Document No.	:	SX-DSV03031
Revision No.	:	R5.0
Date of Issue	:	Dec. 14, 2023
Classification	:	☐ New ■ Change

Technical Reference

- Functional Specification -

Product Name : AC Servo Driver

Product Series Name : MINAS A6S Series for Rotary motor

Product Model Number : Position control type/General-purpose communication type/Multifunction type

Motion Control Business Unit, Industrial Device Business Division
Panasonic Industry Co., Ltd.
7-1-1 Morofuku, Daito－City, Osaka 574-0044, Japan

If you have any questions, please contact the seller (Sales office or Distributor) of the pro

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パナソニック インダストリー株式会社

産業デバイス事業部 モーションコントロールビジネスユニット

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Motion Control Business Unit, Industrial Device Business Division,
Panasonic Industry Co., Ltd.

REVISIONS

Date Date of submission	Page Revised portion Revised figure number	Sym Revision symbol	REVISION Reason for change and description of revision	Signed Stamp
Oct. 27, 2015	-	1.0	NEWLY ISSUED	
Aug. 01, 2016	P1	2.0	Software version upgrade CPU1 Ver 1.03 → Ver 1.05 CPU2 Ver 1.03 → Ver 1.05	
	P5,84,P188,192,200, 224,243		1) Function added: “Infinite revolution absolute function”	
	P4,5,53,54,97,230, 240,244		2) Function added: “External scale position information monitoring function under semi-closed control”	
	P5,149,157,240,242		3) Function added: “Full-closed control support for load variance suppression function”	
	P157,243		4) Function added: “Functional enhancement of quadrant projection suppression function”	
	P4,5,9,10,15,16,53, 184-187,232,233		5) Function added: “Position compare function”	
	P53,54,242		6) Function added: “Serial absolute external scale Z phase shift amount setting in pulse regeneration function”	
	P180-182,237,239		7) Function added: “Slow stop function”	
	P5,10,15,189,190,210,21 1,237,242		8) Function added: “Deterioration diagnosis warning function”	
	P236-238		9) Function added: “Modbus function enhancements”	
	P3,58,191,192,197, 200,201,240		10) Function added: “Block operation function enhancements”	
	Cover		• Change Added “Functional Specification” to document title, changed issuing division name	
	P1		• Addition Added functional comparison table	
	P2		• Addition Added related reference specifications	
	P3,80		• Change Changed description of serial communication scale	
	P6,7,9,10		• Correction Divided frame for control modes	
	P18		• Correction Corrected explanation of output gain when Pr4.16/4.18 = 25 or 26	
	P23		• Addition Added description of communications and front panel exclusive functions	
	P29		• Correction Corrected description of overload factor	
	P34		• Change Deleted notes on temperature information	
	P41		• Correction Corrected connector name error	
	P41		• Addition Added conditions leading to error	
	P43		• Correction Corrected error in explanation of execution display	
	P55,56		• Correction Corrected description on functional explanation, deleted scale item number	
	P60		• Addition Added functional explanation to Pr4.31 and Pr4.42	
	P74		• Addition Added notes in case velocity control is ineffective	

(Note) Revised page numbers are those at the time of issue of the revised edition

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Date Date of submission	Page Revised portion Revised figure number	Sym Revision symbol	REVISION Reason for change and description of revision	Signed Stamp
			(Continued from previous page)	
	P79		• Correction Corrected description of matters to note regarding hybrid deviation	
	P80,230		• Change Changed setting rage for Pr3.23 and Pr3.26	
	P81		• Correction Corrected error in value of scale resolution of note *3	
	P103,112,121		• Correction Set range for Pr1.10 from [0 - 2000] to [0 - 4000]	
	P106,116,124		• Correction Deleted description in note *1	
	P108		• Correction Corrected description of Pr2.11 and Pr2.12 functions	
	P128		• Correction Corrected contents of notch filter in the block diagram	
	P129,165		• Correction Added load variance suppression in the block diagram	
	P138		• Correction Corrected error in the number of maximum allowable simultaneous frequency setting	
	P140,227		• Correction Corrected error in valid range setting for Pr2.14, Pr2.16, Pr2.18, and Pr2.20	
	P143		• Correction Corrected description of parameter settings	
	P144		• Correction Corrected error in functional explanation for Pr2.13	
	P156		• Addition Added contents to method of use	
	P161,163		• Addition Added explanation for synchronous type	
	P163		• Correction Deleted description for bit 3 form functional explanation of Pr6.47	
	P170,171,234		• Correction Corrected contents of points to note	
	P173		• Addition Added contents of note *5	
	P191,193,195		• Correction Corrected protection function name for Err16.0	
	P191,193,195		• Correction Deleted description of Err16.2	
	P192		• Change Changed attribute of Err80.0	
	P192,200		• Addition Added Err93.3	
	P200		• Correction Corrected description of Err93.2 processing	
	P210,232		• Change Changed setting range for Pr4.40 and Pr4.41	
	P210		• Correction Corrected description of Pr6.38 and Pr6.39 corresponding bits	
	P213,235		• Addition Added function and contents to Pr5.20	
	P213,214		• Addition Added example for excessive position deviation setting under two-degree of freedom control	
	P215		• Addition Added abnormal detection of safety function	
	P219		• Correction Corrected timing of dynamic braking	
	P229		• Correction Corrected error in Pr3.13 functions and contents	
	P234		• Correction Corrected description of Pr5.12	

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Date Date of submission	Page Revised portion Revised figure number	Sym Revision symbol	REVISION Reason for change and description of revision	Signed Stamp
			(Continued from previous page)	
	P235		• Addition Added functions and contents to Pr5.31	
	P241		• Change Changed Pr6.47 bit15 to manufacturer specifications	
	P243		• Addition Added Pr6.87	
	P243		• Addition Added Pr6.98	
	P248		• Change Deleted parameters of Class 14	
	P247		• Addition Added parameters to Class 9	
	P252		• Correction Added notes	
	P253		• Addition Added timing diagram for immediate stop operation	
	P258,259		• Correction Added GND wiring in connection diagram	
	P284		• Addition Added read command details of external scale	
	P270,271,283,291		• Correction Corrected error in command configuration	
Aug. 25, 2016	P2	2.1	Software version upgrade CPU1 Ver 1.05 → Ver 1.06 CPU2 Ver 1.05 → Ver 1.06	
	P235		1) “Main power supply AC Off detection time” Expansion of the set range	
	P156,241		2) “Hybrid vibration suppression filter” Expansion of the set range	
	P171,172,244		3) “Allowable motor operating range setting” Expansion of the protection functions	
	-		4) “Block operation function” Specification improvement of Decelerate stop command	
Jul. 10, 2017	P2	2.2	Software version upgrade CPU1 Ver 1.06 → Ver 1.07 CPU2 Ver 1.06 → Ver 1.07	
	P37,277,278		1) Function change "Expansion in range of the manufacturing number indication function"	
	P1,4-9		• Correction Corrected tables of function list	
	P10,66		• Addition Added precautions of Command pulse inhibition function (INH)	
	P11,179		• Addition Added precautions of Command division/multiplication switching function (DIV1,DIV2)	
	P17,20		• Addition Added precautions of signal assignment	
	P96		• Addition Added description of Battery refreshment	
	P105,115,123		• Addition Added precautions of Real-time autimatic tuning	
	P182		• Correction Corrected description of dynamic brake switch input (DB-SEL)	
	P186		• Correction Corrected description of Drop prevention function when alarm comes on	
	P199,206		• Addition Added Err50.2	
	P204		• Addition Added description of Err34.0	
	P222-229		• Correction Corrected description of Safety function	

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Date Date of submission	Page Revised portion Revised figure number	Sym Revision symbol	REVISION Reason for change and description of revision	Signed Stamp
			(Continued from previous page)	
Jul. 26, 2018	P2	2.3	Software version upgrade CPU1 Ver 1.07 → Ver 1.09 CPU2 Ver 1.07 → Ver 1.09	
	P10,66,244		1) Specification extension of command pulse prohibition input (INH)	
	P67,77,81,83,175,240		2) Setting range extension of analog input offset	
	P197-200,253		3) Specification extension of deterioration diagnosis warning function	
	P202,211		• Addition Added the description of Err96.2	
	P201,202,208,209		• Correction Deleted the unnecessary description of alarm	
	P139,140		• Correction Corrected the detailed explanation of gain switching	
	P197,247		• Addition Added the explanation of Pr5.76	
	P142		• Addition Added the explanation of position gain switching time	
	P201,202,208,209		• Change Changed the name of Err44.0, Err45.0, and Err72.0	
	P104		• Correction Corrected the alarm No. of external scale	
	P207		• Correction Corrected the explanation of Err29.2	
	P220		• Correction Corrected the contents of alarm A1	
	P196,253		• Addition Added the explanation of Pr6.88	
	P172		• Correction Corrected the description of internal position command speed regarding the smoothing filter	
	P51,123,131,163,233		• Correction Corrected the explanation of Pr0.05, Pr6.42, and Pr6.48	
	P86		• Correction Corrected the table regarding count direction of external scale for phase AB	
	P5-9,233-258		• Change Changed the title of Chapter	
	P195		• Addition Added notes regarding the position compare output monitor	
	P183		• Correction Corrected note *6	
	P135,234		• Addition Added the block of torque feedforward	
	P204		• Correction Corrected the procedure of Err12.0	
	P225		• Addition Added the canceling method of STO state	
	P76		• Addition Added notes regarding speed limit input	
	P204		• Correction Corrected the cause of Err13.1	
	P169		• Correction Corrected the output position of speed control command	
	P210		• Addition Added the explanation of Err93.8	
Nov.15,2018	P2	2.4	Software version upgrade CPU1 Ver 1.09 → Ver 1.10 CPU2 Ver 1.09 → Ver 1.10	
	P173,253		1) Function addition "High response current control"	
	P3,4,219-222		• Addition Added an explanation about G frame and H frame.	
	P3		• Change Changed related materials (Integrate reference specifications)	

