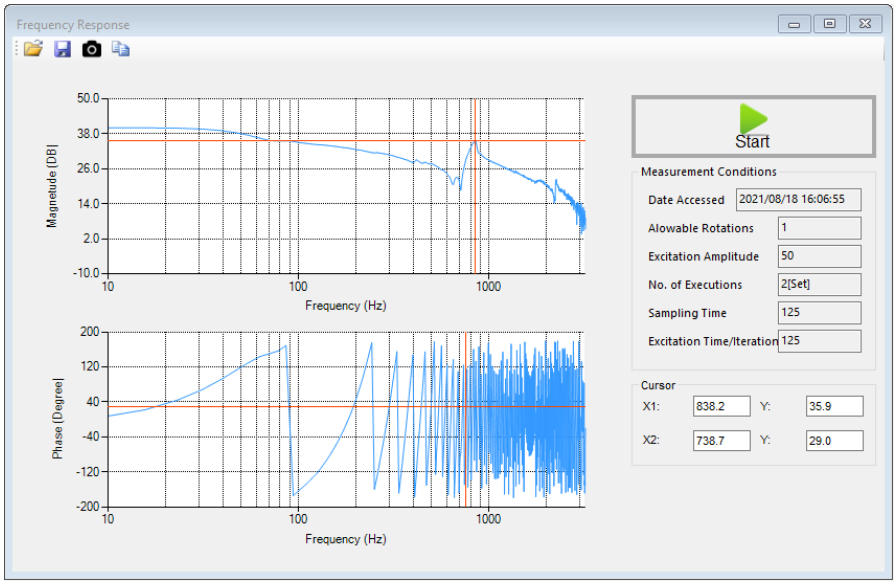
10. Repeat steps 1 to 4 of the operation for the number of times set for the number of measurements in the Mechanical Analysis
11. When the measurements have been completed, click the Finish Button.

The gain and phase graphs will be displayed in the Mechanical Analysis Dialog Box.

♦ Viewing Measurement Graphs

The measurement results are displayed in the graph display area of the Mechanical Analysis Dialog Box.

You can use the cursors to check values on the graphs.



You can use the values that were automatically calculated from the measurement results to design notch filter.

You can save the results from mechanical analysis on the computer, read mechanical analysis data files, save data file to a picture and copy the measurement results from mechanical analysis to the clipboard.

13.7. Troubleshooting

This section describes how to check the meanings of the alarms that may occur, how to investigate the causes of the alarms, and how to clear the alarms.

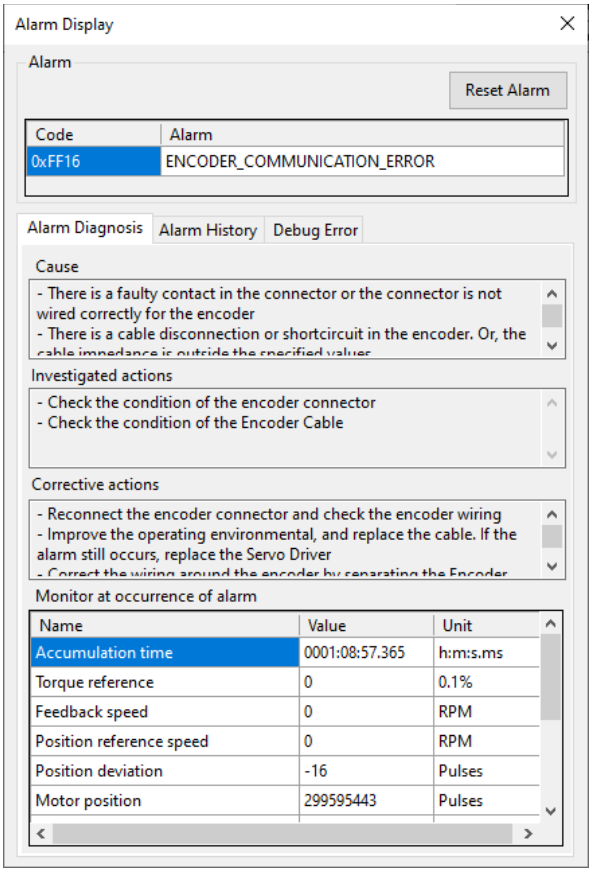
13.7.1. Checking Current Alarm

You can use the Alarm Display Dialog Box to check the cause of the alarm, to find out how to investigate the alarm, and to find out how to correct the alarm.

