

Sanmei Invention Servo
Sí servo 3

Instruction Manual

Main part

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1. Before use

- Si servo driver is a fully digital position control servo driver equipped with high speed CPU for use with a stepping motor.
- Before using the product, read this instruction manual and the booklets attached to the driver and motor carefully to understand the correct usage.
- Be sure to correctly understand and never forget the contents of safety precautions. Be careful not to mishandle the equipment in any case. Improper use may lead to serious accidents including death.
- After reading this instruction manual and the booklets attached to the driver and motor, keep them in a place where you can access and read them whenever needed.

Servo driver models to which the contents of this manual apply

Si servo3	Si-02DT Si-05DT
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2. Precautions

This section provides notes for using the driver safely and correctly. Be sure to observe the following content. Although 100% inspection is performed to confirm normal operation of the product before the shipment, there is a possibility that the driver may malfunction due to initialization failure, aging, or other causes. In order to prevent accidents, **consider incorporating multiple safety measures into your system and your product** to avoid accidents possibly caused by malfunction of this product.

2-1. Safety related symbols

The symbol marks related to safety are shown below. They are divided into "Danger" and "Caution".



Extremely dangerous if handled incorrectly. The product may get damaged, leading to serious accidents including serious injury or death.



Dangerous if handled incorrectly. The product may get damaged, leading to injury. In addition, the items indicated by Caution may lead to a serious accident depending on the situation. All the indicated items are important, so be sure to follow the instructions.

2-2. Safety precautions



(Wiring)

- Be sure to connect the ground terminal of the driver to the grounding connection (class D grounding) and make a one-point ground.

Risk of electric shock or fire.

(Operation)

- Never touch the rotating part of the motor during operation.

Risk of injury.

(Maintenance)

- Never insert your hand in the driver when powered.

Risk of electric shock.



(Installation location)

- Do not use in places subject to high temperature, high humidity, water, corrosive gas, flammable gas, in vicinity of flammable materials, or in an atmosphere with plenty of dust or iron powder.

May cause malfunction, electric shock, fire or explosion.

(Wiring)

- Never supply commercial power to all connectors of the motor and driver.

Risk of failure.

(Operation)

- When performing a trial run, use the motor without load to avoid unexpected accidents.

Risk of injury.

- Before starting operation with the product incorporated into a machine, be sure to be able to perform emergency stop at any time, such as by installing an emergency stop switch, to quickly eliminate the danger.

Risk of injury.

- In the process of adjusting parameters, abnormal vibration may occur due to incorrect adjustment. Allow enough stroke to the machine etc. to avoid danger.

Risk of injury.

- Do not touch the motor or the heat sink of the driver while the power is ON.

Risk of burns due to high temperature.

(Maintenance and inspection)

- Do not disassemble or modify the driver or motor.

May cause damage.

- Do not change the wiring while the power is ON.

Risk of electric shock, injury or damage.

2-3. About safety standards



The products with CE marking have been confirmed to be safe under the following test conditions, so design your products in compliance with these conditions.

(Overvoltage category)

- The product is compatible with Overvoltage category "I", thus use a power supply with double insulation or reinforced insulation from the commercial power line to power the driver. Also, be sure to insert an UL safety standard certified or similar slow blow type fuse between the power supply and the driver. Use a fuse with the ratings below. There is a risk of damage or fire.

For Si-02DE or Si-02LDE: rated current 5A, rated voltage 32V or higher

For Si-05DE or Si-05LDE: rated current 15A, rated voltage 32V or higher

(Pollution degree)

- The product is compatible with environmental pollution degree 2. Never use it in an environment where conductive pollution may occur. There is a risk of damage.

2-4. General precautions

The following are general precautions for using the product to prevent malfunction. Follow the instructions carefully.

2-4-1. Driver related precautions

- Provide proper cooling method, placement, box size, etc. so that the internal temperature of the control panel due to built-in equipment will not exceed the specified temperature range.
- If there is a vibration source nearby, install a shock absorber or the like so that the vibration transmitted to the driver does not exceed the specified value.
- When arranging two or more drivers side by side, secure a space of 20mm or more on both sides and 50mm or more on top and bottom. If sufficient gap cannot be provided, perform forced air cooling with a fan.
- After turning the driver power OFF, make sure that the power LED of the driver is completely turned OFF before turning the driver power ON again. If the power is turned ON repeatedly in a short time, the data in the encoder memory will be destroyed.

2-4-2. Motor related precautions

- It is recommended to use hexagon socket head screws for mounting the motor.
- All lead wires should be fixed. Do not use them movable.
- Some of the lead wires may be damaged by static electricity (static protection marked parts). Take measures to prevent generation of static electricity and eliminate static electricity from the operator on the relevant part.

2-4-3. Precautions related to wiring

- Use the applicable wire size, type and maximum wiring length within the specified range.
- Implement the following measures against noise:
 - 1) Be sure to attach a surge absorption circuit to the coil of a relay, electromagnetic contactor, solenoid, etc.
 - 2) Power lines (AC line, motor line, etc.) should be separated from the signal lines by 30cm or more. Do not pass them in the same duct or bundle them together.
 - 3) Use a noise filter on a power supply and input circuits when using the driver on the same power line as an electric welding machine, electric discharge machine or similar, or when there is a high frequency noise source nearby.
 - 4) The driver uses a switching amplifier, thus noise may appear on the signal lines.
- The driver does not implement measures against radio interference, so insert a line filter when using it near a private house or when radio interference is a problem.
- The wires in the signal cables are as thin as 0.08-0.2mm², thus provide a bend to the cable to avoid applying tension.

3. General specifications

3-1. Driver specifications/characteristics

Driver specifications/characteristics table

Model		Si-02DT	Si-05DT	
Applicable motor model		Refer to List of compatible motors		
Rated output current (A _{0-p})		3.0 (maximum value depending on the connected motor)	5.0 (maximum value depending on the connected motor)	
Maximum output current (A _{0-p})		6.0 (maximum value depending on the connected motor)	10.0 (maximum value depending on the connected motor)	
Control method		Transistor PWM (sine wave drive)		
Allowable load inertia		20 times the motor inertia		
Position feedback		Incremental encoder (resolution 10,000) (when Si servo motor is connected, resolution 800 or 1,600)		
Casing structure		Book type		
Approximate dimensions (mm)		39(W) x 70(H) x 55(D) [excluding protrusions]	42.2(W) x 76(H) x 85(D) [excluding protrusions]	
Approximate mass (kg)		0.1	0.19	
Input power	Supply voltage (V)	Power	DC24V±10%	
		Control	DC24V±10%	
	Rated supply current (A)	Power	maximum 2.8 (when connected to SM-08MT)	maximum 4.0 (when connected to SM-20MT)
		Control	0.05	0.05
	Maximum supply current (A)	Power	maximum 4.0 (when connected to SM-08MT)	maximum 5.0 (when connected to SM-20MT)
		Control	0.1	0.1
Position command method		position reference pulse, Point-Table command, direct communication command		
Use conditions	Operating temperature		0~+50°C	
	Storage temperature		-20~+85°C	
	Use/storage humidity		90%RH or less (no condensation)	
	Vibration resistance		0.5G	
	Shock resistance		2G	
Input	Control input		5 points (function selectable by parameter), photocoupler max. 30VDC	
	Position reference pulse input		CW/CCW, PULSE/SIGN, A/B phase input (selectable by parameter) 5V line driver (26C31 equivalent), photocoupler input from 5V/24V open collector maximum response frequency (per phase) : line driver: 750kpps, open collector: 200kpps (both at 50% pulse duty)	
Output	Control output		3 points (function selectable by parameter) open collector max. 30VDC, 50mA	
	Brake release output		non-voltage contact output max. 60VDC, 1A	
	Encoder output		only Z-phase output	

Driver specifications/characteristics table (continued)

Model		Si-02DT	Si-05DT
Built-in functions	Position control mode	servo mode (superposition control) / step mode parameter switching	
	Positioning time	within 30ms under standard load conditions (separate setting)	
	Servo auto tuning	offline auto tuning by PC via USB	
	Vibration suppression control	Vibration suppression filter (2 steps) Torque notch filter (4 steps)	
	Dynamic brake function	none	
	Regeneration function	optional regenerative circuit can be connected externally	
	Overtravel prevention function	hardware OT, software OT (ON/OFF selectable by parameter)	
	Electronic gear	by setting the electronic gear, one rotation of the motor can be driven with (10,000 x 1/65,535)~(10,000 x 65,535/1) pulses can be switched in 2 steps by control input	
	Point-Table positioning	256 points	
	Machine edge detect sequence	Implemented at power ON	
	Homing	Built-in homing function (7 types)	
	Jog operation	YES	
	Step operation	YES	
	Torque limit function	Normal forward/reverse torque limit value (set by parameter in 0.1% unit) 5 steps of forward/reverse torque limit value switching by control input (each torque limit value is set by parameter)	
	Torque research control	Load torque ripple component compensation (automatic saving of measurement/compensation data by built-in load torque measurement operation)	
Monitor functions	2 LEDs (alarm indication by blinking), control output signals PC monitor screen display with RS485 or USB connection		
Protection functions (alarms)	driver memory error, motor memory error, encoder error, system setting error, excessive position error, overcurrent, operating temperature error, overload, motion control error, serial communication error, power supply overvoltage, power supply undervoltage, control power supply error		
Multi-axis connection functions	setting and adjustment of multiple axes possible by either RS485 multidrop connection or USB hub connection		
Serial communication I/F	RS485 x 1ch (115kbps max.), USB 1.1 x 1ch (Full-Speed Function) (USB cannot be used for control)		
Group control communication commands	Broadcast commands for separate groups		
Setting method	Parameters setting by connected PC (using dedicated PC monitor software)		
Link unit connection	Connection to Real-Time Ethernet via optional link unit		
Automatic mail forward function	Extended function of connected PC monitor software		
Certificate / Environmental compliance	CE (self-declared) / RoHS2 (10 substances) compliant		

3-2. Motor specifications/characteristics

Motor specifications/characteristics table 1

Model		SM-L5MT	SM-02MT	SM-04MT	SM-07MT	SM-08MT	SM-09MT	SM-12MT	SM-20MT	SM-03MN
Rated output torque	N·m	0.06	0.15	0.31	0.45	0.48	0.49	1.2	1.39	0.18
Maximum output torque	N·m	0.11	0.28	0.49	0.74	0.9	0.86	1.8	2.3	0.34
Maximum rotation velocity	min ⁻¹	4500	4500	3000	2000	2500	2000	1000/ 2000 (※1)	2000	6000
Rated current	A0-p	1.6	2.0	2.0	2.0	2.8	2.0	3.0	5.0	2.0
Rated voltage	V	0.96	1.46	2.2	1.8	0.87	1.24	2.6	2.2	2.4
Winding resistance	Ω	0.6±15%	0.73±15%	1.1±15%	0.9±15%	0.31±15%	0.62±15%	0.85±15%	0.44±15%	1.2±10%
Winding inductance	mH	0.46±30%	1.1±20%	2.0±20%	1.9±20%	0.91±30%	1.5±20%	2.7±20%	1.4±20%	2.0(Ref)
Rotor inertia	10 ⁻⁷ kg m ²	8	35	68	114	280	260	430	520	59
Axial runout	mm T.I.R.	0.025	0.05							
Allowable overhanging load (shaft tip)	N	21.6	20.6			38.2	52.9			19.6
Allowable thrust load	N	4.9	9.8				19.6		9.8	14.7
Winding method	—	2-phase hybrid stepping motor bipolar winding								
Insulation class	—	CLASS E	CLASS B							
Insulation resistance	MΩ MIN	100 (at DC500V)								
Withstand voltage	V	500 (at AC 1min)								
Operating temperature	℃	-10~+50								0~+50
Operating relative humidity	%RH	5~95								
Storage temperature	℃	-20~+70								
Mass	kg	0.13	0.26	0.39	0.53	0.63	0.72	1.00	1.24	0.31
Certificate / Environmental compliance / Protection class	—	CE (self-declared) / RoHS2 (10 substances) compliant / IP40								

(※1) 1000min⁻¹ when using Si-02DT driver, 2000min⁻¹ when using Si-05DT driver.

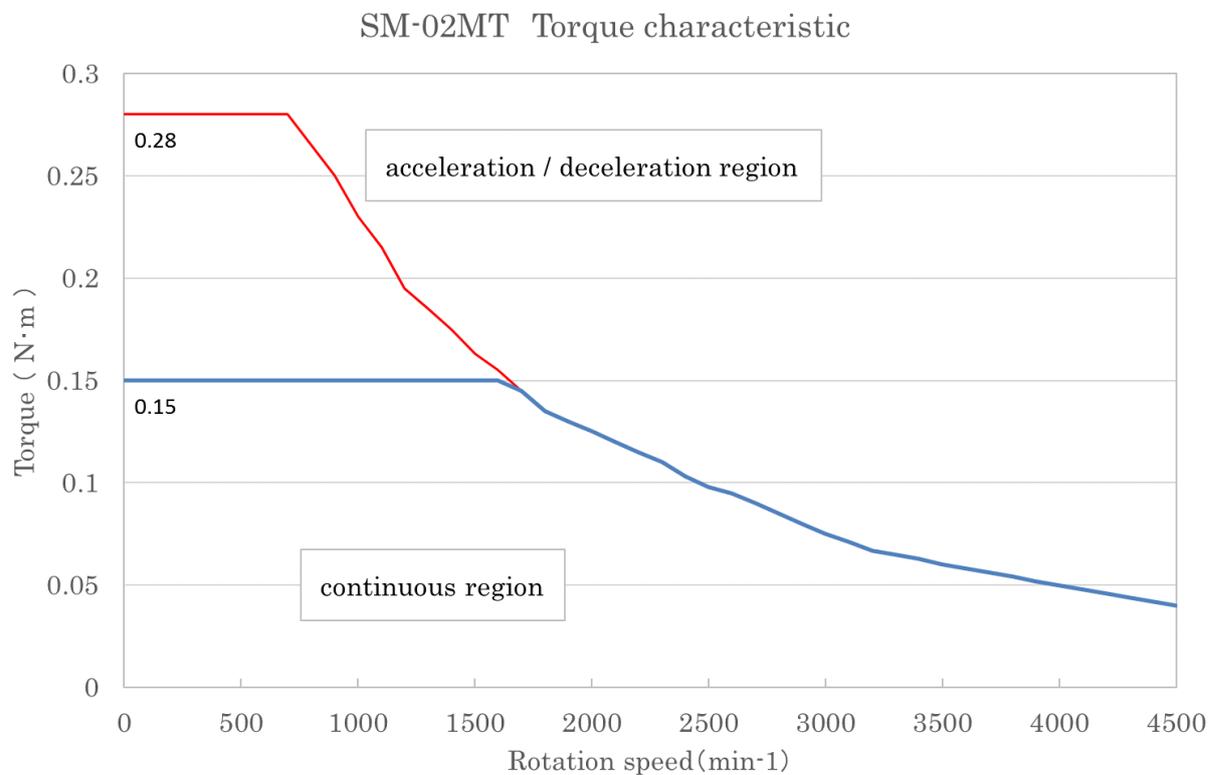
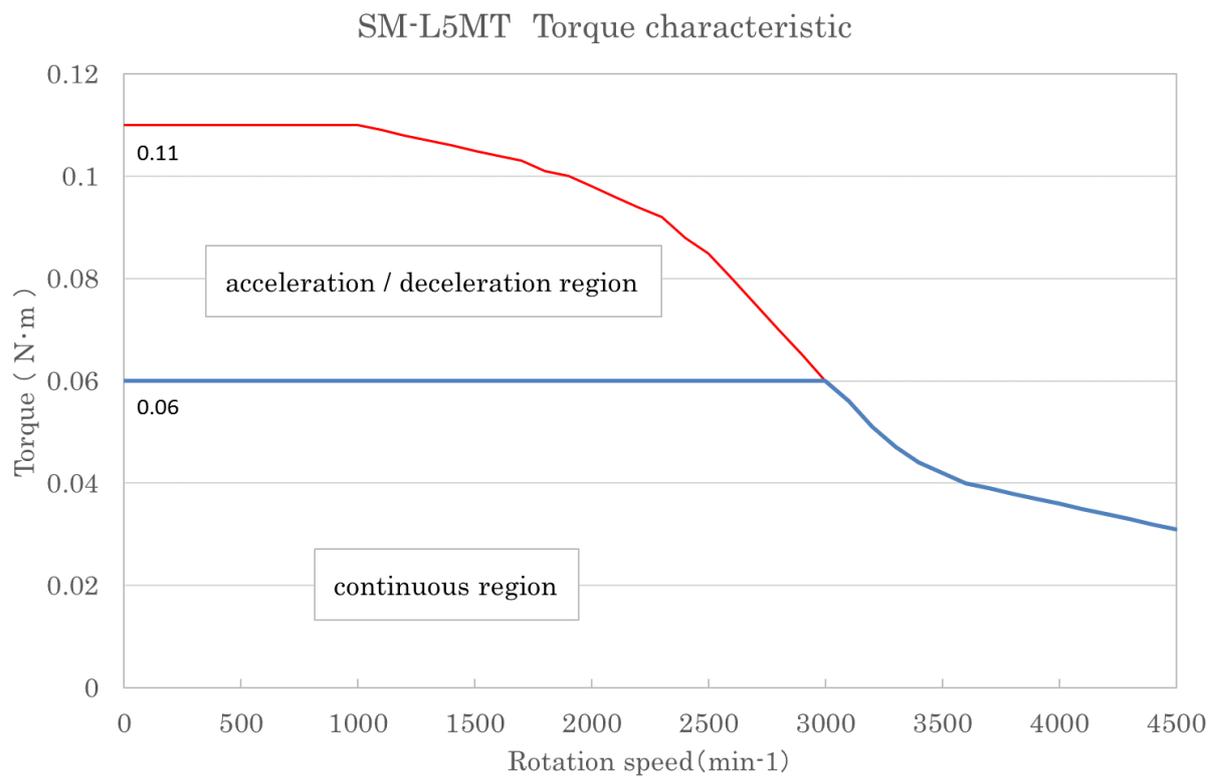
(Connection between Si-02DT and SM-12MT is supported by driver software version 1.01 or later.)

Motor specifications / Characteristics table 2 (Motor with holding brake)

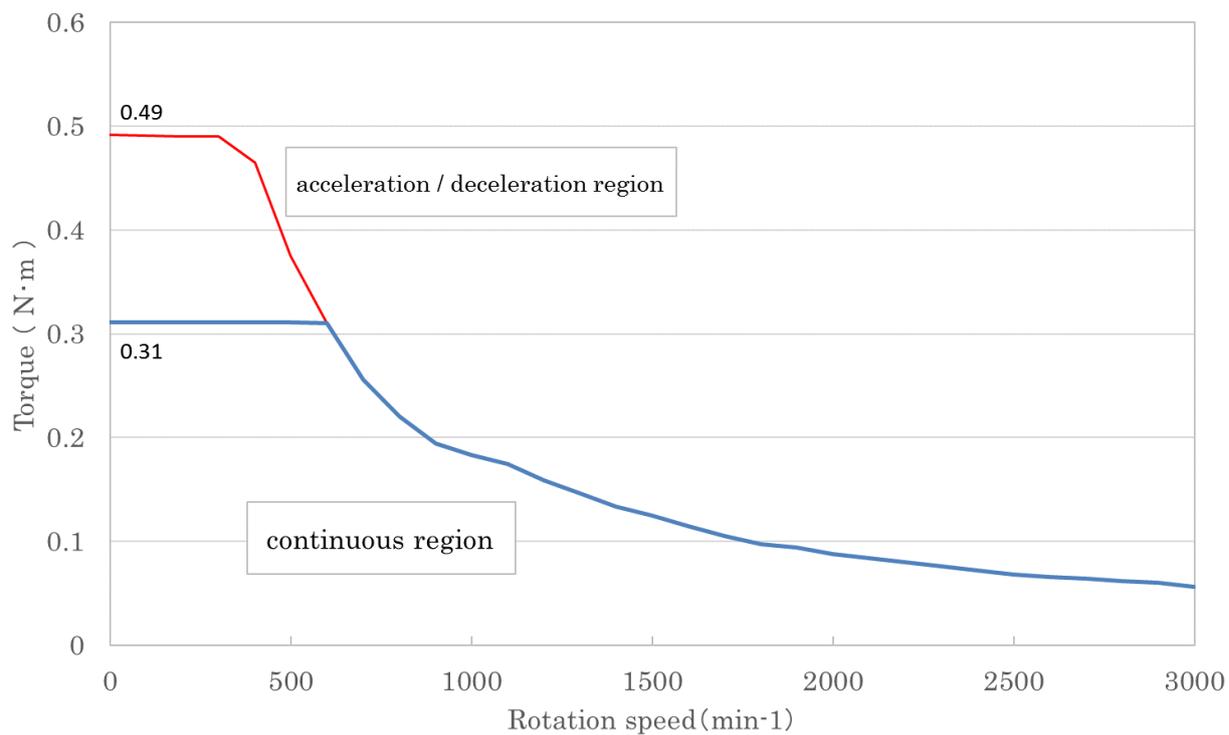
Model		TS3680N370S04	TS3680N371S04	TS3681N324S04	TS3681N325S04	TS3681N327S04
Rated output torque	N·m	0.18	0.3	0.49	1.2	1.39
Maximum output torque	N·m	0.27	0.46	0.87	1.8	2.3
Maximum rotation velocity	min ⁻¹	4500	3000	2000	1000/2000 (※1)	2000
Rated current	A0·p	2.0	2.0	2.0	2.0	5.0
Rated voltage	V	2.2	2.8	2.1	4.5	2.2
Winding resistance	Ω	1.1±15%	1.4±15%	1.05±15%	1.7±15%	0.44±15%
Winding inductance	mH	1.4±20%	2.4±20%	1.5±20%	5.8±20%	1.4±20%
Rotor inertia	10 ⁻⁷ kg·m ²	41	74	280	450	540
Axial runout	mm T.I.R.	0.05				
Allowable overhanging load (shaft tip)	N	20.6			52.9	
Allowable thrust load	N	9.8			19.6	
Winding method	—	2-phase hybrid stepping motor bipolar winding				
Insulation class	—	CLASS B				
Insulation resistance	MΩ MIN	100 (at DC500V)				
Withstand voltage	V	500 (at AC 1min)				
Operating temperature	℃	0~+40				
Operating relative humidity	%RH	5~95				
Storage temperature	℃	-20~+70				
Mass	kg	1.16	1.29	1.62	1.98	2.28
Certificate / Environmental compliance / Protection class	—	CE (self-declared) / RoHS2 (10 substances) compliant / IP40				

(※1) 1000min⁻¹ when using Si-02DT driver, 2000min⁻¹ when using Si-05DT driver.