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REVISIONS

Date Date of submission	Page Revised portion Revised figure number	Sym Revision symbol	REVISION Reason for change and description of revision	Signed Stamp
Sep.13,2019	P1-2	2.5	・Software upgrade CPU1 Ver1.10 -> Ver1.11 CPU2 Ver1.10 -> Ver1.11	
	P3		1) Function addition “Extension of the range of abusolute date”	
	P2-4,90,93-94,98, 209,211,224-225		• Addition Compatible with the battery-less absolute encoder	
	Overall		• Corrected all incorrect entries. • Company name changed.	
Mar.27.2020	P5,8,193	2.6	・Corrected incorrect entries.	
Apr.1.2021	P1-3	2.7	・Software version upgrade CPU1 Ver1.11 → Ver1.12 CPU2 Ver1.11 → Ver1.12	
	P54,55,64,67,183 215,257		1) Function added “Pulse train control when block operations are enabled”	
	P12,18,195 197-198,255		2) Function added “Position compare function enhancement”	
	P72,261		・Addition Added the explanation of C-MODE	
	P54,55		・Addition Added the explanation of DIV1,DIV2	
	P4,9,14,16,19,79,83, 90,91,94,95,108,118, 126,187,193,200,201, 202,205,210,213,232, 250,256,259,265,274, 278,279		・Corrected incorrect entries.	
	Overall		• Company name changed.	
Dec.1.2021	P1-3	3.0	• Software version upgrade CPU1 Ver1.12 → Ver1.13 CPU2 Ver1.12 → Ver1.13	
	No change in this document		1) Function added “Extension of the unit of acceleration/deceleration of Block operation”	
	P255,257		• Addition Added the description of Pr5.96,Pr5.97,Pr5.105,Pr6.25,Pr6.26 （For manufacturer use）	
	No change in this document		• Addition Added the description of Pr60.56,Pr60.57	
	P205,215		• Addition Added the description of Err98.5	
	Overall		• Company name changed.	
	Overall		• Corrected all incorrect entries	
Apr. 1, 2022	-	3.1	• Changed the company name	-
	-		• Changed the front cover format	
May.8.2023	P1-3	4.0	• Software version upgrade CPU1 Ver1.13 → Ver1.14 CPU2 Ver1.13 → Ver1.14	
	P3,6-9,135,169, 204-207,214, 218,265,266		1) Function added “Pulse train control when block operations are enabled”	
	P199,219		2) Function added “In case of 4(=Pr6.28) absolute mode corresponding”	
	No change in this document		3) Function added “In case of 0(=Pr6.28) 6000h order monitor corresponding”	
	P9		• Addition Added notes on full-closed control.	
	Overall		•Changed wording, Corrected all incorrect entries	

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REVISIONS

Date Date of submission	Page Revised portion Revised figure number	Sym Revision symbol	REVISION Reason for change and description of revision	Signed Stamp
Dec. 14, 2023	P1,2,4	5.0	• Software version upgrade CPU1 Ver1.14 → Ver1.15 CPU2 Ver1.14 → Ver1.15	
	P4,218,265		1) Function added "Start of block operation when servo is turned on"	
	P4,218		2) Function added "Origin detection method 3(Z phase),4(Z phase(approximate))"	
	P259,264		• Addition Added the description of Pr5.87,Pr6.78,Pr6.79 (For manufacturer use)	
	P265		• Addition Added the description of Pr6.98 bit28,Pr6.98 bit29	

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Table of Contents

1. Introduction

This document provides explanation about the functions of MINAS-A6 series Servo Drivers.

<MINAS-A6 series Functional comparison>

○:Usable ×:Not usable

Function \ Product		[A6SE] (Basic type) Product number ending with: E CPU1:Ver1.15 CPU2:Ver1.15	[A6SG] (RS485 Communication type) Product number ending with: G CPU1:Ver1.15 CPU2:Ver1.15	[A6SF] (Multifunction type) Product number ending with: F CPU1:Ver1.15 CPU2:Ver1.15
Control mode	Position control	○	○	○
	Velocity control (Internal velocity command)	○	○	○
	Velocity command (Analog velocity command)	×	×	○
	Torque control	×	×	○
	Position/velocity control	○	○	○
	Position/torque control	×	×	○
	Velocity/torque control	×	×	○
	Full-closed control	×	×	○
Analog input		×	×	○
Safety functions		×	×	○
Two-degree-of-freedom control (Position)		○	○	○
Two-degree-of-freedom control (Velocity)		○	○	○
Two-degree-of-freedom control (Full-closed)		×	×	○
Damping function		○	○	○
Model type damping filter		○	○	○
Feed forward function		○	○	○
Load variation suppression function		○	○	○
Third gain switching function		○	○	○
Friction torque compensation		○	○	○
Hybrid vibration suppression function		×	×	○
Quadrant projection suppression function		○	○	○
Torque limit switching function		○	○	○
Allowable motor operating range setting function		○	○	○
Torque saturation protection function		○	○	○
Infinite rotation absolute function		○	○	○
External scale position information monitor function		×	×	○
High response current control		○	○	○
Communication functions	USB (for PANATERM connection)	○	○	○
	RS232 (MINAS standard protocol)	×	○	○
	RS485 (MINAS standard protocol)	×	○	○
	Modbus-RTU *1	×	○	○
Block operation *1	Start on Modbus communication	×	○	○
	Start on input signal	○	○	○

- [A6SF] (Multifunction type): All functions described in this reference can be used.
- [A6SE] (Basic type)/[A6SG] (RS485 Communication type): There are some functions that cannot be used. Where applicable, these items are indicated with “Cannot be used in [A6SE]” or “Cannot be used in [A6SG]” in the descriptions contained in this reference for your confirmation.

*1 For details of Modbus communications and block operations, please refer to Technical reference (Modbus communication and Block operation Specification).

<About Absolute Encoders>

Absolute encoders come in two types: a type that retains multi-turn data with a battery for absolute data (hereafter called the battery-powered absolute encoder), and a type that does not require a battery to retain multi-turn data (hereafter called the “battery-less absolute encoder”).

Functions common to both types of absolute encoders are shown unless specified otherwise.

<Software version>

These materials apply to the servo drivers of the following software versions:

CPU1 Version: Ver.1.15

CPU2 Version: Ver.1.15

* Please confirm the software version from the set-up support software (PANATERM) or from the front panel.

<table>
<tr><th>Software version</th><th>Functional change contents</th><th>Corresponding PANATERM</th></tr>
<tr><td>CPU1 Ver1.03
CPU2 Ver1.03</td><td>Initial release</td><td>6.0.0.2 or later</td></tr>
<tr><td>CPU1 Ver1.05
CPU2 Ver1.05</td><td>Function enhancement version 1
<table>
<tr><th>Additional function</th><th>Related items</th></tr>
<tr><td>1) Infinite revolution absolute function</td><td>4-7-1, 6-8, 9-1</td></tr>
<tr><td>2) External scale position information monitoring function under semi-closed control</td><td>4-8, 9-1</td></tr>
<tr><td>3) Full-closed control support for load variance suppression function</td><td>1-1, 5-2-9, 9-1</td></tr>
<tr><td>4) Functional enhancement of quadrant projection suppression function</td><td>5-2-15, 9-1</td></tr>
<tr><td>5) Position compare function</td><td>1-1, 2-2, 2-3-2, 4-2-4, 6-7, 9-1</td></tr>
<tr><td>6) Serial absolute external scale Z-phase shift amount setting in pulse regeneration function</td><td>4-2-4, 9-1</td></tr>
<tr><td>7) Slow stop function</td><td>6-5-7, 9-1</td></tr>
<tr><td>8) Deterioration diagnosis warning function</td><td>6-9, 7-3, 9-1</td></tr>
<tr><td>9) Modbus function enhancements
- Strobe input operation automatic OFF
- Request action specification switching
- Mirror register setting</td><td>9-1,
Technical reference (Modbus communication and Block operation Specification)</td></tr>
<tr><td>10) Block operation function enhancements
- Input signal start-up
- Full-closed control support
- Infinite length operation
- Absolute mode correspondence to origin offset function</td><td>9-1,
Technical reference (Modbus communication and Block operation Specification)</td></tr>
</table></td><td rowspan="2">6.0.0.9 or later</td></tr>
<tr><td>CPU1 Ver1.06
CPU2 Ver1.06</td><td>Function enhancement version 2
<table>
<tr><th>Additional function</th><th>Related items</th></tr>
<tr><td>1) “Main power supply AC Off detection time” Expansion of the set range
- Changed the lower limit of Pr5.09 from 70 to 20</td><td>7-2, 9-1</td></tr>
<tr><td>2) “Hybrid vibration suppression filter” Expansion of the set range
- Changed the upper limit of Pr6.35 from 6400 to 32000</td><td>5-2-13, 9-1</td></tr>
<tr><td>3) “Allowable motor operating range setting” Expansion of the protection functions
- Added Pr6.97 bit2 (Expansion of Allowable motor operating range abnormal protection)</td><td>6-3, 9-1</td></tr>
<tr><td>4) “Block operation function” Specification improvement of Decelerate stop command</td><td>Technical reference (Modbus communication and Block operation Specification)</td></tr>
</table></td></tr>
</table>