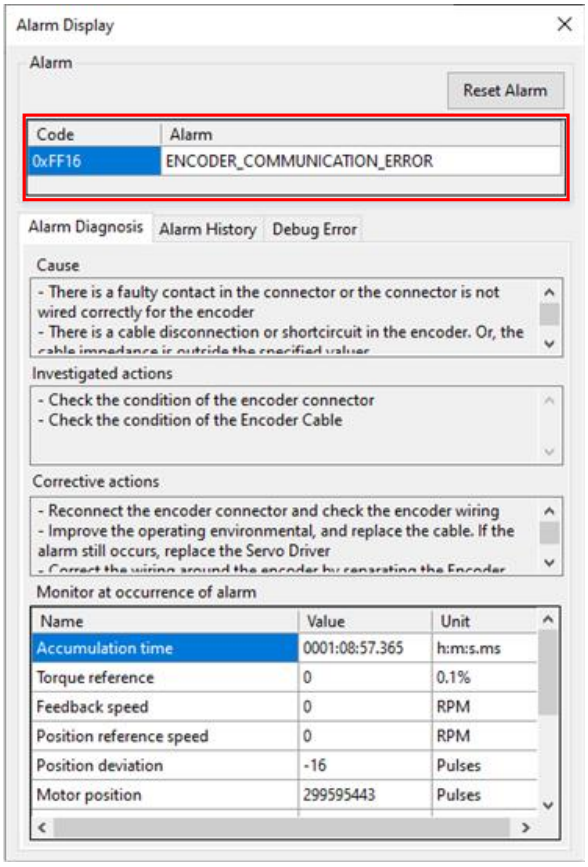
Use the following procedure to check alarms.

1. Select **Trace → Alarm** in the Toolbar

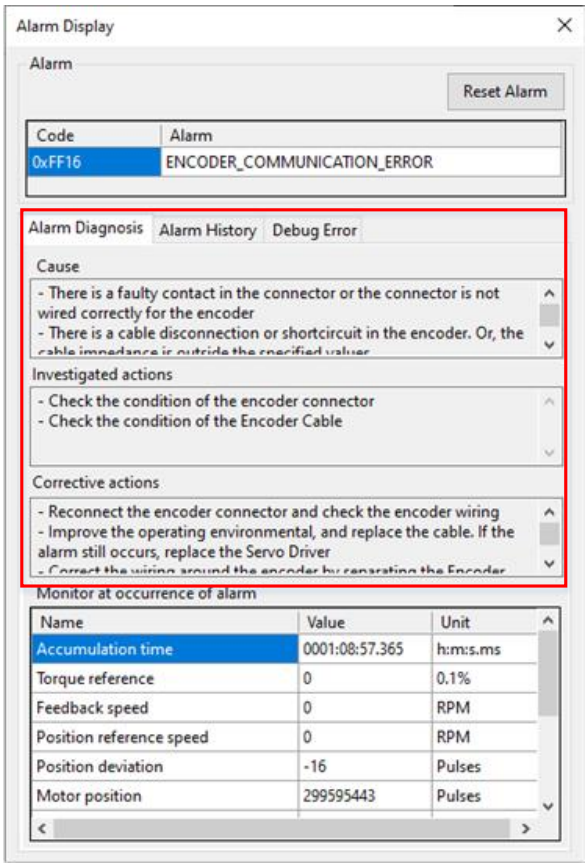
   The Alarm Display Dialog Box will be displayed.



2. Check the Alarm code and alarm meaning in the Alarm Area.



3. If you click the **Alarm diagnosis** Tab, you can check the cause of the alarm, find out how to investigate the alarm, and find out how to correct the alarm.



The data are recorded for alarm tracing:

- Accumulation time
- Torque reference
- Feedback speed
- Position reference speed
- Position deviation
- Motor position
- Main circuit bus voltage
- Driver Temperature

4. When you finish checking the alarm, click the **Close** Button to close Alarm Display dialog.

This concludes the procedure to check alarms.

13.7.2. Checking the Alarm History

You can use the Alarm Display Dialog Box to check the alarm numbers and alarm names for alarms that occurred in the past.

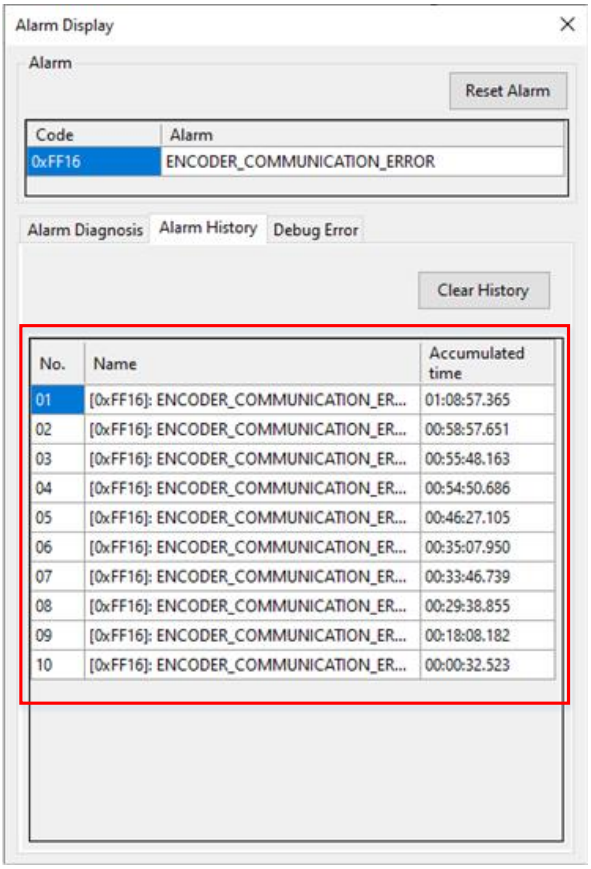
You can display up to 10 alarms that are saved in the history of alarms.