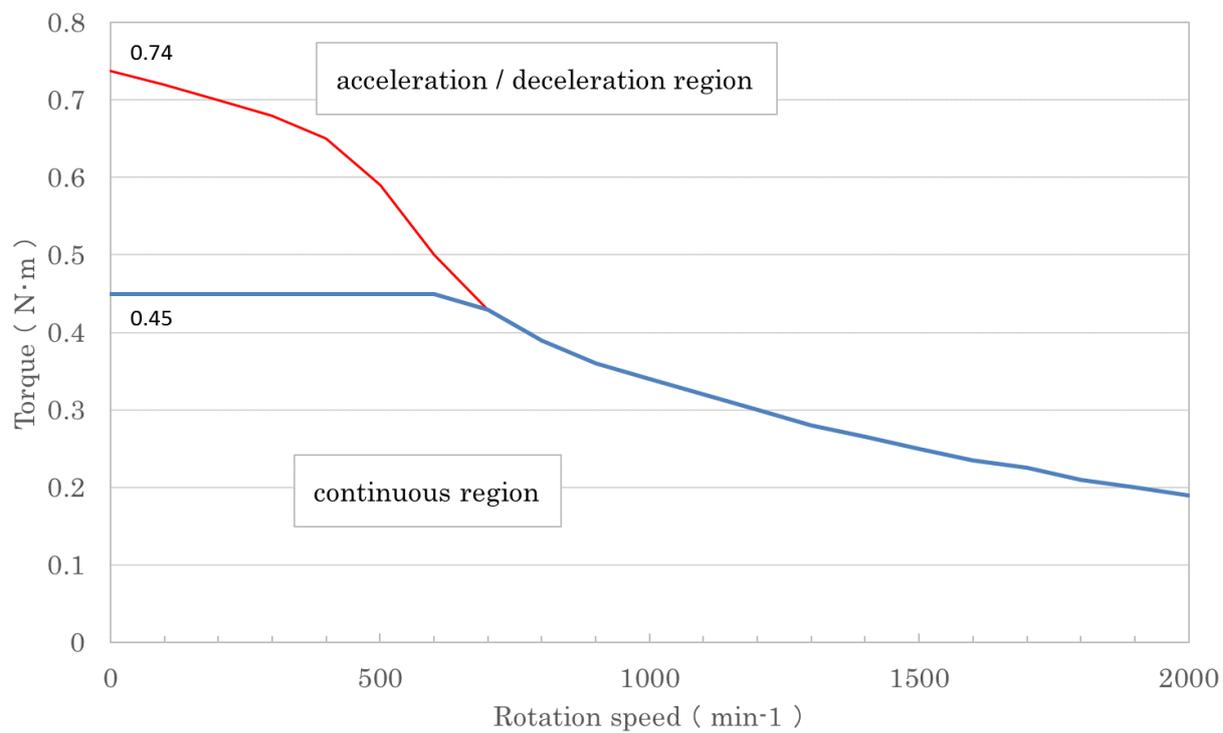
3-3. N-T characteristics



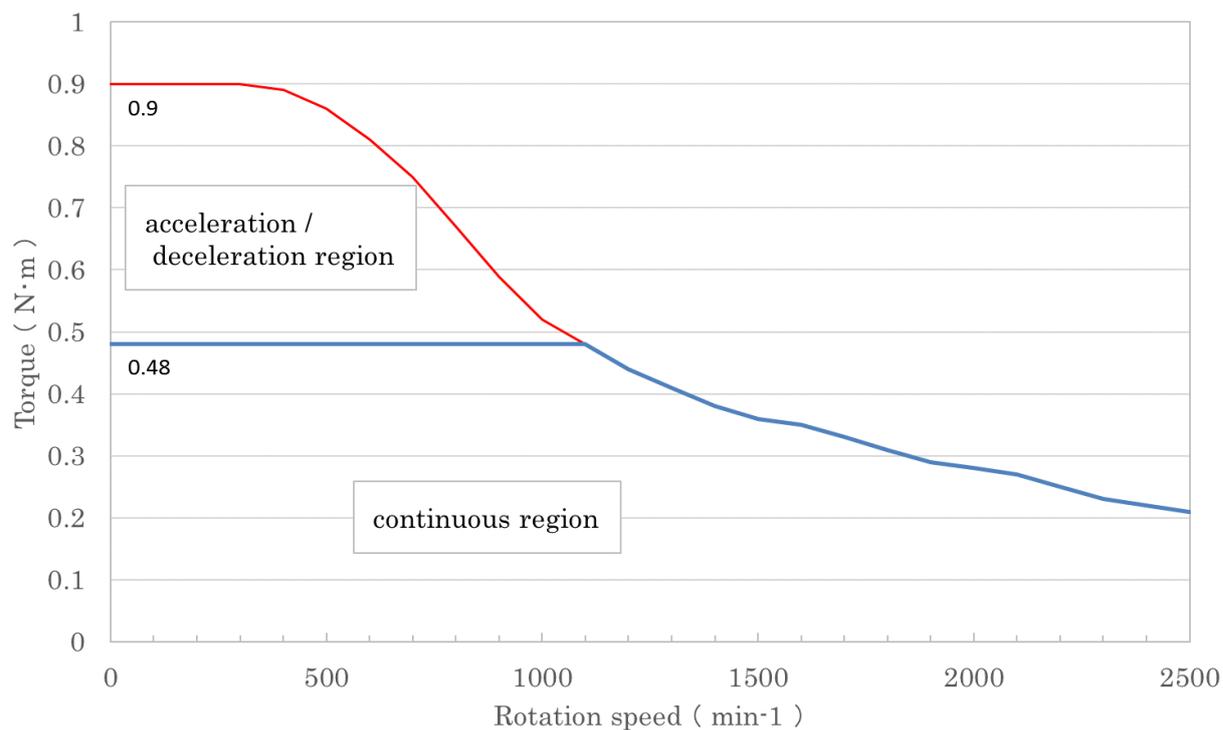
SM-04MT Torque characteristic



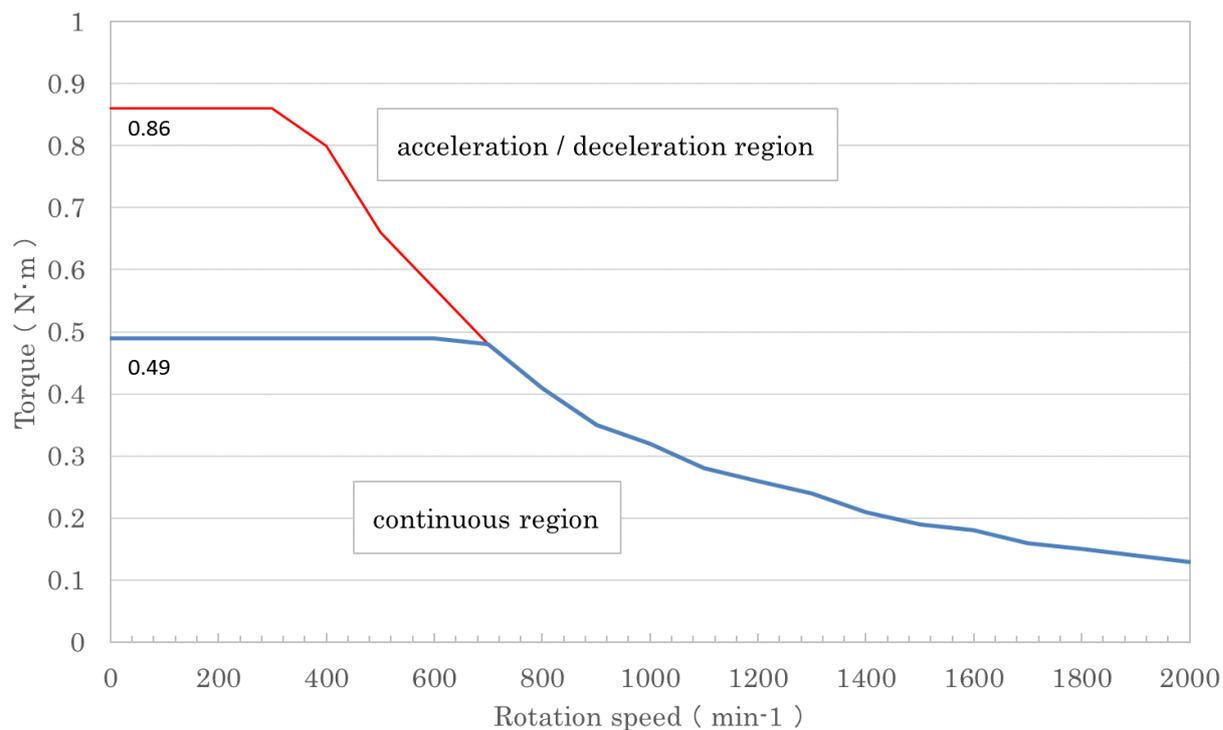
SM-07MT Torque characteristic



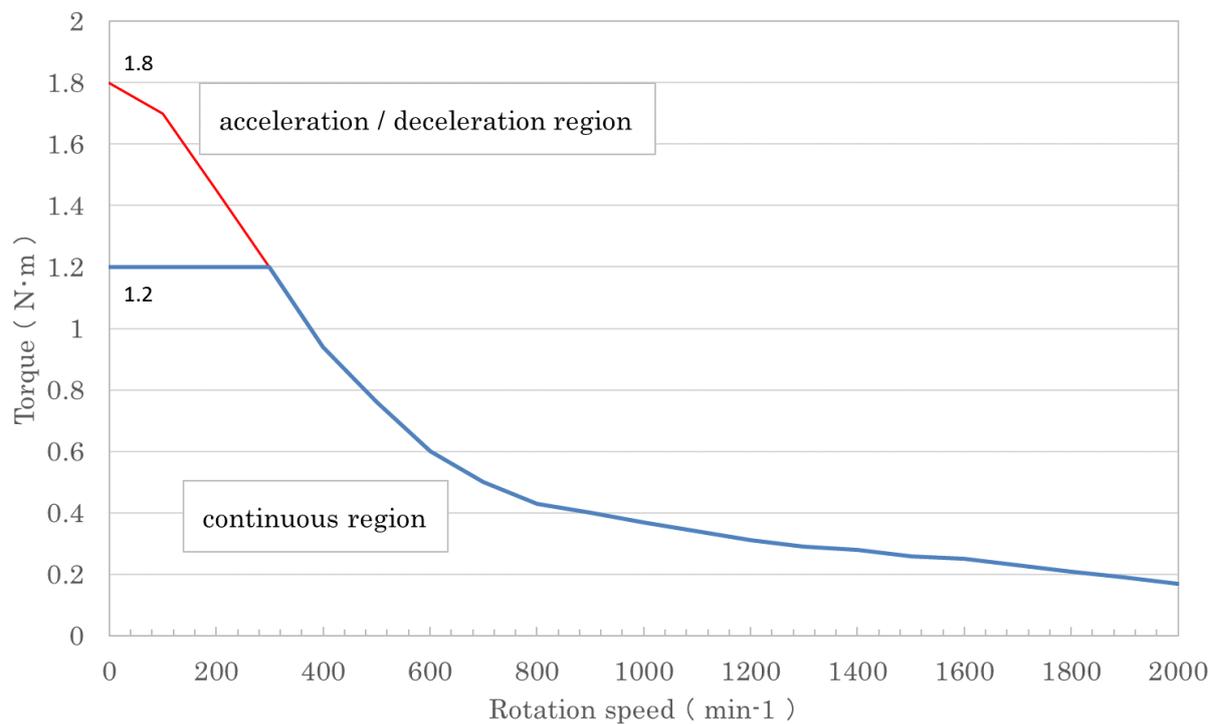
SM-08MT Torque characteristic



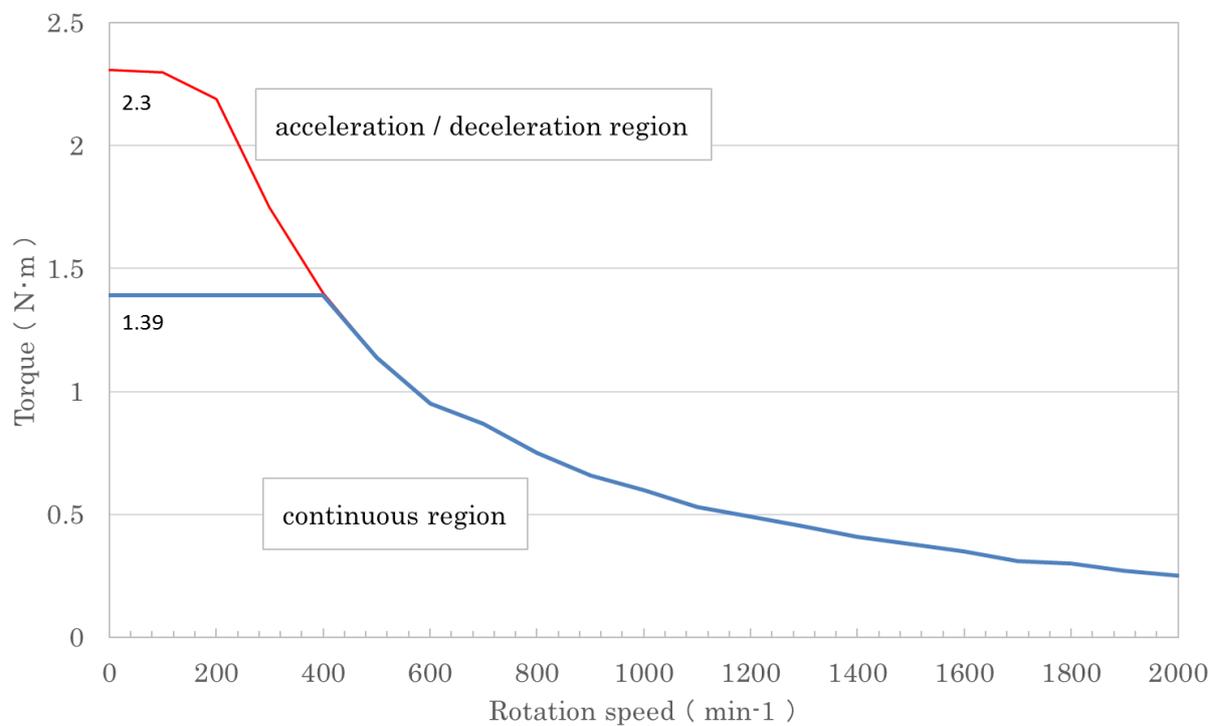
SM-09MT Torque characteristic



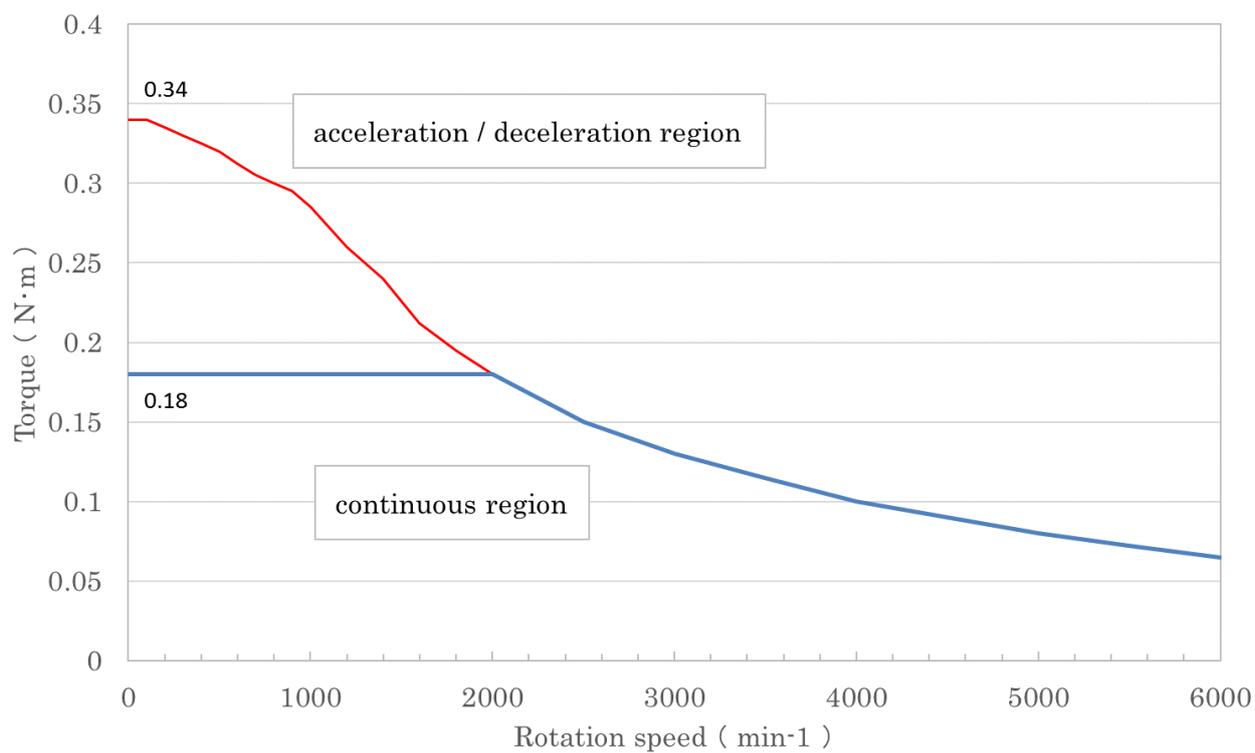
SM-12MT Torque characteristic



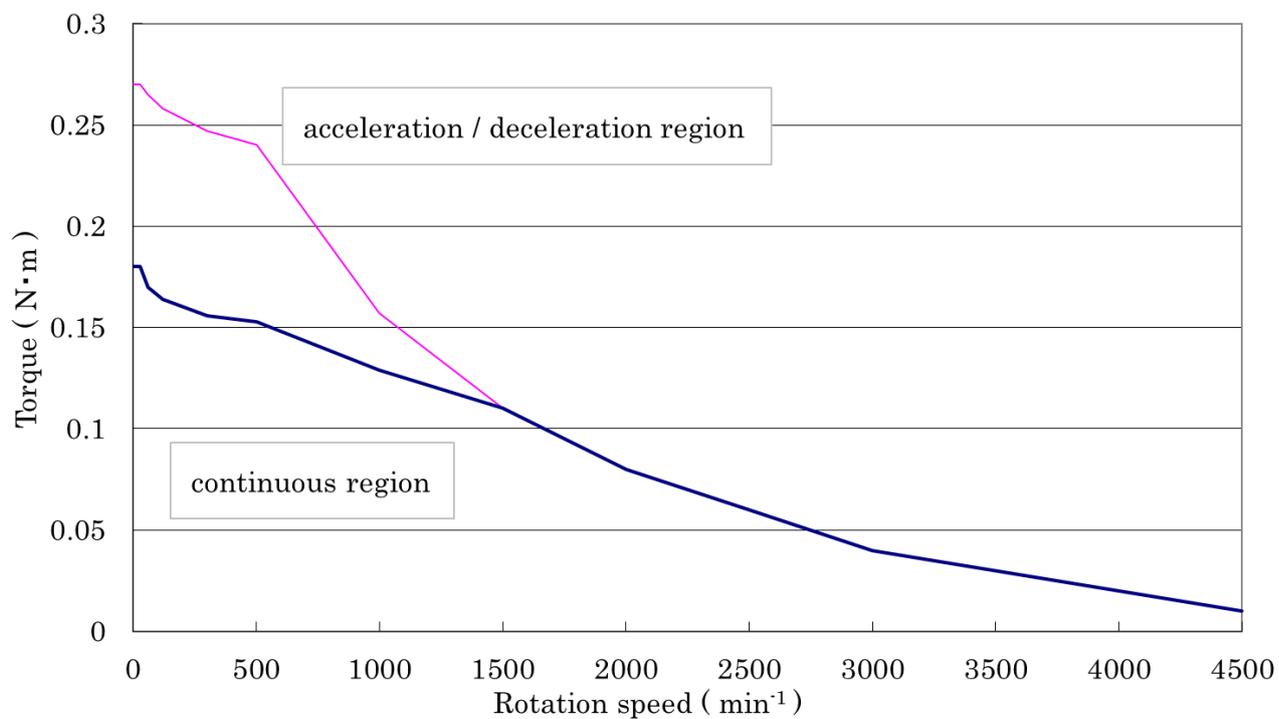
SM-20MT Torque characteristic



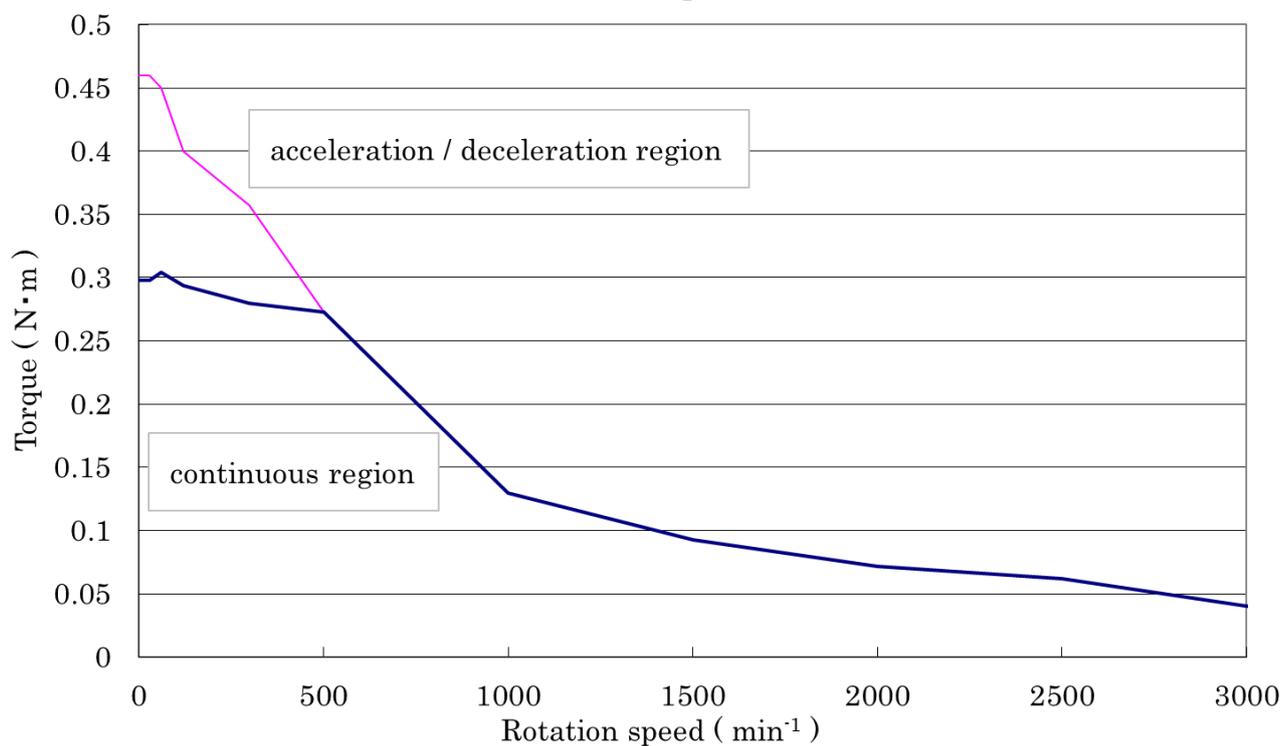
SM-03MN Torque characteristic



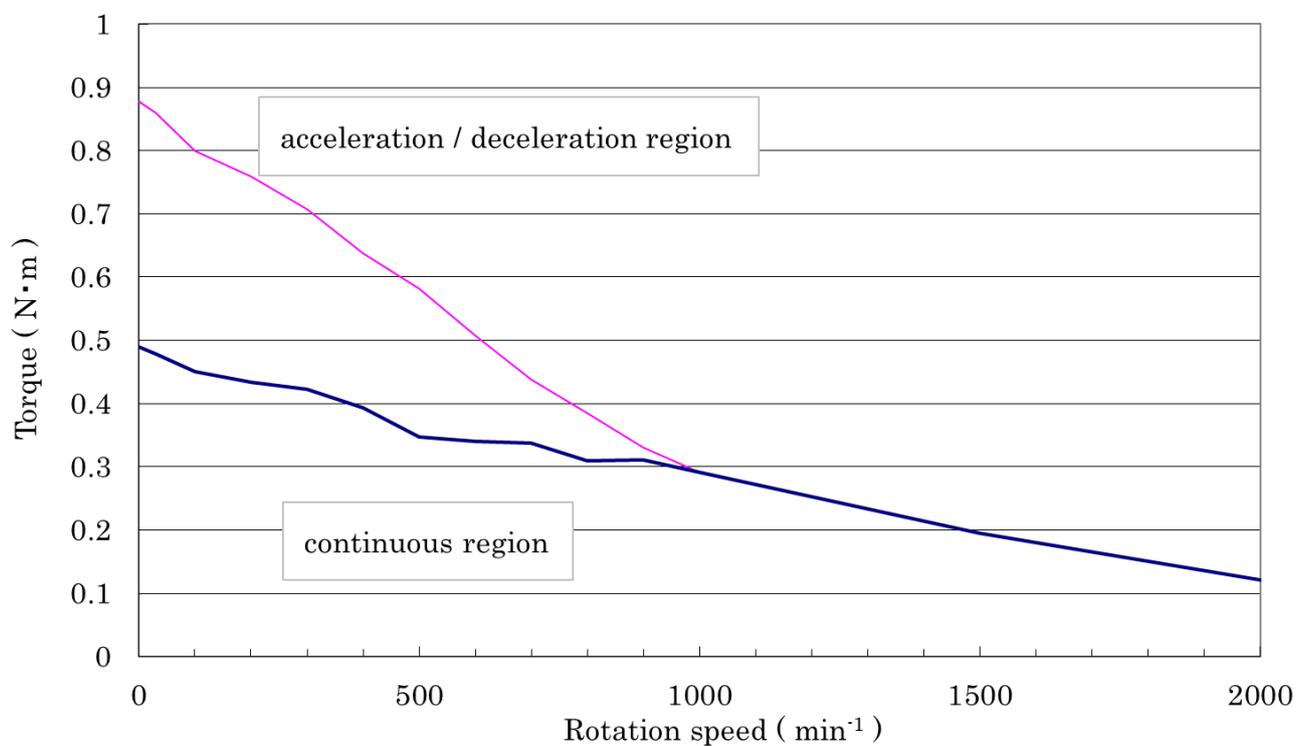
TS3680N370S04 Torque characteristic



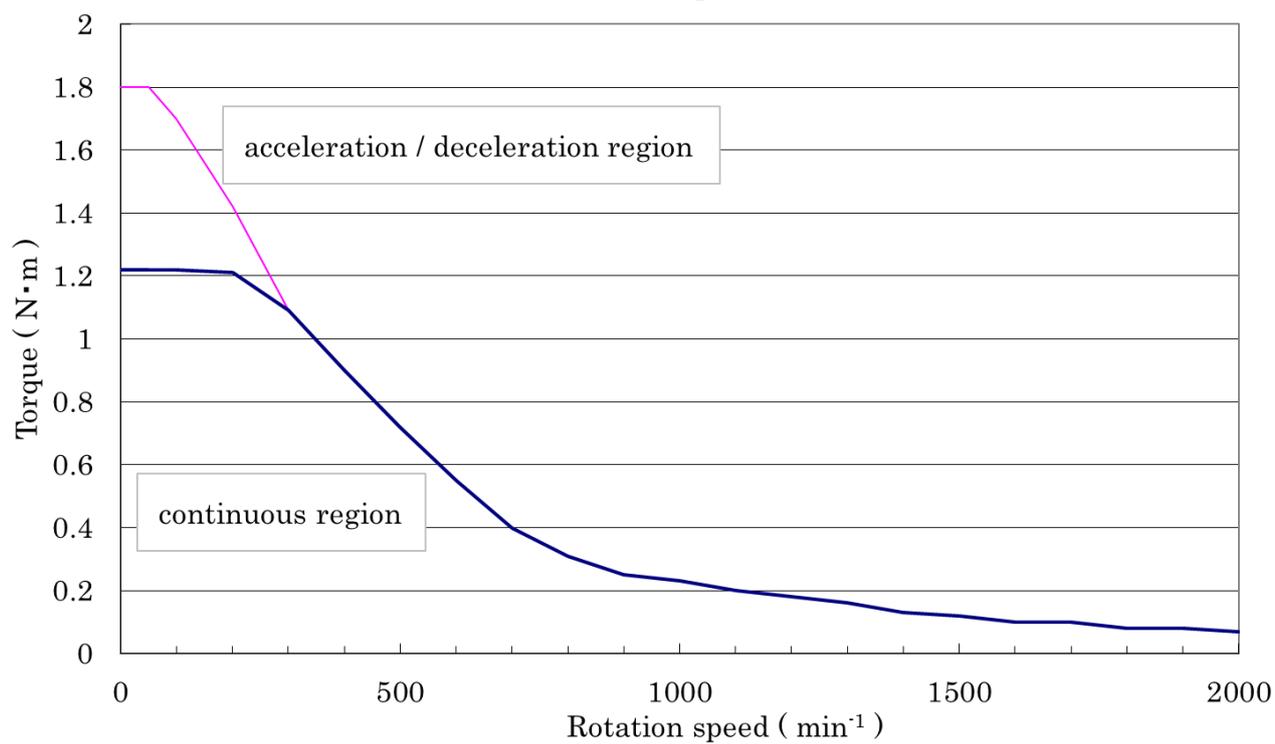
TS3680N371S04 Torque characteristic



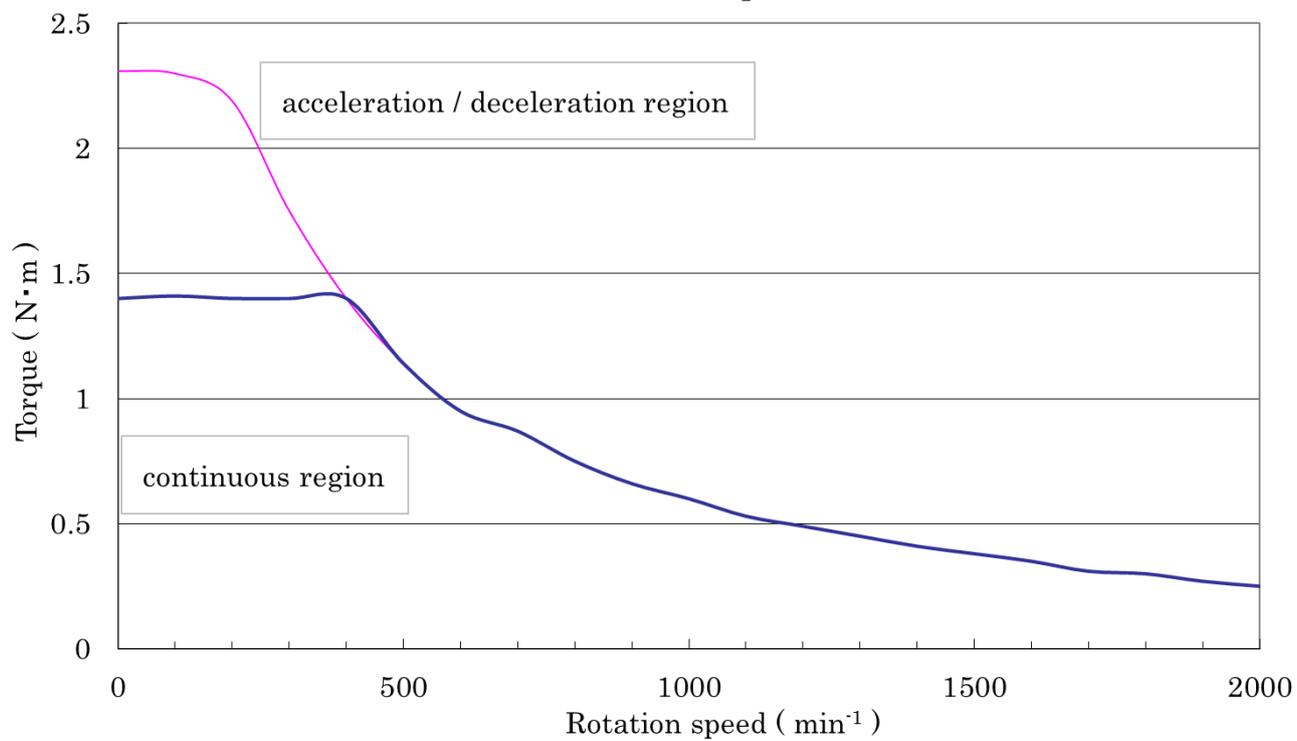
TS3681N324S04 Torque characteristic



TS3681N325S04 Torque characteristic



TS3681N327S04 Torque characteristic



3-4. List of compatible motors

A~E: Supported (See cable connection pattern at the bottom of the page) ※:Note ×: Not supported

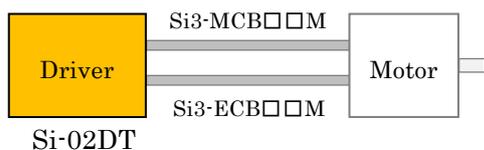
Motor type						Si servo (old model) driver				Si3 driver	
	Name	Model	Rated current [A]	Size □ [mm]	Encoder resolution [CPR]	Si-02 LDE	Si-02 DE	Si-05 LDE	Si-05 DE	Si-02DT	Si-05DT
Si servo 3	0.05Nm	SM-L5MT	1.6	28	10000	×	×	×	×	A	×
	0.2Nm	SM-02MT	2.0	42		×	×	×	×	A	×
	0.4Nm	SM-04MT	2.0	42		×	×	×	×	A	×
	0.7Nm	SM-07MT	2.0	42		×	×	×	×	A	×
	0.8Nm	SM-08MT	2.8	60		×	×	×	×	A	×
	0.9Nm	SM-09MT	2.0	56		×	×	×	×	A	×
	1.2Nm	SM-12MT	3.0	56		×	×	×	×	C ※2	B ※1
	2.0Nm	SM-20MT	5.0	56		×	×	×	×	×	B
	0.3Nm	SM-03MN	2.0	42		×	×	×	×	A	×
Si servo (old model)	0.01Nm	TS3692N61S02	0.35	20	800	D	×	×	×	D	×
	0.05Nm	TS3641N61S02	1.5	28		×	D	×	×	D	×
	0.2Nm	TS3617N370S04 (TS3680N370S04)	2.0	42		×	D	×	×	D	×
	0.4Nm	TS3617N371S04 (TS3680N371S04)	2.0	42	1600	×	D	×	×	D	×
	0.9Nm	TS3653N324S04 (TS3681N324S04)	2.0	56		×	D	×	×	D	×
	1.2Nm	TS3653N325S04 (TS3681N325S04)	2.0	56		×	D ※3	E ※1	×	D ※2	E ※1
	2.0Nm	TS3653N327S04 (TS3681N327S04)	5.0	56		×	×	×	E	×	E

※1: Maximum velocity 2,000min⁻¹ ※2: Maximum velocity 1000min⁻¹ ※3: Maximum velocity 800min⁻¹

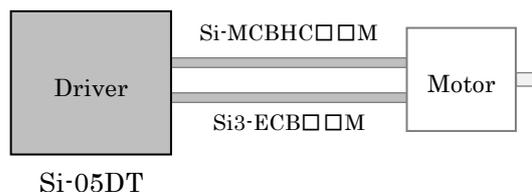
The models in parentheses in the "Model" column are motors with holding brake.

(Cable connection pattern list)

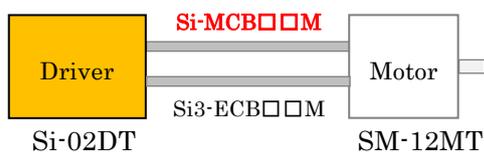
○ Pattern A : Si3 2A driver+Si3 motor



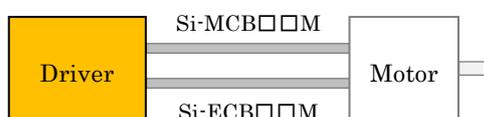
○ Pattern B : Si3 5A driver+Si3 motor



○ Pattern C : Si3 2A driver+SM-12MT
(Supported by driver software version 1.01 or later)



○ Pattern D : Small driver+Si2 motor

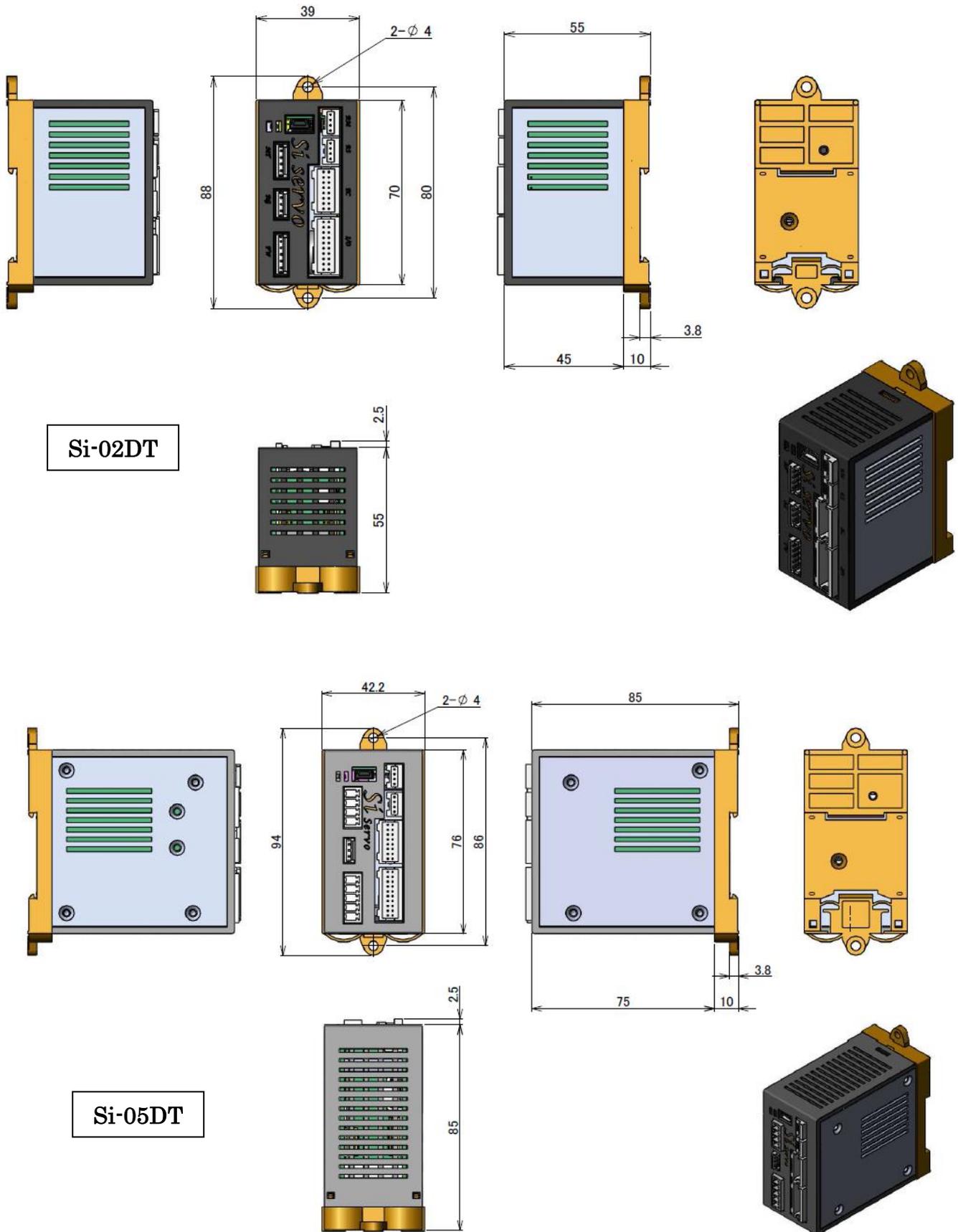


○ Pattern E : Large driver+Si2 motor

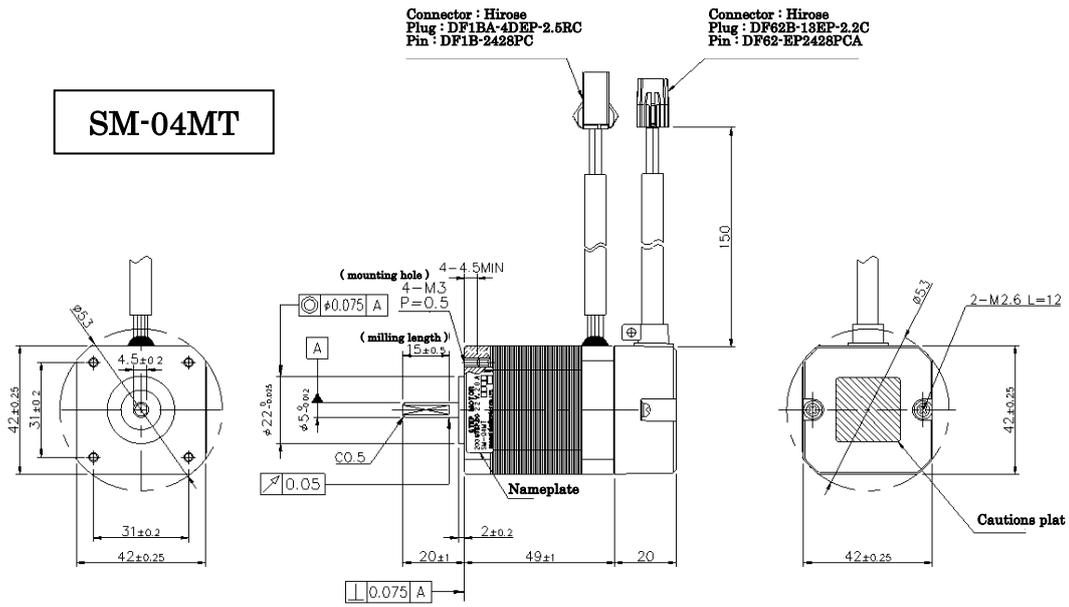


5. Dimensions

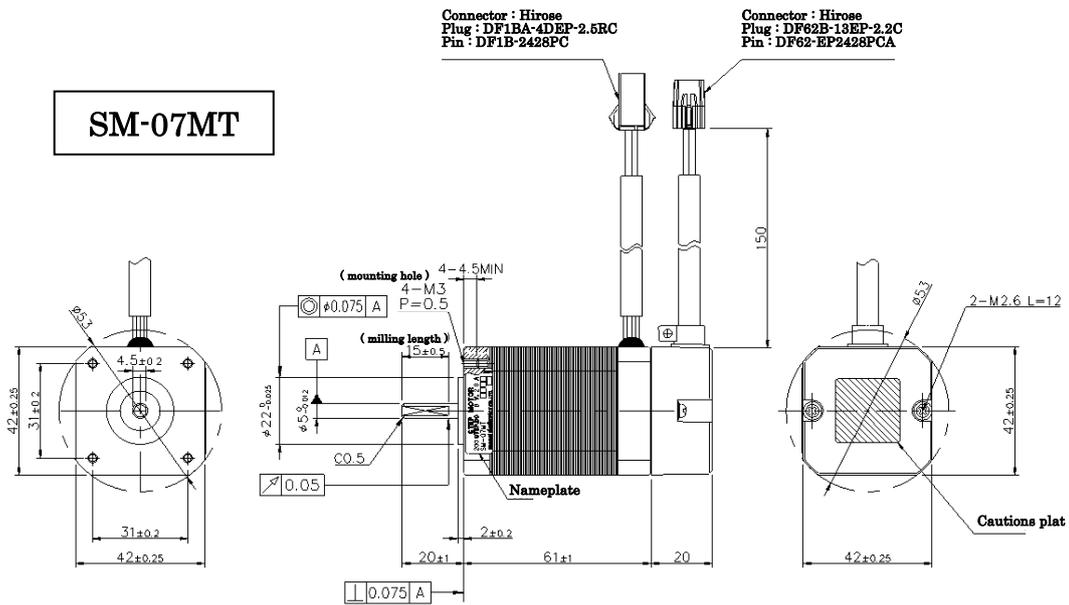
5-1. Driver outline drawings

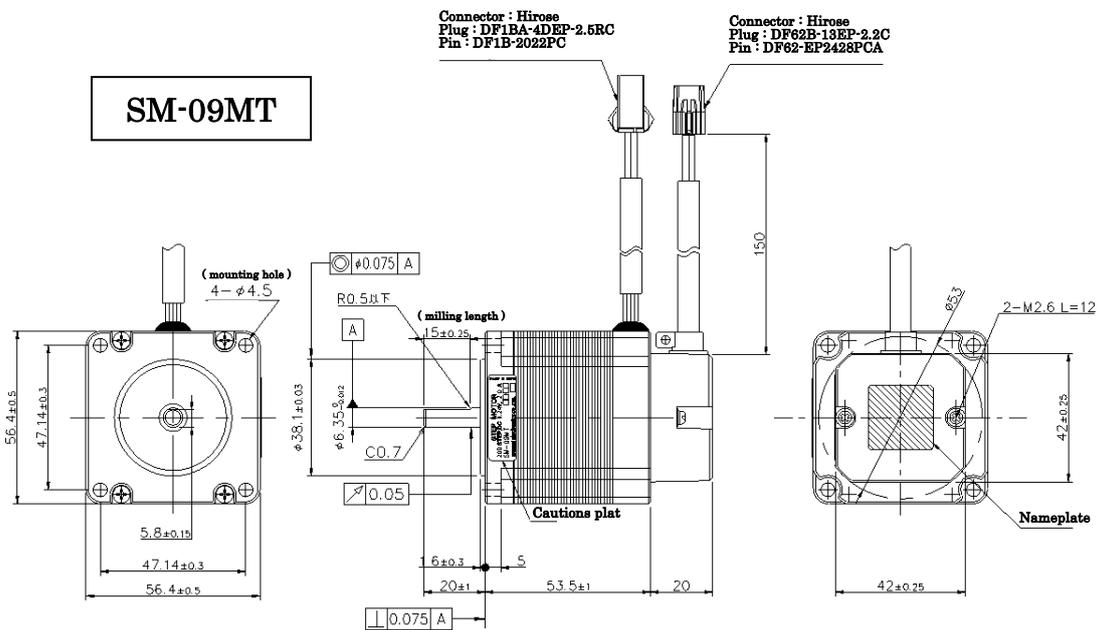
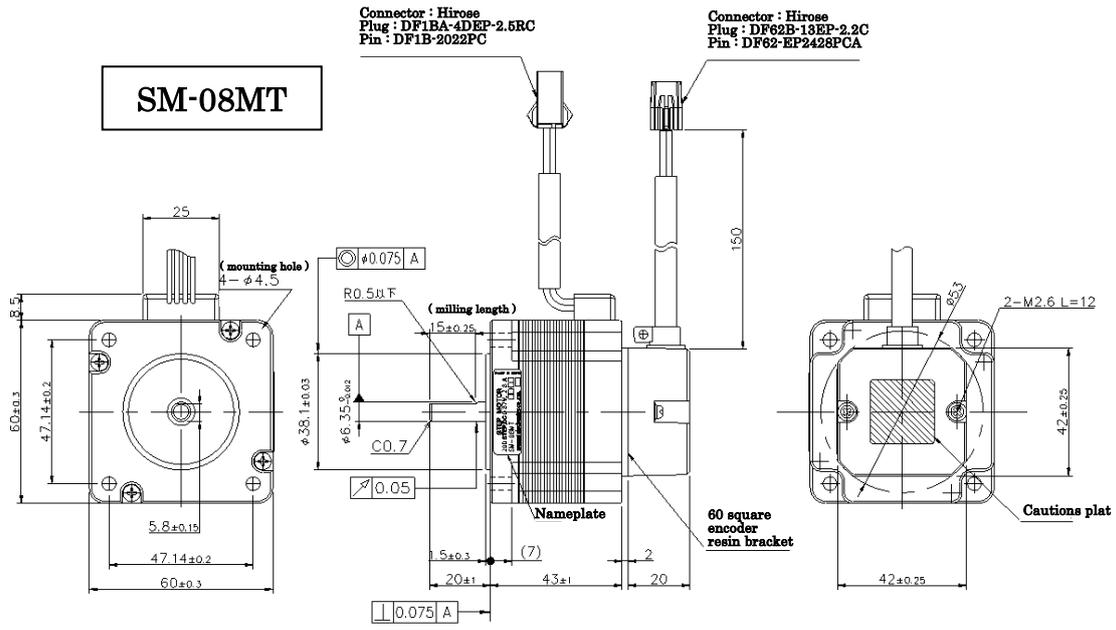