Software version	Functional change contents		Corresponding PANATERM
CPU1 Ver1.07 CPU2 Ver1.07	Function enhancement version 3		6.0.1.6 or later
	Additional function	**Related items**	
	1) Expansion in range of the manufacturing number indication function	3-2-1, 9-3-7 Technical reference (Modbus communication and Block operation Specification)	
CPU1 Ver1.09 CPU2 Ver1.09	Function enhancement version 4		6.0.1.12 or later
	Additional function	**Related items**	
	1) Specification extension of command pulse prohibition input (INH)	2-1,4-2-7,9-1-6	
	2) Setting range extension of analog input offset	4-3,4-4,6-2,9-1-5	
	3) Specification extension of deterioration diagnosis warning function	6-9,9-1-7	
	4) Compatible with the battery-less absolute encoder	1, 1-1, 4-7-1, 4-7-1-4,4-7-1-6,7-2, 7-3 Technical reference (Modbus communication and Block operation Specification)	
CPU1 Ver1.10 CPU2 Ver1.10	Function enhancement version 5		6.0.1.13 or later
	Additional function	**Related items**	
	1) High response current control function ・Extension of setting range in Pr6.11 (current response setup)	5-2-22、9-1-7	
CPU1 Ver1.11 CPU2 Ver1.11	Function enhancement version 6		6.0.1.13 or later
	Additional function	**Related items**	
	1) Extension of the range of absolute date	7-2 Technical reference (Modbus communication and Block operation Specification)	
CPU1 Ver1.12 CPU2 Ver1.12	Function enhancement version 7		6.0.4.0 or later
	Additional function	**Related items**	
	1) Pulse train control when block operations are enabled	4-2-2,4-2-5,4-2-7,6-5-1,7-2,9-1-7 Technical reference (Modbus communication and Block operation Specification)	
	2) Position compare fanction enhancement.	2-1,2-3-1,6-7,9-1-6 Technical reference (Modbus communication and Block operation Specification)	
	3) Origin detection method 15 (Actual position set)	Technical document (Modbus Communication and Block Operation Specification).	
CPU1 Ver1.13 CPU2 Ver1.13	Function enhancement version 8		6.0.5.0 or later
	Additional function	**Related items**	
	1) Extension of the unit of acceleration/deceleration of Block operation	No change in this ocument. Technical document (Modbus Communication and Block Operation Specification).	
CPU1 Ver1.14 CPU2 Ver1.14	Function enhancement version 9		6.0.8.2 or later
	Additional function	**Related items**	
	1) Backlash compensation function	5-2-1,5-2-17,6-10,7-2,9-1-7,9-1-8 Technical reference (Modbus communication and Block operation Specification)	
	2) In case of 4(=Pr6.28) absolute mode corresponding	7-2 Technical reference (Modbus communication and Block operation Specification)	
	3) In case of 0(=Pr6.28) 6000h order monitor corresponding	Technical document (Modbus Communication and Block Operation Specification).	

<table>
<tr><th>Software version</th><th>Functional change contents</th><th>Corresponding PANATERM</th></tr>
<tr><td>CPU1 Ver1.15
CPU2 Ver1.15</td><td>Function enhancement version 10
<table>
<tr><th>Additional function</th><th>Related items</th></tr>
<tr><td>1) Start of block operation when servo is turned on</td><td>This document
7-2,9-1-7
Technical reference (Modbus communication and Block operation Specification)</td></tr>
<tr><td>2) Origin detection method 3(Z phase), 4(Z phase(approximate))</td><td>This document
7-2
Technical reference (Modbus communication and Block operation Specification)</td></tr>
</table></td><td>6.0.10.0
or later</td></tr>
</table>

* A new software version is downward compatible with a old software version.
Parameters used in a old software version can be used in a new software version, as is.
The parameter settings added to a new software version are the default settings with additional capability invalidated and compatible with a old software version.
When using the additional capability, set parameters according to the description of each function in this document.

<Related materials>

SX-DSV03025 : Specifications (Explanation mainly on specifications of hardware)
SX-DSV03042 : Technical reference (Modbus communication and Block operation Specification)

<Points to note>

(1) Unauthorized copying or reproduction of all or a part of this document is strictly prohibited.
(2) The contents of this document (specification, software version, etc.) are subject to change without notice for product improvement.
(3) Changes have been made to the shipment settings in the current MINAS-A6 Series, such as the enabling of two degree of freedom control mode, etc.
When replacing the former series (MINAS-A5 Series, etc.) with the current MINAS-A6 Series, please note that there may be cases where parameter adjustments will become necessary.
(4) MINAS-A6 series may not be fully compatible with the previous series (such as MINAS-A5 series).
When replacing a previous series with a MINAS-A6 series, be sure to evaluate it.

1-1 Basic Specification

<table>
<tr><th colspan="2">Item</th><th>Description</th></tr>
<tr><td colspan="2">Control method</td><td>IGBT PWN method, sinusoidal drive</td></tr>
<tr><td colspan="2">Control mode</td><td>(1) Position control (2) Velocity control (3) Torque control (4) Position/velocity control
(5) Position/torque control (6) Velocity/torque control (7) Full-closed control
The aforementioned 7 modes can be switched by using parameters.*1</td></tr>
<tr><td colspan="2">Encoder feedback</td><td>23-bit (resolution: 8,388,608) 7-serial Battery-powered absolute encoder
23-bit (resolution: 8,388,608) 5-serial Battery-less absolute encoder *6</td></tr>
<tr><td colspan="2">External scale feedback *2, *3</td><td>A/B phase, origin signal differential input
Serial communications scale supporting manufacturers: *5
- Mitutoyo Corporation
- Heidenhain
- Renishaw PLC
- Magnescale Co., Ltd.
- NIDEC Sankyo Corporation
- Fagor Automation S. Coop</td></tr>
<tr><td rowspan="2">Control signal</td><td>Input</td><td>General purpose 10 input
General purpose input functions can be selected by parameter.</td></tr>
<tr><td>Output</td><td>General purpose 6 output
General purpose output functions can be selected by parameter.</td></tr>
<tr><td rowspan="2">Analog signal</td><td>Input</td><td>3 inputs (16 bit A/D: 1 input, 12 bit A/D: 2 inputs)*2</td></tr>
<tr><td>Output</td><td>2 outputs (analog monitors 1 and 2)
Output from I/F connector pins 42 and 43.</td></tr>
<tr><td rowspan="2">Pulse signal</td><td>Input</td><td>2 inputs respectively
Both line driver I/F and open collector I/F are supported with photo coupler input can be supported.
Line driver I/F can be supported with line receiver input.</td></tr>
<tr><td>Output</td><td>4 outputs respectively
Encoder pulse (A/B/Z phase) or external scale pulse (EXA/EXB/EXZ phase) is output by using the line driver.
Z-phase or EXZ-phase pulse can also be output with open collector.
* Pulse signal will not be output when block operation and full-closed control are both valid.</td></tr>
<tr><td rowspan="4">Communication function</td><td>USB</td><td>Parameter setting and status monitoring, etc. are available by connecting PC, etc.</td></tr>
<tr><td>RS232 (MINAS standard protocol)</td><td>1:1 communication with the host controller is possible.*2</td></tr>
<tr><td>RS485 (MINAS standard protocol)</td><td>1:N communication with the host controller is possible.*2</td></tr>
<tr><td>MODBUS-RTU</td><td>1:N communication with superior controller is possible.*2 *4</td></tr>
<tr><td colspan="2">Safety terminal</td><td>Terminal to provide functional safety*2, *3</td></tr>
<tr><td colspan="2">Front panel</td><td>(1) KEY 5 pieces (2) LED 6-digit</td></tr>
<tr><td colspan="2">Regeneration</td><td>A, B, G, H frame: Without built-in regeneration resistor (external resistor only)
C to F frame: Built-in regeneration resistor (External regeneration resistor is also available)</td></tr>
<tr><td colspan="2">Dynamic brake</td><td>A to G frame: Built-in type
H frame: External type only</td></tr>
</table>

*1 For [A6SE], [A6SG] only position control and velocity control (internal velocity only) are available.
*2 This function cannot be used with [A6SE].
*3 This function cannot be used with [A6SG].
*4 Regarding the detail of Modbus communication, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction.
*5 Please contact us for a corresponding part number.
*6 Supported in a software version of function expansion edition 4 or later

1-2 Function (Position control)

Item			Description
Position control	Control input		Deviation counter clear, command pulse input inhibition, command division/multiplication switching, vibration suppression control switching, etc.
	Control output		Positioning complete, etc.
	Pulse input	Maximum command pulse frequency	500 K[pulse/s] (when using the photo coupler input) 8 M[pulse/s] (when using the line receiver input of A-phase /B-phase)
		Input pulse string form	Differential input. Differential input can be selected by parameters. ((1) Positive direction/ negative direction, (2) A-phase/B-phase (3) Command/ direction)
		Command pulse division/multiplication (Setting of electronic gear ratio)	1/1000 to 8000 times Although electronic gear ratio of the encoder resolution (numerator) and command number of pulses per revolution of the motor (denominator) can be arbitrarily set in the range of 1 to 2^{30} for the numerator and in the range of 1 to 2^{30} for the denominator, this product should be used within the aforementioned range.
		Smoothing filter	Primary delay filter or FIR filter is selectable for command input.
	Analog input*1	Torque limit command input	Torque limit can be applied to each direction respectively.
	Damping control		Available (Up to 3 frequency settings, out of 4 settings in total, can be used simultaneously.)
	Model type damping filter		Available (2 filters available) [Requirement] 2 degrees of freedom control is enabled.
	Feed forward function		Available (speed/torque)
	Load variation suppression function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Third gain switching function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Friction torque compensation		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Hybrid vibration suppression function		Not available
	Quadrant projection suppression function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	2 degrees of freedom control		Available (Standard type/Synchronization type) [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Torque limit switching function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Allowable motor operating range setting function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Torque saturation protection function		Available
	Infinite rotation absolute function		Available [Requirement] No hindrance for the motor’s normal run. The 23-bit absolute encoder is connected.
	Position compare output function		Available [Requirement] Block operation valid setting Return to origin completed state in increment mode (when block operation origin return invalidation setting is set to invalid) Other than Countinuous rotating absolute mode (Pr0.15=4).
	Backlash compensation function		Available
	External scale position information monitor function		Available *1
	Block operation		Available *2

*1 This function cannot be used with [A6SE], [A6SG].