Use the following procedure to check the alarm history.

1. Select **Trace → Alarm** in the toolbar

   The Alarm Display Dialog Box will be displayed.

2. Click the Alarm History Tab



   The Alarm History Tab Page will be displayed.

3. You can check alarms that occurred in the past

- A history of up to 10 alarms is saved in the Servo Driver.
- If a new alarm occurs, it is saved as the number 01 alarm and the other alarm numbers are incremented (i.e., they are moved down in the dialog box). The last alarm is discarded.
- You can clear the alarm history by clicking the **Clear History** Button.

4. When you finish checking the alarm history, click the **Close** Button to close Alarm Display dialog.

This concludes the procedure to check the alarm history.

13.7.3. Clearing Alarms

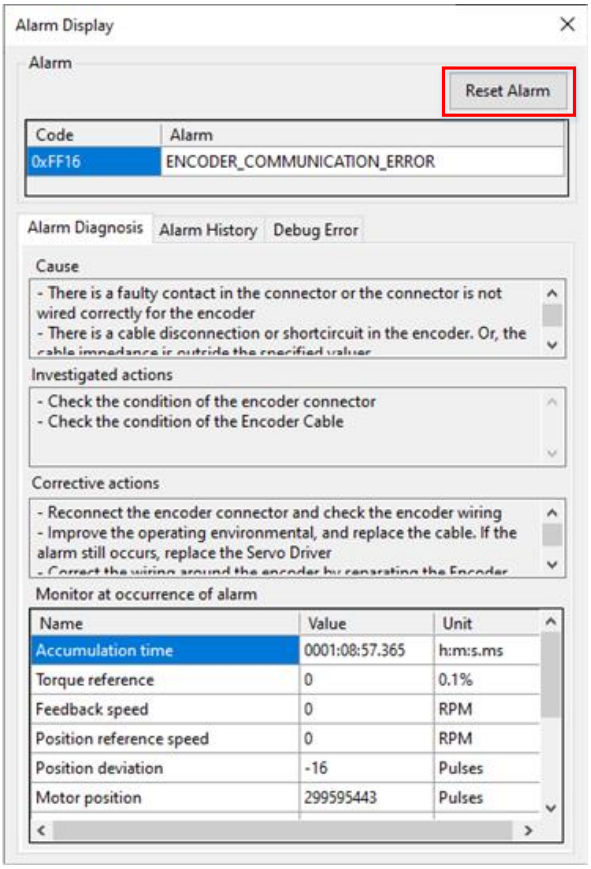
You can reset alarms that occur in the Servo Driver

Use the following procedure to reset alarms.

1. Select **Trace → Alarm** in toolbar

   The Alarm Display Dialog Box will be displayed,

2. Check the alarm meaning in the Alarm Area.
3. Reset the alarm



Click the **Reset Alarm** button

4. When you finish clear the alarm, click the **Close** Button to close Alarm Display dialog.

This concludes the procedure to reset alarms.