SM-04MT

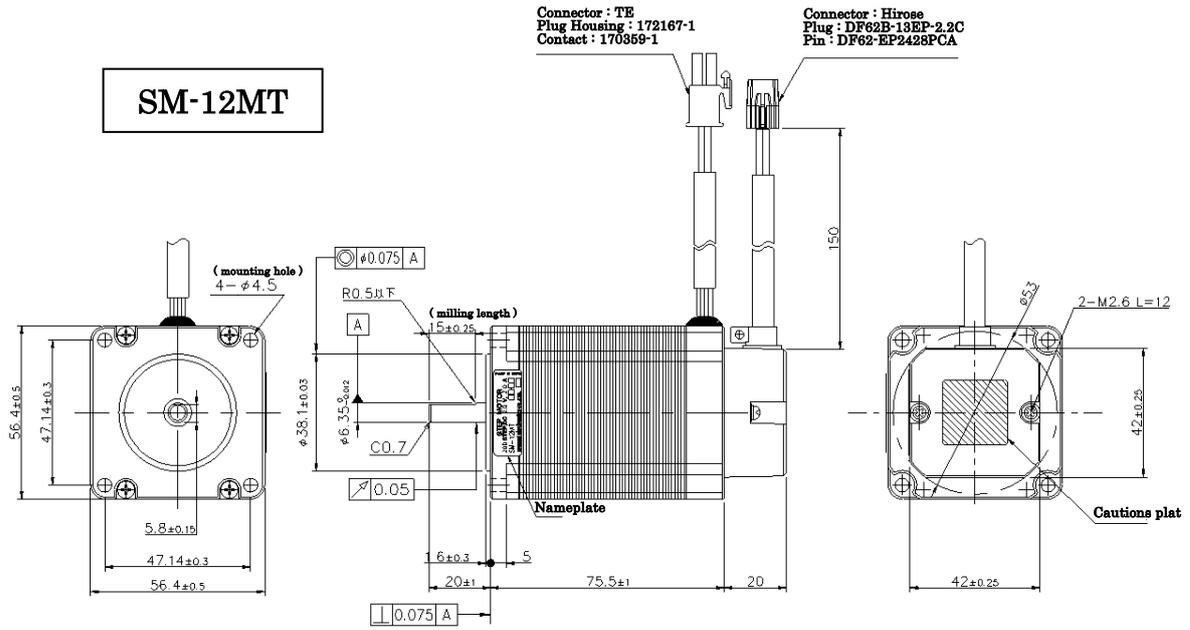


SM-07MT

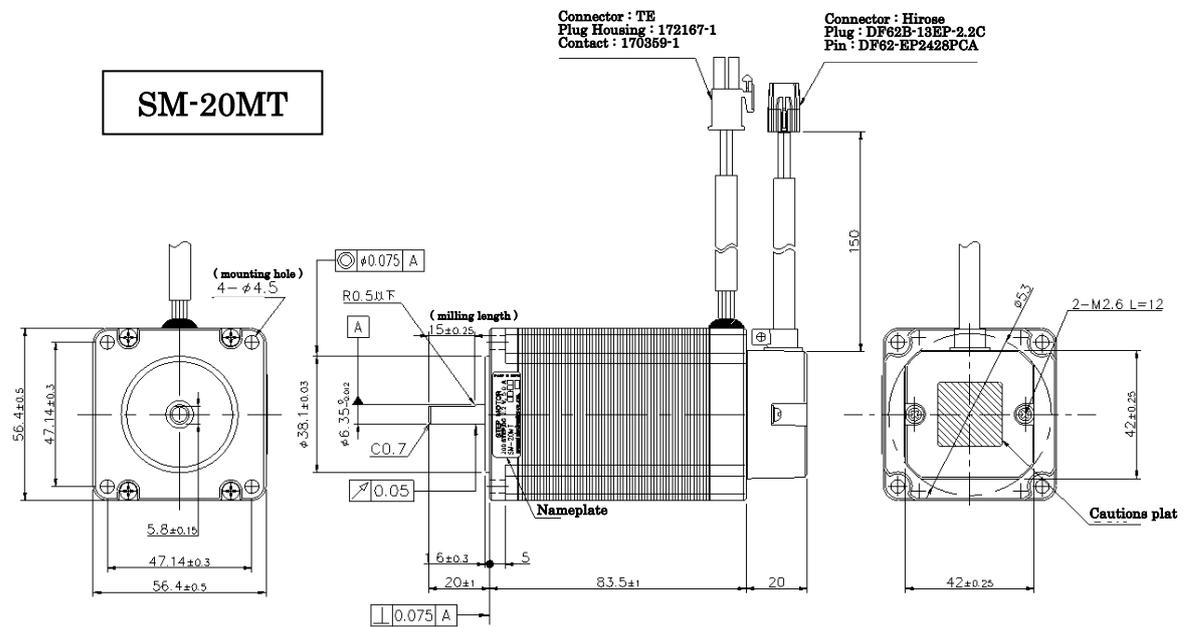




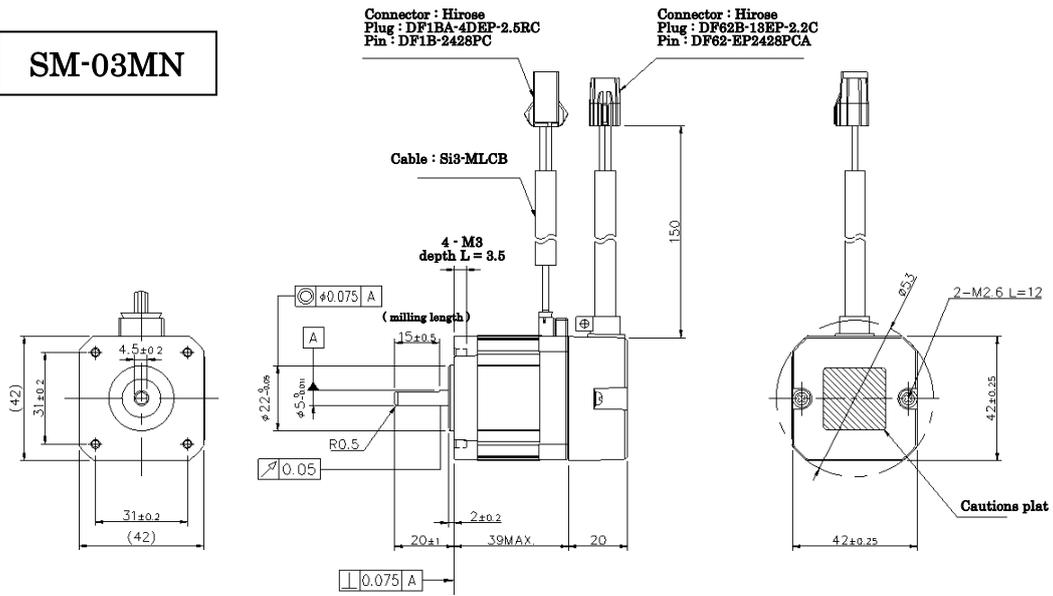
SM-12MT



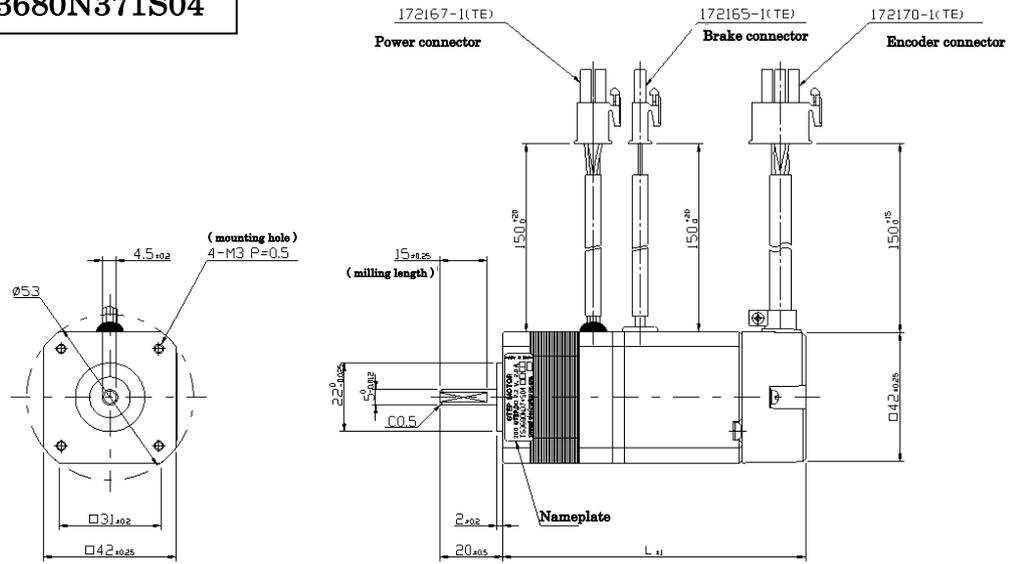
SM-20MT



SM-03MN

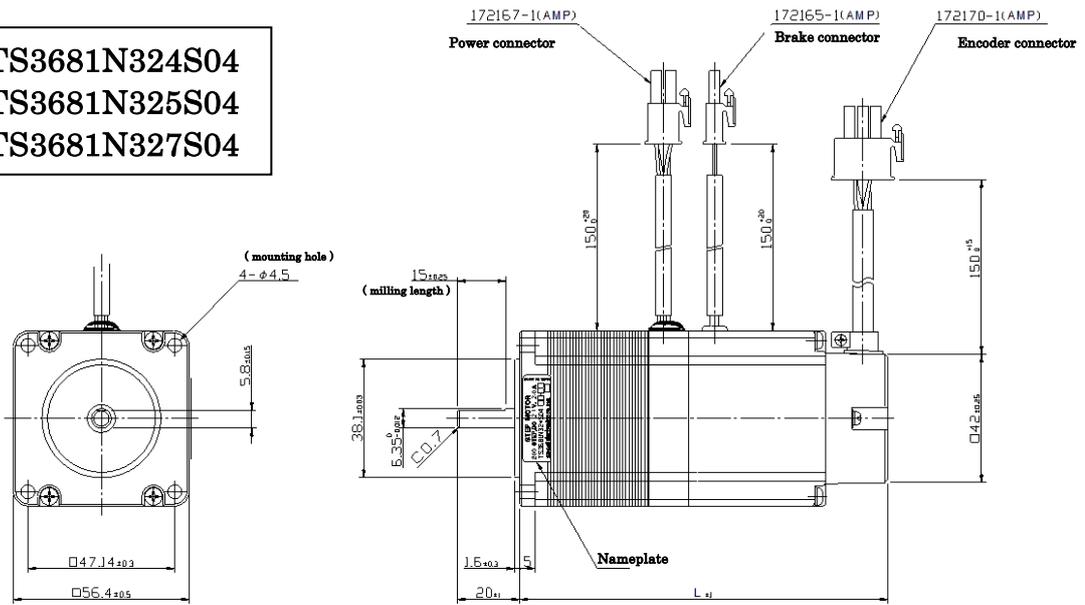


TS3680N370S04
TS3680N371S04



Motor model	L
TS3680N370S04	96
TS3680N371S04	110

TS3681N324S04
 TS3681N325S04
 TS3681N327S04



Motor model	L
TS3681N324S04	118
TS3681N325S04	140
TS3681N327S04	148

6. Connector specifications

6-1. PW Power supply connector pin layout

Power supply to the driver.

PW Power supply connector

Pin Number	Signal Name	Explanation
1	V1	Main power supply terminal DC24V±10%
2	V2	Control power supply terminal DC24V±10%
3	0V	Common for V1, V2 (0V)
4	NC	No internal connection
5	E	Earth terminal

1) Cable compatible terminal

Item	Si-02DT	Si-05DT
Housing	EHR-5 (JST)	XW4B-05B1-H1 (OMRON)
Contact	SEH-001T-P0.6L (JST)	—
Cable compatible wires	AWG22	AWG18

6-2. MT Motor power connector pin layout

Power supply to the motor.

MT Motor power connector pin layout

Pin number	Signal name	Explanation
1	A+	Phase A(+) terminal
2	A-	Phase A(-) terminal
3	B+	Phase B(+) terminal
4	B-	Phase B(-) terminal

1) Cable compatible terminal (driver side)

Item	Si-02DT	Si-05DT
Housing	EHR-4 (JST)	XW4B-04B1-H1 (OMRON)
Contact	SEH-001T-P0.6L (JST)	-
Compatible wires for cable	AWG22	AWG18

2) Cable compatible terminal (motor side)

Item	Motors other than in the next column	SM-12MT, SM-20MT
Housing	DF1B-4DS-2.5RC (Hirose)	172159-1 (TE)
Contact	DF1B-2022SC	170366-1 (TE)
Cable compatible wires	AWG22	AWG18

3) Maximum wiring length

10m or less

6-3. EC Motor encoder connector pin layout

When the power is turned ON, the motor characteristic data is read from the motor memory.

After reading the data, feedback pulses from the encoder are input.

EC Motor encoder connector (driver side)

Pin number	Signal name	Explanation
1	FG	Frame ground
2	NC	No internal connection
3	NC	
4	NC	
5	NC	
6	NC	
7	DO_A	Encoder A phase input / Data output
8	NDO_A	Encoder A phase input / Data output inverted
9	SK_B	Encoder B phase input / Clock output
10	NSK_B	Encoder B phase input / Clock output inverted
11	SEL	Encoder / EEPROM access selection
12	NSEL	Encoder / EEPROM access selection inverted
13	DI_Z	Encoder Z-phase input / Data Input
14	NDI_Z	Encoder Z-phase input / Data Input inverted
15	VCC	+5V power supply
16	GND	Signal ground

EC1 Motor encoder connector (motor side)

Pin number	Signal name	Explanation
1	FG	Frame ground
2	NC	No connection
3	NC	
4	DO_A	Encoder A phase input / Data output
5	NDO_A	Encoder A phase input / Data output inverted
6	SK_B	Encoder B phase input / Clock output
7	NSK_B	Encoder B phase input / Clock output inverted
8	SEL	Encoder / EEPROM access selection
9	NSEL	Encoder / EEPROM access selection inverted
10	DI_Z	Encoder Z-phase input / Data Input
11	NDI_Z	Encoder Z-phase input / Data Input inverted
12	VCC	+5V power supply
13	GND	Signal ground

1) Cable compatible terminal (driver side)

Housing: PADP-16V-1-S (JST)

Contact: SPH-001T-P0.5L (JST)

2) Cable compatible terminal (motor side)

Housing: DF62C-13S-2.2C (Hirose)

Contact: DF62-2428SC (Hirose)

3) Cable compatible wires

AWG24 twisted shielded wires

4) Maximum wiring length

10m or less

6-4. I/O External input/output connector pin layout

Connector for control signal input/output and command pulse input.

I/O External input/output connector

	Number	Signal name		Explanation
	1	FG	Frame ground	Connect the cable shield wire.
	2	NC	-	No internal connection
	3	NC		
	4	NC		
Control output	5	BK2	Brake power supply 2	Non-voltage contact output (voltage 24V, current 1A or less). Connect the brake power supply.
	6	BK1	Brake power supply 1	When the motor is energized, short circuit between BK1 and BK2.
	7	COM_OUT	Output common	Common terminal for control output signal. Connect to 0V.
	8	OUT2	Control output 2	Control output signal terminal.
	9	OUT1	Control output 1	Select the function by parameters N0013 "Control output function select: OUT0"~N0015 "Control output function select: OUT3".
	10	OUT0	Control output 0	(For details refer to "7-2. Control output".)
Control input	11	COM_IN	Input common	Common terminal for control input signal. Connect to DC24V.
	12	IN4	Control input 4	Control input signal terminal.
	13	IN3	Control input 3	Select the function by parameters N0008 "Control output function select: IN0"~N0012 "Control output function select: IN4".
	14	IN2	Control input 2	(For details refer to "7-1. Control input".)
	15	IN1	Control input 1	
	16	IN0	Control input 0	
Command pulse input	17	CCWN	CCW pulse(-)	Input CCW / SIGN / B-phase pulse (select by parameter).
	18	CCWP	CCW pulse(+)	Input 5V pulse on P side with respect to N side.
	19	CWN	CW pulse(-)	Input CW / PULSE / A-phase pulse (select by parameter).
	20	CWP	CW pulse(+)	Input 5V pulse on P side with respect to N side.

1) Cable compatible terminal

Housing: PADP-20V-1-S (JST)

Contact: SPH-001T-P0.5L (JST)

2) Cable compatible wires

AWG24 twisted shielded wires

3) Maximum wiring length

10m or less (3m or less when the command pulse output is by open collector)

6-5. RG External regenerative circuit connector pin layout

RG External regenerative circuit connector pin layout

Pin number	Signal name	Explanation
1	P1	Power supply output terminal
2	P2	Control power output terminal
3	0V	Common for P1, P2 (0V)

1) Cable compatible terminal

Housing: EHR-3 (JST)

Contact: SEH-001T-P0.6L (JST)

2) Cable compatible wires

AWG22 twisted shielded wires

6-6. RM/RS RS485 connector pin layout

RM RS485 host side connector

Pin number	Signal name	Explanation
1	TRx+	Send/receive data
2	TRx-	Send/receive data inverted
3	GND	Signal ground
4	FG	Frame ground

※Connect the shield wire of the communication cable to pin 4 [FG: Frame ground].

RS RS485 client connector

Pin number	Signal name	Explanation
1	TRx+	Send/receive data
2	TRx-	Send/receive data inverted
3	GND	Signal ground
4	FG	Frame ground

※Connect the shield wire of the communication cable to pin 4 [FG: Frame ground].

1) Cable compatible terminal

Housing: PAP-04V-S (JST)

Contact: BPHD-001T-P0.5L (JST)

2) Cable compatible wires

AWG24 twisted shielded wires

3) Maximum wiring length (in case of multidrop a total length from the host controller to the last driver)

20m or less

6 - 7. USB USB connector pin layout

USB USB connector

Pin number	Signal name	Explanation
1	VBUS	USB power
2	USD-	USB data (-)
3	USD+	USB data (+)
4	NC	do not connect
5	SG	USB ground

1) Cable compatible terminal

USB mini-B type plug

2) Cable compatible wires

Commercially available USB cables

※Use a shielded cable type with ferrite cores on both ends.

Example) ELECOM U2C-MF series

6 - 8. Brake connector pin layout

Brake connector (motor side)

Pin number	Signal name	Explanation
1	BKP	+24V power supply
2	BKN	0V

1) Cable compatible terminal

Housing: 172157-1 (TE)

Contact: 170362-1 (TE)

2) Cable compatible wires

AWG18

7. Control input/output

7-1. Control input

7-1-1. List of control input functions

The following signals are available as control input signals. They can be used selectively assigned to 5 terminals IN0,1,2,3,4.

List of control input selections

Code	Selected function	Name	Content
01	SVON	Servo ON	The motor is energized while this signal is turned ON. Otherwise, the motor is in a non-energized state.
02	PJOG	Forward jog	At the rising edge of this signal, rotation starts in forward direction at a constant rotation velocity. At the falling edge the motor will decelerate and stop.
03	NJOG	Reverse jog	At the rising edge of this signal, rotation starts in reverse direction at a constant rotation velocity. At the falling edge the motor will decelerate and stop.
04	ARST	Alarm reset	The rising edge of this signal resets the currently occurring resettable alarm.
20	EMCE	Emergency stop (controlled braking)	Emergency stop. (Emergency stop under control)
21	EMCF	Emergency stop (servo free)	Emergency stop. (Emergency stop with the motor not energized.)
12	POT	Forward OT	While this signal is ON, the forward rotation movement command is ignored. For linear axes etc., connect to (+) side limit switch. When OT signal is ON, the Point-Table start command is ignored.
13	NOT	Reverse OT	While this signal is ON, the reverse rotation movement command is ignored. For linear axes etc., connect to (-) side limit switch. When OT signal is ON, the Point-Table start command is ignored.
05	STR	Start	The rising edge of this signal activates the Point-Table operation at the specified number. The falling edge stops the Point-Table operation.
25	STRP	Start (one shot input)	The rising edge of this signal activates the Point-Table operation at the specified number. To stop the operation, input STP signal.
09	P0_IN	Point number input	Specify the Point-Table start number in binary format. P0_IN is BIT0 (least significant bit), and P7_IN is BIT7. (Point number = P0_IN x 1 + P1_IN x 2 + P2_IN x 4 + P3_IN x 8 + P4_IN x 16 + P5_IN x 32 + P6_IN x 64 + P7_IN x 128)
0A	P1_IN		
0B	P2_IN		
30	P3_IN		
31	P4_IN		
32	P5_IN		
33	P6_IN		
34	P7_IN		
06	ZSTR	Home start	The rising edge of this signal activates the homing operation. The falling edge stops the homing operation.
26	ZSTRP	Home start (one shot input)	The rising edge of this signal activates the homing operation. To stop the operation, input STP signal.
07	DEC	Home deceleration	The home deceleration input signal for homing operation. Connect to the home deceleration switch signal.
2A	STP	Stop (one shot input)	The rising edge of this signal stops the running operation.

Code	Selected function	Name	Content
08	HOLD	Hold	The rising edge of this signal suspends the Point-Table operation. At the falling edge, the Point-Table operation is resumed.
1C	EXIN	Input branch	In Point-Table operation, this signal input selects the branch destination after point completion. For details, refer to Instruction Manual: Point-Table part.
23	EXIN2		
24	EXIN3		
18	SBK	Single block	The rising of this signal activates execution of the next point.
28	MFIN	M complete	At the rising edge of this signal, the M code output is turned OFF and the next point is executed.
29	SENS	Sensor positioning	Input the sensor signal for Point-Table operation or sensor positioning. Connects the signal from external positioning sensor.
27	ERST	Error clear	At the rising edge of this signal, the position error is cleared to 0.
2B	ZSET	Position rewrite	At the rising edge of this signal, the current position is rewritten.
0C	TDIN	Teaching	At the rising edge of this signal, the current position is stored in move amount data of currently specified point number.
38	RSEL	Resolution select	Depending on ON/OFF state of this signal, the move amount per pulse of position command signal is switched.
39	TSEL0	Torque limit value select	The torque limit value is switched depending on the input state of the signals. The torque limit value of the signal in ON state from the 5 signals is selected. If two or more signals are in ON state at the same time, the torque limit value of the last turned ON signal is selected.
3A	TSEL1		
3B	TSEL2		
3C	TSEL3		
3D	TSEL4		
2E	VDIR	Rotation direction select input	Rotation direction of velocity control operation is switched according to ON/OFF state of this signal. Forward rotation is selected when the input is OFF, and reverse rotation is selected when the input is ON.
2F	GSEL	Gain select	Servo gain is switched according to ON/OFF state of this signal.
0E	BKFREE	Brake release	While this signal is ON, the brake release signal BK is ON.
0F	RESET	Software reset	The rising edge of this signal activates the software reset.
40	TSEL0P	Forward direction torque limit value select	Switches the torque limit value in forward direction. Does not affect the torque limit value in reverse direction.
41	TSEL1P		
42	TSEL2P		
43	TSEL3P		
44	TSEL4P		
48	TSEL0N	Reverse direction torque limit value select	Switches the torque limit value in reverse direction. Does not affect the torque limit value in forward direction.
49	TSEL1N		
4A	TSEL2N		
4B	TSEL3N		
4C	TSEL4N		
58	DSTR0	Direct start	The rising edge of this signal activates the Point-Table operation at beforehand specified number. To stop the operation, input STP signal.
59	DSTR1		
5A	DSTR2		
5B	DSTR3		
5C	DSTR4		
5F	TSTR	Start load torque measurement	The rising edge of this signal activates the load torque measurement.
other	-	No function	No function is assigned to the input terminal.

7-1-2. Control input function assignment

To assign an input function to the control input terminal, set the control input function code in parameters N0008 "Control input function select: IN0"~N0012 "Control input function select: IN4".

List of control input function setting parameters

Parameter number	Parameter name	Control input terminal
N0008	Control input function select: IN0	IN0
N0009	Control input function select: IN1	IN1
N0010	Control input function select: IN2	IN2
N0011	Control input function select: IN3	IN3
N0012	Control input function select: IN4	IN4

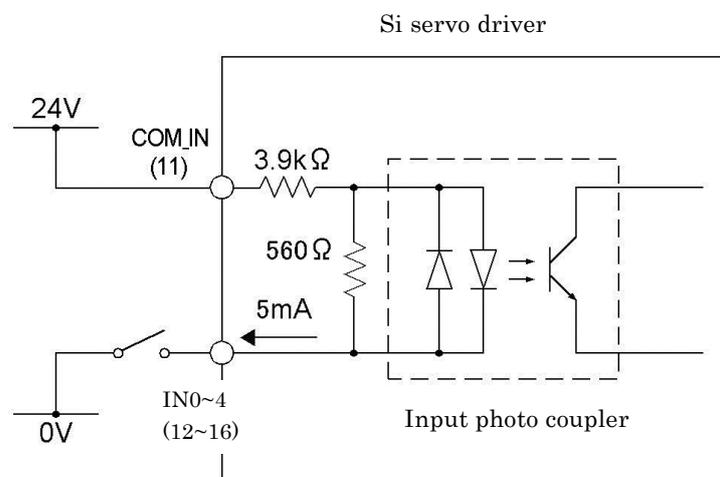
If the same function is assigned to multiple input terminals, the input of that function (signal) is regarded as ON if input on any of the assigned terminals is turned ON.

Example) Assign SVON (code: 01) to IN0, PJOG (code: 02) to IN1, No function to IN2 (code: 00), STP (code: 2A) to IN3, and STR (code: 05) to IN4

Parameter number	Set value
N0008	01h
N0009	02h
N0010	00h
N0011	2Ah
N0012	05h

7-1-3. Control input connection

Separately prepare the input circuit power supply DC24V±10% (consumption current about 5mA/circuit).



7-1-4. Control input logic selection

Input logic of control input terminals can be inverted by setting parameter N0017 "Control input logic select". Set 0 or 1 to each bit corresponding to control inputs IN0~ IN4.

Parameter N0017 "Control input logic select"

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	IN4	IN3	IN2	IN1	IN0

※The bits displayed as "0" are reserved bits. Write 0.

Bit position	Bit name	Function
31~5	-	reserved (write 0)
4	IN4	Control input IN4 logic set
3	IN3	Control input IN3 logic set
2	IN2	Control input IN2 logic set
1	IN1	Control input IN1 logic set
0	IN0	Control input IN0 logic set

Relation between bit setting and control output logic

Bit set value	Setting	When input is CLOSED	When input is OPEN
0	Normal	ON	OFF
1	Inverted	OFF	ON

※"CLOSED" indicates that the primary side of input photocoupler is energized, and "OPEN" indicates that it is not.

7-1-5. Control input response time and high speed input

- The terminal to which the control input function DEC (Home deceleration) or SENS (Sensor positioning) is assigned is set to high-speed input, where the signal input is detected by hardware interrupt.

In case of high speed input setting, the delay time from the external signal input to the current position latch is basically only the delay due to photocoupler hardware shown below.

The high speed input setting is supported on all control input terminals IN0~IN4.

Control input photocoupler transmission delay time

Item	Value
turn ON (OPEN → CLOSE)	10 μ s
turn OFF (CLOSE → OPEN)	150 μ s

- On the terminals to which functions other than DEC/SENS are assigned, the input state is read by internal software every 500 μ s.

With the delay of photocoupler hardware taken into consideration, the maximum delay time from the external signal input to the signal input detection by the internal software is about 650 μ s.

- On the terminals other than with the high-speed input setting, a software filter described in the next section is applied, so in addition to the above described hardware factors, the input transmission delay time is increased accordingly.

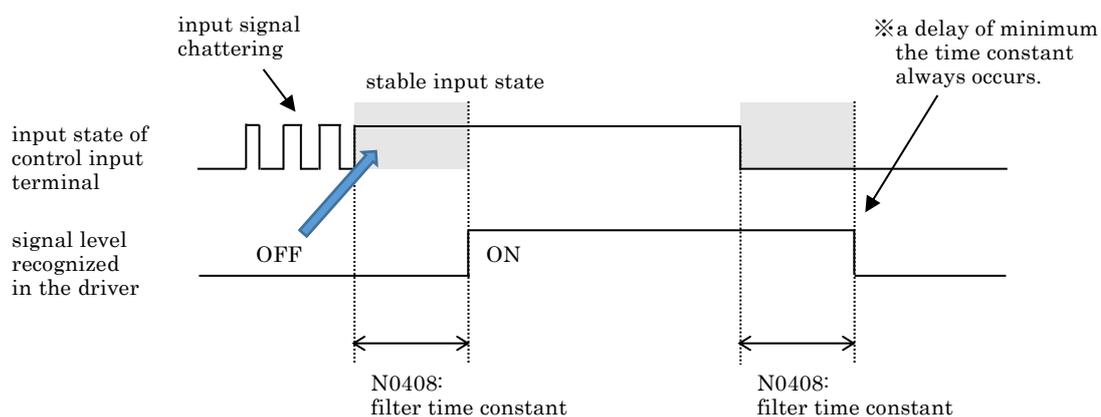
7-1-6. Control input software filter

When a mechanical switch is directly connected to the control input terminal of the servo driver, chattering of the input signal may occur and the operation may deviate from the original intention. A control input software filter is provided as a function to prevent such unintended operation.

Set the time exceeding chattering period of the switch as the time constant of the software filter in parameter N0408 "Control input filter time constant" (in ms).

The signal state recognized in the servo driver is determined when the input state of the control input terminal stabilizes continuously for the time of the control input software filter time constant. The software filter is applied in the same way to any change of signal input OFF → ON and ON → OFF.

※Note that due to the specifications of the control input filter, there will be a delay of at least the filter time constant before the signal input on the control input terminal is recognized in the driver.



7-2. Control output

7-2-1. List of control output functions

The following signals are available as control output signals. They can be used selectively assigned to 3 terminals OUT0,1,2.

List of control output selections

Code	Selected function	Name	Content
01	RDY	Servo ready	Turns ON when the motor is energized. It can also be used as a brake release signal.
02	INP	In-position	Turns ON when position error is within the parameter set range. ※Parameter N0000 "In-position range"
03	ALM	Alarm	Turns ON when something abnormal occurs in the driver.
11	PRG	Program running	Turns ON during Point-Table operation.
12	FIN	Completed	Turns on when operation is completed.
1A	VCMP	Velocity match	Turns ON when the velocity error is within the parameter set range in the velocity control mode. ※Parameter N0414 "VCMP output range"
1B	VZR	Zero velocity	Turns ON when the motor operation command is stopped and the current velocity is within the parameter set range. ※N0207 "Torque completed/VZR output range"
1C	TFIN	Torque completed	Turns ON when torque output is limited and motor shaft velocity is within the parameter set range. ※N0207 "Torque completed/VZR output range"
1D	FIN+TFIN	Completed + Torque completed	During Point-Table operation is the same as Completed (FIN) output, in other operating conditions it turns ON when either FIN or Torque completed (TFIN) is ON.
1E	PTFIN	Point-Table torque completed	Turns ON when in Point-Table operation during torque limiting operation Torque completed (Error clear) occurs.
30	M0	M output	The M code set in Point-Table M function is output. M0 is BIT0 (least significant bit), and M2 is BIT2. (M code = M0 x 1 + M1 x 2 + M2 x 4) (For details, refer to Instruction Manual: Point-Table fpart)
31	M1		
32	M2		
38	TLMT	Torque limited	Turns ON when motor torque output is limited by the torque limit value.
39	SLMT	Velocity limited	Turns ON when rotation velocity limited.
3A	POTOUT	Forward drive prohibited	Turns ON while forward rotation command is blocked.
3B	NOTOUT	Reverse drive prohibited	Turns ON while reverse rotation command is blocked.
3C	ZFIN	Home complete	Turns on when homing is completed.
3D	ZERO	Home position output	Turns ON when actuator is at the home position. ※Parameter N0309 "Home position detection range"

Code	Selected function	Name	Content
04	P0_OUT	Output of currently executed point	Currently executed point or stopped point is output in binary format. P0_OUT is BIT0 (least significant bit), and P7_OUT is BIT7. (Point number = P0_OUT x 1 + P1_OUT x 2 + P2_OUT x 4 + P3_OUT x 8 + P4_OUT x 16 + P5_OUT x 32 + P6_OUT x 64 + P7_OUT x 128)
05	P1_OUT		
06	P2_OUT		
20	P3_OUT		
21	P4_OUT		
22	P5_OUT		
23	P6_OUT		
24	P7_OUT		
14	P0_FIN	Output of execution completed point	The point number for which execution has been completed is output in binary format. P0_FIN is BIT0 (least significant bit), and P7_FIN is BIT7. (Point number = P0_FIN x 1 + P1_FIN x 2 + P2_FIN x 4 + P3_FIN x 8 + P4_FIN x 16 + P5_FIN x 32 + P6_FIN x 64 + P7_FIN x 128)
15	P1_FIN		
16	P2_FIN		
28	P3_FIN		
29	P4_FIN		
2A	P5_FIN		
2B	P6_FIN		
2C	P7_FIN		
3E	ZPLS	Z-phase signal output	Outputs the Z-phase signal of the motor encoder.
09	PON	Power supply ready	Turns ON when the power supply input is normal.
0A	MRDY	Servo can be turned ON	Turns ON when the servo can be turned ON.
0B	NEAR	Near positioning	Turns ON when position error is within the parameter set range. ※Parameter N0404 "Near positioning range"
0C	DEN	Command completed	Turns ON when movement by the position command such as Point-Table or step operation is completed.
0F	PRF	Profile running	Turns ON during profile operation.
13	BK	Brake release	Outputs the motor holding brake control signal. (Basically it is the same output as RDY, but turns ON when the control input BKFREE is turned ON.)
19	SFIN	Sensor detection completed	Turns ON when during sensor positioning the control input signal SENS is input.
37	OVD	Position error limit exceeded	Turns ON when the position error exceeds the parameter set range. ※Parameter N0412 "Maximum position error"
40	AREA0	Range output 0	Turns ON when current position is within the parameter set range. ※Parameter N0430 "Range output 0: Lower limit" ~N0435 "Range output 2: Upper limit "
41	AREA1	Range output 1	
42	AREA2	Range output 2	
other	-	No function	No function is assigned to the output terminal.

7-2-2. Control output function assignment

To assign an output function to the control output terminal, set the control output function code in parameters N0013 "Control output function select: OUT0"~N0016 "Control output function select: BK".

List of control output function setting parameters

Parameter number	Parameter name	Control output terminal
N0013	Control output function select: OUT0	OUT0
N0014	Control output function select: OUT1	OUT1
N0015	Control output function select: OUT2	OUT2
N0016	Control output function select: BK	BK1–BK2

Example) Assign ZFIN (code: 3C) to OUT0, No function (code: 00) to OUT1, TLMT (code: 38) to OUT2, and BK (code: 13) to BK output

Parameter number	Set value
N0013	3Ch
N0014	00h
N0015	38h
N0016	13h

7-2-3. Control output connection

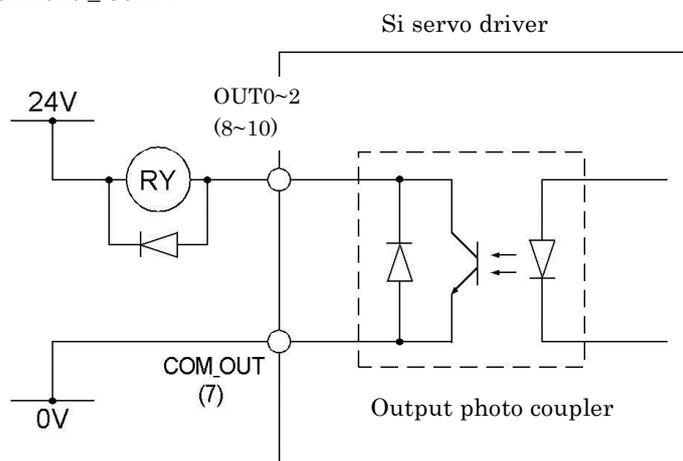
1) OUT0, OUT1, OUT2 (photocoupler outputs)

Separately prepare the power supply for output circuit. It can be used in common with the input circuit power supply, but in such case, add the needed output circuit power capacity to the total power supply capacity.

Be sure to put a surge absorbing element such as a diode to the inductive load. There is a risk of malfunction.

Applied voltage and power supply capacity per control output terminal are as follows.

- Applied voltage $\leq 30V$
- Electrical current $\leq 50mA$

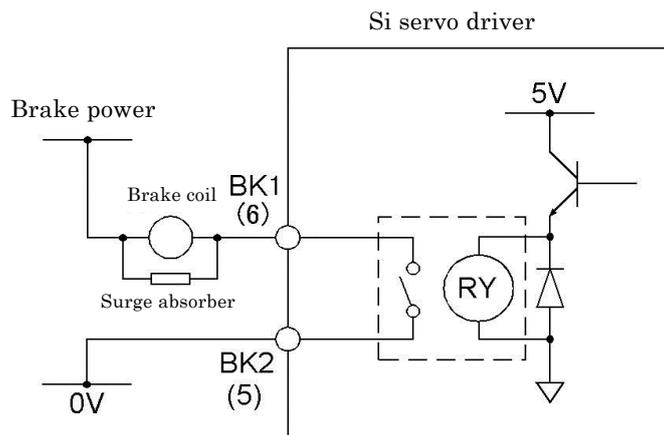


2) BK1, BK2 (relay outputs)

A non-voltage contact output (1a) that can be directly connected to a coil of a motor holding brake is provided.

When using this output terminal as a brake release signal, set the parameter N0016 "Control output function select: BK" to "13h". The output timing of the brake release signal is automatically adjusted to the motor excitation timing, and shorts the relay contacts BK1 and BK2 when the motor is energized. Applied voltage and current capacity of the output terminal are as follows.

- Applied voltage: AC125V, DC60V or less
- Electrical current 1A or less



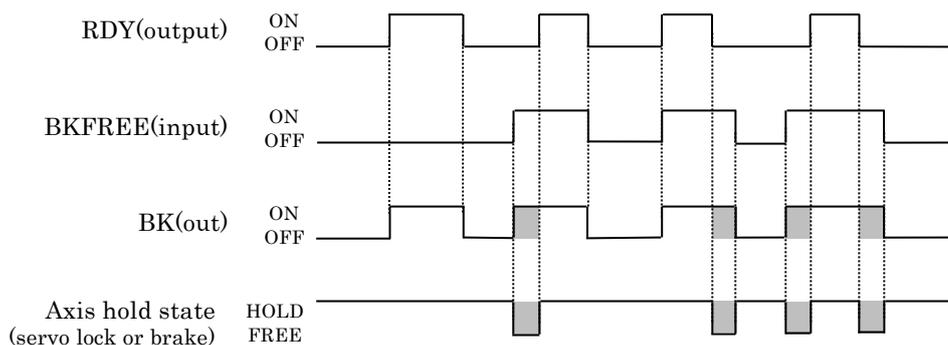
Be sure to insert a surge absorbing element such as a varistor that meets the specifications of the brake coil into the circuit. If not inserted, there is a risk of relay contact damage.

Control output functions other than the brake release signal can be assigned by setting the parameter N0016 "Control output function select: BK". **However, the switching life of a relay is approximately 100,000 times (minimum value), so consider ON/OFF switching frequency of the signal and the operating period before use.**

3) About BK (brake release) control output

In Si servo3, the control output BKFREE can be used to release the brake even when the servo is OFF. For example, this can be used for direct teaching of a robot.

However, releasing the brake during servo OFF of a Z-axis (vertical motion axis) may cause damage to the tool or workpiece by falling in the direction of gravity (shaded areas below). When using this function, refer to the following time chart.



7-2-4. Control output logic selection

The output logic of control output terminals can be inverted by setting parameter N0018 "Control output logic select". Set 0 or 1 to each bit corresponding to the control outputs OUT0~OUT2 and BK.

Parameter N0018 "Control output logic select"

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	BK	OUT2	OUT1	OUT0

※The bits displayed as "0" are reserved bits. Write 0.

Bit position	Bit name	Function
31~4	-	reserved (write 0)
3	BK	BK (relay output) logic set
2	OUT2	Control output OUT2 logic set
1	OUT1	Control output OUT1 logic set
0	OUT0	Control output OUT0 logic set

Relation between bit setting and control output logic

Bit set value	Setting	When output is ON	When output is OFF
0	Normal	CLOSED	OPEN
1	Inverted	OPEN	CLOSED

※"CLOSED" indicates conduction of the output photocoupler or the relay secondary side, and "OPEN" indicates non-conduction.

8. Servo adjustment

8-1. Control mode selection

The following two types of motor control modes can be selected by parameter N0100 "Control mode select (servo/step)".

※The control mode cannot be switched while the servo is ON. If the parameter settings is changed while the servo is ON, the new control mode will be active when the servo is turned OFF and then turned ON again.

Parameter N0100	Control mode
0	Servo mode
1	Step mode

8-2. Servo mode

8-2-1. Overview

Similar to a general servo motor, this mode is using the motor position encoder feedback (resolution 10,000) and operates in a semi-closed control loop.

Servo control is performed by detecting the position and current, while suppressing heat and vibration generation.

When positioning is completed, in addition to servo control, microstep control with phase compensation using the encoder feedback is performed to eliminate minute vibrations.

8-2-2. Basic servo gain setting

The basic servo gain parameters are shown below.

Parameter No.	Parameter name	Explanation
N0101	Position proportional gain	Set the proportional gain of the position loop. If the gain is too large, overshoot or hunting will occur, and if it is too small, excessive position error alarm will occur easily. The rigidity of mechanical system and the size of load inertia determine the upper limit value that allows operation without abnormalities such as vibration.
N0102	Velocity proportional gain	Set the proportional gain of the velocity loop. As a general rule, set a value that is at least 4-times the value of parameter N0101 "Position proportional gain". If the value is too small, overshoot is likely to occur, and if the value is too large, the system starts vibrating.
N0103	Disturbance observer gain	Set the gain of torque disturbance observer control. As a general rule, set to 50~100% of the value of parameter N0102 "Velocity proportional gain". If the value is too small, overshoot is likely to occur, and if the value is too large, the system starts vibrating.
N0104	Load moment of inertia	Set the moment of inertia of the load connected to the motor in [10 ⁻⁷ kg·m ²]. Set to "0" for the motor alone.
N0105	Velocity feedforward coefficient	Set the magnitude of the position command velocity feedforward component added to the velocity control loop. Setting the feedforward component will reduce the steady-state error and shorten the positioning time, but setting it too large, will cause vibrations.

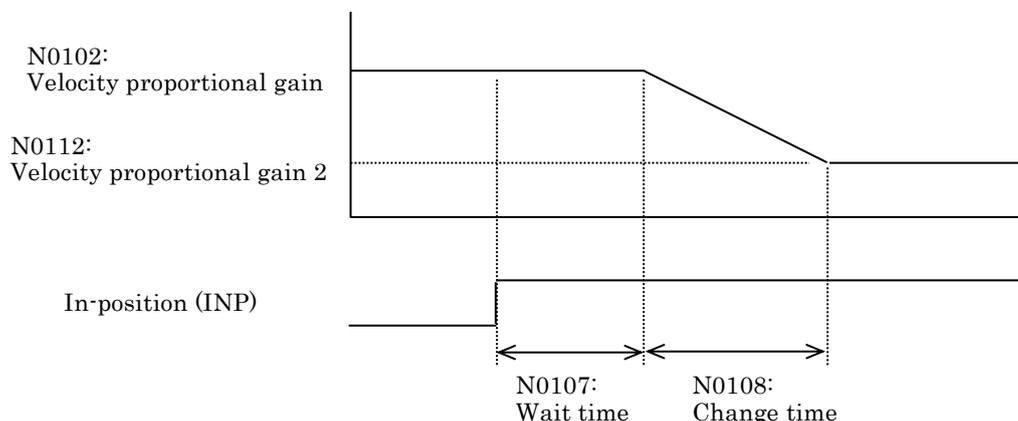
8-2-3. Gain switching function

This function switches position proportional gain, velocity proportional gain, and disturbance observer gain when the condition set by the parameter is satisfied.