*2 Regarding the detail ofBlock Operation function, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction.”

1-3 Function (Velocity control)

Item			Description
Velocity control	Control input		Internal command velocity selection 1, Internal command velocity selection 2, Internal command velocity selection 3, speed zero clamp, etc.
	Control output		Speed arrival, etc.
	Analog input *1	Velocity command input	Velocity command input with analog voltage is possible. Scale setting and command polarity vary depending on parameters.
		Torque limit command input	Torque limit can be applied to each direction respectively.
	Internal velocity command		It is possible to switch 8 speeds of internal velocity with control input.
	Soft start/down function		0 to 10 s/(1000 r/min) Setting is possible for acceleration and deceleration respectively. S shaped acceleration/deceleration is possible.
	Speed zero clamp		Internal velocity command can be clamped to 0 with speed zero clamp input.
	Velocity command filter		Available
	Damping control		Not available
	Model type damping filter		Not available
	Feed forward function		Available (torque)
	Load variation suppression function		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Third gain switching function		Not available
	Friction torque compensation		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Hybrid vibration suppression function		Not available
	Quadrant projection suppression function		Not available
	2 degrees of freedom control		Available (Standard type) [Requirement] Servo-on. No hindrance for the motor's normal run.
	Torque limit switching function		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Allowable motor operating range setting function		Not available
	Torque saturation protection function		Available
	Infinite rotation absolute function		Available [Requirement] No hindrance for the motor's normal run. The 23-bit absolute encoder is connected.
	Position compare output function		Not available
	Backlash compensation function		Not available
	External scale position information monitor function		Available *1
	Block operation		Not available

*1 This function cannot be used with [A6SE], [A6SG].

1-4 Function (Torque control)

Item			Description
Torque control *1	Control input		Speed zero clamp, torque command sign input, etc.
	Control output		Speed arrival, etc.
	Analog input	Torque command input	Torque command input with analog voltage is possible. Scale setting and command polarity vary depending on parameters.
	Speed limit function		Speed limit value can be set by using parameters.
	Damping control		Not available
	Model type damping filter		Not available
	Feed forward function		Not available
	Load variation suppression function		Not available
	Third gain switching function		Not available
	Friction torque compensation		Not available
	Hybrid vibration suppression function		Not available
	Quadrant projection suppression function		Not available
	2 degrees of freedom control		Not available
	Torque limit switching function		Not available
	Allowable motor operating range setting function		Not available
	Torque saturation protection function		Not available
	Infinite rotation absolute function		Available [Requirement] No hindrance for the motor's normal run. The 23-bit absolute encoder is connected.
	Position compare output function		Not available
	Backlash compensation function		Not available
	External scale position information monitor function		Available
	Block operation		Not available

*1 This function cannot be used with [A6SE], [A6SG].

1-5 Function (Full-closed control)

Item			Description
Full-closed control *1 *3	Control input		Deviation counter clear, command pulse input inhibition, command division/multiplication switching, vibration suppression control switching, etc.
	Control output		Positioning complete, etc.
	Pulse input	Maximum command pulse frequency	500 K[pulse/s] (when using the photo coupler input) 8 M[pulse/s] (when using the line receiver input of A-phase /B-phase)
		Input pulse string form	Differential input. Differential input can be selected by parameters. ((1) Positive direction/ negative direction, (2) A-phase/B-phase (3) Command/ direction)
		Command pulse division/multiplication (Setting of electronic gear ratio)	1/1000 to 8000 times Although electronic gear ratio of the encoder resolution (numerator) and command number of pulses per revolution of the motor (denominator) can be arbitrarily set in the range of 1 to 2^{30} for the numerator and in the range of 1 to 2^{30} for the denominator, this product should be used within the aforementioned range.
		Smoothing filter	Primary delay filter or FIR filter is selectable for command input.
	Analog input	Torque limit command input	Torque limit can be applied to each direction respectively.
	Setting range of external scale division/multiplication		1/40 to 1280 times Although ratio of the encoder pulse (numerator) and external scale pulse (denominator) can be arbitrarily set in the range of 1 to 2^{23} for the numerator and in the range of 1 to 2^{23} for the denominator, this product should be used within the aforementioned range.
	Damping control		Available (Up to 2 frequency settings, out of 4 settings in total, can be used simultaneously.)
	Model type damping filter		Not available
	Feed forward function		Available (speed/torque)
	Load variation suppression function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Third gain switching function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Friction torque compensation		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Hybrid vibration suppression function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Quadrant projection suppression function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	2 degrees of freedom control		Available (Standard type) [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Torque limit switching function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Allowable motor operating range setting function		Available [Requirement] Servo-on. No hindrance for the motor’s normal run.
	Torque saturation protection function		Available
	Infinite rotation absolute function		Not available
	Position compare output function		Available [Requirement] Block operation valid setting Return to origin completed state in increment mode (when block operation origin return invalidation setting is set to invalid) Other than Countinuous rotating absolute mode (Pr0.15=4).
	Backlash compensation function		Not available
	External scale position information monitor function		Available
	Block operation		Available *2

*1 This function cannot be used with [A6SE], [A6SG].

*2 Regarding the detail of Block Operation function, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction.”

*3 When using in block operation is invalid setting and absolute mode (Pr.0.15 "absolute encoder setting" = 0,2), set as follows.
(1) Connecting the battery for absolute data For details on whether or not to need the battery connection, refer to 4-7-1.
(2) Set Pr0.01 (control mode) to a value other than 6 (fully closed control), write to EEPROM, and turn on the power again.
(3) Execute multi-rotation clear on the monitor screen. (At this time, the multi-rotation data becomes 0)
(4) Set Pr0.01 (control mode) to 6 (fully closed control), write to EEPROM, and turn on the power again.
*The above settings are unnecessary for the software of function enhancement version 9 or later.

1-6 Function (Common)

Item		Description
Common	Auto-tuning	This function identifies the load inertia real-time and automatically sets up the gain that meets the stiffness setting when the motor is running with host and internal driver operation commands.
	Pulse signal output division function	Number of pulses can be arbitrarily set. (However, the number of encoder pulses is the maximum number.)
	Notch filter	Available (5 filters available)
	Gain switching function	Available
	2-step torque filter	Available [Requirement] Servo-on. No hindrance for the motor's normal operation.
	Protection function	Overvoltage, undervoltage, overspeed, overload, overheat, overcurrent, encoder failure, positional overdeviation, command pulse division, EEPROM failure, etc.
	Alarm data trace back function	Reference of history of alarm data is available.
	Deterioration diagnosis function	Available

2. Interface specification

2-1 I/F connector Input signal specification

Input signals and their functions

Class	Signal name	Symbol	Connector pin No.	Contents	Control mode: Position	Velocity	Torque	Full-closed
Common	Signal power source for control	COM+	7	• This signal can be used for connecting to the positive terminal of the external DC source (12 to 24 V).				
		COM-	41	• This signal can be used for connecting to the negative terminal of the external DC source (12 to 24 V).				
Pulse input	Command pulse input 1	PULSH1	44	• This is the input terminal for the position command pulse dedicated for line driver output. • This input is disabled in factory default settings. When using this signal, "1 "needs to be set for Pr0.05 "Command pulse input selection". • For more information, refer to 4-2-1.	○	- *1	-	○
		PULSH2	45					
	Command sign input 1	SIGNH1	46					
		SIGNH2	47					
	Command pulse input 2	OPC1	1	• This is the input terminal for the position command pulse that supports both of line driver and open collector. • This input is enabled in factory default settings. • For more information, refer to 4-2-1.	○	-	-	○
		PULS1	3					
		PULS2	4					
	Command sign input 2	OPC2	2					
		SIGN1	5					
		SIGN2	6					
Control input	Servo-ON input	SRV-ON	29 (SI6) *	• This is the signal used to control servo-ON (energized status/not energized status of motor).	○	○	○	○
	Positive direction drive prohibition input	POT	9 (SI2) *	• This signal is the drive prohibition input toward the positive direction. • Operations when this input becomes ON are set by using Pr5.04 "Drive prohibition input setting". • When using this signal, a value other than 1 needs to be set for Pr5.04 "Drive prohibition input setting "and connect the machine in such a manner that input is enabled when the moving portion of the machine exceeds the movable range in the positive direction.	○	○	○	○
	Negative direction drive prohibition input	NOT	8 (SI1) *	• This signal is the drive prohibition input toward the negative direction. • Operations when this input becomes ON are set by using Pr5.04 "Drive prohibition input setting". • When using this signal, a value other than 1 needs to be set for "drive prohibition input setting "and the machine needs to be connected in such a manner that input is enabled when the moving portion of the machine exceeds the movable range in the negative direction.	○	○	○	○
	Deviation counter clear input	CL	30 (SI7) *	• This signal clears the position deviation counter. • Position deviation is set to be cleared with edge in the factory default setting. When changing this signal, this signal needs to be set with Pr5.17 "Counter clear input mode". • For more information, refer to 4-2-5.	○	-	-	○
	Alarm clear	A-CLR	31 (SI8) *	• This signal is used to clear the alarm status. • There are alarms that cannot be cleared with this input.	○	○	○	○
	Command pulse inhibit input	INH	33 (SI10) *	• Position command pulse is ignored. *2 • When using this signal, "0" or "2" needs to be set for Pr5.18 "Command pulse prohibition input disable". • For more information, refer to 4-2-7.	○	-	-	○
	Control mode switch input	C-MODE	32 (SI9) *	• This signal is used to switch the control mode. • Do not input the command 10 ms before and after switching the control mode.	○	○	○	-

*1 "- "in the table indicates that operations are not affected even if the input signal is switched ON/OFF.