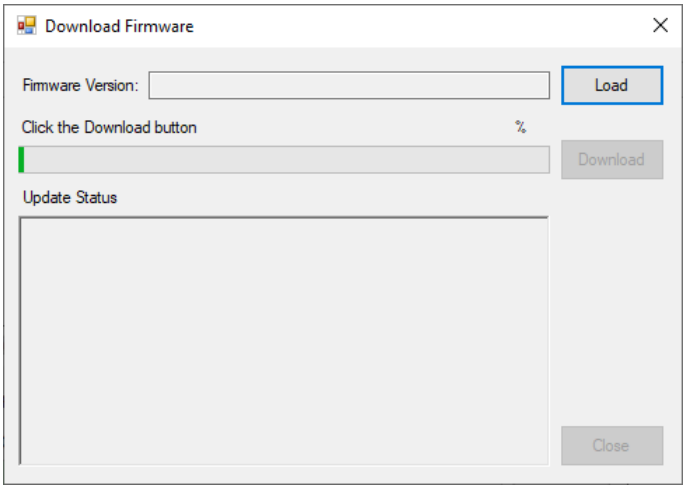
13.8. Update Firmware

It is possible to download the firmware to Servo Driver through USB

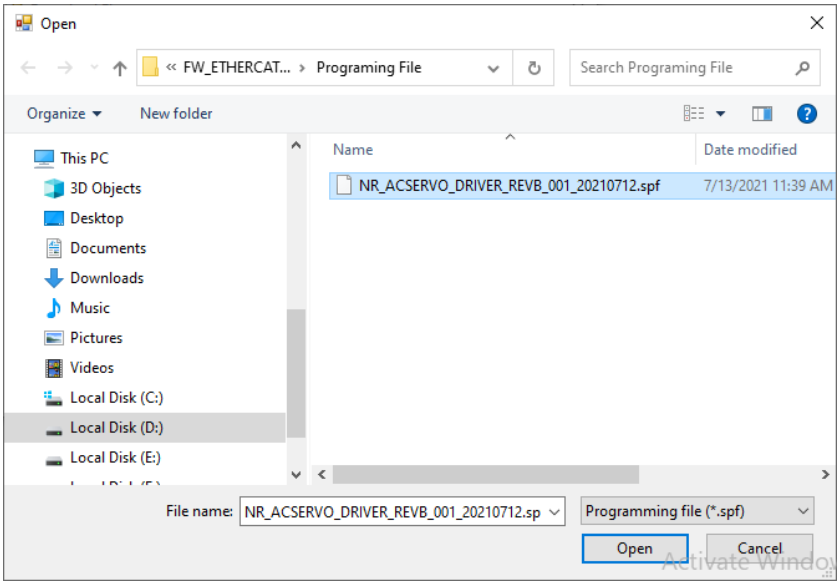
Important: All devices must be in IDLE mode (with no programs running) and motors must be disabled before performing any downloads.

To download firmware to Servo Driver via USB

1. Connect the Servo Driver to PC via USB cable
2. Go to the Download tab and open “Download Firmware” Program, The “Download Firmware” window appears

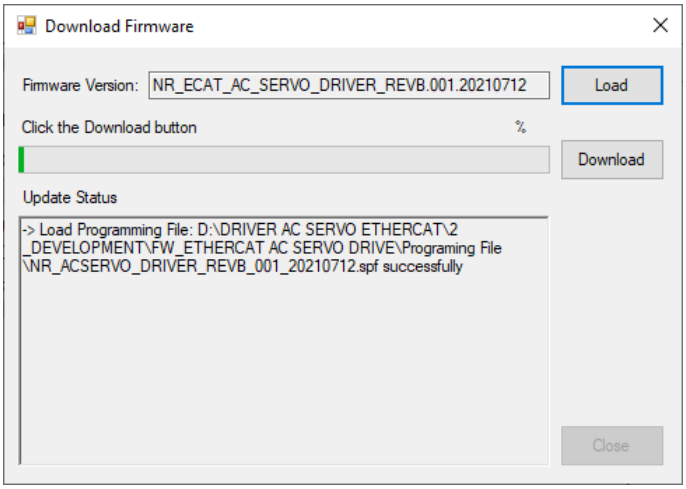


3. Click the **Load** button and locate the updated version of the Servo Driver (***.spf**) firmware file.The file is highlighted when located and selected.

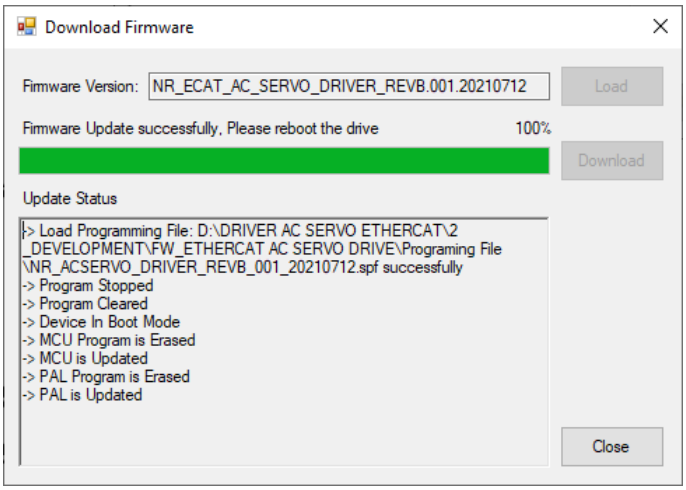


4. Click the **Open** button when the ***.spf** file is located and highlighted.

   The "**Download Firmware**" window is displayed again with the path and Firmware version displayed in the field.



5. Click **Download** to start the download process



6. Once the download process completes downloading the firmware to Servo Driver, click **Close** to exit.
7. Reboot the drive.