Parameter No.	Parameter name	Explanation
N0106	Gain switching condition select	Select the condition to switch the gain. 0: GSEL input When the control input GSEL is ON, gain 2 is used, and when it is OFF, gain 1 is used. 1: INP input When the INP (in-position) signal is ON, gain 2 is used, and when it is OFF, gain 1 is used. 2: NEAR input When the NEAR (near position) signal is ON, gain 2 is used, and when it is OFF, gain 1 is used. 3: Position command stop When the position command stops, gain 2 is used, and when operating, gain 1 is used. 4: Position command direction When the position command is increasing in reverse direction, gain 2 is used, otherwise (position command stopped or forward direction), gain 1 is used.
N0107	Gain switching wait time: from 1 to 2	Set the delay time in [ms] after the switching condition from gain 1 to gain 2 is satisfied until the gain change is applied.
N0108	Gain switching change time: from 1 to 2	Set the change time from gain 1 to gain 2 in [ms].
N0109	Gain switching wait time: from 2 to 1	Set the delay time in [ms] after the switching condition from gain 2 to gain 1 is satisfied until the gain change is applied.
N0110	Gain switching change time: from 2 to 1	Set the change time from gain 2 to gain 1 in [ms].
N0111	Position proportional gain 2	Set the proportional gain of position loop when the condition is satisfied.
N0112	Velocity proportional gain 2	Set the proportional gain of velocity loop when the condition is satisfied.
N0113	Disturbance observer gain 2	Set the gain of torque disturbance observer control when the condition is satisfied.

oGain switching timing

Example: Switching from velocity proportional gain 1 to gain 2 when In-position is turned ON



8-2-4. Torque notch filter

The torque notch filter suppresses resonance in the motor/machine system over a specific frequency band by applying a notch filter to the torque command inside the servo control system. Due to the nature of the filter, it works effectively in the frequency range above 200Hz.

The notch filter can be set for 4 center frequencies.

Parameter No.	Parameter name	Explanation
N0114 N0116 N0118 N0120	Torque notch filter 1: frequency Torque notch filter 2: frequency Torque notch filter 3: frequency Torque notch filter 4: frequency	Set the center frequency of the notch filter. The parameter can be set from 1Hz, but the filter works effectively at frequencies above 200Hz. Setting "0" disables the notch filter.
N0115 N0117 N0119 N0121	Torque notch filter 1: depth Torque notch filter 2: depth Torque notch filter 3: depth Torque notch filter 4: depth	Set the depth of the notch filter. The smaller the value of this parameter, the smaller the attenuation effect at the center frequency of the notch filter and more attenuation at the peripheral frequencies other than the center frequency. As a general rule, use with the initial value "0".

8-3. Step mode

8-3-1. Overview

Similar to a general stepping motor, the set current is continuously supplied during the operation in step mode. Since the motor rotates in synchronization with the command, there is no delay due to control that occurs in closed loop servo mode.

Also, because the rotation angle is detected by the motor position encoder feedback, step-out does not occur. Microstep control with phase compensation is performed by using the motor's high-precision position encoder feedback, which provides superiority in vibration suppression and overshoot suppression.

The parameters related to motor control in step mode are shown below.

Parameter No.	Parameter name	Explanation
N0104	Load moment of inertia	Set the moment of inertia of the load connected to the motor in [10^{-7} kg·m ²]. Set to "0" for the motor alone.
N0124	Step mode positioning current	Set the current during normal operation (when the motor is rotating and before current down when stopped) in [mA]. Normally, set to the rated current of the motor. By setting to a value below the rated current, vibration and heat generation during rotation can be reduced. ※The factory default value for the driver model Si-05DT is the value that matches the smallest motor model that can be connected to this driver: SM-12MT (rated current 3.0[A]). When connecting the motor model SM-20MT to Si-05DT and operating in step mode, set the value to the SM-20MT rated current of about 5000[mA].
N0125	Current down current	Set the amount of current in [mA] to the motor to hold the position when the motor rotation stops (current down function). Although the heat generation can be reduced when the motor is stopped by making this parameter small, positioning may become unstable if the value is too small.
N0126	Current down time limit	Set the time that positioning current continues to flow after the motor rotation has stopped. When set to "0", the positioning current continues to flow without current down.

8-4. Other servo adjustment functions

8-4-1. Vibration suppression filter

Vibration suppression filter suppresses vibration (residual vibration) generated in the motor/machine system over a specific frequency band by applying a frequency filter to the position command in the servo control system. Due to the nature of the filter, it works effectively in the frequency range below 200Hz.

Vibration suppression filter can be set for 2 center frequencies.

The vibration suppression filter is effective in both control modes, servo mode and step mode.

Parameter No.	Parameter name	Explanation
N0122	Vibration suppression filter 1: frequency	Set the center frequency of the vibration suppression filter.
N0123	Vibration suppression filter 2: frequency	The parameter can be set up to 500Hz, but the filter works effectively at frequencies below 200Hz. Setting "0" disables the vibration suppression filter.

9. Operation (common part)

9-1. Power ON timing



Turn ON the main power (V1) and the control power (V2) at the same time or turn ON the control power first. If the main power is turned ON first, the driver may be damaged.

When the control power is supplied, the control output OUT0 is turned ON (regardless of the setting of parameter N0013 "Control output function set: OUT0") as a control start signal. This signal can be used to adjust the timing of the main power turning ON.

When the main power is turned ON, the control start signal turns OFF, indicating that the driver is ready to accept the servo ON command.

9-2. Initialization operation after power ON and servo ON for the first time

When the servo is turned ON for the first time after the power is turned ON, positioning at the nearest motor excitation origin (at a reference point that exists every 7.2° of motor rotation angle) is started to initialize the control software in the driver. Due to positioning to the excitation origin, the motor shaft will rotate up to ±3.6° from the position before the servo ON. Brake release signal is turned ON at the same time as the start of excitation, after that the excitation is continued at the excitation origin for the time period set in parameter N0421 "Startup excitation hold time", followed by turning ON the positioning complete (FIN) or in-position (INP) output.



In the cases where

- a mechanical system such as vertical axis with external force is attached to the motor axis,
- a mechanical brake is held when the motor excitation starts, and the motor cannot rotate,
- an extremely large load is connected to the motor shaft, and vibration occurs when the motor is excited,
- the machine viscosity is extremely high,

causing the motor rotor not being exactly at the excitation origin when the positioning complete signal is output, the subsequent motor control cannot be executed accurately and the risk of unintended operation (vibration, rotating in opposite direction to the command, runaway, etc.) is present.

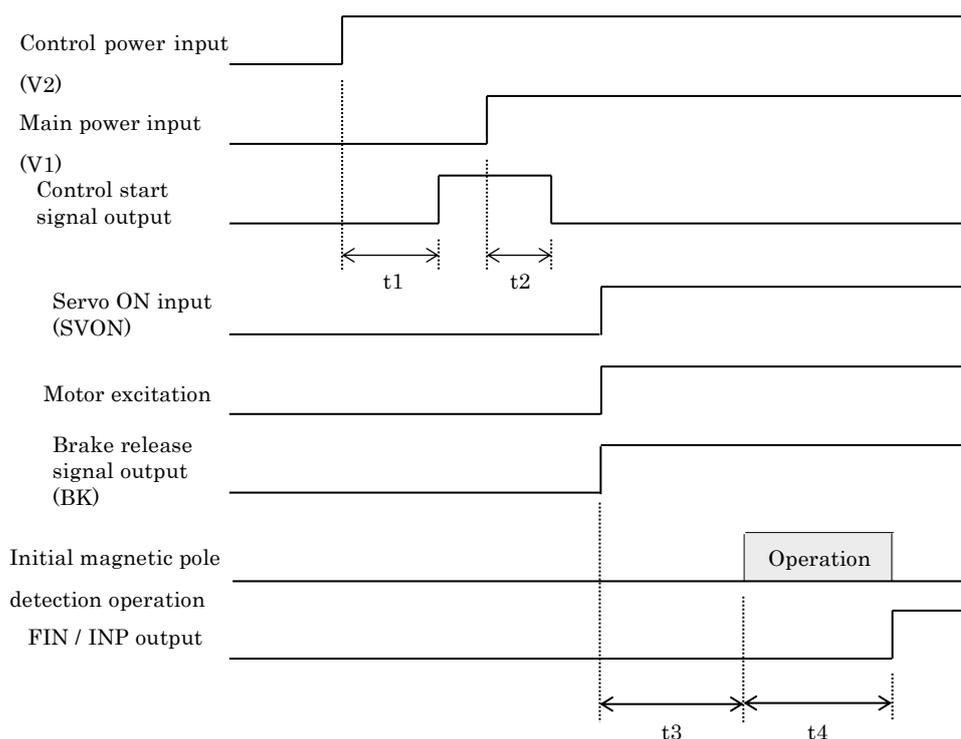
In such case, take one of the following measures to ensure that the control coordinates are initialized:

- Set an appropriately large value for parameter N0421 "Startup excitation hold time".
- Set the parameter N0422 "Initial magnetic pole detection operation select" to 1 and execute the machine end detection sequence.

For the mechanical brake, adjust the timing so that it opens at the start of t3 in the timing chart below, or assign the brake release signal BK to one of the control output terminals and control the brake release by the signal output.

※For details on control output terminals connection, refer to "7-2-3. Control output connection".

Timing of power ON and initialization operation at first servo ON



Power ON timing (※Note)

Symbol	Meaning	time	Unit
t1	Control power - Control start signal output delay time	1,000	ms
t2	Main power - Servo ON ready delay time	50	
t3	Startup excitation hold time	Set with parameter N0421	
t4	Initial magnetic pole detection operation time	approx. 500	

(※Note) The values do not consider the rise time of the control power and the main power.

Servo ON operation setting: When fixed to ON, the motor excitation starts at the same time as the control start signal (OUT0) output turns OFF.

If parameter N0422 "Initial magnetic pole detection operation select" is set to "1", the initial magnetic pole detection will start after t3, and FIN/INP signal will be output after the operation is completed. If set to "0", the initial magnetic pole detection operation is not executed.

9-3. Command input method selection

Select the input method for various operation commands received from control inputs or serial communication commands. The setting is made by parameter N0006 "Command input method select" with 2 bits per operation command:

01: Serial communication command / 00: Control input
to select from.

· Serial communication command setting (set value: 01):

The serial communication command is valid regardless of the control input terminal function setting.
(Control input signal is invalid)

· Control input setting (set value: 00):

Operation commands are given by control inputs. However, if the control input signal corresponding to each operation command is not assigned to any of the control input terminals IN0~IN4, the serial communication command is valid.

※ Only for the servo ON command, if the control input SVON is not assigned, the servo ON state is fixed. (For details refer to "9-4-1. Servo ON operation setting".)

For the control input signals corresponding to each operation command, refer to the table below.

Parameter N0006 "Command input method select"

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	TSEL	RSEL	PNT	ZSTR	STR	JOG	SVON							

※The bits displayed as "0" are reserved bits. Write 0.

Bit position	Bit name	Function
31~14	-	reserved (write 0)
13~12	TSEL	Torque limit value select
11~10	RSEL	Reference pulse multiply select
9~8	PNT	Point number specify
7~6	ZSTR	Homing operation start/stop
5~4	STR	Point-Table operation start/stop
3~2	JOG	Jog operation start/stop
1~0	SVON	Servo ON/OFF

Correspondence between serial communication command and control input for each operation command

Bit name	Function	Serial communication command (set value: 01)	Control input signal (set value: 00)
TSEL	Torque limit value select	[TSELON] [TSELOFF] [TSEL1ON]~[TSEL4ON]	TSEL0~TSEL4 TSEL0P~TSEL4P TSEL0N~TSEL4N
RSEL	Pulse command multiply	[RSELON] [RSELOFF]	RSEL
PNT	Point number specify	[PNT]	P0_IN~P7_IN
ZSTR	Homing operation	[ZSTRON] [ZSTROFF] [ZSTRP]	ZSTR, ZSTRP
STR	Point-Table operation	[STRON] [STROFF] [STRP] [STROND] [STRPD]	STR, STRP
JOG	Jog operation	[PJOG] [NJOG] [JOGOFF] [PJOGD] [NJOGD]	PJOG, NJOG
SVON	Servo ON	[SVON] [SVOFF]	SVON

9 - 4 . Servo ON operation

9 - 4 - 1 . Servo ON operation setting

A control input SVON and serial communication commands [SVON] and [SVOFF] are available for external servo ON/OFF operation. With parameter N0006 "Command input method select" (BIT0, BIT1) set whether to use the control input signal or communication commands for servo ON operation.

Control input setting (set value: 00):

- If control input SVON is assigned to any of the control input terminal functions IN0~IN4, the servo is turned ON / OFF according to the input of the assigned terminal.
- If the control input SVON is not assigned to any of IN0~IN4, the servo ON / OFF operation command is always ON. With this setting, the servo turns ON automatically when the power (main power) is turned ON, and even if the servo is turned OFF due to alarm or emergency stop, the servo turns ON automatically when the alarm or emergency stop is released.

Communication command setting (set value: 01) :

Regardless of the control input terminal function setting, the servo ON / OFF operation command is input by the communication commands [SVON] and [SVOFF]. The command input by the control input SVON is invalid.

Setting servo ON operation by parameter N0006 "Command input method select"

Function	BIT	Set value	Command method
SVON	BIT1 BIT0	11	invalid (do not set)
		10	
		01	Serial communication command [SVON] [SVOFF] (※)
		00	Control input SVON

※The servo ON command by the communication command [SVON] is held in the driver. When the servo is turned ON by [SVON] and the servo is forcibly turned OFF by alarm or emergency stop, and then the alarm/emergency stop is released, the servo ON command is retained internally and the servo is turned ON again.

If the communication command [SVOFF] is executed while the servo is OFF due to alarm or emergency stop, the internally held servo ON command will be released and the servo OFF state will be kept even after the alarm/emergency stop is released.

9-4-2. Servo ON operation by main power voltage

By setting BIT3 of parameter N0413 "Alarm output protection set" to "1", the alarm D00h: Main power input voltage low can be prevented from being output even if the main power voltage (voltage to V1 terminal of the power supply connector) drops.

This can be used to perform servo ON/OFF operation with the main power supply voltage.

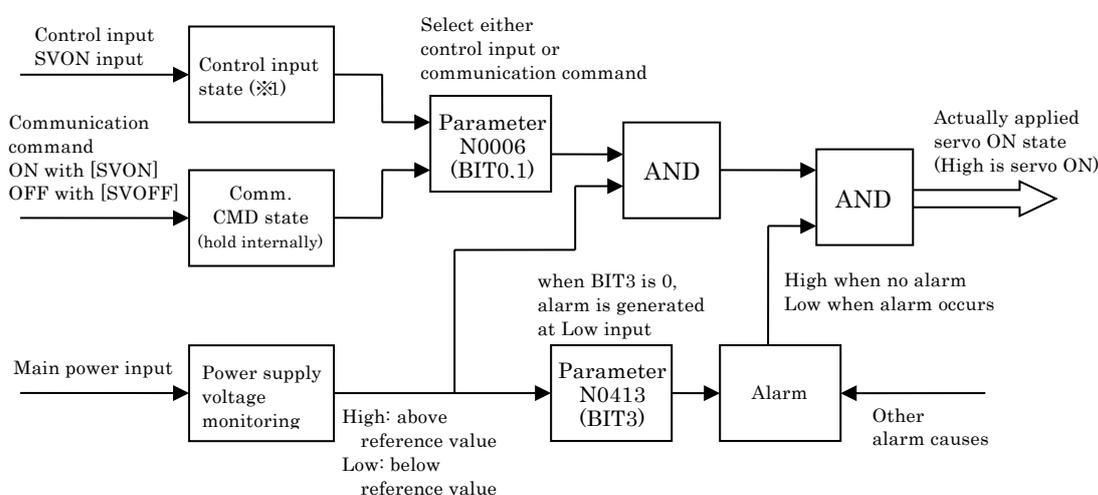
Procedure of servo ON/OFF operation by main power voltage:

1. Set BIT3 of parameter N0413 "Alarm output protection set" to "1" (prohibit output).
2. Select whether the servo ON operation is fixed to ON, or the servo ON operation is performed by the control input SVON or the communication commands [SVON], [SVOFF], set the BIT0, BIT1 of parameter N0006 "Command input method select", parameters N0008 "Control input function select: IN0"~N0012 "Control input function select: IN4" (for details, refer to previous section).
3. Supply the main power, turn ON the servo by method selected in 2.
4. When the input power supply voltage falls below the reference value (20V), the servo turns OFF.
5. When the input power supply voltage recovers above the reference value, the servo turns ON again.

The servo ON state is actually applied as the AND operation (logical product) of the servo ON by control input or by communication command and the power supply voltage state.

Block diagram of the servo ON state is shown below.

(Servo ON control block diagram)



※1) Can be fixed to ON by setting parameter N0006.

※2) reference value: 20V

9 - 5. Motor rotation direction

Set the actual rotation direction of the motor shaft for the forward/reverse rotation operation command with parameter N0001 "Motor rotation direction select".

Parameter set value	Forward direction command	Reverse direction command
0	clockwise (CW) rotation	counterclockwise (CCW) rotation
1	counterclockwise (CCW) rotation	clockwise (CW) rotation

※Clockwise/counterclockwise direction is from the viewpoint of the motor body from the motor shaft side.

9 - 6. Position Reference unit setting (electronic gear)

The electronic gear function can be used to specify the number of position command pulses (position Reference unit) equivalent to one rotation of the motor shaft.

The values of position/movement in built-in positioning operations such as Point-Table functions and the number of pulses of a position reference pulse are handled by this position Reference unit.

To set the electronic gear, set the parameter N0002 "Electronic gear numerator" and the parameter N0003 "Electronic gear denominator" so that the following formula is satisfied.

$$\text{Number of position command pulses per motor rotation} \times \frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = 10,000$$

※10,000 is an internal constant called a control unit.

<Example 1>

1 motor rotation = 3,600 pulses

$$\frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = 10,000 / \text{Number of pulses per motor revolution (3,600)} = \frac{10,000}{3,600}$$

(The value is reduced to the same setting

when electronic gear numerator = 25 and electronic gear denominator = 9)

<Example 2>

Using a mechanical system with a gear reduction ratio 1:3 and a ball screw lead of 5mm and position command 1pulse = 1 μm

⇒motor 3 rotations = 5,000pulses

⇒motor 1 rotation = 5,000pulses / 3

$$\frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = 10,000 / \text{Number of pulses per motor revolution (5,000 / 3)} = \frac{30,000}{5,000}$$

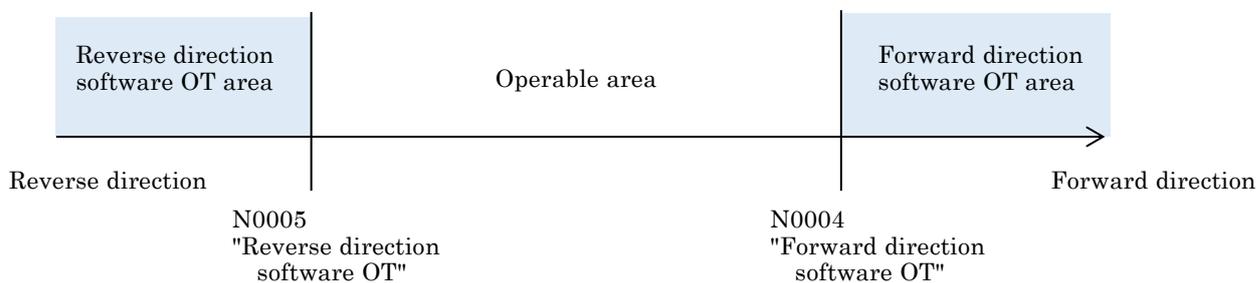
(The value is reduced to the same setting

when electronic gear numerator = 6 and electronic gear denominator = 1)

9-7. Overtravel

9-7-1. Software overtravel

Set the software overtravel range in forward direction and reverse direction with parameters N0004 "Forward direction software OT" and N0005 "Reverse direction software OT".



The operable range is as follows:
 Parameter N0005 set value < Reference unit position < Parameter N0004 set value

The software OT function limits the command when the position command value exceeds the operable range. When operating with position reference pulse, the position command input pulses exceeding the operable range are ignored.

If the OT area is reached during Point-Table operation or jog operation, the operation is interrupted and the positioning stops at the overtravel reference value (N0004 or N0005 set value). At the same time, the control output INP/FIN is turned ON.

If the positioning reaches the OT area of either forward or reverse direction and is stopped, none of Point-Table operations can be started.

In position reference pulse operation, jog operation, and step operation, it is only possible to move in reverse direction when stopped with forward direction OT, and only in forward direction when stopped with reverse direction OT.

Software OT function is invalid in the following cases:

- 1) "0" is set for both N0004 and N0005
- 2) Homing not completed
- 3) Velocity control mode setting (parameter N0019 "Velocity control operation mode select" is "1")
- 4) Rotating coordinate system setting
 (parameter N0417 "Rotating coordinate system lower limit", N0418 "Rotating coordinate system upper limit" are set to other than "0")
- 5) Forward direction software OT reference value is smaller than the reverse direction software OT reference value. (relationship between parameters N0005 > N0004)

9-7-2. Hardware overtravel

By control inputs POT and NOT, the operation command in forward/reverse direction is prohibited.

When operating with position reference pulse, the position command input pulses in the direction in which OT is turned ON are ignored.

If either POT or NOT turns ON during Point-Table operation or jog operation, the operation will be interrupted and the motor shaft will be positioned at the position at that time. At the same time, the control output INP/FIN is turned ON.

If either POT or NOT input is ON, none of Point-Table operations can be started.

In position reference pulse operation, jog operation, and step operation, it is only possible to start in reverse direction when POT is ON, and only in forward direction when NOT is ON.

9-7-3. OT operation classification by state

The following shows whether the operation can be started in opposite direction to OT when the operation is stopped either by hardware OT or software OT during various operations.

	Stop by hardware OT	Move in opposite direction during hardware OT input	Stop by software OT	Move in opposite direction during software OT state
Position ref. pulse	stop	○	stop	○
Point-Table	stop (※1)	×	stop	×
Homing	stop (※1)	×	no stop (※2)	—(※2)
Jog	stop	○	stop	○
Step operation	stop	○	stop	○
Point-Table (velocity control mode)	no stop (※3)	—	no stop (※3)	—
Jog (velocity control mode)	no stop (※3)	—	no stop (※3)	—

※1 If NOT signal is input during Point-Table or homing operation that moves in forward direction, or if POT signal is input during Point-Table or homing operation that moves in reverse direction, the operation is interrupted and the motor stops.

※2 If the homing operation has started, it will be in incomplete state. The software OT is invalid when homing is not completed.

※3 In velocity control mode, all OTs (hardware and software) are invalid.

9-7-4. Notes on software OT setting

- Software OT also occurs when the position command is equal to the set value of parameter N0004 or N0005. If the movement target value for Point-Table operation is set to the same value as the parameters N0004 or N0005, OT will occur when the point execution positioning is completed, and continuous Point-Table operation will be interrupted.
- Note that when the homing operation is completed, the position command value is automatically rewritten to "0" (it can be changed by setting the parameter N0308 "Home position offset"), and if the software OT reference value for either forward or reverse direction is set to "0", the software OT state will be set as soon as the homing operation is completed, thus the Point-Table operation cannot start in this state.

1 0. Position reference pulse operation

1 0-1. Overview

Positioning is performed synchronized with pulse train command input from the host controller such as a PLC.

However, the position reference pulse input in any of the following states is ignored.

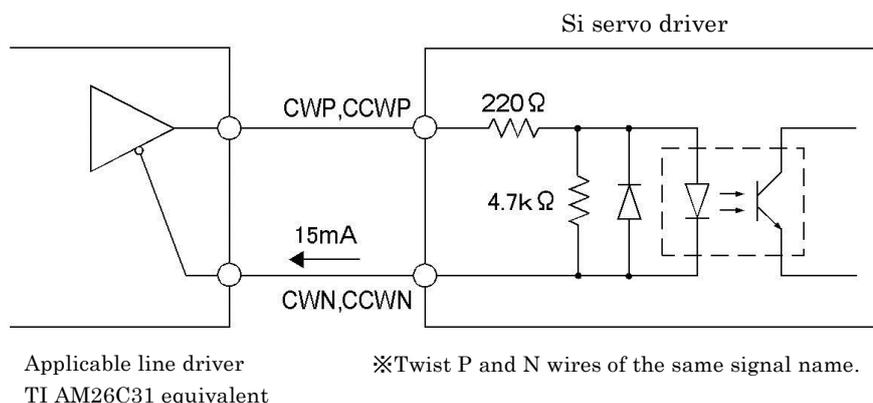
- During servo OFF
- During Point-Table operation, jog, step operation, homing operation
- In overtravel state (either forward or reverse direction, valid only in not restricted direction)
- In velocity control mode (when parameter N0019 "Velocity control operation mode select" is set to "1")

1 0-2. Pulse input connection

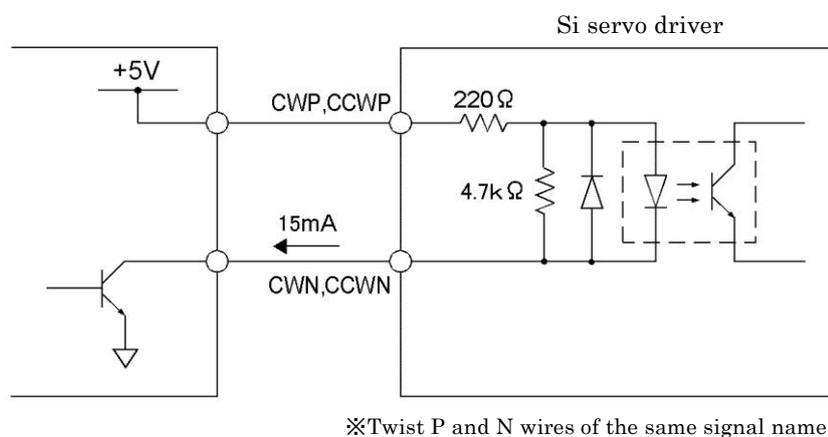
Operation is possible with 5V line driver output (26C31 equivalent) or +5V open collector output.

The electrical current consumption is about 15mA per circuit.

A) In case of 5V line driver output



B) In case of 5V open collector output

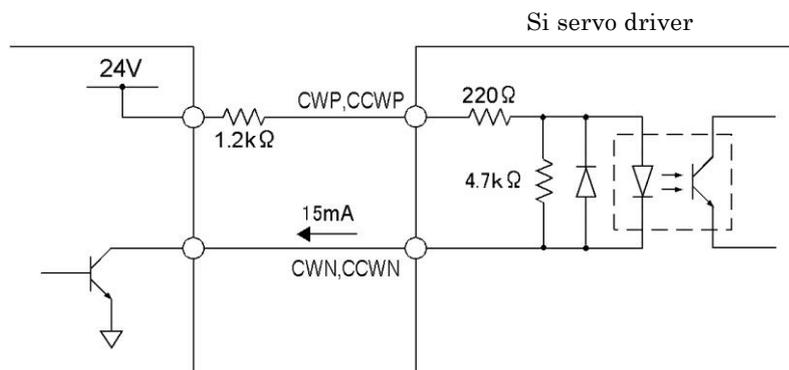


Precautions when using open collector output pulse train command

Compared to line driver output, pulse train by open collector output is less tolerant of external noise, and pulse miscount is likely to occur. Therefore, carefully consider noise countermeasures by using a noise filter and reviewing the wiring route.

C) In case of 24V open collector output

When connecting to open collector output with a power supply higher than 5V, add a current limiting resistor to limit the current to 15mA.



※Twist P and N wires of the same signal name.

Precautions when using open collector output pulse train command

Compared to line driver output, pulse train by open collector output is less tolerant of external noise, and pulse miscount is likely to occur. Therefore, carefully consider noise countermeasures by using a noise filter and reviewing the wiring route.

1 0 - 3 . Reference pulse type selection

By setting parameter N0007 "Reference pulse type select", the type of position reference pulse can be selected from the following three types.

Set value	Input type	Forward command	Reverse command
0	CW / CCW	C W (CWN pin) C C W (CCWN pin) 	C W (CWN pin) C C W (CCWN pin)
1	PULSE / SIGN	PULSE (CWN pin) SIGN (CCWN pin) 	PULSE (CWN pin) SIGN (CCWN pin)
2	A / B phase (90° phase difference)	Phase A (CWN pin) Phase B (CCWN pin) 	Phase A (CWN pin) Phase B (CCWN pin)

Note) The waveforms in the table show the voltage levels of CWN and CCWN terminals.

Pulse counting is performed at the signal edges marked with ↓ and ↑.

※In principle, the position command pulse A / B phase (90° phase difference) is less likely to cause miscounting due to disturbance compared to other methods.

1 0 - 4 . Reference pulse multiply switching

Two scaling factors between the external input number of position reference pulses and the number of position command pulses transmitted to the Si servo driver can be set with parameters N0400 "Reference pulse multiply 1" and N0401 "Reference pulse multiply 2".

The applied scaling factor of the two is determined by the input state of control input RSEL.

RSEL input state	Applied scaling factor
OFF	Parameter N0400 "Reference pulse multiply 1"
ON	Parameter N0401 "Reference pulse multiply 2"

Operation example:

Parameters	Set value
Parameter N0002 "Electronic gear numerator"	10,000
Parameter N0003 "Electronic gear denominator"	3,600
Parameter N0400 "Reference pulse multiply 1"	1
Parameter N0401 "Reference pulse multiply 2"	4

In case of parameters set as shown in the table above (electronic gear set value is 1 motor rotation = 3,600 pulses),

- when RSEL is OFF: the motor rotates once with an external position command of 3,600 pulses.
- when RSEL is ON: the motor rotates once with an external position command of 900 pulses.

(Description)

When RSEL is ON, the multiplication of "4" is applied to the 900 pulses of external input, and 3,600 pulses are transmitted to the Si servo driver. Since the motor operates with the Reference unit set by the electronic gear (1 motor rotation = 3,600 pulses), the motor makes 1 rotation with the received pulses.

1 0 - 5 . In-position signal output

The control output INP is the in-position signal output. The condition for this signal to turn ON is as follows:

absolute value of position error \leq parameter N000 "In-position range"

※Position error: Difference between the positioning target position (command position) and the actual motor shaft position (current position)

(About in-position output permission time setting)

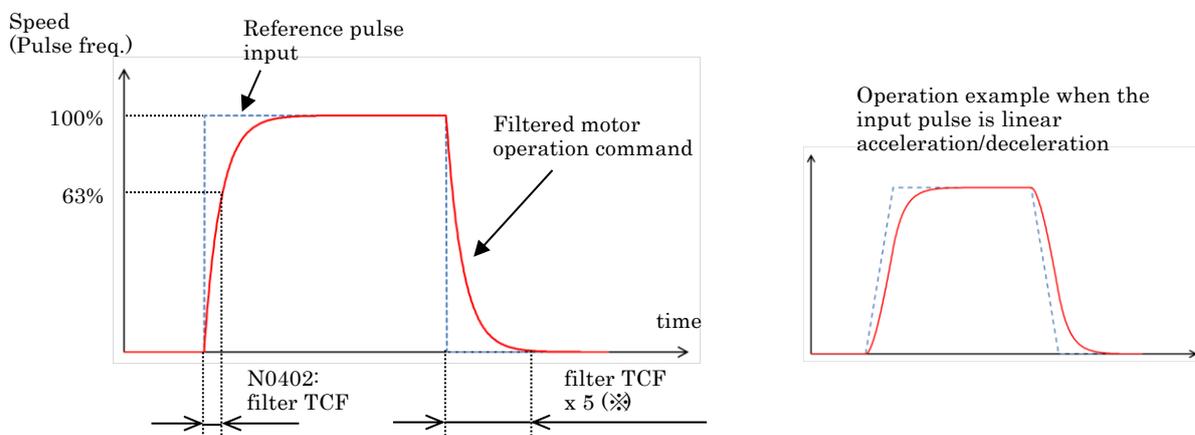
In general in servo control when the motor shaft is rotating, a steady state error (delay in following the motor shaft with respect to the position command) occurs in accordance with the rotation velocity, so in most cases the INP output is turned OFF during rotation, but depending on the pulse frequency of the reference pulse and in-position range setting, the INP output may turn ON even while the motor shaft is rotating.

In-position output permission time setting (parameter N0405) is available to handle such cases. With the in-position output permission time set, the INP output is always OFF for the period set in parameter N0405 after the last pulse of the position command pulse input. Set parameter N0405 to a time (in ms) that is longer than the period of the position command pulses to be used.

1 0 - 6 . Reference pulse smoothing filter

Set the time constant of the filter that smooths the rise and fall speed of the position reference pulse input in parameter N0402 "Reference pulse smoothing filter time constant" (in ms).

The filter is a first-order lag filter, and when the rising edge of the input pulse train frequency is stepwise (no slope), it accelerates to about 63% of the input frequency in the time set in the time constant. The same applies to deceleration at the decrease.

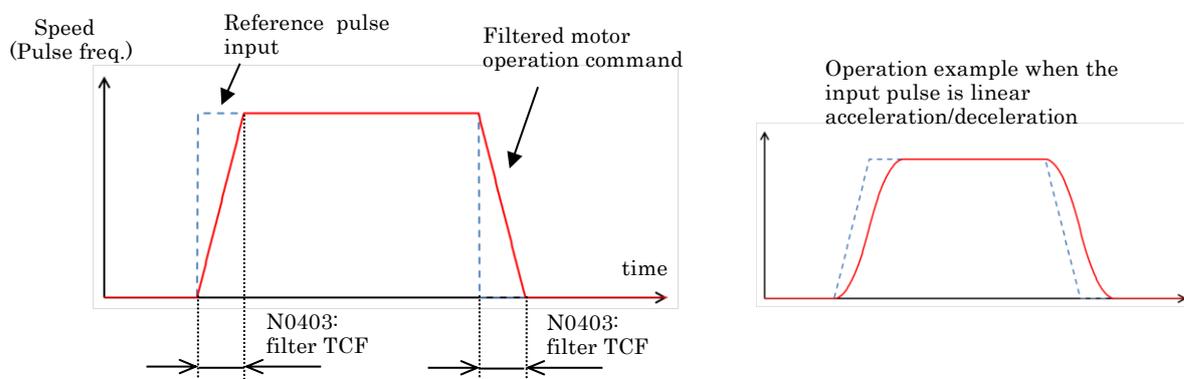


※With the smoothing filter, the time from the last pulse of the input pulse train until the operation command after applying the filter becomes 0 (all actually applied movement position command ends), will be about 5 times the time set as the filter time constant.

1 0 - 7 . Reference pulse simple S-shape acceleration/deceleration filter

Set the time constant of the filter that smooths the rise and fall speed of the position reference pulse input in parameter N0403 "Reference pulse simple S-curve acc/dec filter time constant" (in ms).

The filter is a moving average filter, and when the rising edge of the input pulse train frequency is stepwise (no slope), it accelerates and decelerates linearly in the time set in the time constant. When the input pulse train frequency accelerates or decelerates linearly, the speed change during acceleration / deceleration is smoothed (simple S-shaped acceleration / deceleration).



※With the simple S-shaped acceleration / deceleration filter, the time from the last pulse of the input pulse train until the operation command after applying the filter becomes 0 (all actually applied movement position command ends), will be equal to the filter time constant.

1 1. Torque limit function

1 1-1. Overview

The value of maximum motor torque output can be limited by parameter setting, control input, and serial communication command. The torque limiting function can be used for workpiece pushing operation.

Two types of torque limiting functions are available as shown below.

- (1) Torque limit during position reference pulse operation
- (2) Torque limit during Point-Table operation

The following describes (1).

For the torque limit function during Point-Table operation (2), refer to separate volume "Instruction Manual: Point-Table part".

The following parameters are related to torque limit.

Parameters related to torque limit

Parameter No.	Parameter name
N0200	Forward direction basic torque limit
N0201	Reverse direction basic torque limit
N0202	Torque limit value select 0
N0203	Torque limit value select 1
N0204	Torque limit value select 2
N0205	Torque limit value select 3
N0206	Torque limit value select 4
N0207	Torque completed/VZR output range
N0208	Torque limit inc/dec time constant
N0209	Normal velocity limit
N0210	Velocity limit during torque limit
N0211	Velocity limit when torque limit is released
N0212	Velocity limit acc/dec time constant

For details on parameters refer to "[1 7-2-3. Torque limit function](#)".

1 1 - 2. Torque limit value setting

The torque limit values can be set by parameters N0200 "Forward direction basic torque limit", N0201 "Reverse direction basic torque limit", N0202 "Torque limit value select 0"~N0205 "Torque limit value select 4". The set torque limit values are switched by control inputs TSEL0~TSEL4 (both forward and reverse directions), TSEL0P~TSEL4P (forward direction only) and TSEL0N~TSEL4N (reverse direction only).

The torque limit values are set in [0.1%] of the motor rating.

Torque limit values setting parameters

Parameters	Control input			Unit	Lower limit	Upper limit
	TSEL□	TSEL□P	TSEL□N			
N0200 "Forward direction basic torque limit"	—	—	—	0.1%	0	2000
N0201 "Reverse direction basic torque limit"	—	—	—			
N0202 "Torque limit value select 0"	TSEL0	TSEL0P	TSEL0N			
N0203 "Torque limit value select 1"	TSEL1	TSEL1P	TSEL1N			
N0204 "Torque limit value select 2"	TSEL2	TSEL2P	TSEL2N			
N0205 "Torque limit value select 3"	TSEL3	TSEL3P	TSEL3N			
N0206 "Torque limit value select 4"	TSEL4	TSEL4P	TSEL4N			

1 1 - 2 - 1. Normal torque limit

When the control inputs TSEL0~TSEL4, TSEL0P~TSEL4P, and TSEL0N~TSEL4N are not turned ON, the torque limit value in forward direction is set by parameter N0200 "Forward direction basic torque limit", and the torque limit value in reverse direction is set by parameter N0201 "Reverse direction basic torque limit".