*2 When Pr5.18 "Command pulse prohibition input (INH) disable" is set to 0, ignore the position command pulse and, at the same time, clear the accumulated pulses of the position command filter function as well as the remnant pulses of the command division/multiplication function.
When the INH input is turned ON, a discrepancy will occur between the position command data controlled by the higher-level device and the internal position command of the servo driver and, as a result, the origin position data before the INH input will be lost. When restarting an operation that requires the position control, always conduct the return to origin.

Class	Signal name	Symbol	Connector pin No.	Contents	Control mode			
					Position	Velocity	Torque	Full-closed
Control input	Command division/multiplication switch input 1	DIV1	28 (SI5) *	• This signal is used to switch the numerator of command division/multiplication. *1 • For more information, refer to 6-4.	○	-	-	○
	Vibration suppression control switch input 1	VS-SEL1	26 (SI3) *	• This signal is used to switch the frequency to which vibration suppression control is applied. A maximum of 4 frequencies can be switched along with vibration suppression control switch input 2 (VS-SEL2). • For more information, refer to 5-2-7-1.	○	-	-	○
	Gain switch input	GAIN	27 (SI4) *	• This signal can be used to switch between the first gain and second gain. • For more information, refer to 5-2-5.	○	○	○	○
	Torque limit switch input	TL-SEL	-	• This signal can be used to switch between the first/second torque limit. • For more information, refer to 6-1.	○	○	-	○
	Internal command velocity selection 1 input	INTSPD1	33 (SI10) *	• This signal is used to select the internal command velocity (1 to 8). • For more information, refer to 4-3-2.	-	○	-	-
	Internal command velocity selection 2 input	INTSPD2	30 (SI7) *		-	○	-	-
	Internal command velocity selection 3 input	INTSPD3	28 (SI5) *		-	○	-	-
	Speed zero clamp input	ZEROSPD	26 (SI3) *	• This signal is used to set the velocity command to zero. • When using this signal, a value other than“0 ”needs to be set for Pr3.15 “Speed zero clamp function selection”. • For more information, refer to 4-3-3.	-	○	○	-
	Vibration suppression control switch input 2	VS-SEL2	-	• This signal is used to switch the frequency to which vibration suppression control is applied. A maximum of 4 frequencies can be switched along with vibration suppression control switch input 1 (VS-SEL1). • For more information, refer to 5-2-7-1.	○	-	-	○
	Velocity command sign input	VC-SIGN	-	• This signal specifies the sign of velocity command input when controlling velocity. • For more information, refer to 4-3-1 and 4-3-2.	-	○	-	-
	Torque command sign input	TC-SIGN	-	• This signal specifies the sign of torque command input when controlling torque. • For more information, refer to 4-4-1 and 4-4-2.	-	-	○	-
	Command division/multiplication switch input 2	DIV2	-	• This signal is used to switch the command division/multiplication. *1 • For more information, refer to 6-4.	○	-	-	○
	Forced alarm input	E-STOP	-	• This signal generates Err87.0 “Forced alarm input error”.	○	○	○	○
	Inertia ratio switch input	J-SEL	-	• This signal is used to switch the inertia ratio. • For more information, refer to 5-2-12.	○	○	○	○
	Dynamic brake (DB) switch input	DB-SEL	-	• This signal is used to switch dynamic brake (DB) On/Off. • Switching is only possible when main power supply Off is detected. • For more information, refer to 4-3-1 and 6-5-3	○	○	○	○
	Position compare switch input	CMP-SEL	-	•Switches between valid and invalid of the position compare output function. •For more information, refer to 6-7.	○	-	-	○

*1 When the DIV1/DIV2 input has been changed over to change the division numerator, the relationship will change between the position command data controlled by the higher-level device and the internal position command after the position command filter of the servo driver. When conducting an operation that requires the position control, carry out the return to origin.

<table>
<tr><th rowspan="2">Class</th><th rowspan="2">Signal name</th><th rowspan="2">Symbol</th><th rowspan="2">Connector pin No.</th><th rowspan="2">Contents</th><th colspan="4">Control mode</th></tr>
<tr><th>Position</th><th>Velocity</th><th>Torque</th><th>Full-closed</th></tr>
<tr><td rowspan="7">Analog input *1</td><td>Positive direction torque limit input</td><td>P-ATL</td><td>16</td><td>• This signal specifies the torque limit value in the positive direction with the analog voltage.
• For more information, refer to 6-2.</td><td>○</td><td>○</td><td>-</td><td>○</td></tr>
<tr><td>Negative direction torque limit input</td><td>N-ATL</td><td>18</td><td>• This signal specifies the torque limit value in the negative direction with the analog voltage.
• For more information, refer to 6-2.</td><td>○</td><td>○</td><td>-</td><td>○</td></tr>
<tr><td>Velocity command input</td><td>SPR</td><td>14</td><td>• Velocity command is input with analog voltage.
• For more information, refer to 4-3-1.</td><td>-</td><td>○</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Torque command input</td><td rowspan="2">TRQR</td><td>14</td><td>• Torque command is input with analog voltage when 0 is set for Pr3.17 “Torque command selection”.
• For more information, refer to 4-4-1.</td><td>-</td><td>-</td><td>○</td><td>-</td></tr>
<tr><td>16</td><td>• Torque command is input with analog voltage when 1 is set for Pr3.17 “Torque command selection”.
• For more information, refer to 4-4-2.</td><td>-</td><td>-</td><td>○</td><td>-</td></tr>
<tr><td>Speed limit input</td><td>SPL</td><td>14</td><td>• The speed limit value is input with analog voltage when 1 is set for Pr3.17 “Torque command selection”.
• For more information, refer to 4-4-2.</td><td>-</td><td>-</td><td>○</td><td>-</td></tr>
</table>

*1 This function cannot be used with [A6SE], [A6SG].

<table>
<tr><th>Class</th><th>Name</th><th>Symbol</th><th>Connector pin No.</th><th>Contents</th></tr>
<tr><td rowspan="3">Analog input</td><td>Analog input 1</td><td>AI1</td><td>14</td><td>• The maximum allowable input voltage is ±10 V.
• Analog input with 16-bit resolution.
• ±27888[LSB] = ±10[V], 1[LSB] ≒ 0.359[mV]
The accuracy of analog input values is not guaranteed.</td></tr>
<tr><td>Analog input 2</td><td>AI2</td><td>16</td><td>• The maximum allowable input voltage is ±10 V.
• Analog input with 12-bit resolution.
• ±1707[LSB] =±10[V], 1[LSB] ≒ 5.86[mV]
The accuracy of analog input values is not guaranteed.</td></tr>
<tr><td>Analog input 3</td><td>AI3</td><td>18</td><td>• The maximum allowable input voltage is ±10 V.
• Analog input with 12-bit resolution.
• ±1707[LSB] =±10[V], 1[LSB] ≒ 5.86[mV]
The accuracy of analog input values is not guaranteed.</td></tr>
</table>

- For the pin with “* ”in the connector pin number, it is possible to change the signal function and logic by using signals from Pr4.00 to Pr4.09 (SI* input selection). However, note that pin No. to which the following functions can be assigned are predetermined.
  Deviation counter clear input (CL): SI7
  Command pulse input inhibit input (INH): SI10
- Functions with “- ”in the Connector pin No. column indicate that these functions are not assigned with factory setting.