14. Parameter and Object lists

14.1. List of Parameters

Parameter No.	Data Type	Name	Setting Range	Unit	Default Setting	When Enabled
Pr02 (2100h)	UINT	Speed Loop Gain	10 to 1000	0.1Hz	400	Immedi-ately
Pr03 (2101h)	UINT	Speed Loop Integral Gain	10 to 1000	0.01ms	2000	Immedi-ately
Pr04 (2102h)	UINT	Position Loop Gain	10 to 1000	0.1/s	400	Immedi-ately
Pr05 (2103h)	UINT	Moment of Inertia Ratio	0 to 20000	1%	100	Immedi-ately
Pr06 (2104h)	UINT	Second Speed Loop Gain	10 to 20000	0.1Hz	400	Immedi-ately
Pr07 (2105h)	UINT	Second Speed Integral gain	15 to 51200	0.01ms	200	Immedi-ately
Pr08 (2106h)	UINT	Second Speed Loop Integral Time Constant	15 to 51200	0.01ms	2000	Immedi-ately
Pr08 (2106h)	UINT	Second Position Loop Gain	10 to 20000	0.1/s	400	Immedi-ately
Pr09 (2107h)	UINT	Speed Feedforward	0 to 100	1%	0	Immedi-ately
Pr10 (2108h)	UINT	Speed Feedforward Filter Frequency	10 to 5000	1Hz	5000	Immedi-ately
Pr11 (2109h)	UINT	Torque Feedforward	0 to 1000	0.01	1	Immedi-ately
Pr12 (210Ah)	UINT	Torque Feedforward Filter Frequency	0 to 5000	1Hz	5000	Immedi-ately
Pr13 (210Bh)	UINT	Gain Switching Selection	0 to 4	-	0	Immedi-ately
Pr14 (210Ch)	UINT	Gain Switching Level for Torque Reference	0 to 300	1%	0	Immedi-ately
Pr15 (210Dh)	UINT	Gain Switching Level for Seed Reference	0 to Maxspeed	RPM	0	Immedi-ately
Pr16 (210Eh)	UDINT	Gain Switching Level for Position Error (Deviation)	0 to 2147483647	Pos.unit	0	Immedi-ately
Pr17 (2131h)	UINT	Gain Switching Time 1	0 to 65535	1ms	0	Immedi-ately
Pr18 (2132h)	UINT	Gain Switching Time 2	0 to 65535	1ms	0	Immedi-ately
Pr19 (2135h)	UINT	Gain Switching Waiting Time 1	0 to 65535	1ms	0	Immedi-ately
Pr20 (2136h)	UINT	Gain Switching Waiting Time 2	0 to 65535	1ms	0	Immedi-ately
Pr31 (2205h)	UINT	Multiturn Limit	0 to 65535	1Rev	65535	Immedi-ately
Pr38	UDINT	Electronic Gear Ratio (Numerator)	1 to 1073741824	1 scale pitch/re-volution	1	Immedi-ately
Pr39	UDINT	Electronic Gear Ratio (Denominator)	1 to 1073741824	1 scale pitch/re-volution	1	Immedi-ately
Pr40 (2305h)	UINT	Soft Start Acceleration/Deceleration Time	0 to 10000	1ms	200	Immedi-ately
Pr41 (2308h)	UINT	Speed Feedback Filter Frequency	100 to 5000	1Hz	5000	Immedi-ately
Pr42 (230Ah)	UINT	Deceleration Time for Servo OFF	0 to 10000	1ms	0	Immedi-ately
Pr43 (230Ch)	UINT	Speed Feedforward Average Movement Time	0 to 5100	0.1ms	0	Immedi-ately
Pr44 (2401h)	UINT	First Stage First Torque Reference Filter Frequency	1 to 5000	1Hz	5000	Immedi-ately
Pr45 (2402h)	UINT	First Stage Second Torque Reference Filter Frequency	1 to 5000	1Hz	5000	Immedi-ately
Pr46 (2403h)	UINT	Forward Torque Limit	0 to 300	1%	100	Immedi-ately
Pr47 (2404h)	UINT	Reverse Torque Limit	0 to 300	1%	100	Immedi-ately
Pr49 (2405h)	UINT	Emergency Stop Torque	0 to 300	1%	100	Immedi-ately