1 1 - 2 - 2. Torque limit value selection (in both forward and reverse directions simultaneously)

When the control inputs TSEL0~TSEL4 are turned ON, the forward and reverse direction torque limit value set in the parameter corresponding to each control input is applied.

If two or more of the control inputs TSEL0~TSEL4 are ON at the same time, the torque limit value corresponding to the control input that last changed from OFF to ON is applied.

1 1 - 2 - 3. Torque limit value selection in forward direction

When the control inputs TSEL0P~TSEL4P are turned ON, the forward direction torque limit value set in the parameter corresponding to each control input is applied.

If two or more of the control inputs TSEL0P~TSEL4P are ON at the same time, the torque limit value corresponding to the control input that last changed from OFF to ON is applied.

The inputs TSEL0P~TSEL4P do not affect the reverse direction torque limit.

When TSEL0P~TSEL4P and TSEL0~TSEL4 are turned ON at the same time, the forward direction torque limit value selected by TSEL0P~TSEL4P is applied.

※There are some restrictions on the torque limit function in specific operating conditions. For details refer to "[1 1 - 5. Precautions when using torque limit function](#)".

1 1-2-4. Torque limit value selection in reverse direction

When the control inputs TSEL0N~TSEL4N are turned ON, the reverse direction torque limit value set in the parameter corresponding to each control input is applied.

If two or more of the control inputs TSEL0N~TSEL4N are ON at the same time, the torque limit value corresponding to the control input that last changed from OFF to ON is applied.

The inputs TSEL0N~TSEL4N do not affect the forward torque limit.

When TSEL0N~TSEL4N and TSEL0~TSEL4 are turned ON at the same time, the reverse direction torque limit value selected by TSEL0N~TSEL4N is applied.

※There are some restrictions on the torque limit function in specific operating conditions. For details refer to "1 1-5. Precautions when using torque limit function".

1 1-2-5. Torque limit increase/decrease time constant

In parameter N0208 "Torque limit inc/dec time constant", specify the slope of increase/decrease when the torque limit value changes depending on the input state of control input TSEL0, etc. in "Time for 100% increase/decrease of torque limit value" in [ms].

1 1-2-6. Velocity limit

Set the velocity limit value in [min^{-1}] when the torque limit selection signal is not input (normal) and when the torque limit selection signal is input (torque limited) conditions.

State	Conditions	Velocity limit parameter
A: Normal	TSEL0~TSEL4, TSEL0P~TSEL4P, TSEL0N~TSEL4N are all OFF (※excluding C: When torque limit is released)	N0209: Normal velocity limit
B: When torque is limited	At least one of TSEL0~TSEL4, TSEL0P~TSEL4P, TSEL0N~TSEL4N is ON	N0210: Velocity limit during torque limit
C: When torque limit is released	Period from when the torque limit is released until the position error is eliminated	N0211: Velocity limit when torque limit is released

Set the slope when the velocity limit value changes with the parameter N0212 "Velocity limit acc/dec time constant" in "Time for velocity limit value to increase/decrease 3000min^{-1} " in [ms].

※There are some restrictions on the velocity limit function in specific operating conditions. For details refer to "1 1-5. Precautions when using torque limit function".

1 1-2-7. Torque limit control setting

Set the torque limit control method by BIT0 of the parameter N0213 "Torque limit option function".

Set value	Control method and content
0	Torque limit value feedback control Due to torque limit processing in the driver when the motor shaft is rotating at high velocity, the motor shaft can accelerate to high velocity even if the torque limit value specified by the user is small. The torque actually output from the motor shaft is controlled so that it does not exceed the torque limit specified by the user.
1	Compatible to old models (simple torque command) This method simply gives an upper limit to the servo control in the driver according to the torque limit value specified by the user. If the torque limit is small, the motor shaft will not be able to accelerate above a certain velocity.

1 1 - 3. Control output signals related to torque limit

Function	Name	Content
TLMT	Torque limited	Turns ON when the motor torque output is limited by the torque limit value.
VZR	Zero velocity	Turns ON when the motor rotation command is stopped and the absolute value of the motor shaft rotation velocity is less than or equal to the velocity set in parameter N0207 "Torque completed/VZR output range".
TFIN	Torque completed	Turns ON when Torque limited (TLMT) is ON and the absolute value of the motor shaft rotation velocity is less than or equal to the velocity set in parameter N0207 "Torque completed/VZR output range".
FIN+TFIN	Completed + Torque completed	During Point-Table operation is the same as Completed (FIN) output, in other operating conditions it turns ON when either FIN or Torque completed (TFIN) is ON.

1 1 - 4. Position error clear

The position error is cleared at ON edge of the control input ERST or with the communication command [ERST].

When clearing the error with control input, select ERST with parameters N0008 "Control input function selection: IN0"~N0012 "Control input function selection: IN4".

For details on [ERSET] command, refer to "Instruction Manual: Serial Communication part".

1 1-5. Precautions when using torque limit function

1 1-5-1. Precautions related to torque limit and velocity limit functions in step mode

In step mode, the torque limit and velocity limit operate as follows:

- The same value is applied to forward direction torque limit and reverse direction torque limit. The applied value is the set value in parameter N0200 "Forward direction basic torque limit" or the value selected by control inputs TSEL0P~TSEL4P. Inputs by TSEL0N~TSEL4N are invalid.
- For the actually applied torque limit value, the smaller value of the following two is applied:
 - A) Positioning holding torque determined by parameter N0124 "Step mode positioning current" or N0125 "Current down current"
 - B) Torque limit determined by parameter N0200 "Forward direction basic torque limit" or N0202 "Torque limit value select 0"~N0206 "Torque limit value select 4"
- All velocity limit functions are disabled.

1 1-5-2. Precautions related to torque limit function in servo mode

In servo mode, when position command is stationary and the motor axis is stopped by positioning, the torque limit operates as follows:

- The same value is applied to forward direction torque limit and reverse direction torque limit. The applied value is the set value in parameter N0200 "Forward direction basic torque limit" or the value selected by control inputs TSEL0P~TSEL4P. Inputs by TSEL0N~TSEL4N are invalid.

1 1-5-3. Other notes

- 1) The torque set as the torque limit value can be output only when rotation of the motor shaft is stopped. The output torque when the motor shaft is rotating is smaller than the torque command in relation to the shaft rotation velocity.
- 2) If the torque is continuously output in acceleration/deceleration region exceeding the motor 100% rating (refer to N-T characteristic chart), an overload alarm may occur or the motor and driver may generate significant heat, thus set the torque to rated 100% or less.
- 3) If BIT0 of parameter N0213 "Torque limit options" is set to "0" (compatible with old models), lowering the torque limit lowers the upper limit of rotation velocity. Note that if the operation command velocity is higher than the upper limit velocity, the motor rotation cannot follow the operation command and the position error increases. As a general rule, it is recommended to use parameter N0213:BIT0 with "1" (torque limit feedback control: factory setting).
- 4) When torque limit is selected, alarm 500h: Excessive position error does not occur even if the position error exceeds the parameter set value (N0412 "Maximum position error").

However, if the position error becomes extremely large (equivalent to 200,000 motor rotations: see the table below for details), an alarm 501h: Position error cannot be calculated is issued.

Motor model	Reference value (encoder pulse unit)
TS3692N61S02, TS3641N61S02	±160,000,000
TS36□□N370S04, TS36□□N371S04 TS36■N324S04, TS36■N325S04 TS36■N327S04	±320,000,000
SM-L5MT etc. Si servo3 motors	±2,000,000,000

□: 17 (standard motor) or 80 (motor with brake), ■: 53 (standard motor) or 81 (motor with brake)

1 2. Point-Table operation

1 2-1. Operation mode selection

In Point-Table operation, the operation is executed by selecting data from the Point-Table (up to 256 points) registered in advance in the driver.

The following two operation modes depending on the setting of parameter N0019 "Velocity control operation mode select" are available.

Set value	Operation mode
0	Positioning operation
1	Velocity control operation

※To make the parameter setting change effective, it is necessary to cycle the driver power or perform a software reset.

The following sections explain the basic functions and methods of Point-Table operation. For details, refer to separate volume "Point-Table functions".

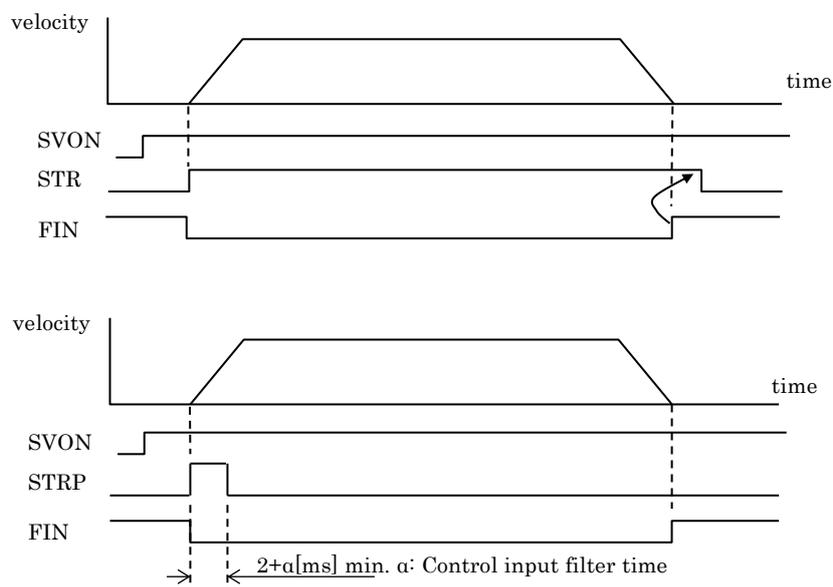
1 2-2. Positioning operation mode

1 2-2-1. Basic procedure

For the Point-Table operation commands, either control inputs or communication commands can be selected and used.

1. Using parameter N0006 "Command input method select" specify whether to use control input signal or communication command for "SVON", "STR", "Point specify" operations.
2. Send the communication command [SVON] or input the control input SVON and turn the servo ON.
3. Set the point number to execute with control inputs P0_IN~P7_IN or with communication command [PNT].
4. Operation starts at the rising edge of STR or STRP signal or at communication command [STRON] or [STRP].

Note: Be sure to confirm that the FIN signal is ON before turning the STR signal OFF. If the STR signal is turned OFF before the FIN signal is turned ON, the point positioning operation will be canceled. Therefore, when using incremental positioning command, this may cause an unintended displacement.



1 2 - 2 - 2. Direct start

With the rising edge of control inputs DSTR0~DSTR4, the Point-Table at the number set in parameters N0425 "Direct start point number: DSTR0"~N0429 "Direct start point number: DSTR4" is started.

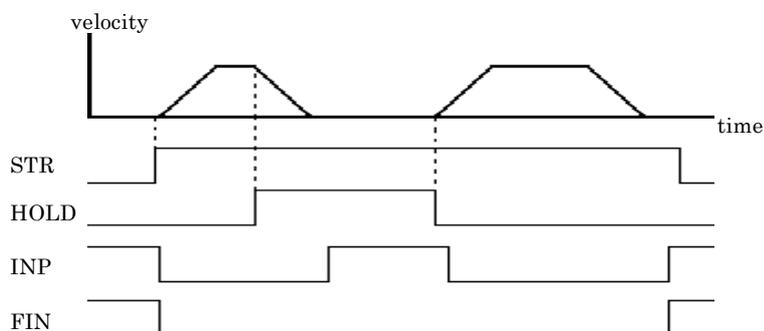
Direct start point setting parameters list

Parameter number	Parameter name	Control input
N0425	Direct start point number: DSTR0	DSTR0
N0426	Direct start point number: DSTR1	DSTR1
N0427	Direct start point number: DSTR2	DSTR2
N0428	Direct start point number: DSTR3	DSTR3
N0429	Direct start point number: DSTR4	DSTR4

The timing of direct start input signals DSTR0~DSTR4 is the same as for STRP signal. Set the command input method and the servo ON control in the same way as for STRP.

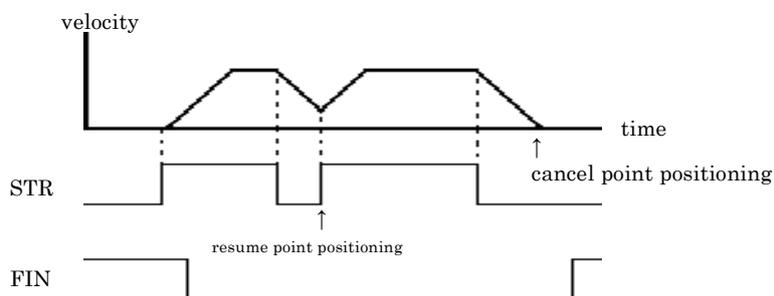
1 2 - 2 - 3. Pause positioning operation

If HOLD signal is turned ON or communication command [HOLDON] is received during the positioning operation, the operation will pause. When paused, the remaining movement amount is retained. Deceleration is according to the acceleration/deceleration time constant set in Point-Table. The operation is resumed with HOLD signal turned OFF or with communication command [HOLDOFF].

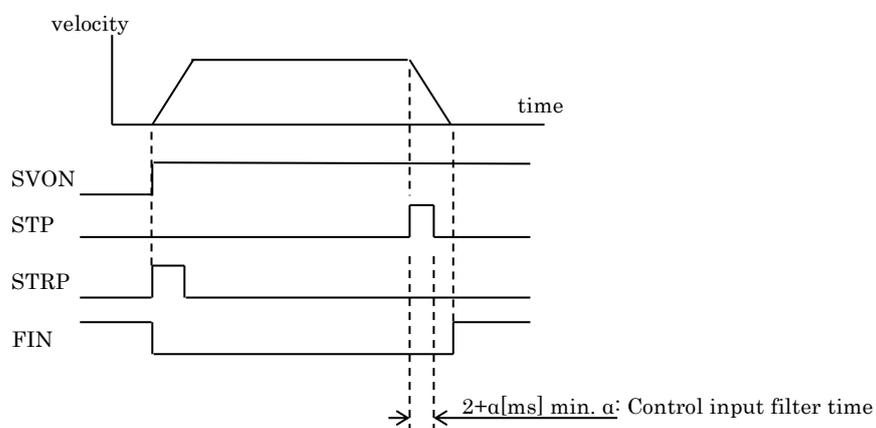


1 2 - 2 - 4. Canceling positioning operation

If STR input is turned OFF during positioning operation, the motor will decelerate according to the acceleration/deceleration time constant of the Point-Table, and when it stops, the program currently being executed and the remaining movement amount will be canceled. If the STR input is turned ON again before stopping, the program will not be canceled and the point positioning will resume.



If Point-Table operation is started by STRP or DSTR0~DSTR4 input, cancel the operation by STP input.

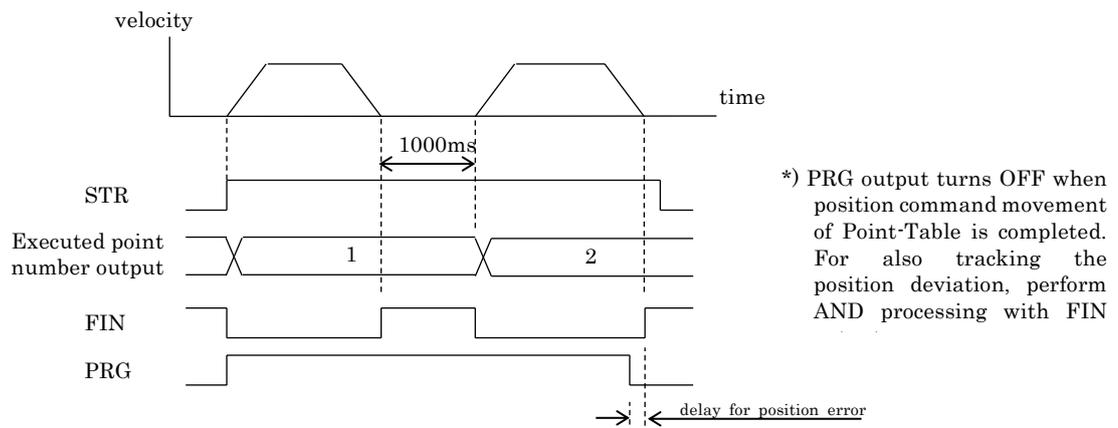


1 2 - 2 - 5. Currently executed point output and PRG output

Currently executed point number (0 to 255) is output by the control outputs P0_OUT~P7_OUT and the communication command [MON] number 0A. Also, PRG signal can be used as indication of program running or program ended.

Example) Start at point No. 1 with the following settings

Point No.	Wait time [ms]	Branch destination point number
1	1000	2
2	0	256



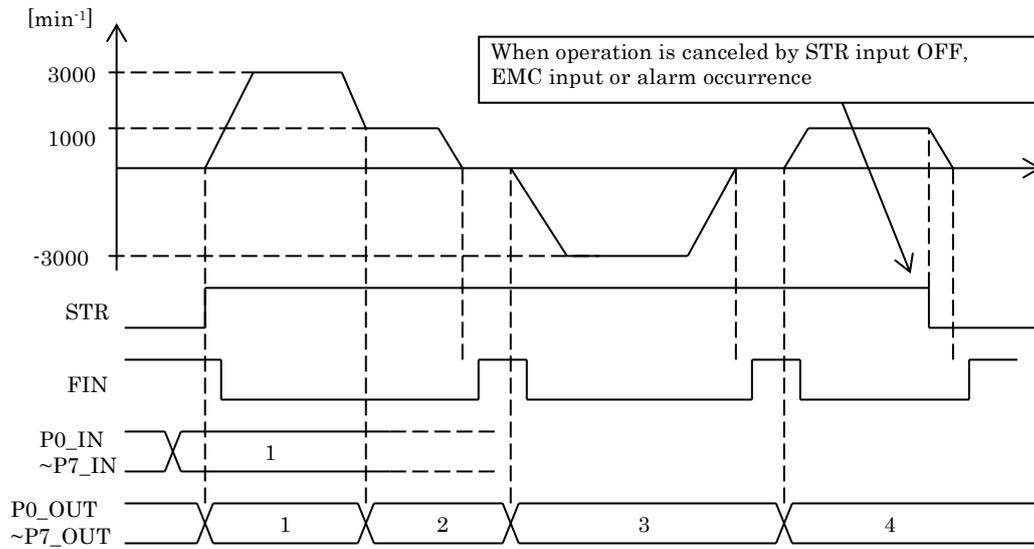
1 2 - 2 - 6. Point completed output

The control outputs P0_FIN~P7_FIN and the communication command [MON] number 0A output the execution completed point number.

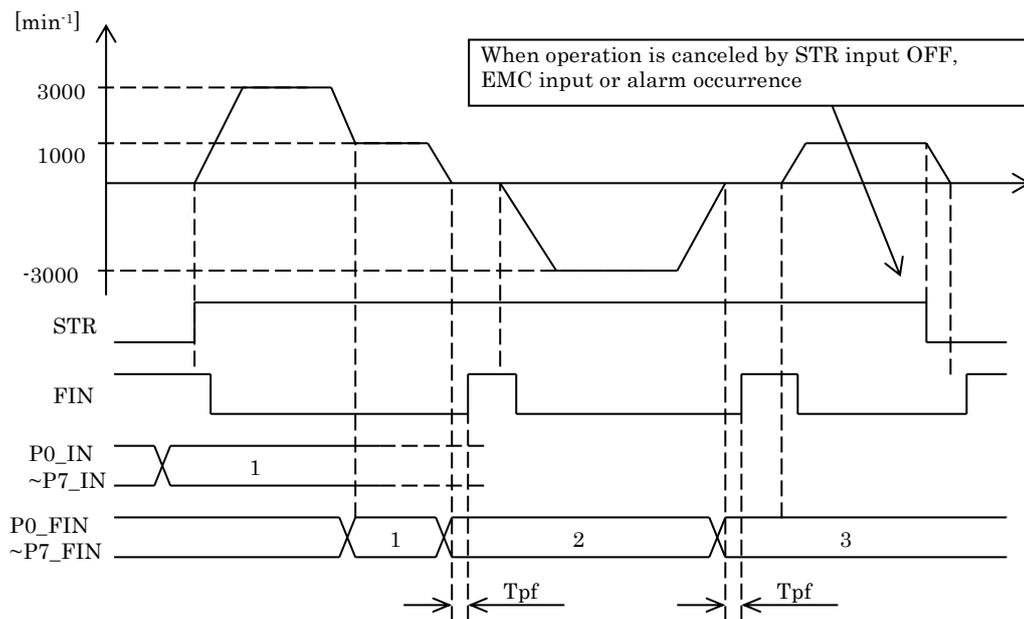
An example of Point-Table settings for currently executed point output (P0_OUT~P7_PUT) and point completed output (P0_FIN~P7_FIN) is shown below.

Point	Absolute/relative	Move amount	Velocity	Wait time	Branch destination	Continuous	...
:	:	:	:	:	:	:	
1	0	16000	3000	0	2	1	
2	0	24000	1000	500	3	0	
3	0	0	3000	500	4	0	
4	0	20000	1000	0	256	0	

[Example of currently executed point output by P0_OUT~P7_OUT outputs]



[Example of point completed output by P0_FIN~P7_FIN outputs]



Tpf: delay for position

*) P0_FIN~P7_FIN outputs change when the position command movement of the Point·Table is completed. For also tracking the position error, perform AND processing with FIN output.

1 2-2-7. Teaching function

Current position can be stored (teaching) in specified Point-Table data by control input signal TDIN or by communication command [TDIN]. Also, the "Absolute value/relative value" of the point number at which the teaching is performed is automatically set to 0 (absolute value).

1) Rewriting only RAM data

When frequent rewriting of the data during operation is needed and considering the write limit number of nonvolatile memory (standard value is 100,000 times), perform the teaching in the following manner. The contents of the data rewritten by this method will be cleared by turning the power OFF or by performing a software reset.

a) When teaching with communication command

- ① Set the parameter N0006 "Command input method select" as shown in the table on the right. (Set communication command [PNT] to point designated device)
- ② Move the motor to the position to memorize.
- ③ Use [PNT] command to specify the point number for teaching.
- ④ Use [TDIN] command to import the current position.

Func.	BIT	Set value	Select device
Point specify	BIT9	0	communication command [PNT]
	BIT8	1	
ZSTR	BIT7	—	—
	BIT6	—	
STR	BIT5	—	—
	BIT4	—	
JOG	BIT3	—	—
	BIT2	—	
SVON	BIT1	—	—
	BIT0	—	

b) When teaching with control input

- ① Set the parameter N0006 "Command input method select" as shown in the table on the right. (Set control input signals P0_IN~P7_IN to point designated device)
- ② Move the motor to the position to memorize.
- ③ Use P0_IN~P7_IN to specify the point number for teaching.
- ④ The current position is captured at the rising edge of the control input signal TDIN.
- ⑤ Lower the control input signal TDIN within 2 seconds. (If it is High for 2 seconds or more, the data will be written in non-volatile memory)

Func.	BIT	Set value	Select device
Point specify	BIT9	0	Control input signal P0_IN~P7_IN
	BIT8	0	
ZSTR	BIT7	—	—
	BIT6	—	
STR	BIT5	—	—
	BIT4	—	
JOG	BIT3	—	—
	BIT2	—	
SVON	BIT1	—	—
	BIT0	—	

Note) When teaching with communication command [TDIN], the point can only be specified with communication command [PNT] (control inputs P0_IN~P7_IN cannot be used).

When teaching with control input TDIN, it is possible to specify the point with communication command [PNT] by setting BIT8, BIT9 of parameter N0006 "Command input method select" to "01" (communication command).

2) Rewriting RAM data and EEPROM data

When teaching is performed by the following method, the rewritten data will be retained after the power is turned OFF.

a) When teaching with communication command

- ① Set the parameter N0006 "Command input method select" as shown in the table on the right. (Set communication command [PNT] to point designated device)
- ② Move the motor to the position to memorize.
- ③ Use [PNT] command to specify the point number for teaching.
- ④ Use [TDIN] command to import the current position.
- ⑤ Write the contents of RAM data to EEPROM with [FLASH] command.

Func.	BIT	Set value	Select device
Point specify	BIT9	0	communication command [PNT]
	BIT8	1	
ZSTR	BIT7	—	—
	BIT6	—	
STR	BIT5	—	—
	BIT4	—	
JOG	BIT3	—	—
	BIT2	—	
SVON	BIT1	—	—
	BIT0	—	

b) When teaching with control input

- ① Set the parameter N0006 "Command input method select" as shown in the table on the right. (Set control input signals P0_IN~P7_IN to point designated device)
- ② Move the motor to the position to memorize.
- ③ Use P0_IN~P7_IN to specify the point number for teaching.
- ④ Keep the control input signal TDIN High for 2 seconds or more. The taught data is written to EEPROM.

Func.	BIT	Set value	Select device
Point specify	BIT9	0	Control input signal P0_IN~P7_IN
	BIT8	0	
ZSTR	BIT7	—	—
	BIT6	—	
STR	BIT5	—	—
	BIT4	—	
JOG	BIT3	—	—
	BIT2	—	
SVON	BIT1	—	—
	BIT0	—	

Note) When teaching with communication command [TDIN], the point can only be specified with communication command [PNT] (control inputs P0_IN~P7_IN cannot be used).

When teaching with control input TDIN, it is possible to specify the point with communication command [PNT] by setting BIT8, BIT9 of parameter N0006 "Command input method select" to "01" (communication command).

1 2 - 3. Velocity control operation mode

Velocity control operation mode is set by parameter N0019 "Velocity control operation mode select" set to "1" (cycle the power after setting the parameter). Use the input signal STR and signals P0_IN~P7_IN to perform velocity control operation set in Point-Table "Velocity" item. VZR (zero velocity) and VCMP (velocity arrival) signals are output during velocity control. The VZR output is regarded as the motor stop, and the servo lock state is set at that position (control switches to position control to hold the current position).

[Point positioning] and [Sensor positioning] functions cannot be used during the velocity control operation mode. Also, the operation by reference pulse from the host controller cannot be performed (input pulses are ignored).

1 2 - 3 - 1. Point-Table setting in velocity control operation mode

In the velocity control operation mode, only 4 items, namely "Absolute/relative value", "Velocity", "Acceleration/deceleration" (rotation direction setting) and "Torque" of each table point are used. Other settings are ignored.

Item	Setting content	Setting range
Absolute/ relative value	Set the motor rotation direction.	0: Forward direction 1: Reverse direction
Velocity	Set the rotation velocity.	1~6000[min^{-1}]
Acceleration/ deceleration	Set the acceleration/deceleration time constant (in acceleration time to 3000 min^{-1}).	1~9999[ms]
Torque	Set the torque limit value during point execution.	0~2000 [0.1%]

※ If VDIR (rotation direction selection input) is set as the control input, the setting of "Absolute/relative value" becomes invalid and input operates as control input VDIR.

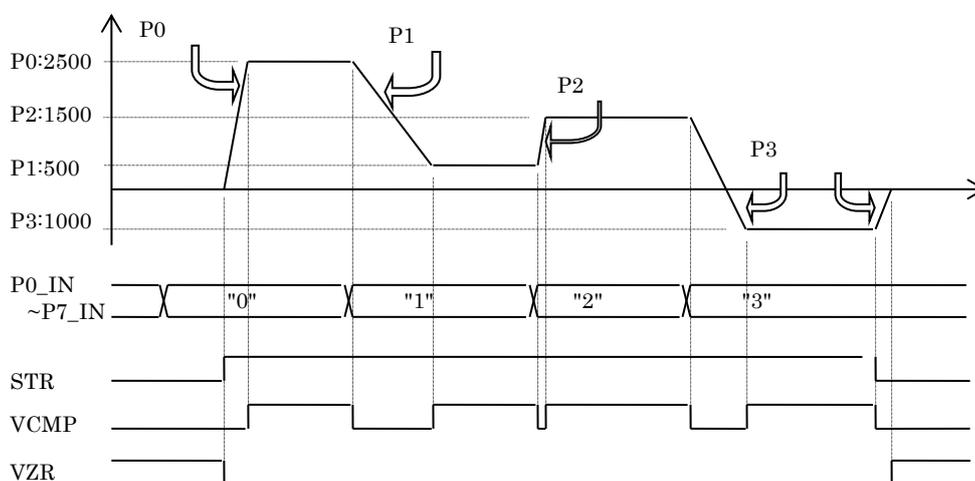
1 2-3-2. Operation examples

(1) Normal operation

Specify the point number with inputs P0_IN~P7_IN, and perform velocity control operation with STR input.

[Point-Table setting]

Point	Absolute/ relative value	Velocity	Acceleration/ deceleration
0	0	2500	200
1	0	500	1000
2	0	1500	100
3	1	1000	400
:	:	:	:
:	:	:	:

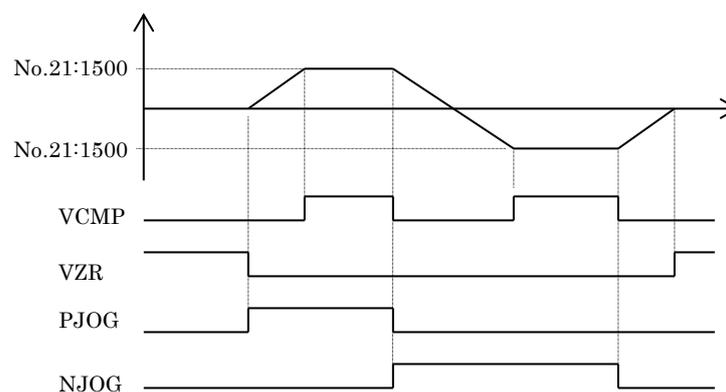


(2) JOG operation

By PJOG/NJOG signal input, the velocity control operation is performed at the velocity specified by the parameter.

[Parameters setting]

No.	Parameter name	Set value	Unit
21	Jog velocity	1500	min ⁻¹
22	Jog acc/dec time constant	1000	ms



1 3. Homing operation

By executing the servo driver's built-in homing sequence, the servo driver's coordinate (mechanical home) is set to "0" when the homing operation is completed.

Either the control input or communication command can be selected as the command method for homing. The FIN output, which is also used as the positioning completion output is normally used as the homing completion output. To confirm the homing completion separately from the positioning completion output FIN, use the control output ZFIN.

1 3 - 1. Homing parameters

The following parameters must be set to perform homing.

1. Parameter N0300 "Homing method select"

Select one of 8 available homing methods.

Cycle the power for the parameter change to take effect.

List of homing methods

Number: Description	Timing
<p>0: LS pass</p> <p>Home position is set at the Homing final travel distance from the first Z pulse appearing after the DEC signal is turned OFF.</p>	
<p>1: LS ride</p> <p>① When DEC is OFF at the start Home position is set at the Homing final travel distance from the first Z pulse appearing after the DEC signal is turned ON.</p> <p>② When DEC is ON at the start Motor rotates in opposite direction to homing direction and reverses direction when the DEC is turned OFF. Then it travels in homing direction at a low velocity, and after the DEC is detected ON, the home position is set at the Homing final travel distance from the first Z pulse appearing after the DEC signal is turned ON.</p>	

(continued on next page)

Number: Description	Timing
<p>2: LS inverted</p> <p>When DEC is detected, the motor direction is reversed, and home position is set at the Homing final travel distance from the first Z pulse appearing after the DEC signal is turned OFF.</p>	<p>The diagram shows the following signals and their timing:</p> <ul style="list-style-type: none"> Approach velocity: Ramps up to a peak, then ramps down to a lower level. Creep vel: Ramps up to a peak, then ramps down to a lower level. DEC: A pulse that occurs during the approach phase. Z pulse: A series of pulses that occur after the DEC signal is turned off. ZSTR: A signal that is active during the approach phase. FIN: A signal that is active during the approach phase. <p>The homing final travel distance is indicated by a shaded area on the velocity profile, starting from the first Z pulse after the DEC signal is turned off.</p>
<p>3: Pushing</p> <p>The motor is pushed against the machine end, then reversed, and the home position is set at the Homing final travel distance from the first Z pulse. The pushing torque is set by parameter N0306 "Homing push torque" (in 0.1% of the rated torque).</p> <p>The reversal is performed after the motor pushes against the machine end (= torque is limited) and the rotation stops for 1000ms.</p>	<p>The diagram shows the following signals and their timing:</p> <ul style="list-style-type: none"> Creep vel: Ramps up to a peak, then ramps down to a lower level. Z pulse: A series of pulses that occur after the motor has stopped for 1000ms. ZSTR: A signal that is active during the approach phase. FIN: A signal that is active during the approach phase. <p>The homing final travel distance is indicated by a shaded area on the velocity profile, starting from the first Z pulse after the 1000ms stop.</p>
<p>4: No homing</p> <p>The position at power ON is the home position. ZSTR command is not accepted (homing is completed when power is turned ON).</p>	

(continued on next page)

Number: Description	Timing
<p>5: Ignoring Z pulse, sensor positioning (1)</p> <p>① When DEC is OFF at the start Home position is set at the Homing final travel distance from the DEC signal turned ON (Z pulse is not observed).</p> <p>② When DEC is ON at the start Motor rotates in opposite direction to homing direction until DEC turns OFF, then rotates in the homing direction to detect the rising edge of the DEC signal.</p>	<p>①</p> <p>3000 Approach velocity Homing final travel distance Acc/dec TCF DEC ZSTR FIN</p> <p>②</p> <p>Approach velocity Homing final travel distance Approach velocity DEC ZSTR FIN</p>
<p>6: Ignoring Z pulse, sensor positioning (2)</p> <p>Home position is set at the Homing final travel distance from the DEC signal turned ON (Z pulse is not observed). (motor rotates in homing direction regardless of the state of DEC at start)</p>	<p>Approach velocity Homing final travel distance DEC ZSTR FIN</p>
<p>7: Pushing, ignoring Z pulse</p> <p>The motor is pushed against the machine end, then reversed, and the home position is set at the Homing final travel distance from the point of reversal. The pushing torque is set by parameter N0306 "Homing push torque" (in 0.1% units of the rated torque). The reversal is performed after the motor pushes against the machine end (= torque is limited) and the rotation stops for 1000ms.</p>	<p>Creep vel pushing point Homing final travel distance 1000ms ZSTR FIN</p>
<p>8: Z pulse positioning</p> <p>The motor rotates in homing direction, and the home position is set at the Homing final travel distance from the first detected Z pulse rising edge.</p>	<p>Creep vel Homing final travel distance Z pulse ZSTR FIN</p>

2. Parameter N0301 "Homing direction select"

Set the rotation direction when starting homing. Set to 0 when the home deceleration LS (or machine end when pushing) is in + direction and set to 1 when in - direction.

Cycle the power for the parameter change to take effect.

3. Parameter N0302 "Homing approach velocity"

Set the fast rotation velocity for homing.

4. Parameter N0303 "Homing creep velocity"

Set the slow rotation velocity for homing.

5. Parameter N0304 "Homing acc/dec time constant"

Set the homing acceleration/deceleration time constant in "Time to reach 3,000min⁻¹" in ms.

6. Parameter N0305 "Homing final travel distance"

Set the distance from Z pulse detection position (or from LS detection position for methods 5 and 6) to the home position.

7. Parameter N0306 "Homing push torque"

Set the pushing torque for homing method 3 "Pushing" in % of rated torque.

The rated torque (100%) is the output torque at the rotation velocity of 0min⁻¹ indicated by the "continuous region" of the N-T characteristic chart.

This parameter is not used in any other method than the pushing homing.

8. Parameter N0307 "Homing grid mask pulses"

The motor encoder Z-phase input is ignored during the number of pulses (in motor encoder pulses) set in this parameter from the home deceleration LS (or machine end in pushing).

If set to "0", the grid mask function is turned OFF.

The reference point for counting the number of grid mask pulses for each homing method is as follows:

Parameter N0300	Homing method	Counting reference
0	LS pass	LS falling edge
1	LS ride	LS rising edge
2	LS inverted	LS falling edge
3	Pushing	Machine end
4	No homing	none
5	Ignoring Z pulse, sensor positioning (1)	
6	Ignoring Z pulse, sensor positioning (2)	
7	Pushing, ignoring Z pulse	Machine end
8	Z pulse detection	Homing start position

9. Parameter N0006 "Command input method select"

Select the input method for inputs ("SVON" and "ZSTR") required for homing. Set whether to use control input or communication command for each input.

1 3 - 2. Homing operation procedure

Follow the procedure below for homing.

- (1) When using a home LS, connect it to the control input DEC. Connection requires a DC24V external power supply like other control inputs.
- (2) Set the parameters required for homing.
- (3) If the servo is OFF (if an alarm occurs, reset the alarm), turn ON the servo by control input SVON or by communication command [SVON].
- (4) The homing operation is started at the rising edge of control input ZSTR, ZSTRP or by the communication command [ZSTRON], [ZSTRP].
- (5) If the homing is started with control input ZSTR or ZSTRP, turn OFF the ZSTR input after confirming FIN or ZFIN output (when using communication command [ZSTRON], send the communication command [ZSTROFF]).

1 3 - 3. Cancel homing operation

When the homing is started with control input ZSTR, the homing operation is interrupted by turning OFF the ZSTR input. If the communication command [STP] is sent during the homing operation, the motor will decelerate and stop with the time constant of parameter "Homing acceleration/deceleration time constant".

When homing is started with control input ZSTRP, the homing operation is interrupted by STP input. If homing is interrupted, the machine home will not be updated and homing will not be completed.

※If homing operation is started with communication command [ZSTRON], it can be interrupted with [ZSTROFF].

1 3 - 4. Homing operation completed output

Completion of homing operation can be judged with the control output ZFIN. ZFIN is turned OFF during the homing operation and turns ON when the homing is completed.

1 3 - 5. Homing operation precautions

If the position of DEC signal (the pushing position in the case of pushing homing) and of the motor encoder Z pulse are close to each other, the order in which the DEC signal and Z pulse signal are input may change depending on the operating conditions. In this case, the positioning when the homing is completed becomes undefined (positioning is performed at one of the two locations separated by the distance of one rotation of the motor shaft).

To prevent such a phenomenon, implement one of the following methods.

- 1) Adjust the fastening between the motor shaft and the mechanical system so that the position where the DEC sensor turns ON and the position of the motor encoder Z pulse are separated (motor shaft 180° is recommended).
- 2) By setting the parameter N0307 "Number of grid mask pulses", the Z pulse input immediately after the DEC signal is turned ON, is ignored.

By using item 0C: "DEC-Z pulse distance" of numerical monitor communication command [MON], the distance from DEC signal ON to Z pulse ON (unit: motor encoder pulse) in last performed homing operation can be monitored. Make adjustment by referring to this value.