2-2 I/F connect Output signal specification

Output signals and their functions

Class	Signal name	Symbol	Connector pin No.	Contents	Control mode: Position	Control mode: Velocity	Control mode: Torque	Control mode: Full-closed
Common	Frame ground	FG	Shell	• This output is connected to the ground terminal inside of the servo driver.				
	Signal ground	GND	13,15 17,25	• Signal ground • This output is insulated from the power source for control signal (COM-) inside of the servo driver.				
Pulse output/Position compare output	A-phase output/Position compare output 1	OA+/ OCMP1+	21	• Divided encoder signal or external scale signal (A/B/Z phase) is output with differential output. (Corresponding to RS422) • The ground of line driver of the output circuit is connected to the signal ground (GND) and the ground is not insulated. • The maximum output frequency is 4 M[pulse/s] (after multiplication by 4). • Can be used as position compare output, by setting bits 0 to 2 of Pr4.47 "Pulse output select" to 1.	○	○	○	○
		OA-/ OCMP1-	22					
	B-phase output/Position compare output 2	OB+ / OCMP2+	48					
		OB- / OCMP2+	49					
	Z-phase output/Position compare output 3	OZ+/OCM P3+	23					
		OZ-/ OCMP3+	24					
	Z-phase output/Position compare output 4	CZ/ OCMP4	19	• This is the open collector output of the Z-phase signal. • The emitter side of the transistor of the output circuit is connected to the signal ground (GND) and the ground is not insulated.				
Control output	Servo-Alarm output	ALM	36 37 (SO3) *	• This output signal indicates that the driver is in alarm status. • The output transistor is turned ON when the driver is at normal status, and the output transistor turns OFF at alarm status.	○	○	○	○
	Servo-Ready output	S-RDY	34 35 (SO2) *	• This output signal indicates that the driver is ready to be activated. • If control and main power are established and the driver is not in alarm status, the output transistor is turned on.	○	○	○	○
	External brake release signal	BRK-OFF	10 11 (SO1) *	• The timing signal which activates the electromagnetic brake of the motor is output. • The output transistor is turned ON when electromagnetic brake is released.	○	○	○	○
	Positioning complete	INP	38 39 (SO4) *	• The positioning complete signal is output. • The output transistor is turned ON when positioning is completed. • For more information, refer to 4-2-6.	○	- *1	-	○
	Speed arrival output	AT-SPEED	38 39 (SO4) *	• The speed arrival signal is output. • The output transistor is turned ON when a velocity is reached. • For more information, refer to 4-3-4.	-	○	○	-
	Torque in-limit signal output	TLC	40 (SO6) *	• Torque in-limit signal is output. • The output transistor is turned ON while torque is limited • For more information, refer to 6-6.	○	○	○	○
	Zero-speed detection signal	ZSP	12 (SO5) *	• The zero-speed detection signal is output. • The output transistor is turned ON while zero speed is detected.	○	○	○	○

*1 For the signal with "- "sign in the table, the output transistor is always turned off.

Class	Signal name	Symbol	Connector pin No.	Contents	Control mode			
					Position	Velocity	Torque	Full-closed
Control output	Speed matching output	V-COIN	-	• The speed matching signal is output. • The output transistor is turned ON when the velocity matching status is detected. • For more information, refer to 4-3-5.	-	○	○	-
	Positioning complete 2	INP2	-	• The positioning complete signal 2 is output. • The output transistor is turned ON when positioning is completed. • For more information, refer to 4-2-6.	○	-	-	○
	Warning output 1	WARN1	-	• The warning output signal set by using Pr 4.40 “Warning output select 1 ”is output. • The output transistor is turned ON while an alarm is occurring.	○	○	○	○
	Warning output 2	WARN2	-	• The warning output signal set by using Pr 4.41“Warning output select 2”is output. • The output transistor is turned ON while an alarm is occurring.	○	○	○	○
	Position command ON/OFF output	P-CMD	-	• The output transistor is turned ON when there is a position command.	○	-	-	○
	Speed in-limit output	V-LIMIT	-	• The output transistor is turned ON when velocity limit is applied while torque is controlled.	-	-	○	-
	Alarm clear attribute output	ALM-ATB	-	• The output transistor is turned on if an alarm that can be cleared occurs.	○	○	○	○
	Velocity command ON/OFF output	V-CMD	-	• The output transistor is turned ON when the velocity command is applied while the velocity is controlled.	-	○	-	-
	Servo-ON status output	SRV-ST	-	• The output transistor is turned on when the servo turns ON.	○	○	○	○
	Deterioration diagnosis velocity output	V-DIAG	-	• The output transistor is turned ON when motor velocity of Pr5.75 (Deterioration diagnosis velocity setting) is within the range of PR4.35 (velocity concurrence width) • There is a hysteresis of 10 r/min in concurrence judgment for deterioration diagnosis velocity.	○	○	○	○
	Position compare output	CMP-OUT	-	• The output transistor is turned ON when the actual position has passed the position set by the parameter.	○	-	-	○
Analog output	Analog monitor 2 output	IM	42	• Analog monitor 2 is output. • For more information, refer to 2-3-3.	○	○	○	○
	Analog monitor 1 output	SP	43	• Analog monitor 1 is output. • For more information, refer to 2-3-3.	○	○	○	○

- For the pin with “*” in the connector pin number, it is possible to change the signal function by using signals from Pr4.10 to Pr4.15 (SO* input select).
- Functions with “-” in the Connector pin No. column indicate that these functions are not assigned with factory setting.

2-3 Input/output signal assignment function

Default input/output signal assignment can be changed.

2-3-1 Input signal assignment

For input signals, arbitrary function can be assigned to any input pin of I/F connector.
In addition, the logic can be changed.
However, some assignment limit is applied to specific signals. Refer to "(2) When using the reassigned input signal".

(1) Using with the default setting
The table below shows default signal assignment.

Input signal *2	Applicable parameter	Default setting ( ): decimal notation	Default setup					
			Position control/ Full-closed control		Velocity control		Torque control	
			Signal name	Logic *1	Signal name	Logic *1	Signal name	Logic *1
SI1 input	Pr4.00	00828282h (8553090)	NOT	b-contact	NOT	b-contact	NOT	b-contact
SI2 input	Pr4.01	00818181h (8487297)	POT	b-contact	POT	b-contact	POT	b-contact
SI3 input	Pr4.02	0091910Ah (9539850)	VS-SEL1	a-contact	ZEROSPD	b-contact	ZEROSPD	b-contact
SI4 input	Pr4.03	00060606h (394758)	GAIN	a-contact	GAIN	a-contact	GAIN	a-contact
SI5 input	Pr4.04	0000100Ch (4108)	DIV1	a-contact	INTSPD3	a-contact	- *3	-
SI6 input	Pr4.05	00030303h (197379)	SRV-ON	a-contact	SRV-ON	a-contact	SRV-ON	a-contact
SI7 input	Pr4.06	00000f07h (3847)	CL	a-contact	INTSPD2	a-contact	-	-
SI8 input	Pr4.07	00040404h (263172)	A-CLR	a-contact	A-CLR	a-contact	A-CLR	a-contact
SI9 input	Pr4.08	00050505h (328965)	C-MODE	a-contact	C-MODE	a-contact	C-MODE	a-contact
SI10 input	Pr4.09	00000E88h (3720)	INH	b-contact	INTSPD1	a-contact	-	-

*1 a-contact and b-contact show the following statuses.
a-contact: The signal input is open with COM-. →Function disabled (OFF state)
The signal input is connected to COM-. →Function enabled (ON state)
b-contact: The signal input is open with COM-. →Function disabled (ON state)
The signal input is connected to COM-. →Function enabled (OFF state)
For the purpose of this specification, the status of the input signal is defined as ON when the signal activates the specified function and OFF when the signal deactivates the specified function.
*2 Regarding the input allocation pin No. of the input signals SI1 to SI10, refer to the Specifications described in Chapter 1 "Introduction."
*3 "- "in the table indicates that status that no function is assigned.

(2) When using the reassigned input signal

The following parameters need to be changed when reallocating the input signal.

Class	No.	Parameter name	Setting range	Unit	Function
4	00	SI1 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI1 inputs. This parameter is set according to hexadecimal presentation standard.*1 After hexadecimal presentation, this parameter is set for each control mode as below. 00----**h: Position/Full-closed control 00--**--h: Velocity control 00**----h: Torque control The function number needs to be set for "**". For the function number, see the table below. Logical setup is included in a function number. Example) To make this pin as DIV1_a-contact for position/full-closed control, and as INSTPD1_b-contact for velocity control, and as disabled in torque control mode, set to 00008E0Ch. Position ... 0Ch Velocity ... 8Eh Torque ... 00h *1 Note that decimal representation is used for the front panel display.
4	01	SI2 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI2 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	02	SI3 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI3 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	03	SI4 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI4 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	04	SI5 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI5 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	05	SI6 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI6 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	06	SI7 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI7 inputs. This parameter is set according to hexadecimal presentation standard Setup procedure is the same as described for Pr 4.00.
4	07	SI8 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI8 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	08	SI9 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI9 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.
4	09	SI10 input selection	0 to 00FFFFFFh	-	Functions are assigned to SI10 inputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.00.

Function number table

Signal name	Symbol	Setup value	
		a-contact	b-contact
Invalid	-	00h	Setting is impossible.
Positive direction drive prohibition input	POT	01h	81h
Negative direction drive prohibition input	NOT	02h	82h
Servo-ON input	SRV-ON	03h	83h
Alarm clear	A-CLR	04h	Setting is impossible.
Control mode switch input	C-MODE	05h	85h
Gain switch input	GAIN	06h	86h
Deviation counter clear input	CL	07h	Setting is impossible.
Command pulse input inhibit input	INH	08h	88h
Torque limit switch input	TL-SEL	09h	89h
Vibration suppression control switch input	VS-SEL1	0Ah	8Ah
Vibration suppression control switch input 2	VS-SEL2	0Bh	8Bh
Command division/multiplication switch input	DIV1	0Ch	8Ch
Command division/multiplication switch input 2	DIV2	0Dh	8Dh
Internal command velocity selection 1 input	INTSPD1	0Eh	8Eh
Internal command velocity selection 2 input	INTSPD2	0Fh	8Fh
Internal command velocity selection 3 input	INTSPD3	10h	90h
Speed zero clamp input	ZEROSPD	11h	91h
Velocity command code input	VC-SIGN	12h	92h
Torque command sign input	TC-SIGN	13h	93h
Forced alarm input	E-STOP	14h	94h
Inertia ratio switch input	J-SEL	15h	95h
Dynamic brake switching input	DB-SEL	16h	Setting is impossible
Position compare switch input	CMP-SEL	17h	97h

Precautions)