Parameter No.	Data Type	Name	Setting Range	Unit	Default Setting	When Enabled
Pr50 (2406h)	UINT	Speed Limit During Torque Control	0 to maxspeed	RPM	-	Immedi-ately
Pr51 (2407h)	UINT	First Notch Filter Selection	0 to 1	-	0	Immedi-ately
Pr52 (2408h)	UINT	First Notch Filter Frequency	0 to 5000	1Hz	5000	Immedi-ately
Pr53 (2409h)	UINT	First Notch Filter Q Value	50 to 1000	0.01	0	Immedi-ately
Pr54 (240Ah)	UINT	First Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately
Pr55 (240Bh)	UINT	Second Notch Filter Selection	0 to 1	-	0	Immedi-ately
Pr56 (240Ch)	UINT	Second Notch Filter Frequency	0 to 5000	1Hz	5000	Immedi-ately
Pr57 (240Dh)	UINT	Second Notch Filter Q Value	50 to 1000	0.01	0	Immedi-ately
Pr58 (240Eh)	UINT	Second Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately
Pr59 (240Fh)	UINT	Third Notch Filter Selection	0 to 1	-	0	Immedi-ately
Pr60 (2410h)	UINT	Third Notch Filter Frequency	0 to 5000	1Hz	5000	Immedi-ately
Pr61 (2411h)	UINT	Third Notch Filter Q Value	50 to 1000	0.01	0	Immedi-ately
Pr62 (2412h)	UINT	Third Notch Filter Depth	0 to 1000	0.001	0	Immedi-ately
Pr63 (2502h)	UINT	Rotation Detection Level	0 to Maxspeed	1RPM	20	Immedi-ately
Pr64 (2506h)	UINT	Brake Servo Off Delay Time	0 to 500	1ms	10	Immedi-ately
Pr65 (2507h)	UINT	Brake Reference Output Speed Level	0 to Maxspeed	1ms	10	Immedi-ately
Pr66 (2508h)	UINT	Servo OFF Brake Command Waiting Time	0 to 500	RPM	10	Immedi-ately
Pr67 (2509h)	UINT	Momentary Power Interruption Hold Time	20 to 50000	1ms	100	Immedi-ately
Pr68 (2520h)	UDINT	Position Deviation Overflow Alarm Level	0 to 1073741824	Pos.uint	-	Immedi-ately
Pr69 (2522h)	UDINT	Position Completed Width	0 to 1073741824	Pos.uint	-	Immedi-ately
Pr70 (2526h)	UDINT	Position Deviation Overflow Alarm Level at Servo ON	0 to 1073741824	Pos.uint	-	Immedi-ately
Pr71 (252Bh)	UINT	Overload Warning Level	1 to 300	%	300	Immedi-ately
Pr72 (2600h)	UINT	Regenerative Resistor Value	0 to 65535	0.1Ohm	-	Immedi-ately
Pr73 (2601h)	UINT	Regenerative Resistor Capacity	0 to 65535	1Watt	-	Immedi-ately
(250Ah)	UINT	Input Signal Selection 1	0 to 65535	-	0	Immedi-ately
(250Bh)	UINT	Input Signal Selection 2	0 to 65535	-	0	Immedi-ately
(250Ch)	UINT	Input Signal Selection 3	0 to 65535	-	0	Immedi-ately
(250Dh)	UINT	Input Signal Selection 4	0 to 65535	-	0	Immedi-ately
(250Eh)	UINT	Input Signal Selection 5	0 to 65535	-	0	Immedi-ately
(250Fh)	UINT	Input Signal Selection 6	0 to 65535	-	0	Immedi-ately
(2510h)	UINT	Output Signal Selection 1	0 to 65535	-	0	Immedi-ately
(2511h)	UINT	Output Signal Selection 2	0 to 65535	-	0	Immedi-ately
(2512h)	UINT	Output Signal Selection 3	0 to 65535	-	0	Immedi-ately
(2513h)	UINT	Output Signal Selection 4	0 to 65535	-	0	Immedi-ately

14.2. Object List

Index	Subin-dex	Name	Data Type	Ac-cess	PDO Map-ping	Saving to EEPROM	Default Value	Lower Limit	Upper Limit
1000h	0	Device type	UDINT	RO	No	No	0x00020192	-	-
1001h	0	Error register	USINT	RO	No	No	-	-	-
1008h	0	Manufacturer device name	STRING	RO	No	No	-	-	-
100Ah	0	Manufacturer software version	STRING	RO	No	No	-	-	-
1018h	Identity object								
	0	Number of entries	UDINT	RO	No	No	4	-	-
	1	Vendor ID	UDINT	RO	No	No	0xB9E	-	-
	2	Product code	UDINT	RO	No	No	0x05	-	-
	3	Revision number	UDINT	RO	No	No	1	-	
	4	Serial number	UDINT	RO	No	No	1	-	-
10F1h	Sync error settings								
	0	Number of entries	UDINT	RO	No	No	-	-	-
	1	Local Error Reaction	UDINT	RW	No	No	1	-	-
	2	Sync Error Counter Limit	UDINT	RW	No	No	4	0	15
1600h	First Receive PDO mapping								
	0	Number of objects in this PDO	USINT	RO	No	Yes	7	0	0xFFFFFFFF
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	No	Yes	0x607A0020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60FF0020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	No	Yes	0x60710010	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	No	Yes	0x60FE0020	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	No	Yes	0x60600010	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	No	Yes	0x60B80010	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
1601h	Second Receive PDO mapping								
	0	Number of objects in this PDO	USINT	RO	No	Yes	4	0	0xFFFFFFFF
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	No	Yes	0x607A0020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60FE0020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	No	Yes	0x60B80010	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
1602h	Third Receive PDO mapping								
	0	Number of objects in this PDO	USINT	RO	No	Yes	3	0	0xFFFFFFFF
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60400010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60FE0020	0	0xFFFFFFFF