1 4. Other operation functions

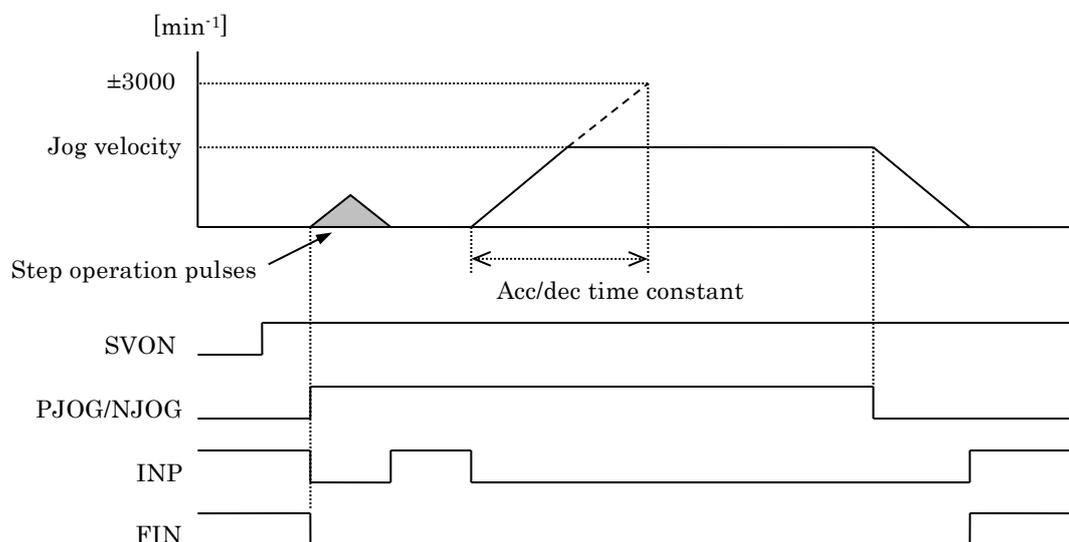
1 4-1. Jog operation

Jog operation is a function that rotates the motor at a constant velocity only while the operation command is ON.

1 4-1-1. Jog operation setting

The parameters related to jog operation are as follows:

No.	Parameter name	Explanation
N0310	Jog velocity	Set the rotation velocity during jog operation in [min^{-1}].
N0311	Jog acc/dec time constant	Set the acceleration/deceleration time constant of the jog operation as the time to accelerate/decelerate for the velocity difference of 3000min^{-1} in [ms].
N0312	Step operation pulses 0	Set the step movement amount for 2-step feed jog operation. The 2-step feed jog operation is convenient in case of manual fine adjustments of the machine position etc.



1 4-1-2. Jog operation command method

There are two ways to execute jog operation.

- Control input signal PJOG/NJOG
- Communication commands [PJOG] [NJOG] [JOGOFF]

Select the command method for jog operation with parameter N0006 "Command input method select" BIT2,3.

Settings for jog operation executing by communication commands

Function	BIT	Set value	Select device
JOG	BIT3	0	communication command [PJOG] [NJOG] [JOGOFF]
	BIT2	1	

Settings for jog operation execution by control inputs

Function	BIT	Set value	Select device
JOG	BIT3	0	control input PJOG/NJOG
	BIT2	0	

1 4 - 2 . Step operation

Step operation is a function to move and perform positioning by the amount specified in advance with parameters.

1 4 - 2 - 1 . Step operation setting

The parameters related to step operation are as follows:

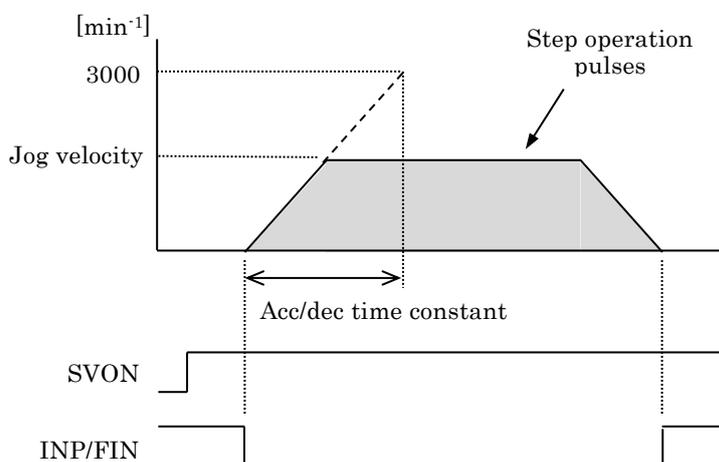
No.	Parameter name	Explanation
N0310	Jog velocity	Set the rotation velocity during step operation in [min^{-1}].
N0311	Jog acc/dec time constant	Set the acceleration/deceleration time constant of the step operation as the time to accelerate/decelerate the velocity difference of 3000min^{-1} in [ms].
N0312 N0313 N0314 N0315	Step operation pulses 0 Step operation pulses 1 Step operation pulses 2 Step operation pulses 3	Set the movement amount for step operation. At the start of step operation by the serial communication command it is possible to select from 4 movement amounts.

1 4 - 2 - 2 . Step operation command method

Step operation is started by serial communication command.

[STEPON], [STEPOFF], [STEP0ON]~[STEP3ON], [STEP0P]~[STEP3P], [STEP0N]~[STEP3N]

For details on step operation commands, refer to "Instruction Manual: Serial Communication part".



1 4 - 3 . Profile operation

Profile operation is a method in which profile data such as the target position and velocity is given at the same time as the activation command each time the operation is started.

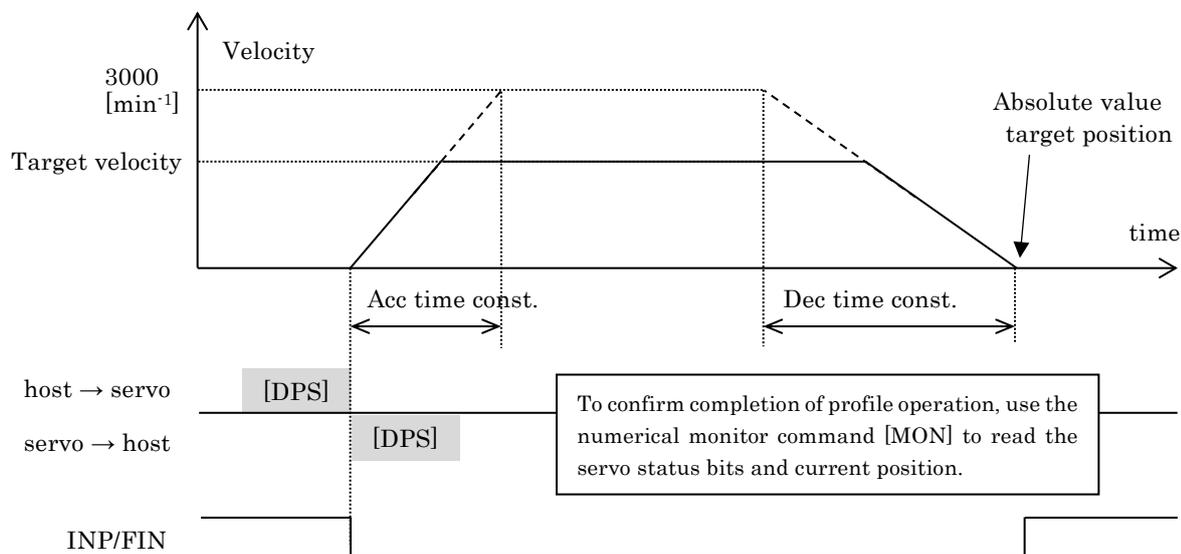
The data protocol used with network-compatible link units Si-LNK-M3 and Si-LNK-EC has been developed so that it can be used for serial communication control from any host controller.

1 4 - 3 - 1 . Profile operation command

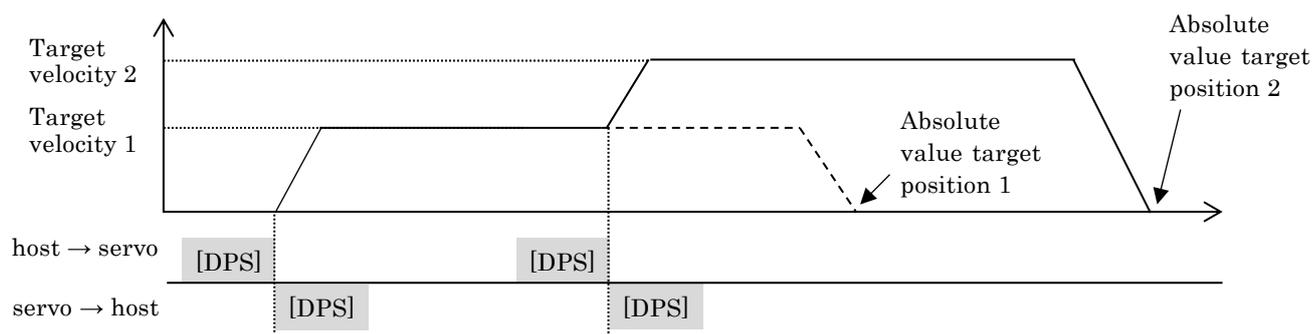
The serial communication command [DPS] is used for profile operation. Specify the absolute value target position, target velocity, acceleration, and deceleration as command data. When the command is received, positioning is invoked with the specified profile.

For details on send / receive data of the communication command [DPS], refer to "Instruction Manual: Serial Communication part".

Item	Explanation	Unit
Absolute value target position	Specify the final target position (absolute value) for positioning.	Reference unit
Target velocity	Specify the target velocity for positioning operation in [min^{-1}].	min^{-1}
Acceleration time constant	Set the acceleration time from velocity 0 to 3000min^{-1} in [ms]. ※If deceleration time constant is omitted, this data will be applied to both acceleration and deceleration.	ms/ 3000min^{-1}
Deceleration time constant	Set the acceleration time from velocity 3000 to 0min^{-1} in [ms]. ※This data can be omitted. If omitted, deceleration operates at the same slope as acceleration.	ms/ 3000min^{-1}



☆ By issuing the [DPS] command during profile operation, it is possible to continuously shift from current operation state to operation at a new target position and velocity.



1 4-3-2. Current position latch function

Function to save (latch) the motor shaft position at the ON edge of control input SENS. By reading the saved position data with a communication command, positioning can be performed based on the sensor detected position.

※The control input terminal to which the control input SENS is assigned performs special input processing so that the processing from the hardware signal input to the acquisition of current position of the motor shaft is executed with minimum delay. For details refer to "7-1-5. Control input response time and high speed input".

The procedure for positioning based on the sensor position is as follows.

1. Operation is activated by the communication command [DPS] (positioning with a temporary target position) or the communication commands [PJOG] [NJOG] / control inputs PJOG / NJOG (rotate at a constant velocity).

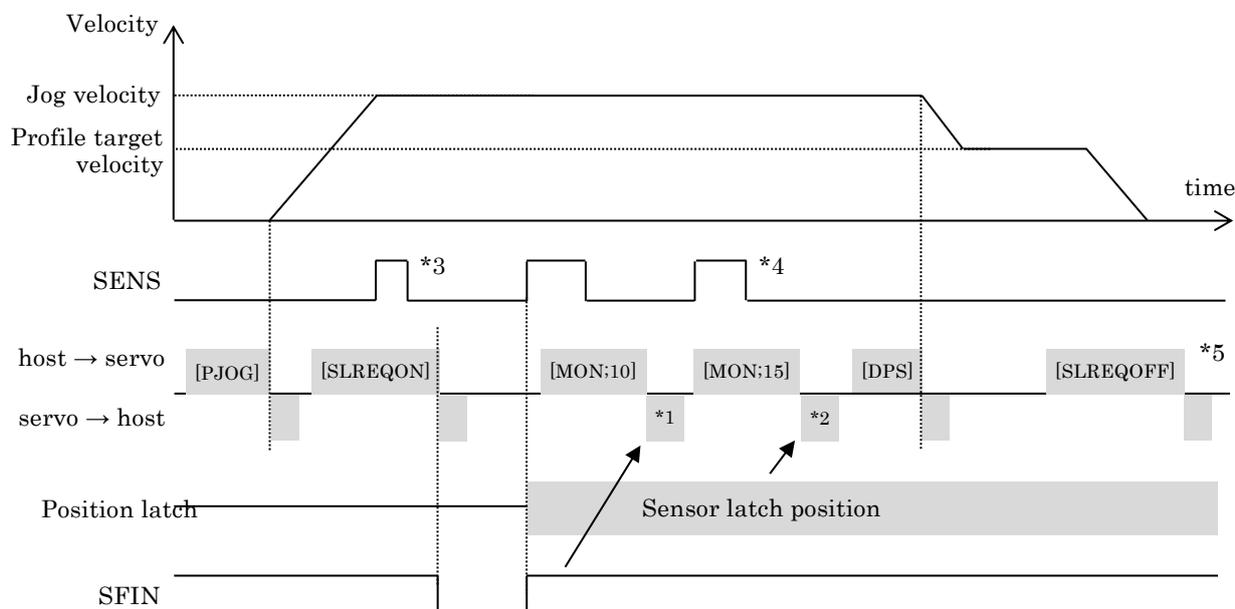
※When using jog operation, it is necessary to select communication command or control input in the input method selection.

2. Send the command [SLREQON] to enable sensor signal detection. By inputting this command, the servo driver enters the sensor input standby state, and the control output SFIN (sensor detection completed) and the servo status bit SFIN are turned OFF.
3. At the ON edge of the control input SENS, the current position (sensor latch position) of the motor shaft at that time is captured. When the current position is captured, the control output SFIN and servo status bit SFIN change to ON.

※Current position is captured only with the first SENS signal after [SLREQON] is input.

4. Read the sensor latch position using monitor item 15: "Sensor latch position" of the numerical monitor communication command [MON].

On the host controller, calculate the final positioning target position based on the sensor latch position, and start positioning with the communication command [DPS].



*1: SFIN is read on BIT12 of the reply data (servo status bits) of [MON:10].

*2: The sensor latch position is returned in [MON:15].

*3: The SENS signal input before [SLREQON] transmission is ignored.

*4: The second and subsequent SENS signal inputs after [SLREQON] transmission are ignored.

*5: In order to operate the latch function repeatedly, it is necessary to cancel the input standby state by the command [SLREQOFF].

1 4 - 4 . Torque research control

1 4 - 4 - 1 . Overview

This function measures and compensates the load torque pulsations that appear due to characteristics of the mechanical system, for example such as a ball screw.

Specify the lower and upper limits of the range in Reference unit to which the compensation is applied by using the parameters. It is possible to select whether to apply the compensation only within the range set with the lower and upper limit, or also periodically in the same way compensate also the area outside the range set with the lower and upper limit.

It is possible to set two compensation areas, and the compensation components are applied combined.

Prm No.	Parameter name	Explanation																										
N0214	Torque research control function select	<p>Set to enable or disable the torque research control.</p> <table border="1"> <thead> <tr> <th>Function</th> <th>BIT</th> <th>Set value</th> <th>Explanation</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Compensation range 2</td> <td rowspan="2">BIT3</td> <td>11</td> <td>No torque compensation</td> </tr> <tr> <td>10</td> <td>With compensation (only within the range)</td> </tr> <tr> <td rowspan="2">BIT2</td> <td>01</td> <td>With compensation (repeat outside the range)</td> </tr> <tr> <td>00</td> <td>No torque compensation</td> </tr> <tr> <td rowspan="4">Compensation range 1</td> <td rowspan="2">BIT1</td> <td>11</td> <td>No torque compensation</td> </tr> <tr> <td>10</td> <td>With compensation (only within the range)</td> </tr> <tr> <td rowspan="2">BIT0</td> <td>01</td> <td>With compensation (repeat outside the range)</td> </tr> <tr> <td>00</td> <td>No torque compensation</td> </tr> </tbody> </table>	Function	BIT	Set value	Explanation	Compensation range 2	BIT3	11	No torque compensation	10	With compensation (only within the range)	BIT2	01	With compensation (repeat outside the range)	00	No torque compensation	Compensation range 1	BIT1	11	No torque compensation	10	With compensation (only within the range)	BIT0	01	With compensation (repeat outside the range)	00	No torque compensation
Function	BIT	Set value	Explanation																									
Compensation range 2	BIT3	11	No torque compensation																									
		10	With compensation (only within the range)																									
	BIT2	01	With compensation (repeat outside the range)																									
		00	No torque compensation																									
Compensation range 1	BIT1	11	No torque compensation																									
		10	With compensation (only within the range)																									
	BIT0	01	With compensation (repeat outside the range)																									
		00	No torque compensation																									
N0215 N0216 N0217 N0218	Compensation range 1: Lower limit Compensation range 1: Upper limit Compensation range 2: Lower limit Compensation range 2: Upper limit	Set the range in Reference unit of the areas to which torque compensation is applied.																										
N0219	Load torque measurement velocity	<p>Set the motor shaft rotation velocity for load torque measurement operation in [min⁻¹].</p> <p>Set to the same value as the motor rotation velocity when operating with limited torque in actual operation of the device.</p>																										
N0220	Pressing torque limit correction	Set the correction amount of the internal torque limit value when the object to be pressed is pressurized by torque research control in units of the motor rating ratio [0.1%].																										

1 4 - 4 - 2. Load torque measurement operation

The built in load torque measurement sequence is started by rising edge of control input TSTR.

During the load torque measurement operation, the motor shaft rotates at the velocity set in parameter N0219 "Load torque measurement velocity", and the torque compensation data is calculated based on the detected load torque by the servo driver at each position.

The range to measure the load torque with specified rotation velocity set in N0219 is set with parameters N0215 "Compensation range 1: Lower limit coordinate value"~N0218 "Compensation range 2: Upper limit coordinate value" (two ranges can be set). At other positions, the motor shaft rotates with the velocity set in parameter N0310 "Jog velocity".

Completion of the load torque measurement operation can be judged with the control output FIN. FIN turns OFF during the load torque measurement operation, and turns ON when the measurement is completed.

1 4 - 5. Emergency stop

An emergency stop command can be input using two methods: control input and serial communication command.

Two types of operations for emergency stop are available: control braking and servo free.

In control braking, the motor stops in the position by control (servo does not turn OFF).

In case of servo free, the motor servo turns OFF and the motor stops by free run.

In both control braking and servo free emergency stops, the Point-Table, homing, and jog operations are interrupted. Reference pulse input during the emergency stop is ignored.

1 4 - 5 - 1. Emergency stop with control input

When performing an emergency stop with control input, select EMCE (control braking) or EMCF (servo free) with parameters N0008 "Control input function select: IN0"~N0012 "Control input function select: IN4".

1 4 - 5 - 2. Emergency stop with serial communication command

Use [EMCON] and [EMCOFF] commands to make an emergency stop with communication command.

Select the control braking/servo free operation with [EMCON] command data (for details, refer to separate volume "Instruction Manual: Serial Communication part").

1 5. Communication functions

Si servo3 has RS485 and USB communication interfaces for serial communication.

1 5 - 1. USB communication interface

1 5 - 1 - 1. Overview

The USB communication is used for various parameter settings and test operation using the dedicated PC monitor software "Si-Wave3". Note that USB communication cannot be used for control during actual operation of the machine.

1 5 - 1 - 2. USB communication specifications

Compliant standard	USB1.1 (Full Speed, maximum 12Mbps) USB COM class Uses standard virtual COM port device driver ※1
Communication method	characters
	half-duplex
Data format	8bit ASCII code HEX
Maximum cable length	3m ※2
Multi-axis connection	Up to 15 axis can be connected to PC by hub

※1 A device driver installation information file is included in the dedicated PC monitor software file.

※2 Use a shielded cable type with ferrite cores on both ends.

Example) ELECOM U2C-MF series

1 5 - 2. RS485 communication interface

1 5 - 2 - 1. Overview

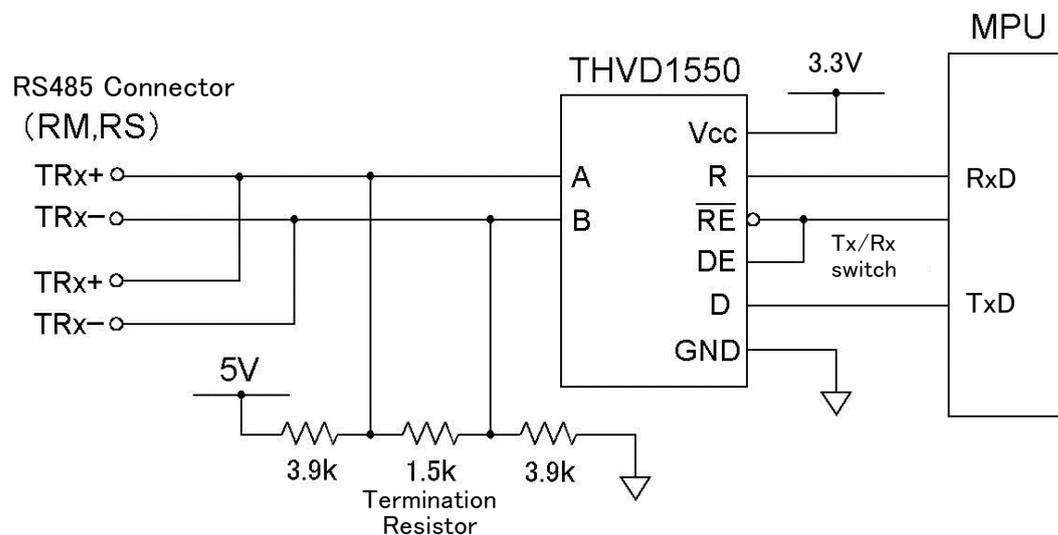
RS485 communication can be used for various parameter settings and test operation by the dedicated PC monitor software "Si-Wave3", and by creating a control program that sends and receives serial communication commands on a host device such as PLC, the communication can be used for control during machine operation.

In addition, multi-axis control of up to 15 axes is possible with a serial communication cable multidrop connection.

For details on RS485 serial communication specifications and serial communication commands, refer to separate volume "Instruction Manual: Serial Communication part".

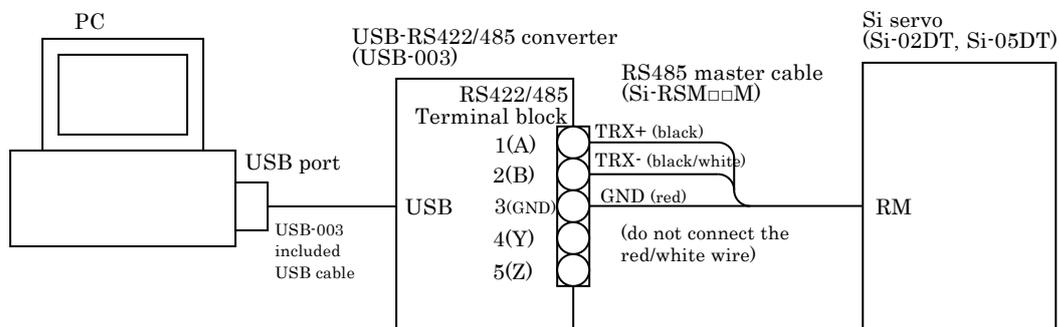
1 5 - 2 - 2. Communication interface circuit

The input/output signal circuit of RS485 communication interface is shown below.



1 5 - 2 - 3. Example of connection with a PC

To communicate by RS485 between a personal computer and Si servo, connect the two by inserting a USB-RS422/485 converter between them. The connection diagram when using a USB-RS422/485 converter USB-003 (manufactured by Human Data) is shown below.



Recommended peripherals:

USB-003 Rev 4 or later (※) (manufactured by Human Data)

Set the setting switches SW1, SW2 as shown in the table below and wire as shown in the figure above.

Operation mode	SW1				SW2	
	1	2	3	4	1	2
with RS485 termination	ON	ON	ON	OFF	ON	OFF

For details, refer to USB-003 User's manual.

※In USB-003 Rev3 or earlier, there is no SW2, only SW1 can be set.

1 6. Alarm/diagnostic functions

1 6-1. Alarm

If any abnormality occurs during Si servo3 driver operation, the content of the abnormality is displayed as an alarm.

When an alarm occurs, the servo will turn OFF and the motor will stop in free run.

At the same time, all operations are interrupted and all operation commands during the alarm are invalid.

1 6-1-1. List of alarms

Category	Category name	Alarm number	Alarm name	
1	Driver memory	100h	Driver memory failure detected	
		101h	Monitor/diagnosis data corrupted	
		102h	User parameters data corrupted	
		103h	Point-Table data corrupted	
		104h	Motor model parameters data corrupted	
		105h	System parameters data corrupted	
		106h	Monitor management data corrupted	
2	Motor memory	200h	Encoder cable break	
		201h	Motor memory failure detected	
		202h	Motor memory data corrupted	
3	Encoder	300h	Encoder AB phase cannot be detected	
		301h	Encoder Z-phase cannot be detected	
		302h	Encoder Z-phase error detected	
4	System setting	400h	Abnormal motor/driver combination	
		401h	Electronic gear setting error	
5	Servo control	500h	Excessive position error	
6		501h	Cannot calculate position error	
		600h	Phase A overcurrent	
		601h	Phase A sensor failure detected	
7		602h	Phase A disconnection detected	
		700h	Phase B overcurrent	
		701h	Phase B sensor failure detected	
8		702h	Phase B disconnection detected	
		800h	Driver internal overheat	
9		801h	Temperature sensor failure detected	
		900h	Overload	
		901h	Motor power line short circuit detected	
10		Motion control	A00h	Insufficient acceleration/deceleration range
			A01h	Excessive command speed
			A02h	Unable to calculate unit movement amount
	A03h		Unable to calculate electronic gear	
	A04h		Motion sequence error	
11	Serial communication	B00h	Synchronous communication data error	
		B01h	Synchronous communication cycle timeout	
12	Power supply voltage	C00h	Input power voltage too high	
13		C01h	Excessive regenerative energy	
		D00h	Input power voltage too low	
		D01h	Insufficient DC power capacity	
14		E00h	Control power voltage too high	
15		F00h	Control power voltage too low	

1 6 - 1 - 2. Alarm details

The following table shows the causes of alarms, the measures to be taken to clear the alarm (content details), and possibility to reset the alarm.

Number	Name	Category	Reset
100h	Driver memory failure detected	1: Driver memory	×
	Cause: The data storage memory in the driver cannot be read or written. Or an abnormal value was read. Recovery: Replace the driver because the memory may be damaged.		
101h	Monitor/diagnosis data corrupted	1: Driver memory	×
	Cause: Some or all of the monitor/diagnosis data is corrupted. (checksum error) Recovery: Press the diagnostic clear button on the PC software Si-Wave3 or issue the [HCL] command to clear the diagnostic data.		
102h	User parameters data corrupted	1: Driver memory	×
	Cause: Some or all of the user parameters are corrupted. (checksum error) Recovery: Write user parameters data from PC software Si-Wave3.		
103h	Point-Table data corrupted	1: Driver memory	×
	Cause: Some or all of the Point-Table data is corrupted. (checksum error) Recovery: Write Point-Table data from PC software Si-Wave3.		
104h	Motor model parameters data corrupted	1: Driver memory	×
	Cause: Some or all of the motor model parameters data is corrupted. (checksum error) Recovery: Write model parameters data from PC software Si-Wave3.		
105h	System parameters data corrupted	1: Driver memory	×
	Cause: Some or all of the system parameters data is corrupted. (checksum error) Recovery: Write system parameters data from PC software Si-Wave3.		
106h	Monitor management data corrupted	1: Driver memory	×
	Cause: Some or all of the monitor management data is corrupted. (checksum error) Recovery: Automatically recovers when the power is turned ON again. If the alarm occurs frequently, replace the driver.		
200h	Encoder cable break	2: Motor memory	×
	Cause: The encoder connector has poor contact or the cable is broken. * This alarm occurs during the initialization process after the power is turned on. It does not occur if the encoder signal line is broken during operation. Recovery: Disconnect and insert again the encoder connector. Replace the cable.		
201h	Motor memory failure detected	2: Motor memory	×
	Cause: Data could not be read from the motor memory, or an invalid value was read. Recovery: Replace the motor because the memory may be damaged.		
202h	Motor memory data corrupted	2: Motor memory	×
	Cause: Some or all of the motor memory data is corrupted. (checksum error) Recovery: Replace the motor.		

Number	Name	Category	Reset
300h	Encoder AB phase cannot be detected	3: Encoder	×
	Cause: The A-phase and B-phase signal lines connector has poor contact, or the signal wires are broken. * This alarm occurs during the initialization process after the power is turned on. It does not occur if the encoder signal line is broken during operation. Recovery: Disconnect and insert again the encoder connector. Replace the cable.		
301h	Encoder Z-phase cannot be detected	3: Encoder	×
	Cause: The Z-phase signal lines connector has poor contact, or the signal wires are broken. Recovery: Disconnect and insert again the encoder connector. Replace the cable.		
302h	Encoder Z-phase error detected	3: Encoder	×
	Cause: Z-phase pulse was detected multiple times within one rotation of the motor. Recovery: Take measures against noise, as the signal may be affected by noise.		
400h	Abnormal motor/driver combination	4: System setting	×
	Cause: The motor that is connected to the driver is not compatible. Recovery: Connect a compatible motor. (see 3-4. List of compatible motors)		
401h	Electronic gear setting error	4: System setting	×
	Cause: A value was set that exceeds the allowable setting value of the electronic gear. Recovery: The alarm does not occur within the settable range, so there is a possibility of internal malfunction of the driver due to influence of noise. Take measures against noise.		
500h	Excessive position error	5: Servo control	○
	Cause: The position error exceeds the parameter set value (N0412 "Maximum position error value"). Recovery: Review the operation commands (velocity/acceleration/deceleration). Adjust the gains.		
501h	Cannot calculate position error	5: Servo control	○
	Cause: The position error exceeds the specified value (for details, refer to 1-1-5-3. Other notes) Recovery: Review the operation velocity command and electronic gear setting.		
600h	Phase A overcurrent	6: Servo control	○
	Cause: A motor current exceeding the specified level has occurred for more than 5ms in the motor A phase winding. Recovery: Check the parameter settings, machine load status (whether the machine collision occurred, etc.), and command pulse speed. Check if there is a short circuit between A+ and A- phases or between A+ or A- and the ground. Replace the motor or driver as it may be defective.		
601h	Phase A sensor failure detected	6: Servo control	×
	Cause: The phase A current detection sensor does not properly operate. Recovery: Replace the driver because the A-phase current detection sensor may be damaged.		
602h	Phase A disconnection detected	6: Servo control	×
	Cause: Abnormality occurred on the motor power line (A+, A-). Recovery: Confirm that there is no breaking, disconnection or miswiring of the motor power lines (A+, A-).		

Number	Name	Category	Reset
700h	Phase B overcurrent	7: Servo control	○
	<p>Cause: A motor current exceeding the specified level has occurred for more than 5ms in the motor B phase winding.</p> <p>Recovery: Check the parameter settings, machine load status (whether the machine collision occurred, etc.), and command pulse speed. Check if there is a short circuit between B+ and B- phases or between B+ or B- and the ground. Replace the motor or driver as it may be defective.</p>		
701h	Phase B sensor failure detected	7: Servo control	×
	<p>Cause: The phase B current detection sensor does not operate properly.</p> <p>Recovery: Replace the driver because the B-phase current detection sensor may be damaged.</p>		
702h	Phase B disconnection detected	7: Servo control	×
	<p>Cause: Abnormality occurred on the motor power line (B+, B-).</p> <p>Recovery: Confirm that there is no breaking, disconnection or miswiring of the motor power lines (B+, B-).</p>		
800h	Driver internal overheat	8: Servo control	○
	<p>Cause: The driver internal temperature has exceeded the allowable value (70°C).</p> <p>Recovery: Place the driver on a location by considering ambient temperature and airflow, not to retain heat. Dissipate heat with stirring fan.</p>		
801h	Temperature sensor failure detected	8: Servo control	×
	<p>Cause: The temperature sensor inside the driver detected an abnormal value.</p> <p>Recovery: Replace the driver because the temperature detection sensor may be damaged.</p>		
900h	Overload	9: Servo control	○
	<p>Cause: The motor detected an overload condition by electronic thermal model.</p> <p>Recovery: Check the parameter settings, machine load status (whether the machine collision occurred, etc.), and command pulse speed.</p>		
901h	Motor power line short circuit detected	9: Servo control	○
	<p>Cause: Momentary high current in the driver</p> <p>Recovery: Check if there is a short circuit between the motor power lines and the ground. Replace the motor or driver as it may be defective.</p>		

Number	Name	Category	Reset
A00h	Insufficient acceleration/deceleration range	10: Motion control	○
	Cause: The travel distance required for acceleration/deceleration is not sufficient in Point-Table operation. Recovery: Check that the travel distance, velocity, and electronic gear are set to appropriate values.		
A01h	Excessive command velocity	10: Motion control	○
	Cause: The command velocity exceeds the maximum rotation velocity of specific motor model. Recovery: Check that the velocity and electronic gear are set to appropriate values.		
A02h	Unable to calculate unit movement amount	10: Motion control	○
	Cause: The distance that can be traveled in one step was exceeded in Point-Table operation. Recovery: Check that the electronic gear and move amount are set to appropriate values.		
A03h	Unable to calculate electronic gear	10: Motion control	○
	Cause: The distance that motor shaft can rotate within one control cycle is exceeded. Recovery: The alarm does not occur under normally set conditions, so there is a possibility of internal malfunction of the driver due to influence of noise. Take measures against noise.		
A04h	Motion sequence error	10: Motion control	×
	Cause: An error occurred during sequence processing of Point-Table or homing operation in the driver. Recovery: The alarm does not occur under normally set conditions, so there is a possibility of internal malfunction of the driver due to influence of noise. Take measures against noise.		
B00h	Synchronous communication data error	11: Serial comm.	○
	Cause: An error in the received data was detected during synchronous communication with Si link unit (Si-Link-M3 or Si-LNK-EC). Recovery: Take measures against noise, as the signal may be affected by noise.		
B01h	Synchronous communication cycle timeout	11: Serial comm.	○
	Cause: Synchronous communication of Si link unit (Si-Link-M3 or Si-LNK-EC) is interrupted. Recovery: Disconnect and insert again the RS485 serial communication connector. Replace the cable. Also noise influence may be considered, so take measures against noise.		

Number	Name	Category	Reset
C00h	Input power voltage too high	12: Power supply voltage	○
	Cause: The input power supply voltage is above the specified value. Recovery: Check if the input power supply voltage is appropriate.		
C01h	Excessive regenerative energy	12: Power supply voltage	○
	Cause: The regenerative capacity of the driver was exceeded and the internal voltage of the driver exceeded the specified value. Recovery: Review the operation commands (velocity/acceleration/deceleration). Connect an external regenerative circuit. (see 2.0. Regenerative circuit)		
D00h	Input power voltage too low	13: Power supply voltage	○
	Cause: The input power supply voltage is below the specified value. Recovery: Check if the input power supply voltage is appropriate.		
D01h	Insufficient DC power capacity	13: Power supply voltage	○
	Cause: The voltage dropped due to insufficient capacity of the DC power supply to the driver. Recovery: Check if the DC power supply capacity is sufficient.		
E00h	Control power voltage too high	14: Power supply voltage	○
	Cause: The control power supply voltage is above the specified value. Recovery: Check if the control power supply voltage is appropriate.		
F00h	Control power voltage too low	15: Power supply voltage	○
	Cause: The control power supply voltage is below the specified value. Recovery: Check if the control power supply voltage is appropriate.		

1 6 - 1 - 3. Alarm reset methods

To clear the alarm, remove the cause of the alarm and then follow the procedure below.

- Control input ARST
- Serial communication command [ARST] (alarm reset)
- Turn OFF the power and then turn it ON again.

1 6 - 1 - 2. The alarms for which the "Reset" item is marked with "×" in the Alarm details above cannot be cleared by control input ARST or communication command [ARST]. Turn OFF and ON the power.

1 6 - 2 . Get alarm status

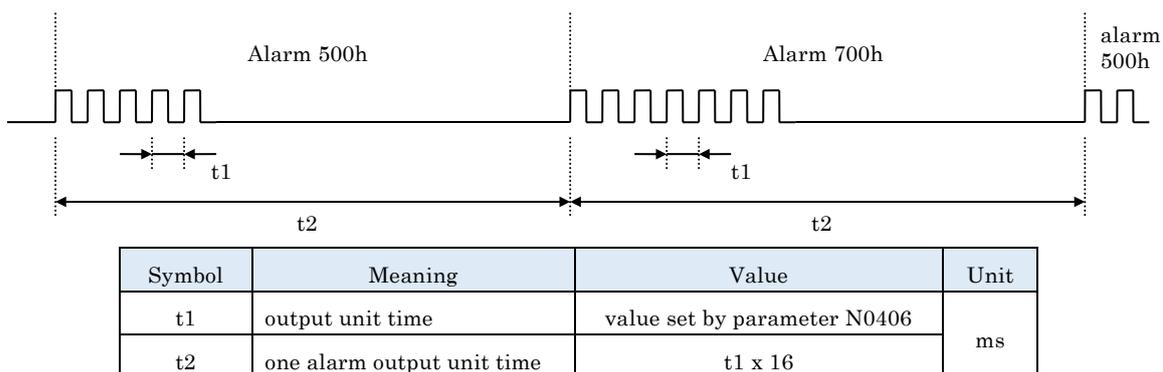
1 6 - 2 - 1 . Control output ALM

When an alarm occurs, the control output ALM turns ON.

If parameter N0406 "Alarm signal output time constant" is 0, the ALM output will be a level output, and the ALM will stay turned ON when an alarm occurs.

If parameter N0406 "Alarm output time constant" has a value other than 0, the **category number** of the alarm currently occurring is indicated by pulses. The lowest category number of occurring alarm is output first, then in order to the highest number, and continuously repeating from the lowest to the highest number.

Example) Alarm 500h: Excessive position error, and alarm 700h: Phase B overcurrent are occurring



1 6 - 2 - 2 . Serial communication

The list of currently occurring alarms can be obtained by using the dedicated PC monitor software "Si-Wave3" or the serial communication command [DIAG].

1 6-3. Prohibit/permit alarm

The alarm occurrence prohibition/permission for the following alarms can be set by parameter N0413 "Alarm output protection set".