- Regarding the detail of Block action-related signals, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 "Introduction."
- Do not set a value other than that specified in the table.
- The same function cannot be assigned to multiple signals. Otherwise, Err 33.0 "I/F input multiple assignment error 1 " or Err 33.1 "I/F input multiple assignment error 2 "occurs.
- Deviation counter clear input (CL) can only be assigned to SI7 inputs. If the input is assigned to other than that, Err33.6 "Counter clear assignment error "occurs.
- Command pulse inhibition input (INH) can only be assigned to SI10 inputs. If the input is assigned to other than that, Err33.7 "Command pulse input inhibition input "occurs.
- When using the control mode switch input (C-MODE), all control modes need to be set. If configuration is made only for 1 or 2 modes, Err33.2"I/F input function number error 1 "or Err33.3"I/F input function number error 2"occurs.
- The control input pin configured for invalid does not affect operations.
- Functions used in multiple control modes (Servo-ON input, alarm clear function, etc.) need to be assigned to the same pin and the logic should be matched. If not configured properly, any of Err33.0 "I/F input duplicate assignment error 1", Err33.1 "I/F input duplicate assignment error 2, Err33.2"I/F input function number error 1", Err33.3 "I/F input function number error 2"occurs.
- Servo-ON input signal (SRV-ON) needs to be assigned. If the signal is not assigned, servo cannot be turned ON.
- When using the Dynamic brake switch input, all control modes need to set after set Pr 6.36(Dynamic brake operation input) =1.If configurationis mode only for 1 or 2 mode, Err33.2"I/F input function number error 1" or Err33.3"I/F input function number error 2" occurs.For more information, refer to 6-5-3.
- Depending on the operating state of the driver, the control mode may be forced to switch over inside the driver. Since such operation affects the input signal processing, **basically allocate the same function to one terminal for all modes.**

  [Conditions for the control mode to be forced to switch over inside the driver]

  - In case of frequency characteristics measurement of the set-up support software (PANATERM) (Forced to turn to any of the position, velocity, and torque control)
  - In case of the trial run of the set-up support software (PANATERM) operating (Forced to turn to the position control)
  - In case of the motor trial run of the front panel operating (Forced to turn to the velocity control)

2-3-2 Output signal assignment

For output signals, arbitrary function can be assigned to any output pin of I/F connector.
Logic of output pin cannot be changed.

(1) Using with the default setting

The table below shows default signal assignment.

Output signal *1	Applicable parameter	Default setting ( ): decimal notation	Default setup		
			Position control/ Full-closed control	Velocity control	Torque control
			Signal name	Signal name	Signal name
S01 outputs	Pr4.10	00030303h (197379)	BRK-OFF	BRK-OFF	BRK-OFF
S02 outputs	Pr4.11	00020202h (131586)	S-RDY	S-RDY	S-RDY
S03 outputs	Pr4.12	00010101h (65793)	ALM	ALM	ALM
S04 outputs	Pr4.13	00050504h (328964)	INP	AT-SPEED	AT-SPEED
S05 outputs	Pr4.14	00070707h (460551)	ZSP	ZSP	ZSP
S06 outputs	Pr4.15	00060606h (394758)	TLC	TLC	TLC

*1 Regarding the output allocation pin No. of the output signals S01 to S06, refer to the Specifications described in Chapter 1 “Introduction.”

(2) When using the reassigned input signal

The following parameters need to be changed when reallocating the output signal.

Class	No.	Parameter name	Setting range	Unit	Function
4	10	S01 output selection	0 to 00FFFFFFh	-	Functions are assigned to SO1 outputs. This parameter is set according to hexadecimal presentation standard.*1 After hexadecimal presentation, this parameter is set for each control mode as below. 00----**h: Position/Full-closed control 00--**--h: Velocity control 00**----h: Torque control The function number needs to be set for "**". For the function number, see the table below. *1 Note that decimal representation is used for the front panel display.
4	11	S02 output selection	0 to 00FFFFFFh	-	Functions are assigned to SO2 outputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.10.
4	12	S03 output selection	0 to 00FFFFFFh	-	Functions are assigned to SO3 outputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.10.
4	13	S04 output selection	0 to 00FFFFFFh	-	Functions are assigned to SO4 outputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.10.
4	14	S05 output selection	0 to 00FFFFFFh	-	Functions are assigned to SO5 outputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.10.
4	15	S06 output selection	0 to 00FFFFFFh	-	Functions are assigned to SO6 outputs. This parameter is set according to hexadecimal presentation standard. Setup procedure is the same as described for Pr 4.10.

Function number table

Signal name	Symbol	Setup value
Invalid	-	00h
Alarm output	ALM	01h
Servo-ready output	S-RDY	02h
External brake release signal	BRK-OFF	03h
Positioning complete	INP	04h
Speed arrival output	AT-SPEED	05h
Torque in-limit signal is output	TLC	06h
Zero-speed detection signal	ZSP	07h
Speed matching output	V-COIN	08h
Warning output 1	WARN1	09h
Warning output 2	WARN2	0Ah
Position command ON/OFF output	P-CMD	0Bh
Positioning complete 2	INP2	0Ch
Speed in-limit output	V-LIMIT	0Dh
Alarm attribute output	ALM-ATB	0Eh
Velocity command ON/OFF output	V-CMD	0Fh
Servo-ON status output	SRV-ST	10h
Position compare output	CMP-OUT	14h
Deterioration diagnosis velocity output	V-DIAG	15h

Precautions)

- Regarding the detail of Block action-related signals, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 "Introduction."
- For output signals, the same function can be assigned to multiple signals.
- For the control output pins specified as disabled, output transistors are always turned off.
- Do not set a value other than that specified in the table.
- Setting for all control modes is required when using the position compare output, (CMP-OUT). In case setting is made only to one or two control modes, Err33.4 "Output function number error 1 protection" or Err33.5 "Output function number error 2 protection" will occur.
- Depending on the operating state of the driver, the control mode may be forced to switch over inside the driver. Since such operation affects the output signal processing, basically allocate the same function to one terminal for all modes.

  [Conditions for the control mode to be forced to switch over inside the driver]

  - In case of frequency characteristics measurement of the set-up support software (PANATERM) (Forced to turn to any of the position, velocity, and torque control)
  - In case of the trial run of the set-up support software (PANATERM) operating (Forced to turn to the position control)
  - In case of the motor trial run of the front panel operating (Forced to turn to the velocity control)

2-3-3 Analog signal output function

Various monitor information can be output in analog value from the I/F connector (pins 42 and 43). Type of monitor to be output and scaling of analog monitor (output gain setting) can be arbitrarily set by using parameters.

■ Relevant parameters

Class	No.	Parameter name	Setting range	Unit	Function
4	16	Analog monitor 1 Type	0 to 28	-	The type of monitor for analog monitor 1 is selected. * Refer to the following table.
4	17	Analog monitor 1 output gain	0 to 214748364	[Monitor unit in Pr 4.16]/V	Output gain of analog monitor 1 is set. For Pr 4.16 = 0 "Motor velocity", 1 V is output at the motor velocity [r/min] = Pr 4.17 setup value.
4	18	Analog monitor 2 Type	0 to 28	-	The type of monitor for analog monitor 2 is selected. * Refer to the following table.
4	19	Analog monitor 2 output gain	0 to 214748364	[Monitor unit in Pr 4.18]/V	Output gain of analog monitor 2 is set. For Pr 4.18 = 4 "Torque command", 1 V is output at the torque command [%] = Pr 4.19 setup value.
4	21	Analog monitor output setting	0 to 2	-	The output type of analog monitor is selected. 0: Output of data with sign -10V to 10V 1: Absolute value data output 0V to 10V 2: Data output with offset 0V to 10V (5 V at center)

- The table below shows types of monitor set in Pr 4.16 "Analog monitor 1 type "and Pr 4.18 "Analog monitor 2 type". Pr 4.17 "Analog monitor 1 output gain "and Pr 4.19 "Analog monitor 2 output gain "set the conversion gain in accordance to the unit suitable for the type respectively. When the gain is set to 0, the gain shown at the right end column of the table is automatically applied.

Pr4.16/Pr4.18	Monitor type	Unit	Output gain for setting Pr 4.17/Pr 4.19 = 0
0	Motor velocity	r/min	500
1	Position command velocity *4	r/min	500
2	Internal position command velocity *4	r/min	500
3	Velocity control command	r/min	500
4	Torque command	%	33
5	Command position deviation *5	Pulse (command unit)	3000
6	Encoder position deviation *5	Pulse (Encoder unit)	3000
7	Full-closed deviation *5	Pulse (External scale unit)	3000
8	Hybrid deviation	Pulse (Command unit)	3000
9	Voltage across PN	V	80
10	Regenerative load factor	%	33
11	Overload factor	%	33
12	Positive direction torque limit	%	33
13	Negative direction torque limit	%	33
14	Speed limit value	r/min	500
15	Inertia ratio	%	500
16	Analog input 1 *2	V	1
17	Analog input 2 *2	V	1
18	Analog input 3 *2	V	1
19	Encoder temperature *3	°C	10
20	Driver temperature	°C	10
21	Encoder single-turn data *1	Pulse (Encoder unit)	110000
23	Command input state	0: No command 1: With command	*6
24	Gain selection state	0: 1st gain selected 1: 2nd and 3rd gain selected	*6