Index	Subin-dex	Name	Data Type	Ac-cess	PDO Map-ping	Saving to EEPROM	Default Value	Lower Limit	Upper Limit
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60FE0020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
1A00h	Frist Transmit PDO mapping								
	0	Number of objects in this PDO	USINT	RO	No	Yes	8	0	0xFFFFFFFF
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60770020	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	No	Yes	0x60F40020	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	No	Yes	0x60B90010	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	No	Yes	0x60BA0020	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	No	Yes	0x60BC0020	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	No	Yes	0x60FD0020	0	0xFFFFFFFF
1A01h	Second Transmit PDO mapping								
	0	Number of objects in this PDO	USINT	RO	No	Yes	6	0	0xFFFFFFFF
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60B90010	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	No	Yes	0x60BA0020	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	No	Yes	0x60BC0020	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	No	Yes	0x60FD0020	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
1A02h	Third Transmit PDO mapping								
	0	Number of objects in this PDO	USINT	RO	No	Yes	3	0	0xFFFFFFFF
	1	Mapping entry 1	UDINT	RW	No	Yes	0x60410010	0	0xFFFFFFFF
	2	Mapping entry 2	UDINT	RW	No	Yes	0x60640020	0	0xFFFFFFFF
	3	Mapping entry 3	UDINT	RW	No	Yes	0x60FD0010	0	0xFFFFFFFF
	4	Mapping entry 4	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	5	Mapping entry 5	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	6	Mapping entry 6	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	7	Mapping entry 7	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
	8	Mapping entry 8	UDINT	RW	No	Yes	0	0	0xFFFFFFFF
1C00h	Sync Manager communication type								
	0	Number of used Sync Manager channels	USINT	RO	No	4	-	-	-
	1	Communication type sync manager 0	USINT	RO	No	1	-	-	-

Index	Subin-dex	Name	Data Type	Ac-cess	PDO Map-ping	Saving to EEPROM	Default Value	Lower Limit	Upper Limit
	2	Communication type sync manager 1	USINT	RO	No	2	-	-	-
	3	Communication type sync manager 2	USINT	RO	No	3	-	-	-
	4	Communication type sync manager 3	USINT	RO	No	4	-	-	-
1C12h	Sync Manager PDO assignment 2								
	0	Number of assigned PDOs	USINT	RW	No	Yes	1	0	2
	1	Index of assigned RxPDO 1	USINT	RW	No	Yes	0x1601	0x1600	0x1602
1C13h	Sync Manager PDO assignment 3								
	0	Number of assigned PDOs	USINT	RW	No	Yes	1	0	2
	1	Index of assigned TxPDO 1	USINT	RW	No	Yes	0x1A01	0x1600	0x1602
1C32h	Sync Manager 2 (process data output) synchronization								
	0	Number of synchro-nization parameters	UINT	RO	No	No	11	-	-
	1	Synchronization type	UINT	RW	No	No	-	-	-
	2	Cycle time	UDINT	RO	No	No	-	-	-
	3	Reserved	UDINT	RO	No	No	-	-	-
	4	Synchronization types supported	UINT	RO	No	No	0x0005	-	-
	5	Minimum cycle time	UDINT	RO	No	No	250000	-	-
	6	Calc and copy time	UDINT	RO	No	No	62500	-	-
	7	Reserved	UDINT	RO	No	No	-	-	-
	8	Get cycle time	UINT	RW	No	No	-	-	-
	9	Delay time	UDINT	RO	No	No	0	-	-
	10	Sync0 Cycle Time	UDINT	RW	No	No	-	-	-
	11	SM-event missed counter	UINT	RO	No	No	-	-	-
	12	Reserved	UDINT	RO	No	No	-	-	-
	20	Sync error	USINT	RO	No	No	-	-	-
1C33h	Sync Manager 2 (process data output) synchronization								
	0	Number of synchronization parameters	UINT	RO	No	No	11	-	-
	1	Synchronization type	UINT	RW	No	No	-	-	-
	2	Cycle time	UDINT	RO	No	No	-	-	-
	3	Reserved	UDINT	RO	No	No	-	-	-
	4	Synchronization types supported	UINT	RO	No	No	0x0005	-	-
	5	Minimum cycle time	UDINT	RO	No	No	250000	-	-
	6	Calc and copy time	UDINT	RO	No	No	62500	-	-
	7	Reserved	UDINT	RO	No	No	-	-	-
	8	Get cycle time	UINT	RW	No	No	-	-	-
	9	Delay time	UDINT	RO	No	No	0	-	-
	10	Sync0 Cycle Time	UDINT	RW	No	No	-	-	-
	11	SM-event missed counter	UINT	RO	No	No	-	-	-
	12	Reserved	UDINT	RO	No	No	-	-	-