Parameter N0413 "Alarm output protection set"

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	PUV	COMM	DEC	OVD

※The bits displayed as "0" are reserved bits. Write 0.

Bit position	Bit name	Alarm name
31~5	-	reserved (write 0)
3	PUV	Input power voltage too low
2	COMM	Synchronous communication alarm (B00h, B01h)
1	DEC	Insufficient acceleration/deceleration range
0	OVD	Excessive position error

Relation between bit setting and control output logic

Bit set value	Setting
0	Alarm generation permitted
1	Alarm generation prohibited

1 6 - 4. Monitor data and diagnostic information

1 6 - 4 - 1. List of monitor data

Monitor data are various numerical and bit data that indicate the operating status of the Si servo3 driver.

They can be read using the dedicated PC monitor software "Si-Wave3" or the serial communication command [DIAG].

List of monitor data (1/3)

Number	Data name	Unit	Remarks
D000	Alarm number	-	monitor data is "0"
D001	Number of startup	-	
D002	Elapsed time after startup (hour)	hour	
D004	Elapsed time after startup (100 μ s)	100 μ s	
D006	Reference position before filter	Reference unit	
D008	Reference position after filter	Reference unit	
D010	Actual position	Reference unit	
D012	Internal reference position before filter	control unit	
D014	Internal reference position after filter	control unit	
D016	Actual internal position	control unit	
D018	Position error	encoder unit	
D020	Velocity of reference positoin	control unit/s	
D022	Velocity feed forward	control unit/s	
D024	Control effort	control unit/s	
D026	Actual velocity	control unit/s	
D028	Gain switch timer count	ms	
D030	Applied position proportional gain	1/s	
D031	Applied velocity loop proportional gain	rad/s	
D032	Applied disturbance observer gain	rad/s	
D033	Observer disturbance estimated torque	0.1%	
D034	Torque feedforward	0.1%	
D035	Torque demand	0.1%	
D036	Current down timer count	ms	
D038	Overlay control timer count	ms	
D039	Current control switch timer count	ms	
D040	Rotor electrical angle	internal electrical angle	

(continued on next page)

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List of monitor data (2/3)

Number	Data name	Unit	Remarks
D041	d-axis target current	internal A/D	
D042	q-axis target current	internal A/D	
D043	Phase A target current	internal A/D	
D044	Phase B target current	internal A/D	
D045	Phase A actual current	internal A/D	
D046	Phase B actual current	internal A/D	
D047	d-axis actual current	internal A/D	
D048	q-axis actual current	internal A/D	
D049	Actual Torque	0.1%	
D050	Applied current proportional gain	-	
D051	Applied current integral gain	-	
D052	A/d current integral component	-	
D054	B/q current integral component	-	
D056	Electronic thermal cumulative value	-	
D058	Position reference pulse cumulative	-	
D059	Main circuit detected voltage	voltage A/D	
D060	Control circuit detected voltage	voltage A/D	
D061	Thermistor detected temperature	voltage A/D	
D062	Built-in temperature sensor value	voltage A/D	
D063	Built-in temperature sensor calculation result	voltage A/D	
D064	Load inertia moment estimation result	-	
D070	Encoder pulse input cumulative	—	
D071	Torque output effective value	0.1%	
D072	Velocity error effective value	control unit/s	
D112	Motion operation status number	-	
D114	Executing point table No.	-	
D115	Completed point number	-	
D116	M code output	-	
D117	Torque peak	0.1%	
D118	Sensor latch position	Reference unit	
D120	Command remain distance	Reference unit	
D122	Relative command value	Reference unit	
D124	DEC-Z distance	encoder unit	
D126	Z pulse latch position	Reference unit	
D128	Distance from starting position·L	Reference unit	
D130	Distance from starting position·H	-	
D132	Current control mode	-	
D134	Applied velocity limit	control unit/s	
D136	Applied forward direction torque limit	0.1%	
D137	Applied reverse direction torque limit	0.1%	
D138	Cumulative move amount after startup	control unit	

(continued on next page)

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List of monitor data (3/3)

Number	Data name	Unit	Remarks
D160	Operation command bits 0 (hardware wire)	-	
D162	Operation command bits 1 (hardware wire)	-	
D164	Operation command bits 2 (hardware wire)	-	
D166	Operation command bits 3 (hardware wire)	-	
D168	Status bits 0	-	
D170	Status bits 1	-	
D172	Status bits 2	-	
D174	Status bits 3	-	
D176	Input state of control input terminal	-	
D177	Output state of control output terminal	-	
D178	Operation state of waveform monitor	-	
D192	Operation command bits 0 (serial command)	-	
D194	Operation command bits 1 (serial command)	-	
D196	Operation command bits 2 (serial command)	-	
D198	Operation command bits 3 (serial command)	-	
D200	Interpolated reference position	Reference unit	
D202	Reference velocity	Reference unit/s	
D204	Profile target position	Reference unit	
D206	Profile velocity	Reference unit/s	
D208	Profile acceleration	Reference unit/s ²	
D210	Profile deceleration	Reference unit/s ²	
D212	Profile torque limit	0.1%	
D214	Velocity offset	Reference unit/s	
D216	Torque offset	0.1%	
D218	Position rewrite command value	Reference unit	
D220	Position error set command value	encoder unit	
D222	Arbitrary output of output terminals	-	
D223	Arbitrary output bit mask of output terminals	-	
D224	Data save/initialization command	-	

1 6 - 4 - 2. Diagnostic information

A list of monitor data at the time when an alarm occurs in a Si servo3 driver is retained in the driver as diagnostic information (last 31 times). Since the alarm number that occurred is recorded in D000 "Alarm number" of the diagnostic information, the list can be used as an alarm history.

Diagnostic information can be read with the dedicated PC monitor software "Si-Wave3", and also with

- diagnostic information read command [DIAG]
- command [ALHP] that reads only the alarm number from the past 31 diagnostic information items.

1 6 - 4 - 3. Clear diagnostic information

The diagnostic information can be cleared with the "Diagnostic information clear" button of the dedicated PC monitor software "Si-Wave3", or with the serial communication command [HCL].

1 7. Parameters

1 7-1. List of parameters

1 7-1-1. Basic functions

Number	Parameter name	Reboot	Unit	Detail chapter
N0000	In-position range		encoder unit	<u>1 0-5.</u>
N0001	Motor rotation direction select	○	-	<u>9-5.</u>
N0002	Electronic gear numerator	○	-	<u>9-6.</u>
N0003	Electronic gear denominator	○	-	
N0004	Forward direction software OT	○	Reference unit	<u>9-7-1.</u>
N0005	Reverse direction software OT	○	Reference unit	
N0006	Command input method select		-	<u>9-3.</u>
N0007	Reference pulse type select	○	-	<u>1 0-3.</u>
N0008	Control input function select: IN0	○	-	<u>7-1-2.</u>
N0009	Control input function select: IN1	○	-	
N0010	Control input function select: IN2	○	-	
N0011	Control input function select: IN3	○	-	
N0012	Control input function select: IN4	○	-	<u>7-2-2.</u>
N0013	Control output function select: OUT0	○	-	
N0014	Control output function select: OUT1	○	-	
N0015	Control output function select: OUT2	○	-	
N0016	Control output function select: BK	○	-	<u>7-1-4.</u>
N0017	Control input logic selection	○	-	
N0018	Control output logic selection	○	-	<u>7-2-4.</u>
N0019	Velocity control operation mode select	○	-	<u>1 2-1.</u>
N0020	Axis number	○	-	Serial comm. part

1 7 - 1 - 2. Servo tuning

Number	Parameter name	Reboot	Unit	Detail chapter
N0100	Control mode select (servo/step)		-	<u>1 2 - 1 .</u>
N0101	Position proportional gain		1/s	<u>8 - 2 - 2 .</u>
N0102	Velocity proportional gain		rad/s	
N0103	Disturbance observer gain		rad/s	
N0104	Load moment of inertia		10^{-7}kg m^2	
N0105	Velocity feedforward coefficient		%	
N0106	Gain switching condition select		-	<u>8 - 2 - 3 .</u>
N0107	Gain switching wait time: 1 to 2		ms	
N0108	Gain switching change time: 1 to 2		ms	
N0109	Gain switching wait time: 2 to 1		ms	
N0110	Gain switching change time: 2 to 1		ms	
N0111	Position proportional gain 2		1/s	
N0112	Velocity proportional gain 2		rad/s	<u>8 - 2 - 4 .</u>
N0113	Disturbance observer gain 2		rad/s	
N0114	Torque notch filter 1: frequency		Hz	
N0115	Torque notch filter 1: depth		-	
N0116	Torque notch filter 2: frequency		Hz	
N0117	Torque notch filter 2: depth		-	
N0118	Torque notch filter 3: frequency		Hz	
N0119	Torque notch filter 3: depth		-	
N0120	Torque notch filter 4: frequency		Hz	<u>8 - 4 - 1 .</u>
N0121	Torque notch filter 4: depth		-	
N0122	Vibration suppression filter 1: frequency		Hz	
N0123	Vibration suppression filter 2: frequency		Hz	<u>8 - 3 .</u>
N0124	Step mode positioning current		mA	
N0125	Current down current		mA	
N0126	Current down time limit		ms	

1 7 - 1 - 3. Torque limit function

Number	Parameter name	Reboot	Unit	Detail chapter
N0200	Forward direction basic torque limit		0.1%	<u>1 1 - 2 - 1 .</u>
N0201	Reverse direction basic torque limit		0.1%	
N0202	Torque limit value select 0		0.1%	<u>1 1 - 2 .</u>
N0203	Torque limit value select 1		0.1%	
N0204	Torque limit value select 2		0.1%	
N0205	Torque limit value select 3		0.1%	
N0206	Torque limit value select 4		0.1%	
N0207	Torque completed/VZR output range		min ⁻¹	<u>1 1 - 3 .</u>
N0208	Torque limit inc/dec time constant		ms	<u>1 1 - 2 - 5 .</u>
N0209	Normal velocity limit		min ⁻¹	<u>1 1 - 2 - 6 .</u>
N0210	Velocity limit during torque limit		min ⁻¹	
N0211	Velocity limit when torque limit is released		min ⁻¹	
N0212	Velocity limit acc/dec time constant		ms	
N0213	Torque limit option function		-	
N0214	Torque research control function select		-	<u>1 1 - 2 - 7 .</u>
N0215	Compensation range 1: lower limit		Reference unit	
N0216	Compensation range 1: upper limit		Reference unit	
N0217	Compensation range 2: lower limit		Reference unit	
N0218	Compensation range 2: upper limit		Reference unit	
N0219	Load torque measurement velocity		min ⁻¹	
N0220	Pressing torque limit correction		0.1%	<u>1 4 - 4 .</u>

1 7 - 1 - 4. Homing and jog

Number	Parameter name	Reboot	Unit	Detail chapter
N0300	Homing method select		-	<u>1 3 - 1 .</u>
N0301	Homing direction select		-	
N0302	Homing approach velocity		min ⁻¹	
N0303	Homing creep velocity		min ⁻¹	
N0304	Homing acc/dec time constant		ms	
N0305	Homing final travel distance		Reference unit	
N0306	Homing push torque		0.1%	
N0307	Homing grid mask pulses		encoder unit	
N0308	Home position offset		Reference unit	
N0309	Home position detection range		Reference unit	
N0310	Jog velocity		min ⁻¹	<u>1 4 - 1 - 1 .</u>
N0311	Jog acc/dec time constant		ms	
N0312	Step operation pulses 0		Reference unit	
N0313	Step operation pulses 1		Reference unit	
N0314	Step operation pulses 2		Reference unit	
N0315	Step operation pulses 3		Reference unit	<u>1 4 - 2 - 1 .</u>

1 7 - 1 - 5. Other functions

Number	Parameter name	Reboot	Unit	Detail chapter
N0400	Reference pulse multiply 1		-	
N0401	Reference pulse multiply 2		-	1 0 - 4 .
N0402	Reference pulse smoothing filter time constant		ms	1 0 - 6 .
N0403	Reference pulse simple S-curve acc/dec filter time constant		ms	1 0 - 7 .
N0404	Near positioning range		encoder unit	
N0405	In-position output permission time		ms	1 0 - 5 .
N0406	Alarm signal output time constant		ms	1 6 - 2 - 1 .
N0407	ZPLS output minimum time / Stop time after PTFIN		ms	Point-Table part
N0408	Control input filter time constant		ms	7 - 1 - 6 .
N0409	Current position rewrite value		Reference unit	
N0410	Follow-up start width		encoder unit	
N0411	Servo free delay time		ms	
N0412	Maximum position error		encoder unit	
N0413	Alarm output protection set		-	
N0414	VCMP output range		min ⁻¹	1 2 - 3 .
N0415	External output positioning final travel		Reference unit	
N0416	Point selection multiply		-	
N0417	Rotating coordinate system lower limit	○	Reference unit	Point-Table part
N0418	Rotating coordinate system upper limit	○	Reference unit	
N0419	Communication format select	○	-	Serial comm. part
N0420	Reply wait time		ms	Serial comm. part
N0421	Startup excitation hold time		ms	9 - 2 .
N0422	Initial coordinate detection operation select		-	9 - 2 .
N0423	Serial communication reply order	○	-	Serial comm. part
N0424	Serial communication axis group number	○	-	Serial comm. part
N0425	Direct start point number: DSTR0		-	1 2 - 2 - 2 .
N0426	Direct start point number: DSTR1		-	
N0427	Direct start point number: DSTR2		-	
N0428	Direct start point number: DSTR3		-	
N0429	Direct start point number: DSTR4		-	
N0430	Range output 0: lower limit		Reference unit	
N0431	Range output 0: upper limit		Reference unit	
N0432	Range output 1: lower limit		Reference unit	
N0433	Range output 1: upper limit		Reference unit	
N0434	Range output 2: lower limit		Reference unit	
N0435	Range output 2: upper limit		Reference unit	

1 7 - 2 . Parameters details

1 7 - 2 - 1 . Basic functions

Number	Name	Unit	Setting range	Initial value	Reboot
N0000	In-position range	encoder unit	0~999999	2	
	<p>Set the ON range of control outputs INP and FIN.</p> <p>When the absolute value of position error (difference between the position command and the current position) is less than or equal to the set value of this parameter, the control output INP turns ON indicating in-position state.</p> <p>When the position command of the internal positioning operation (Point-Table operation, homing, jog, profile) is completed and the absolute value of the position error is less than or equal to the set value of this parameter, the control output FIN turns ON indicating positioning completed state.</p> <p>※The unit of this parameter is the motor encoder unit. For the encoder resolution of each motor model, refer to "3-4. List of compatible motors".</p>				
N0001	Motor rotation direction select	-	0~1	0	○
	<p>Set the rotation direction of the motor shaft with respect to the operation command.</p> <p>0: Rotate clockwise (viewed from the motor shaft side) by the forward direction command</p> <p>1: Rotate counterclockwise (viewed from the motor shaft side) by the forward direction command</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				
N0002	Electronic gear numerator	-	1~65535	1	○
N0003	Electronic gear denominator			1	○
	<p>Set the number of position command pulses (position Reference unit) equivalent to one rotation of the motor shaft.</p> <p>Set so that the following formula holds.</p> $\text{number of position command pulses per motor revolution} \times \frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = 10,000(\text{internal control unit})$ <p>For more information on electronic gear settings, refer to "9-6. Position Reference unit setting (electronic gear)".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				
N0004	Forward direction software OT	Reference	-2147483648~	0	○
N0005	Reverse direction software OT	unit	2147483647	0	○
	<p>Set the software overtravel reference value for forward and reverse directions.</p> <p>The software OT function is disabled in the following cases:</p> <ol style="list-style-type: none"> 1) When "0" is set for both forward and reverse directions 2) Homing is not completed 3) When rotating coordinate system is set <p>(N0417 "Rotating coordinate system lower limit", N0418 "Rotating coordinate system upper limit" are set to other than "0")</p> <ol style="list-style-type: none"> 4) When the set data has relation: reverse direction software OT > forward direction software OT <p>For details on software OT function, refer to "9-7-1. Software overtravel".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				

Number	Name	Unit	Setting range	Initial value	Reboot																																																																										
N0006	Command input method select	-	0000h~ FFFFh	0000h																																																																											
<p>Select the input method for various operation commands received from control inputs or serial communication commands.</p> <p>2 bits of data per operation command:</p> <p>01: Serial communication command</p> <p>00: Control input</p> <p>to select from. Only the command inputs selected with this setting will be valid, other command inputs will be ignored. (In case when the serial communication command is ignored, Command input method not selected error [ERR:04] will be returned).</p> <p>For details on command input method selection, refer to "9 - 3 . Command input method selection".</p>																																																																															
<table border="1"> <thead> <tr> <th>Function</th> <th>BIT</th> <th>Set value</th> <th>Command input</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Torque limit value select</td> <td rowspan="2">BIT13</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT12</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> <tr> <td rowspan="4">Pulse command multiply</td> <td rowspan="2">BIT11</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT10</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> <tr> <td rowspan="4">Point number specify</td> <td rowspan="2">BIT9</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT8</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> <tr> <td rowspan="4">Homing operation</td> <td rowspan="2">BIT7</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT6</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> <tr> <td rowspan="4">Point-Table operation</td> <td rowspan="2">BIT5</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT4</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> <tr> <td rowspan="4">Jog operation</td> <td rowspan="2">BIT3</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT2</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> <tr> <td rowspan="4">Servo ON</td> <td rowspan="2">BIT1</td> <td>11</td> <td rowspan="2">invalid (do not set)</td> </tr> <tr> <td>10</td> </tr> <tr> <td rowspan="2">BIT0</td> <td>01</td> <td>Serial communication command</td> </tr> <tr> <td>00</td> <td>Control input</td> </tr> </tbody> </table>						Function	BIT	Set value	Command input	Torque limit value select	BIT13	11	invalid (do not set)	10	BIT12	01	Serial communication command	00	Control input	Pulse command multiply	BIT11	11	invalid (do not set)	10	BIT10	01	Serial communication command	00	Control input	Point number specify	BIT9	11	invalid (do not set)	10	BIT8	01	Serial communication command	00	Control input	Homing operation	BIT7	11	invalid (do not set)	10	BIT6	01	Serial communication command	00	Control input	Point-Table operation	BIT5	11	invalid (do not set)	10	BIT4	01	Serial communication command	00	Control input	Jog operation	BIT3	11	invalid (do not set)	10	BIT2	01	Serial communication command	00	Control input	Servo ON	BIT1	11	invalid (do not set)	10	BIT0	01	Serial communication command	00	Control input
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Number	Name	Unit	Setting range	Initial value	Reboot
N0007	Reference pulse type select	-	0~2	0	○
	Select the type of position reference pulse from the following 3 types: 0: CW / CCW method 1: PULSE / SIGN method 2: A / B phase 90° phase difference method For details on pulse type selection, refer to " 1 0 - 3 . Reference pulse type selection ". ※This parameter setting becomes effective after the power is turned ON again.				
N0008	Control input function select: IN0	-	00h~FFh	38h	○
N0009	Control input function select: IN1			39h	○
N0010	Control input function select: IN2			3Ah	○
N0011	Control input function select: IN3			3Bh	○
N0012	Control input function select: IN4			27h	○
	Assign the control input function to the control input terminals IN0~IN4. Set the code of the control input function to be assigned. For details on assigning control input functions, refer to " 7 - 1 - 2 . Control input function assignment ". ※This parameter setting becomes effective after the power is turned ON again.				
N0013	Control output function select: OUT0	-	00h~FFh	1Dh	○
N0014	Control output function select: OUT1			03h	○
N0015	Control output function select: OUT2			3Eh	○
N0016	Control output function select: BK			13h	○
	Assign the control output function to the control output terminals OUT0~OUT2, and BK. Set the code of the control output function to be assigned. For details on assigning control output functions, refer to " 7 - 2 - 2 . Control output function assignment ". ※This parameter setting becomes effective after the power is turned ON again.				
N0017	Control input logic selection	-	00h~1Fh	00h	○
	Set the input logic of the control input terminal. The setting is done in bit units, where bit 0 is for normal setting (signal is ON when input is CLOSED), and bit 1 is for reverse setting (signal is ON when input is OPEN). BIT4: IN4 BIT3: IN3 BIT2: IN2 BIT1: IN1 BIT0: IN0 For details on control output logic settings, see " 7 - 1 - 4 . Control input logic selection ". ※This parameter setting becomes effective after the power is turned ON again.				

Number	Name	Unit	Setting range	Initial value	Reboot
N0018	Control output logic selection	-	00h~0Fh	00h	○
	<p>Set the output logic of the control output terminal.</p> <p>The setting is done in bit units, where bit 0 is for normal setting (signal is ON when output is CLOSED), and bit 1 is for reverse setting (signal is ON when output is OPEN).</p> <p>BIT3: BK1 – BK2 BIT2: OUT2 BIT1: OUT1 BIT0: OUT0</p> <p>For details on control output logic settings, see "7-2-4. Control output logic selection".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				
N0019	Velocity control operation mode select	-	0~1	0	○
	<p>Select the operation mode for Point-Table operation.</p> <p>0: Positioning operation mode 1: Velocity control operation mode</p> <p>For details on Point-Table, refer to "1 2 - 1 . Operation mode selection".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				
N0020	Axis number	-	0~14	0	○
	<p>Set the axis number for RS485 multidrop communication.</p> <p>For details on axis numbers, refer to "Instruction Manual: Serial Communication part".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				

1 7 - 2 - 2 . Servo tuning

Number	Name	Unit	Setting range	Initial value	Reboot
N0100	Control mode select (servo/step)	-	0~1	0	
	<p>Select the motor control mode from servo mode and step mode.</p> <p>0: Servo mode 1: Step mode</p> <p>※The control mode cannot be switched while servo is ON. If the parameter settings is changed while the servo is ON, the new control mode will be applied when the servo is turned OFF and then turned ON again.</p> <p>For details on servo mode and step mode, refer to "8-2. Servo mode" and "8-3. Step mode".</p>				
N0101	Position proportional gain	1/s	0~1000	50	
	<p>Set the proportional gain of the position loop in servo mode.</p> <p>If the gain is too large, overshoot or hunting will occur, and if it is too small, excessive position error alarm will occur easily. The rigidity of mechanical system and the size of load inertia determine the upper limit value that allows operation without abnormalities such as vibration.</p>				
N0102	Velocity proportional gain	rad/s	0~1000	500	
	<p>Set the proportional gain of the velocity loop in servo mode.</p> <p>As a general rule, set a value that is at least 4-times the value of parameter N0101 "Position proportional gain".</p> <p>If the value is too small, overshoot is likely to occur, and if the value is too large, the system starts vibrating.</p>				

Number	Name	Unit	Setting range	Initial value	Reboot
N0103	Disturbance observer gain	rad/s	0~1000	500	
	<p>Set the gain of torque disturbance observer control in servo mode.</p> <p>As a general rule, set to 50~100% of the value of parameter N0102 "Velocity proportional gain".</p> <p>If the value is too small, overshoot is likely to occur, and if the value is too large, the system starts vibrating.</p>				
N0104	Load moment of inertia	10^{-7} kg m ²	0~65536	0	
	<p>Set the moment of inertia of the load connected to the motor in [10^{-7}kg m²].</p> <p>Set to "0" for the motor alone.</p>				
N0105	Velocity feedforward coefficient	%	0~100	0	
	<p>Set the magnitude of the position command velocity feedforward component added to the velocity control loop.</p> <p>Setting the feedforward component will reduce the steady-state error and shorten the positioning time, but setting it too large, will cause vibrations.</p>				
N0106	Gain switching condition select	-	0~4	0	
	<p>Select the conditions for switching the gain with the gain switching function.</p> <p>0: GSEL input</p> <p>1: INP signal</p> <p>2: NEAR signal</p> <p>3: Position command stopped</p> <p>4: Position command direction</p> <p>For details on gain switching function, refer to "8-2-3. Gain switching function".</p>				
N0107	Gain switching wait time: 1 to 2	ms	0~999999	0	
	<p>Set the delay time in [ms] after the switching condition from gain 1 to gain 2 is satisfied until the gain change is applied.</p>				
N0108	Gain switching change time: 1 to 2	ms	0~999999	0	
	<p>Set the change time from gain 1 to gain 2 in [ms].</p>				
N0109	Gain switching wait time: 2 to 1	ms	0~999999	0	
	<p>Set the delay time in [ms] after the switching condition from gain 2 to gain 1 is satisfied until the gain change is applied.</p>				
N0110	Gain switching change time: 2 to 1	ms	0~999999	0	
	<p>Set the change time from gain 2 to gain 1 in [ms].</p>				
N0111	Position proportional gain 2	1/s	0~1000	50	
N0112	Velocity proportional gain 2	rad/s	0~1000	500	
N0113	Disturbance observer gain 2	rad/s	0~1000	500	
<p>Set the servo gain when the gain switching condition is satisfied.</p> <p>The function of each gain is the same as in parameters N101~N103.</p>					

Number	Name	Unit	Setting range	Initial value	Reboot
N0114	Torque notch filter 1: frequency	Hz	0~2500	0	
N0116	Torque notch filter 2: frequency			0	
N0118	Torque notch filter 3: frequency			0	
N0120	Torque notch filter 4: frequency			0	
<p>Set the center frequency of notch filter applied to the internal torque command of the servo control system in [Hz].</p> <p>Set equal to the resonance frequency of the mechanical system. The parameter can be set from 1Hz, but the filter works effectively at frequencies above 200Hz.</p> <p>Setting "0" disables the notch filter.</p> <p>The available parameters and control contents of notch filters 1~4 are the same. If 4 different frequencies are set, the filters will operate on 4 notch frequencies simultaneously.</p> <p>※Torque notch filter is effective only when operating in servo mode.</p>					
N0115	Torque notch filter 1: depth	-	0~100	0	
N0117	Torque notch filter 2: depth			0	
N0119	Torque notch filter 3: depth			0	
N0121	Torque notch filter 4: depth			0	
<p>Set the depth of notch filter applied to the internal torque command of the servo control system.</p> <p>The smaller the value of this parameter, the smaller the attenuation effect at the center frequency of the notch filter and more attenuation at the peripheral frequencies other than the center frequency.</p> <p>As a general rule, use with the initial value "0".</p>					
N0122	Vibration suppression filter 1: frequency	Hz	0~500	0	
N0123	Vibration suppression filter 2: frequency			0	
<p>Set the center frequency of vibration suppression filter applied to the internal position command of the servo control system in [Hz].</p> <p>Set equal to the residual vibration frequency of the machine. The parameter can be set up to 500Hz, but the filter works effectively at frequencies below 200Hz.</p> <p>Setting "0" disables the vibration suppression filter.</p> <p>The available parameters and control contents of vibration suppression filters 1~2 are the same. If 2 different frequencies are set, the filters will operate on 2 frequencies simultaneously.</p>					
N0124	Step mode positioning current	mA	0~5000	※by model	
<p>Set the current in [mA] during normal operation (when the motor is rotating and before current down when stopped) in step mode. Normally, set to the rated current of the motor.</p> <p>By setting to a value below the rated current, vibration and heat generation during rotation can be reduced.</p>					
N0125	Current down current	mA	0~5000	※by model	
<p>Set the amount of current in [mA] to the motor to hold the position when the motor rotation stops (current down function) in step mode. (current down function)</p> <p>Although the heat generation can be reduced when the motor is stopped by making this parameter small, positioning may become unstable if the value is too small.</p>					
N0126	Current down time limit	ms	0~999999	100	
<p>Set the time that positioning current continues to flow after the motor rotation has stopped in step mode. When set to "0", the positioning current continues to flow without current down.</p>					

1 7 - 2 - 3. Torque limit function

Number	Name	Unit	Setting range	Initial value	Reboot								
N0200	Forward direction basic torque limit	0.1%	0~2000	2000									
N0201	Reverse direction basic torque limit			2000									
	<p>Set the maximum motor torque output (torque limit value) during normal operation in both forward and reverse directions in [0.1%] of the motor rated torque.</p> <p>"During normal operation", refers to the state where none of the torque limit selections by control inputs TSEL0~TSEL4 and serial communication command [TSELON] are active.</p>												
N0202	Torque limit value select 0	0.1%	0~2000	2000									
N0203	Torque limit value select 1			2000									
N0204	Torque limit value select 2			2000									
N0205	Torque limit value select 3			2000									
N0206	Torque limit value select 4			2000									
	<p>Set the torque limit value selected by control inputs TSEL0~TSEL4 or serial communication command [TSELON] in [0.1%] of motor rated torque.</p> <p>For details on torque limit function and torque limit value, refer to "1 1. Torque limit function" and "1 1 - 2. Torque limit value setting".</p>												
N0207	Torque completed/VZR output range	min ⁻¹	0~6000	10									
	<p>Set the control output TFIN (torque completion) and VZR (zero velocity) ON range in [min⁻¹].</p> <p>The control output TFIN turns ON when the motor torque output is limited by the torque limit value and the motor shaft rotation velocity is below the set value of this parameter.</p> <p>The control output VZR turns ON when the motor operation command is stopped and the motor shaft velocity is below the set value of this parameter.</p>												
N0208	Torque limit inc/dec time constant	ms	0~999999	0									
	<p>Set the slope of increase/decrease when the torque limit value changes with the torque limit value selection function in "Time for 100% torque limit value increase/decrease time" in [ms].</p>												
N0209	Normal velocity limit	min ⁻¹	0~6000	6000									
N0210	Velocity limit during torque limit	min ⁻¹	0~6000	6000									
N0211	Velocity limit when torque limit is released	min ⁻¹	0~6000	6000									
	<p>Set the maximum value of the motor shaft rotation velocity (velocity limit value) for each operating state by the torque limit function in [min⁻¹]. For details on velocity limit, refer to "1 1 - 2 - 6. Velocity limit".</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">State</th> <th>Conditions</th> </tr> </thead> <tbody> <tr> <td>Normal operation</td> <td>All torque limit selections TSEL0~4 and [TSELON] are OFF</td> </tr> <tr> <td>Torque is limited</td> <td>One torque limit selection of TSEL0~4 and [TSELON] is ON</td> </tr> <tr> <td>Torque limit is released</td> <td>Period from when the torque limit is released until the position error is eliminated</td> </tr> </tbody> </table>					State	Conditions	Normal operation	All torque limit selections TSEL0~4 and [TSELON] are OFF	Torque is limited	One torque limit selection of TSEL0~4 and [TSELON] is ON	Torque limit is released	Period from when the torque limit is released until the position error is eliminated
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N0212	Velocity limit acc/dec time constant	ms	0~999999	0									
	<p>Set the slope when the velocity limit value changes with the torque limit function in "time for velocity limit value to increase or decrease for 3000min⁻¹" in [ms].</p>												

Number	Name	Unit	Setting range	Initial value	Reboot																									
N0213	Torque limit option function	-	0000h~0003h	0003h																										
	<p>Set the option function related to the torque limit. The setting is done in bit units. For details on torque limit control setting (BIT0), see "1 1 - 2 - 7. Torque limit control setting", and for details on Point-Table torque completion condition (BIT1), see Instruction Manual: Point-Table part "2-9-3. Torque completion condition set".</p> <table border="1"> <thead> <tr> <th>Function</th> <th>BIT</th> <th>Set value</th> <th>Explanation</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Point-Table torque completed condition</td> <td rowspan="2">BIT1</td> <td>1</td> <td>TFIN compliant operation</td> </tr> <tr> <td>0</td> <td>Compatible to old models (linked to command completion)</td> </tr> <tr> <td rowspan="2">Torque limit value control</td> <td rowspan="2">BIT0</td> <td>1</td> <td>Torque limit value feedback control</td> </tr> <tr> <td>0</td> <td>Compatible to old models (simple torque command limit)</td> </tr> </tbody> </table>					Function	BIT	Set value	Explanation	Point-Table torque completed condition	BIT1	1	TFIN compliant operation	0	Compatible to old models (linked to command completion)	Torque limit value control	BIT0	1	Torque limit value feedback control	0	Compatible to old models (simple torque command limit)									
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N0214	Torque research control function select	-	0000h~000Fh	0000h																										
	<p>Set to enable or disable the torque research control. The setting is done in bit units. For details on torque research control, refer to "1 4 - 4. Torque research control".</p> <table border="1"> <thead> <tr> <th>Function</th> <th>BIT</th> <th>Set value</th> <th>Explanation</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Compensation range 2</td> <td rowspan="2">BIT3</td> <td>11</td> <td>No torque compensation</td> </tr> <tr> <td>10</td> <td>With compensation (only within the range)</td> </tr> <tr> <td rowspan="2">BIT2</td> <td>01</td> <td>With compensation (repeat outside the range)</td> </tr> <tr> <td>00</td> <td>No torque compensation</td> </tr> <tr> <td rowspan="4">Compensation range 1</td> <td rowspan="2">BIT1</td> <td>11</td> <td>No torque compensation</td> </tr> <tr> <td>10</td> <td>With compensation (only within the range)</td> </tr> <tr> <td rowspan="2">BIT0</td> <td>01</td> <td>With compensation (repeat outside the range)</td> </tr> <tr> <td>00</td> <td>No torque compensation</td> </tr> </tbody> </table>					Function	BIT	Set value	Explanation	Compensation range 2	BIT3	11	No torque compensation	10	With compensation (only within the range)	BIT2	01	With compensation (repeat outside the range)	00	No torque compensation	Compensation range 1	BIT1	11	No torque compensation	10	With compensation (only within the range)	BIT0	01	With compensation (repeat outside the range)	00
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N0215	Compensation range 1: lower limit	Reference unit	-2147483648~2147483647	0																										
N0216	Compensation range 1: upper limit			0																										
N0217	Compensation range 2: lower limit			0																										
N0218	Compensation range 2: upper limit			0																										
<p>Set the range for torque compensation in torque research control in Reference units. Two compensation areas can be set.</p>																														
N0219	Load torque measurement velocity	min ⁻¹	0~6000	1																										
	<p>Set the motor velocity in [min⁻¹] during the load torque automatic measurement by torque research control. Set to the same value as the motor rotation velocity when operating with limited torque in actual operation of the device.</p>																													
N0220	Pressing torque limit correction	0.1%	-2000~2000	0																										
	<p>Set the correction amount of the internal torque limit value when the object to be pressed is pressurized by torque research control in units of the motor rating ratio [0.1%].</p>																													

1 7 - 2 - 4. Homing and jog

Number	Name	Unit	Setting range	Initial value	Reboot
N0300	Homing method select	-	0~8	0	
	Select the homing operation method. 0: LS pass 1: LS ride 2: LS inverted 3: Pushing 4: No homing 5: Ignoring Z pulse, sensor positioning (1) 6: Ignoring Z pulse, sensor positioning (2) 7: Pushing, ignoring Z pulse 8: Z pulse positioning For details on homing operation, refer to "1 3. Homing operation".				
N0301	Homing direction select	-	0~1	1	
	Select the direction of rotation when starting homing operation. 0: Forward direction 1: Reverse direction				
N0302	Homing approach velocity	min ⁻¹	0~6000	300	
	Set the rotation velocity when starting homing operation in [min ⁻¹].				
N0303	Homing creep velocity	min ⁻¹	0~6000	60	
	Set the rotation velocity during Z pulse detection in homing operation in [min ⁻¹].				
N0304	Homing acc/dec time constant	ms	0~999999	500	
	Set the acceleration/deceleration time constant of homing operation as the time to accelerate/decelerate the velocity difference of 3000min ⁻¹ in [ms] .				
N0305	Homing final travel distance	Reference unit	-2147483648~ 2147483647	0	
	Set the distance from Z pulse rise to home position during homing operation in Reference units. Set the distance from DEC signal rising edge or from pushing reverse position in homing method that does not use the Z pulse.				
N0306	Homing push torque	0.1%	0~2000	500	
	Set the push torque for pushing homing (homing method 3 or 7) in [0.1%] of the motor rated torque.				

Number	Name	Unit	Setting range	Initial value	Reboot
N0307	Homing grid mask pulses	encoder unit	0~999999	0	
	<p>Set the range in which Z pulse detection is ignored during homing operation.</p> <p>The motor encoder Z pulse input is ignored in the distance range (grid mask range) set in this parameter from the rising edge of the DEC signal input. In case of pushing homing (homing method 3 or 7), the pushing reverse position is the base point of the grid mask range.</p> <p>※The unit of this parameter is the motor encoder unit. For the encoder resolution of each motor model, refer to "<u>3-4. List of compatible motors</u>".</p>				
N0308	Home position offset	Reference unit	-2147483648~ 2147483647	0	
	Set the position command value when the homing operation is completed.				
N0309	Home position detection range	Reference unit	0~999999	2	
	<p>Set the ON range of control output ZERO.</p> <p>The control output ZERO turns ON when both following conditions are met.</p> <ul style="list-style-type: none"> · Position command = 0 · The absolute value of the current position (Reference unit) is less than or equal to the set value in this parameter. 				
N0310	Jog velocity	min ⁻¹	0~6000	300	
	Set the rotation velocity during jog operation in [min ⁻¹].				
N0311	Jog acc/dec time constant	ms	0~999999	100	
	Set the acceleration/deceleration time constant of the jog operation as the time to accelerate/decelerate for the velocity difference of 3000min ⁻¹ in [ms].				
N0312	Step operation pulses 0	Reference unit	-2147483648~ 2147483647	0	
N0313	Step operation pulses 1			0	
N0314	Step operation pulses 2			0	
N0315	Step operation pulses 3			0	
<p>Set the movement amount for step operation.</p> <p>It is possible to select from 4 move amounts at the start of step operation by serial communication command.</p> <p>The step operation pulses 0 is also used as the step operation amount in 2-step feed jog operation.</p> <p>For details on jog operation (2-step feed jog operation), refer to "<u>1-4-1. Jog operation</u>", and for step feed operation, refer to "<u>1-4-2. Step operation</u>".</p>					

1 7 - 2 - 5. Other functions

Number	Name	Unit	Setting range	Initial value	Reboot
N0400	Reference pulse multiply 1	-	0~9999	1	
N0401	Reference pulse multiply 2			1	
	<p>Set the scaling factor between the external position command pulses input and the position command pulses transmitted to the internal control system. The applied scaling factor of the two available scaling factors is determined by the control input RSEL or by the serial communication command [RSELON] [RSELOFF].</p> <p>For details on pulse input scaling, refer to "1 0 - 4. Reference pulse multiply switching".</p>				
N0402	Reference pulse smoothing filter time constant	ms	0~9999	0	
	<p>Set the time constant of the filter for smoothing the rising/falling speed of the position reference pulse input in [ms]. The smoothing filter is a first order lag filter.</p> <p>For details on smoothing filter, refer to "1 0 - 6. Reference pulse smoothing filter".</p>				
N0403	Reference pulse simple S-curve acc/dec filter time constant	ms	0~128	0	
	<p>Set the time constant of the filter for averaging the rising/falling speed of the position reference pulse input in [ms]. The simple S-curve acceleration/deceleration filter is a moving average filter.</p> <p>For details on simple S-curve acceleration/deceleration filter, refer to "1 0 - 7. Reference pulse simple S-shape acceleration/deceleration filter".</p>				
N0404	Near positioning range	encoder unit	0~999999	10	
	<p>Set the ON range of control output NEAR.</p> <p>When the absolute value of position error (difference between the position command and the current position) is less than or equal to the set value in this parameter, the control output NEAR turns ON indicating near position state.</p> <p>※The unit of this parameter is the motor encoder unit. For the encoder resolution of each motor model, refer to "3 - 4. List of compatible motors".</p>				
N0405	In-position output permission time	ms	0~9999	0	
	<p>The condition of position command state is added to the turn ON conditions of the in-position output. The in-position output is always turned off for the period set in this parameter after the movement of the position command is completed.</p> <p>For details on in-position output enable function, refer to "1 0 - 5. In-position signal output".</p>				
N0406	Alarm signal output time constant	ms	0~9999	0	
	<p>Set the unit time for turning ON/OFF the control output ALM in [ms] when an alarm occurs.</p> <p>When this parameter is set to "0", the control output ALM becomes level output (turned ON with alarm).</p> <p>For details on ALM output settings during alarm, see "1 6 - 2 - 1. Control output ALM".</p>				

Number	Name	Unit	Setting range	Initial value	Reboot
N0407	ZPLS output minimum time / Stop time after PTFIN	ms	0~9999	10	
	<p>Set the minimum ON time of control output ZPLS and the stop time after control output PTFIN in [ms].</p> <p>From the time when ON edge of the motor encoder Z pulse is detected, the control output ZPLS always turns ON for the period set in this parameter. If the motor is in Z pulse position after the set time has elapsed, the output will continue to be turned ON.</p> <p>If the Point-Table torque limit function is set to execute the next point continuously after clearing the error, the next point will be activated after waiting (PTFIN output is turned ON) for the time set in this parameter.</p> <p>For details on stop time after PTFIN, refer to Instruction Manual: Point-Table part "2-9-2. When "Wait time" is set to other value than 0[ms]".</p>				
N0408	Control input filter time constant	ms	0~9999	5	
	<p>Set the time constant of the software filter applied to the signals of control input terminal in [ms].</p> <p>When the state of the control input terminal is stable for the period set in this parameter, the signal state is transmitted to the driver.</p> <p>For details on control input terminal filter, see "<u>7 - 1 - 6. Control input software filter</u>".</p>				
N0409	Current position rewrite value	Reference unit	-2147483648~ 2147483647	0	
	<p>The current position rewriting operation is executed at ON edge of control input ZSET, and the current position (Reference unit) is rewritten to the value set in this parameter.</p>				
N0410	Follow-up start width	encoder unit	0~999999	0	
	<p>Set the reference value to start the follow-up operation.</p> <p>Follow-up operation is performed when the motor shaft rotation angle from the time of servo OFF exceeds the value set in this parameter.</p> <p>Follow-up operation is an operation to rewrite the position command according to the motor shaft rotation while the servo is OFF. If follow-up is not performed, the position command is held at the position at the time of servo OFF, and the motor shaft will be positioned at the original angle at the next servo ON.</p> <p>※The unit of this parameter is the motor encoder unit. For the encoder resolution of each motor model, refer to "<u>3 - 4. List of compatible motors</u>".</p>				
N0411	Servo free delay time	ms	0~9999	0	
	<p>Set the time from servo OFF command until the servo actually becomes free in [ms].</p> <p>This can be used for timing adjustment with the motor brake coil control signal.</p>				
N0412	Maximum position error	encoder unit	0~999999	999999	
	<p>Set the reference value for the excessive position error alarm.</p> <p>When the absolute value of position error (difference between position command and current position) exceeds the value set in this parameter, an excessive position error alarm is generated.</p> <p>※The unit of this parameter is the motor encoder unit. For the encoder resolution of each motor model, refer to "<u>3 - 4. List of compatible motors</u>".</p>				

Number	Name	Unit	Setting range	Initial value	Reboot
N0413	Alarm output protection set	-	0000h~000Fh	0000h	
	<p>Set whether to enable or disable the alarm.</p> <p>The setting is done in bit units, where bit 0 is for alarm generation permitted, and bit 1 is for alarm generation prohibited (suppressed).</p> <p>BIT3: Input power voltage too low</p> <p>BIT2: COMM Synchronous communication alarm (B00h, B001h)</p> <p>BIT1: DEC Insufficient acceleration/deceleration range</p> <p>BIT0: Excessive position error</p>				
N0414	VCMP output range	min ⁻¹	0~6000	10	
	<p>Set the ON range of control output VCMP in [min⁻¹].</p> <p>In velocity control operation mode, if the difference (absolute value) between the command velocity and the motor rotation velocity is less than or equal to the value set in this parameter, the control output VCMP will turn ON indicating the matching condition. However, VCMP turns OFF during stop state and during command velocity change in velocity control operation.</p> <p>For details on velocity control operation mode and control output VCMP, see "1 2 - 3 . Velocity control operation mode".</p>				
N0415	External signal positioning final travel distance	Reference unit	-2147483648~ 2147483647	0	
	<p>This parameter is used when operating connected to MECHATROLINK-III link unit (Si-LNK-M3). Set the final travel distance for external input positioning constant velocity feed (EX_FEED) and external input positioning (EX_POSING).</p>				
N0416	Point selection multiply	-	0~255	1	
	<p>Set the coefficient to multiply the point number specified by control inputs P0_IN~P7_IN.</p> <p>The numerical value (0~255) specified by the control inputs P0_IN~P7_IN is multiplied by the value set in this parameter and used as a Point-Table number that is actually specified.</p>				
N0417	Rotating coordinate system lower limit	Reference unit	-999999~ 999999	0	○
N0418	Rotating coordinate system upper limit			0	○
	<p>Set the coordinate lower/upper limit when setting the rotating coordinate system as the position control coordinate system.</p> <p>The rotating coordinate system is a coordinate system used for rotary table control. The coordinate value circulates in the range from the lower limit to the upper limit.</p> <p>For details on rotating coordinate system, refer to Instruction Manual: Point-Table part "2-12. Rotating coordinate system".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				

Number	Name	Unit	Setting range	Initial value	Reboot																																																						
N0419	Communication format select	-	0000h~001Fh	0000h	○																																																						
	<p>Set the RS485 serial communication speed (baud rate), end character (EOT[04h] or ETX[03h]) in the reply data from servo driver, and lowercase/uppercase of hexadecimal numbers (A~F) in the reply data.</p> <p>The setting is done in bit units.</p> <table border="1" data-bbox="561 421 1184 613"> <thead> <tr> <th>Item</th> <th>BIT</th> <th>Setting: 0</th> <th>Setting: 1</th> </tr> </thead> <tbody> <tr> <td>End character</td> <td>4</td> <td>EOT</td> <td>ETX</td> </tr> <tr> <td>Hexadecimal</td> <td>3</td> <td>lowercase</td> <td>uppercase</td> </tr> <tr> <td>Communication speed</td> <td>0~2</td> <td colspan="2">table below</td> </tr> </tbody> </table> <table border="1" data-bbox="644 658 1101 1070"> <thead> <tr> <th colspan="4">Communication speed (BIT0~2)</th> </tr> <tr> <th>BIT2</th> <th>BIT1</th> <th>BIT0</th> <th>Communication speed (bps)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>9600</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>19200</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>38400</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>57600</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>115200</td></tr> <tr><td>1</td><td>0</td><td>1</td><td rowspan="3">9600</td></tr> <tr><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td></tr> </tbody> </table> <p style="text-align: center;">※This parameter setting becomes effective after the power is turned ON again.</p>					Item	BIT	Setting: 0	Setting: 1	End character	4	EOT	ETX	Hexadecimal	3	lowercase	uppercase	Communication speed	0~2	table below		Communication speed (BIT0~2)				BIT2	BIT1	BIT0	Communication speed (bps)	0	0	0	9600	0	0	1	19200	0	1	0	38400	0	1	1	57600	1	0	0	115200	1	0	1	9600	1	1	0	1	1	1
Item	BIT	Setting: 0	Setting: 1																																																								
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1	0	1	9600																																																								
1	1	0																																																									
1	1	1																																																									
N0420	Reply wait time	ms	0~9999	0																																																							
	<p>Set the wait time in RS485 serial communication from receiving/executing the serial communication command from the host device until starting the reply in [ms].</p> <p>For details on serial communication command transmission/receiving timing, refer to "Instruction Manual: Serial Communication part".</p>																																																										
N0421	Startup excitation hold time	ms	0~999999	0																																																							
	<p>Set the time to keep the fixed phase excitation state after the servo is turned ON for the first time after the power is turned ON.</p> <p>It may be necessary to set an appropriately large value for this parameter under conditions where the mechanical load connected to the motor shaft is extremely large or the mechanical system is highly viscous.</p> <p>For details, refer to "<u>9-2. Initialization operation after power ON and servo ON for the first time</u>".</p>																																																										
N0422	Initial magnetic pole detection operation select	-	0~1	1																																																							
	<p>When this parameter is set to 1, the machine end detection operation is executed when the servo is turned ON for the first time after the power is turned ON.</p> <p>For details, refer to "<u>9-2. Initialization operation after power ON and servo ON for the first time</u>".</p>																																																										

Number	Name	Unit	Setting range	Initial value	Reboot
N0423	Serial communication reply order	-	0~15	0	○
	<p>Set the overall command communication reply order in RS485 serial communication.</p> <p>Assign a value to this parameter for all axes that perform overall communication in order from 0 on without omission.</p> <p>For details on overall command communication, refer to "Instruction Manual: Serial Communication part".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				
N0424	Serial communication axis group number	-	0~15	0	○
	<p>Set the group number corresponding to RS485 serial communication group command.</p> <p>For details on group command communication, refer to "Instruction Manual: Serial Communication part".</p> <p>※This parameter setting becomes effective after the power is turned ON again.</p>				
N0425	Direct start point number: DSTR0			0	
N0426	Direct start point number: DSTR1			0	
N0427	Direct start point number: DSTR2	-	0~255	0	
N0428	Direct start point number: DSTR3			0	
N0429	Direct start point number: DSTR4			0	
	<p>Set the Point-Table number to be activated by the Point-Table direct activation function.</p> <p>At the ON edge of control inputs DSTR0~DSTR4, the Point-Table number set in the corresponding parameter is started.</p> <p>For details on direct start function, refer to "<u>1 2 - 2 - 2 . Direct start</u>".</p>				
N0430	Range output 0: lower limit			0	
N0431	Range output 0: upper limit			0	
N0432	Range output 1: lower limit	Reference	-2147483648~	0	
N0433	Range output 1: upper limit	unit	2147483647	0	
N0434	Range output 2: lower limit			0	
N0435	Range output 2: upper limit			0	
	<p>Set the ON range of range output function in Reference unit.</p> <p>Control outputs AREA0~AREA2 turn ON when the current position of the motor axis is within the following range:</p> <p>Range output lower limit ≤ Current value ≤ Range output upper limit</p>				

1 7 - 3 . Parameters setting method

Parameters can be set by the following methods:

1) Connect the Si servo3 driver to a PC via USB or RS485 serial communication, and use the dedicated PC monitor software "Si-Wave3".

※When connecting with RS485, the RS485 master cable and RS485-USB converter are required.

For connection details, refer to "[1 5 - 2 - 3 . Example of connection with a PC](#)".

2) Connect the Si servo driver and the host controller (such as PLC) with RS485 serial communication cable, and use the parameter read ([PR]) /write ([PW]) commands.

The parameter values set by communication command [PW] will not be retained after the power is turned OFF. Execute command [FLASH] to store the set values.

When parameters are transmitted with Si-Wave3, they are saved in the driver's internal memory when transmitted.

The driver's internal memory can be rewritten up to 100,000 times.

1 7 - 4 . Factory default values for some parameters

The factory set values for some parameters differ depending on the driver model.

For details see the table below.

Number	Name	Si-02DT	Si-05DT
N0124	Step mode positioning current	2000	3000 ※
N0125	Current down current	1500	2000

※The factory default value for the driver model Si-05DT parameter N0124 "Step mode positioning current" is the value that matches the smallest motor model that can be connected to this driver: SM-12MT (rated current 3.0[A]).

When connecting the motor model SM-20MT to the Si-05DT and operating in step mode, set the value to the SM-20MT rated current of about 5000[mA].

1 8 . Status indicating LED

1 8 - 1 . Overview

The operating status of Si servo3 driver is indicated with two LEDs (green and red).

1 8 - 2 . Green LED

The operating status is indicated by green LED as follows.

LED (green) indications

LED indication	State	Content
OFF	none	The driver has no power supply and is not operating.
ON	Normal	Control power and main power are being supplied, and the driver is operating normally.
Blinking (1)	Communication setting	Indicates the communication speed (baud rate) of RS485 serial communication.
Blinking (2)	Writing to driver memory	Data is being written to the driver internal memory.
Blinking (3)	Warning	Indicates occurrence of a minor operation abnormality.

1 8 - 2 - 1 . Communication setting

Immediately after turning ON the power, the setting of RS485 serial communication speed (baud rate) is indicated by LED blinking.

(The baud rate is set with BIT0~3 of parameter N0419 "Communication format select")

Parameter N0419 BIT 0~3 set value	Communication speed (bps)	Number of blinks
0	9600	0-times (no blinking)
1	19200	1-times
2	38400	2-times
3	57600	3-times
4	115200	4-times

1 8 - 2 - 2 . Writing to driver memory indication

When the communication command [FLASH] is received or the teaching operation is performed by the control input, the parameters in the driver and the Point-Table data are written to the driver internal memory (nonvolatile memory). While the writing is in progress, the green LED blinks at a cycle of 1Hz (500ms ON, 500ms OFF).

If the power is turned OFF during the writing, the writing will not be completed normally and the alarms 101h: Motor/diagnosis data corrupted, 102h: User parameters data corrupted, 103h: Point-Table data corrupted, 104h: Motor model parameters data corrupted, 105h: System parameters data corrupted, 106h: Monitor management data corrupted will be issued at the next power ON, so be careful. It takes about 3 seconds to write all the parameters and Point-Table data (256 points) to the memory.

1 8 - 2 - 3. Warning

Minor abnormalities that occur during operation are indicated by blinking green LED.

Warning

Number of blinks	State	Content
2-times	Power supply not turned ON	The power supply is not turned ON.
3-times	Serial communication abnormality	This warning occurs when the baud rate of serial communication from the host device does not match the setting in the driver. The warning is cleared when serial communication data with the same baud rate is received.
4-times	Emergency stop status	The driver is in emergency stop state of either EMCE (control braking) or EMCF (servo free).
5-times	Overtravel	Overtravel state occurs in case of either the software OT in forward / reverse direction or the hardware OT in forward / reverse direction.
6-times	Power cycle parameter change	It is necessary to turn on the power again to apply the parameter change.

1 8 - 3 . Red LED

The operating status is indicated by red LED as follows.

LED (red) indications

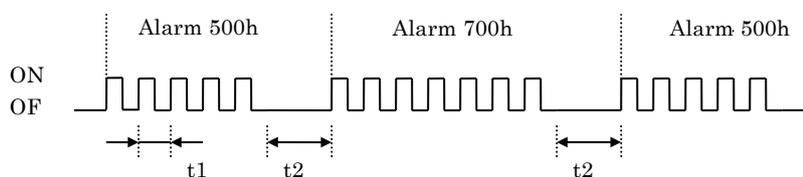
LED indication	Link unit status	Content
OFF	Normal	Control power is supplied and the driver is operating normally
Blinking (1)	Alarm	Alarm has occurred.
Blinking (2)	CPU error	CPU error has occurred.

1 8 - 3 - 1 . Alarm indication

If an alarm has occurred, **the category number** of the alarm that is currently occurring is indicated by blinking.

The lowest category number of occurring alarm is output first, then in order to the highest number, and continuously repeating from the lowest to the highest number.

Example) Alarm 500h: Excessive position error, and alarm 700h: Phase B overcurrent are occurring



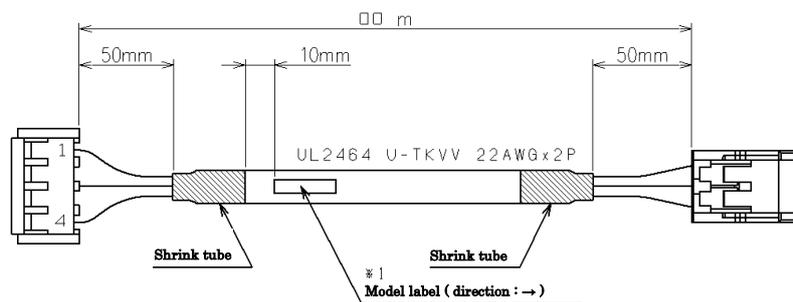
Symbol	Meaning	Value	Unit
t1	Blinking unit time	400	ms
t2	Pause time between alarms	800	

1 8 - 3 - 2 . CPU error indication

If the driver system cannot continue to operate due to some reason such as noise, the LED will blink with high speed (about 4Hz) and all operations will be disabled. In this case, the ALM signal is not output. If operation is not restored after the power is cycled OFF and ON, contact the manufacturer.

1 9. Options

1 9-1. Motor cable Si3-MCB□□M (for Si-02DT)



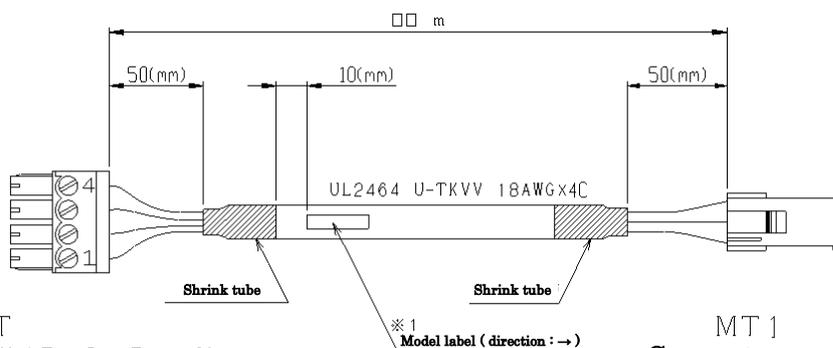
MT
Connector : EHR-4
(JST)

※1: Si3-MCB□□M

MT1
Connector : DF1B-4DS-2.5RC
(Hirose)

Connector name	MT		Connector name	MT1	
Terminal number	Signal name	Wire color	Terminal number	Signal name	Wire color
1	A+	black	1	A+	black
2	A-	black/white	2	A-	black/white
3	B+	red	3	B+	red
4	B-	red/white	4	B-	red/white

1 9-2. Motor cable Si-MCBHC□□M (for Si-05DT)



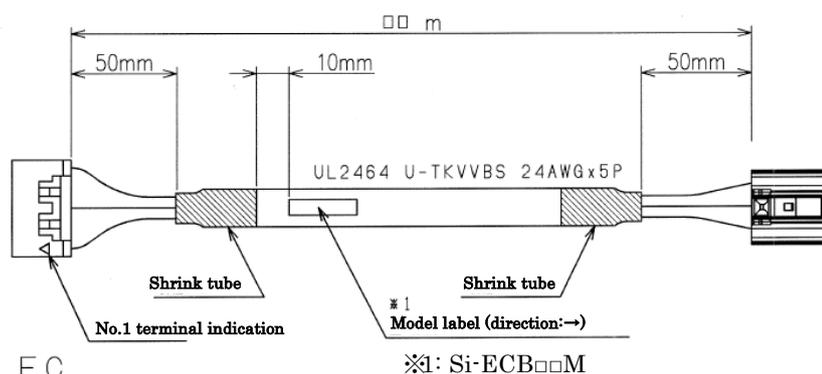
MT
Connector : XW4B-04B1-H1
(OMRON)

※1: Si-MCBHC□□M

MT1
Connector : 172159-1
(AMP)

Connector name	MT		Connector name	MT1	
Terminal number	Signal name	Wire color	Terminal number	Signal name	Wire color
1	A+	red	1	A+	red
2	A-	white	2	A-	white
3	B+	black	3	B+	black
4	B-	green	4	B-	green

1 9 - 3 . Encoder cable Si3-ECB□□M

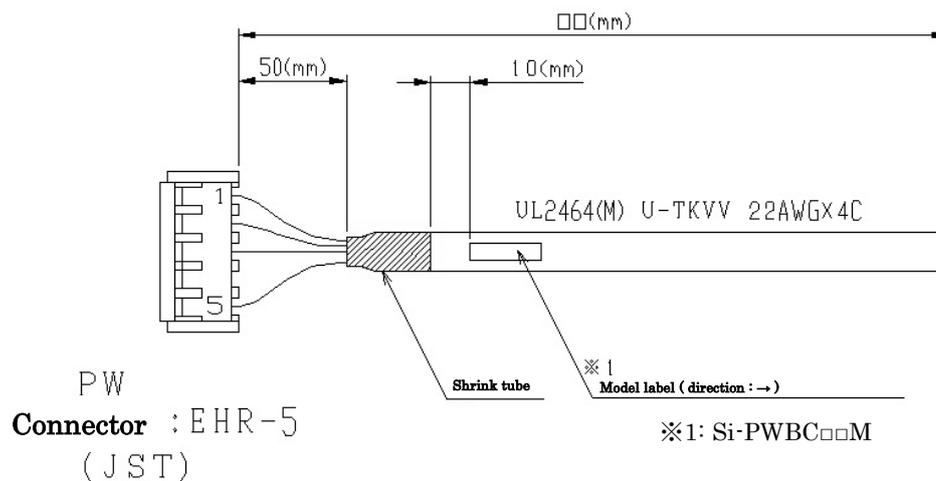


EC
 Connector : PADP-16V-1-S
 (JST)

EC1
 Connector : DF62C-13S-2.2C
 (Hirose)

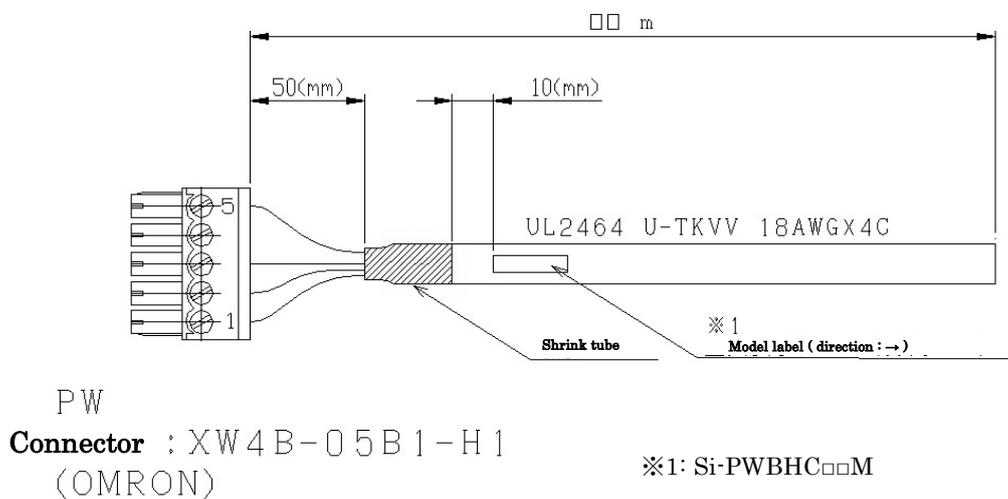
Connector name	EC		Connector name	EC1	
Terminal number	Signal name	Wire color	Terminal number	Signal name	Wire color
1	FG	shield	1	FG	shield
2~6	NC	-	2,3	NC	-
7	DO-A	black	4	DO-A	black
8	NDO-A	black/white	5	NDO-A	black/white
9	SK-B	red	6	SK-B	red
10	NSK-B	red/white	7	NSK-B	red/white
11	SEL	green	8	SEL	green
12	NSEL	green/white	9	NSEL	green/white
13	DI-Z	yellow	10	DI-Z	yellow
14	NDI-Z	yellow/white	11	NDI-Z	yellow/white
15	Vcc	brown	12	Vcc	brown
16	GND	brown/white	13	GND	brown/white

1 9 - 4 . Power cable Si-PWBC□M (for Si-02DT)



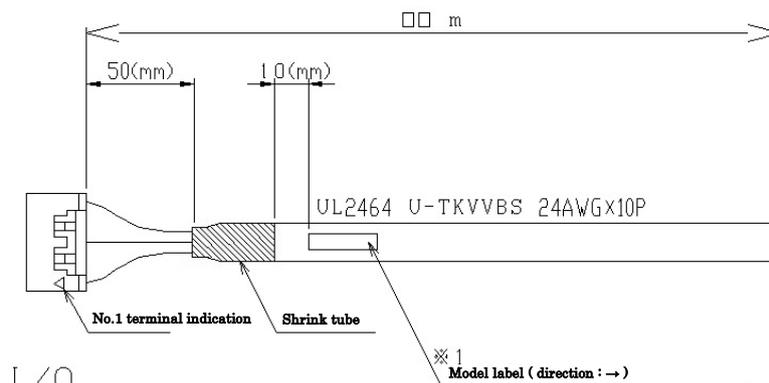
Connector name	PW		
	Terminal number	Signal name	Wire color
	1	V1	red
	2	V2	white
	3	0V	black
	4	NC	-
	5	E	green

1 9 - 5 . Power cable Si-PWBHC□□M (for Si-05DT)



Connector name	PW		
	Terminal number	Signal name	Wire color
	1	V1	red
	2	V2	white
	3	0V	black
	4	NC	-
	5	E	green

19-6. I/O cable Si-IOB□□M



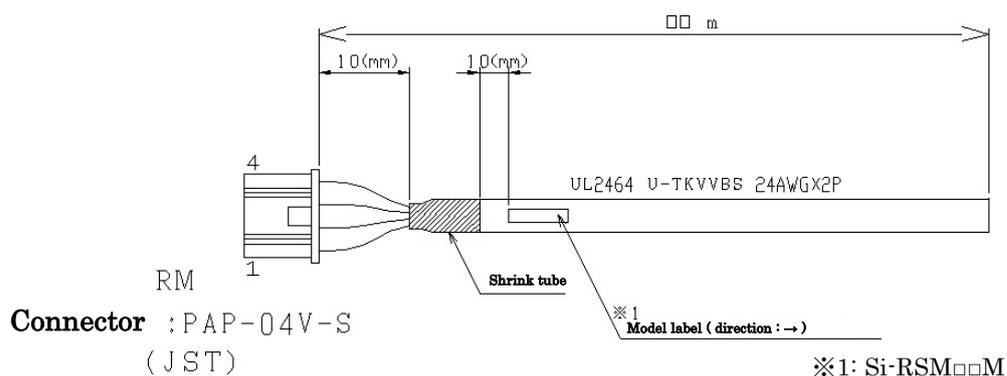
I/O

Connector : PADP-20V-1-S
(JST)

※1: Si-IOB□□M

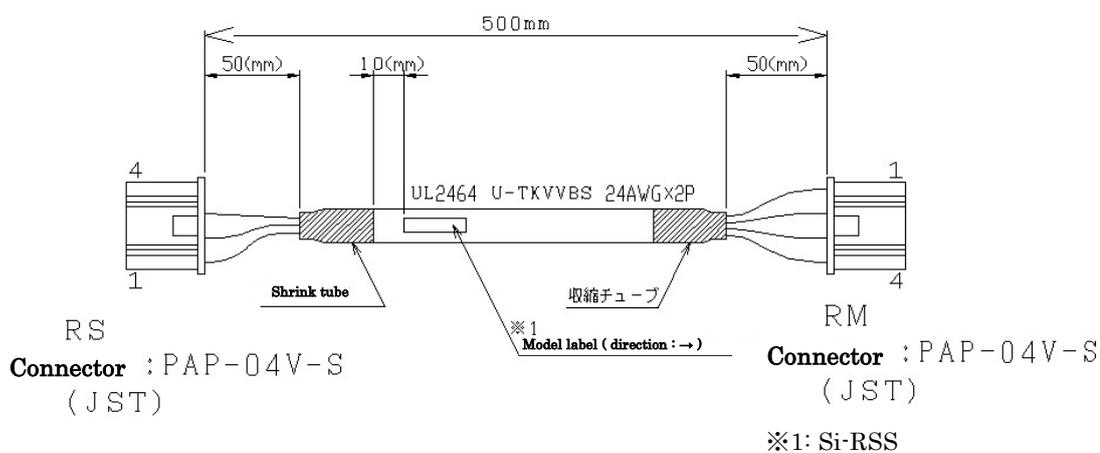
Connector name	I/O	
Terminal number	Signal name	Wire color
1	FG	shield
2~4	NC	-
5	BK2	black
6	BK1	black/white
7	COM-OUT	red
8	OUT2	red/white
9	OUT1	green
10	OUT0	green/white
11	COM-IN	yellow
12	IN4	yellow/white
13	IN3	brown
14	IN2	brown/white
15	IN1	blue
16	IN0	blue/white
17	CCWN	gray
18	CCWP	gray/white
19	CWN	orange
20	CWP	orange/white

1 9 - 7 . RS485 master cable Si-RSM□□M



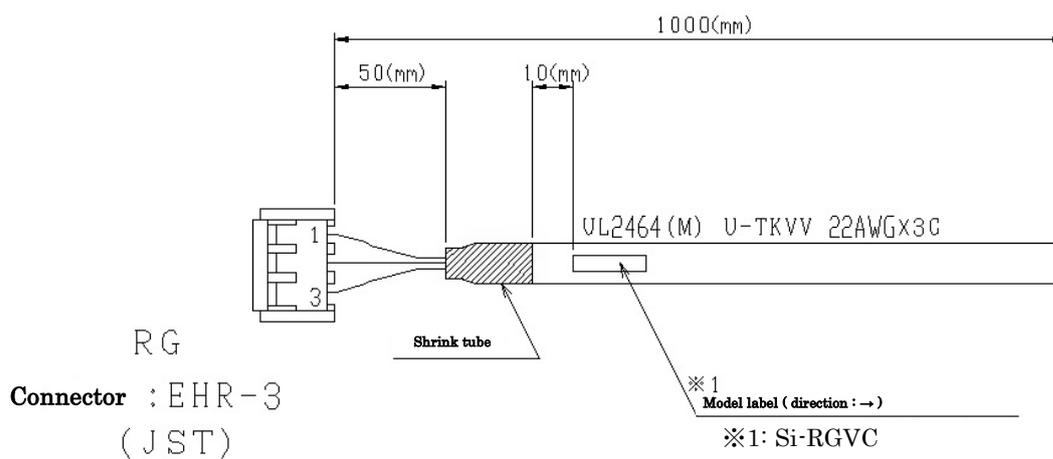
Connector name	RM	
Terminal number	Signal name	Wire color
1	TRX+	black
2	TRX-	black/white
3	GND	red
4	FG	shield

1 9 - 8 . RS485 slave cable Si-RSS



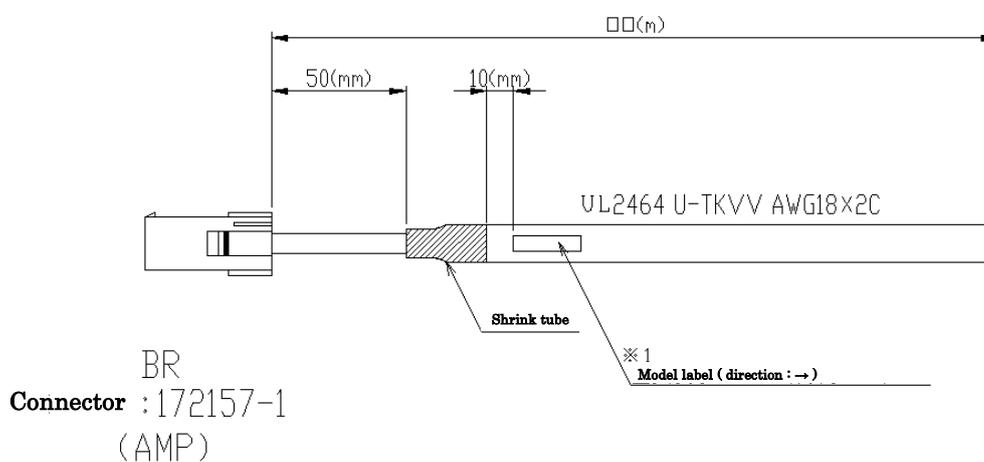
RS			RM		
Connector name	Signal name	Wire color	Connector name	Signal name	Wire color
Terminal number	Signal name	Wire color	Terminal number	Signal name	Wire color
1	TRX+	black	1	TRX+	black
2	TRX-	black/white	2	TRX-	black/white
3	GND	red	3	GND	red
4	FG	shield	4	FG	shield

1 9 - 9 . Regenerative cable Si-RGVC



Connector name	RG	
Terminal number	Signal name	Wire color
1	P1	red
2	P2	white
3	0V	black

1 9 - 1 0 . Electromagnetic brake cable Si-BRK□□M



Connector name	BR	
Terminal number	Signal name	Wire color
1	BKP	black
2	BKN	white

1 9 - 1 1 . Connector kit Si3-CNK02 (for Si-02DT)

Part name	Model	Quantity	Manufacturer
Connector (RG)	EHR-3	1	JST
Pin (RG)	SEH-001T-P0.6L	4	JST
Connector (MT)	EHR-4	1	JST
Pin (MT)	SEH-001T-P0.6L	5	JST
Housing (PW)	EHR-5	1	JST
Pin (PW)	SEH-001T-P0.6L	5	JST
Housing (RS, RM)	PAP-04V-S	2	JST
Pin (RS, RM)	BPHD-001T-P0.5	10	JST
Housing (IO)	PADP-20V-1-S	1	JST
Pin (IO)	SPH-001T-P0.5L	18	JST
Housing (EC)	PADP-16V-1-S	1	JST
Pin (EC)	SPH-001T-P0.5L	12	JST
Housing (MT1)	DF1B-4DS-2.5RC	1	Hirose
Pin (MT1)	DF1B-2022SC	4	Hirose
Connector (EC1)	DF62C-13S-2.2C	1	Hirose
Pin (EC1)	DF62-2428SC	12	Hirose

1 9 - 1 2 . Connector kit Si3-CNK05 (for Si-05DT)

Part name	Model	Quantity	Manufacturer
Connector (RG)	EHR-3	1	JST
Pin (RG)	SEH-001T-P0.6L	4	JST
Connector (MT)	XW4B-04B1-H1	1	Omron
Pin (MT)	216-203	5	WAGO
Housing (PW)	XW4B-05B1-H1	1	Omron
Pin (PW)	216-203	5	WAGO
Housing (RS, RM)	PAP-04V-S	2	JST
Pin (RS, RM)	BPHD-001T-P0.5	10	JST
Housing (IO)	PADP-20V-1-S	1	JST
Pin (IO)	SPH-001T-P0.5L	18	JST
Housing (EC)	PADP-16V-1-S	1	JST
Pin (EC)	SPH-001T-P0.5L	12	JST
Housing (MT1)	172159-1	1	TE
Pin (MT1)	170365-1	5	TE
Connector (EC1)	DF62C-13S-2.2C	1	Hirose
Pin (EC1)	DF62-2428SC	12	Hirose

(Si-MCBHC□□M, Si-PWBHC□□M compatible product)

1 9 - 1 3 . Regenerative capacitor kit Si-RGVCK

Part name	Model	Quantity	Manufacturer
Electrolytic capacitor	EKMH630LGB472MA50M (63V, 4700 μ F)	1	Nippon Chemi-Con
Resistor	SPR2C222J (2W, 2.2k Ω)	1	KOA

2 0 . Regenerative circuit

Si servo driver does not have a built-in regenerative circuit. Therefore, if the power supply voltage in the driver rises above the specified value due to regenerative operation, an alarm C01h "Excessive regenerative energy" will be issued.

In such case, it is necessary to connect an external regenerative circuit to RG connector of the driver.

Use the regenerative cable (Si-RGVC) to connect a capacitor and a resistor to RG regenerative connector. The regenerative energy W that can be absorbed by the capacitor with electrostatic capacity C when the power supply voltage is 24VDC is $W = 962C$ [J]. Select a capacitor so that W is larger than the regenerative energy in one operation cycle.

Recommended capacitor C is a large aluminum electrolytic capacitor with rated voltage 63V, 105°C, long life and high ripple characteristics (eg. Nippon Chemi-Con LXA series or similar.).

Resistor R is intended to discharge the capacitor. Normally, use a 1W, 2.2k Ω resistor.

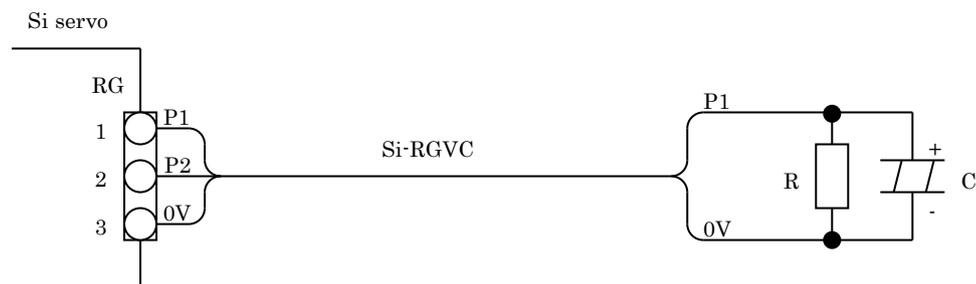
Regenerative cable Si-RGVC is a product option.

The resistor and capacitor can be prepared by the customer, or the regenerative capacitor kit (Si-RGVCK) can be used.

Regenerative capacitor kit Si-RGVCK

Electrolytic capacitor: EKM630LGB472MA50M (product of Nippon Chemi-Con, 63V, 4700 μ F)

Resistor: SPR2C222J (KOA, 2W, 2.2k Ω)



(not used P2 requires taping terminal processing)

 ■Contact information■■■

(Sales inquiry)

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