Index	Subin-dex	Name	Data Type	Ac-cess	PDO Map-ping	Saving to EEPROM	Default Value	Lower Limit	Upper Limit
	20	Sync error	USINT	RO	No	No	-	-	-
2000h to 26FFh	0	Servo Driver Parameters	-	-	-	-	-	-	-
2700h	0	User parameter Configuration	UDINT	RW	No	No	0	0	0xFFFFFFFF
2701h	Position user unit								
	0	Number of entries	USINT	RO	No	No	2	-	-
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823
2702h	Velocity user unit								
	0	Number of entries	UDINT	RO	No	No	2	-	-
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823
2703h	Acceleration user unit								
	0	Number of entries	UDINT	RO	No	No	2	-	-
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823
2704h	Torque user unit								
	0	Number of entries	UDINT	RO	No	No	2	-	-
	1	Numerator	UDINT	RW	No	Yes	1	1	1073741823
	2	Denominator	UDINT	RW	No	Yes	1	1	1073741823
603Fh	0	Error code	UINT	RO	Yes	No	-	-	-
6040h	0	Controlword	UINT	RW	Yes	No	0	0	0xFFFF
6041h	0	Statusword	UINT	RO	Yes	No	-	-	-
605Ah	0	Quick stop option code	INT	RW	No	Yes	2	0	4
605Bh	0	Shutdown option code	INT	RW	No	Yes	0	0	1
605Ch	0	Disable operation option code	INT	RW	No	Yes	1	0	1
605Dh	0	Halt option code	INT	RW	No	Yes	1	0	4
605Eh	0	Fault reaction option code	INT	RW	No	Yes	0	0	0
6060h	0	Modes of operation	SINT	RW	Yes	Yes	0	0	0
6061h	0	Modes of operation display	SINT	RO	Yes	No	0	-	-
6062h	0	Position demand value	DINT	RO	Yes	No	-	-	-
6063h	0	Position actual internal value	DINT	RO	Yes	No	-	-	-
6064h	0	Position actual value	DINT	RO	Yes	No	-	-	-
6065h	0	Following error window	UDINT	RW	No	Yes	-	0	1073741823
6066h	0	Following error time out	UINT	RW	No	Yes	0	0	65535
6067h	0	Position window	UDINT	RW	No	Yes	-	0	1073741823
6068h	0	Position window time	UINT	RW	No	Yes	0	0	65535
606Bh	0	Velocity demand value	DINT	RO	Yes	No	-	-	-
606Ch	0	Velocity actual value	DINT	RO	Yes	No	-	-	-
606Dh	0	Velocity window	UINT	RW	No	Yes	0	0	65535

Index	Subin-dex	Name	Data Type	Ac-cess	PDO Map-ping	Saving to EEPROM	Default Value	Lower Limit	Upper Limit
606Eh	0	Velocity window time	UINT	RW	No	Yes	0	0	65535
6071h	0	Target torque	INT	RW	Yes	No	0	-32768	32767
6072h	0	Max torque	UINT	RW	Yes	No	Motor max torque	0	65535
6074h	0	Torque demand value	INT	RO	Yes	No	-	-	-
6076h	0	Motor rated torque	UDINT	RO	No	No	-	-	-
6077h	0	Torque actual value	INT	RO	Yes	No	-	-	-
607Ah	0	Target position	DINT	RW	Yes	No	0	-2147483648	2147483647
607Ch	-	Home offset	DINT	RW	No	Yes	0	-536870912	536870911
607Dh	Software position limit								
	0	Number of entries	USINT	RO	No	No	2	-	-
	1	Min position limit	DINT	RW	No	Yes	0	-2147483648	2147483647
	2	Max position limit	DINT	RW	No	Yes	0	-2147483648	2147483647
6085h	0	Quick stop deceleration	UDINT	RW	Yes	Yes	1000	0	4294967295
6087h	0	Torque slope	UDINT	RW	Yes	Yes	1000	0	4294967295
6098h	0	Homing method	SINT	RW	Yes	No	0	0	35
6099h	Homing speeds								
	0	Number of entries	USINT	RO	No	No	2	-	-
	1	Speed during search for switch	UDINT	RW	Yes	Yes	0	0	Motor max speed
	2	Speed during search for zero	UDINT	RW	Yes	Yes	0	0	Motor max speed
609Ah	0	Homing acceleration	UDINT	RW	Yes	Yes	1000	0	4294967295
60B1h	0	Velocity offset	DINT	RW	Yes	No	0	-2147483648	2147483647
60B2h	0	Torque offset	INT	RW	Yes	No	0	-32768	32768
60B8h	0	Touch probe function	UINT	RW	Yes	No	0	0	0xFFFF
60B9h	0	Touch probe status	UINT	RO	Yes	No	-	-	-
60BAh	0	Touch probe pos1 pos value	DINT	RO	Yes	No	-	-	-
60BCh	0	Touch probe pos2 pos value	DINT	RO	Yes	No	-	-	-
60E0h	0	Positive torque limit value	UINT	RW	Yes	Yes	-	0	65535
60E1h	0	Negative torque limit value	UINT	RW	Yes	Yes	-	0	65535
60F4h	0	Following error actual value	DINT	RO	Yes	No	-	-	-
60FCh	0	Position demand internal value	DINT	RO	Yes	No	-	-	-
60FDh	0	Digital inputs	UDINT	RO	Yes	No	-	-	-
60FEh	Digital outputs								
	0	Number of entries	USINT	RO	No	No	-	-	-
	1	Physical outputs	UDINT	RW	Yes	No	0	0	0xFFFFFFFF
	2	Bit mask	UDINT	RW	No	Yes	0xFFFF	0	0xFFFFFFFF
60FFh	0	Target velocity	DINT	RW	Yes	No	0	-2147483648	2147483647
6502h	0	Supported drive mode	UDINT	RO	No	No	0xA0	-	-

Revision History

Revision	Date	Descriptions	Author
REVA.001	10.10.2021	Initial version	V.N.D
REVE.001	08.10.2022	Add Software Manual	V.N.D
REVE.002	01.12.2022	Rename software, series,…	V.N.D