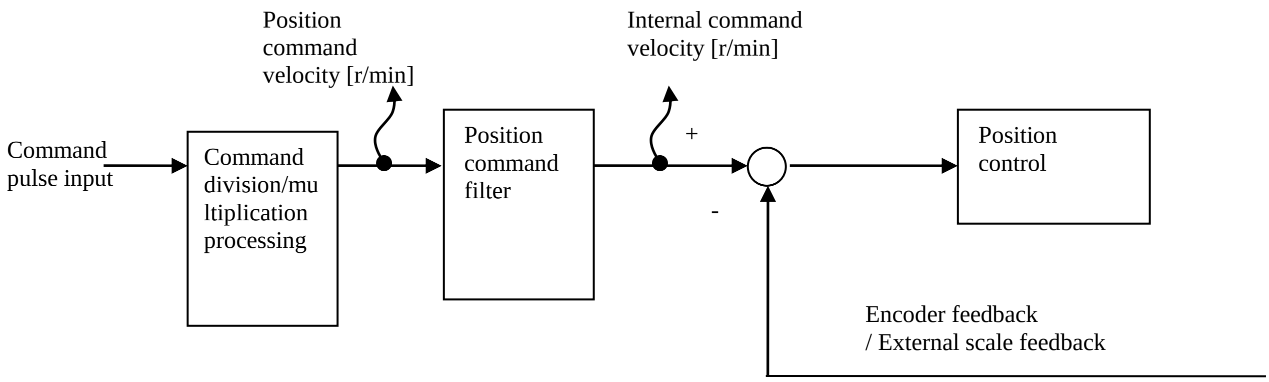
Pr4.16/Pr4.18	Monitor type	Unit	Output gain for setting Pr 4.17/Pr 4.19 = 0
25	Positioning complete state	0: Positioning not completed 1: Positioning completed	*6
26	Alarm triggered state	0: Alarm not triggered 1: Alarm triggered	*6
27	Motor power consumption	W	100
28	Motor power electrical energy	Wh	100

*1 The direction of monitor data is basically in accordance with Pr0.00 "Rotation direction setting". However, the CCW direction always serves as positive for Encoder single-turn data. In addition, when the incremental encoder is used, a normal value is output after it passes through the first Z phase.

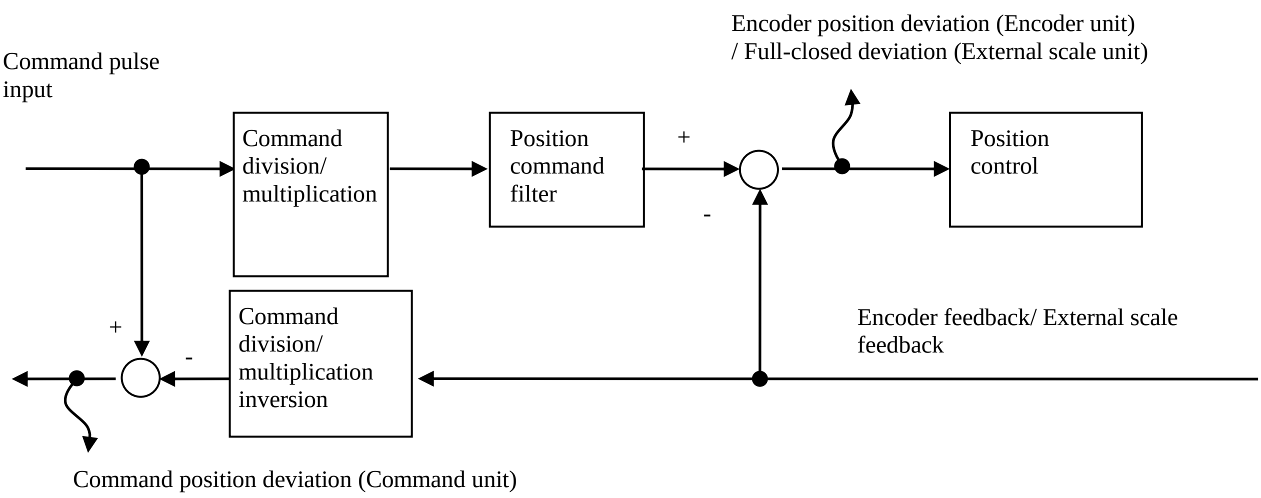
*2 For analog inputs 1 to 3, terminal voltage is always output regardless of usage of analog input function.

*3 For temperature information from the encoder, a value appears only when 23-bit absolute encoder or 20-bit incremental serial encoder is used. For other encoders, "0 "is always output.

*4 For the command pulse input, the speed before the command filter (smoothing, FIR filter) is defined as position command velocity and speed after filter is defined as internal command velocity.



*5 Command position deviation is the deviation from the command pulse input. Encoder position deviation/full-closed deviation is the deviation at the input portion of position control. The following figure shows details.



*6 Regardless of the setting Pr 4.17 and Pr 4.19, output gain become 0V in unit 0 or become 5V in unit 1.

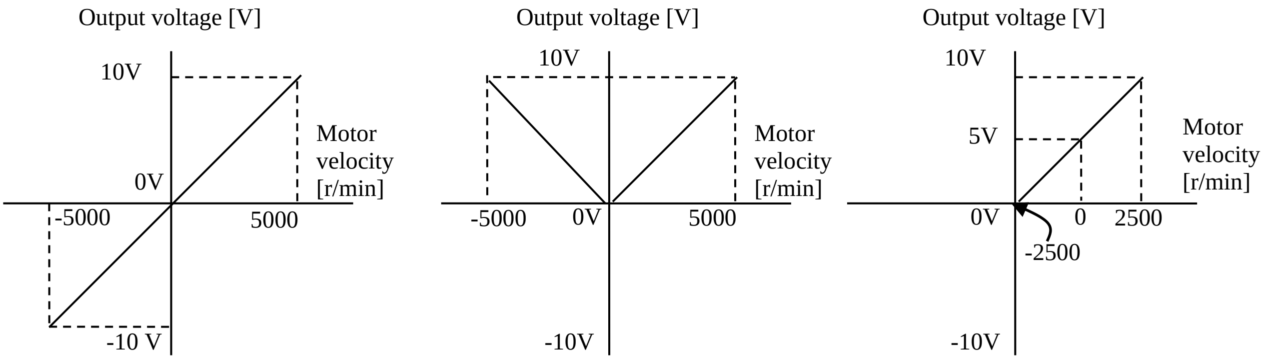
• About Pr4.21 “Analog monitor output setting ”

The following figure shows output specification when Pr4.21 is 0, 1 or 2.

Pr4.21 = 0, signed data output (Output range: -10 to 10 V)

Pr4.21 = 1, absolute value data output (Output range: 0 to 10 V)

Pr4.21 = 2, data output with offset (Output range: 0 to 10 V)

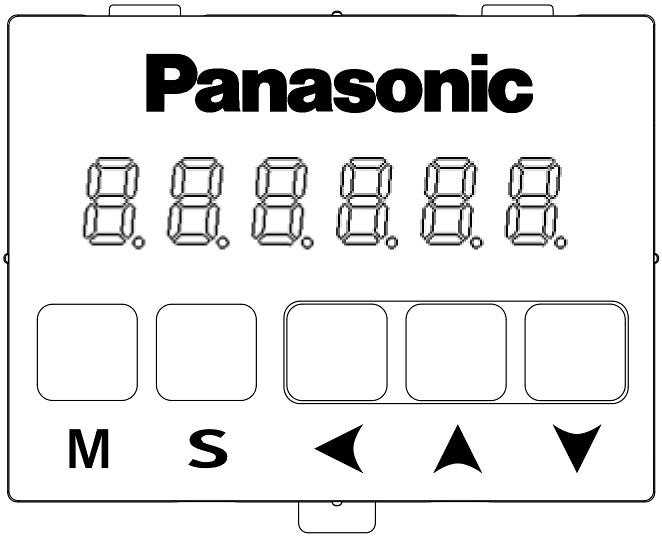


* If monitor type is motor velocity and conversion gain is 500 (1V=500 r/min)

3. Front panel specification

3-1 Front panel operation method

3-1-1 Configuration of operation portion and display portion



3-1-2 Functions of key switch

Switch	Conditions for enabling	Function
M MODE key	Enabled with the selection display	(1) Monitor mode (2) Parameter setting mode (3) EEPROM writing mode (4) Auxiliary function mode 4 modes can be switched.
S SET key	Always enabled	Note) Switching between the selection display and execution display
▲ ▼	Available for the digit on which the flashing decimal point is displayed	These keys are used to change display in each mode, change data, select parameters, etc., execute operations.
◀		This key is used to move to the upper digit on which data is changed.

Note) "Selection display "and "Execution display "are available for the aforementioned 4 modes respectively.
For more information, refer to 3-1-3.

3-1-3 Operation method

Execution display of monitor mode appears according to setting in Pr5.28 "Initial state of LED "after turning ON. Data number of monitor data (number of ** part in d**) to be configured as initial display needs to be set for parameter. For example, if Pr5.28 is 1, "d01.SPd "becomes the initial display. Refer to 3-2-1 for data number of monitor data.

Selection display

Monitor mode

Meaning

Position deviation (Command unit)

Motor velocity

The display moves in the direction of an arrow when ▲ is pressed and the display moves in the inverse direction when ▼ is pressed.

SET key

Execution display

Monitor mode

Dipplay example	Meaning	Reference items
	Position deviation: 5 pulse	3-2-1(1)
	Motor velocity: 1000r/min	3-2-1(2)

MODE key

Parameter setting mode (selection display)

Pr 0.00

Pr 0.01

The display moves in the direction of an arrow when ▲ is pressed and the display moves in the inverse direction when ▼ is pressed..

Pr 0.01

Pr 0.11

Pr 1.11

When ◄ is pressed, the flashing decimal point moves to the upper digit and the value on the digit can be changed.
It is possible to change the classification number at the first digit from the left and change the parameter number at the following digits.

Note For parameters that "r "is displayed in front of the classification number, changes are reflected after resetting the power.

SET key

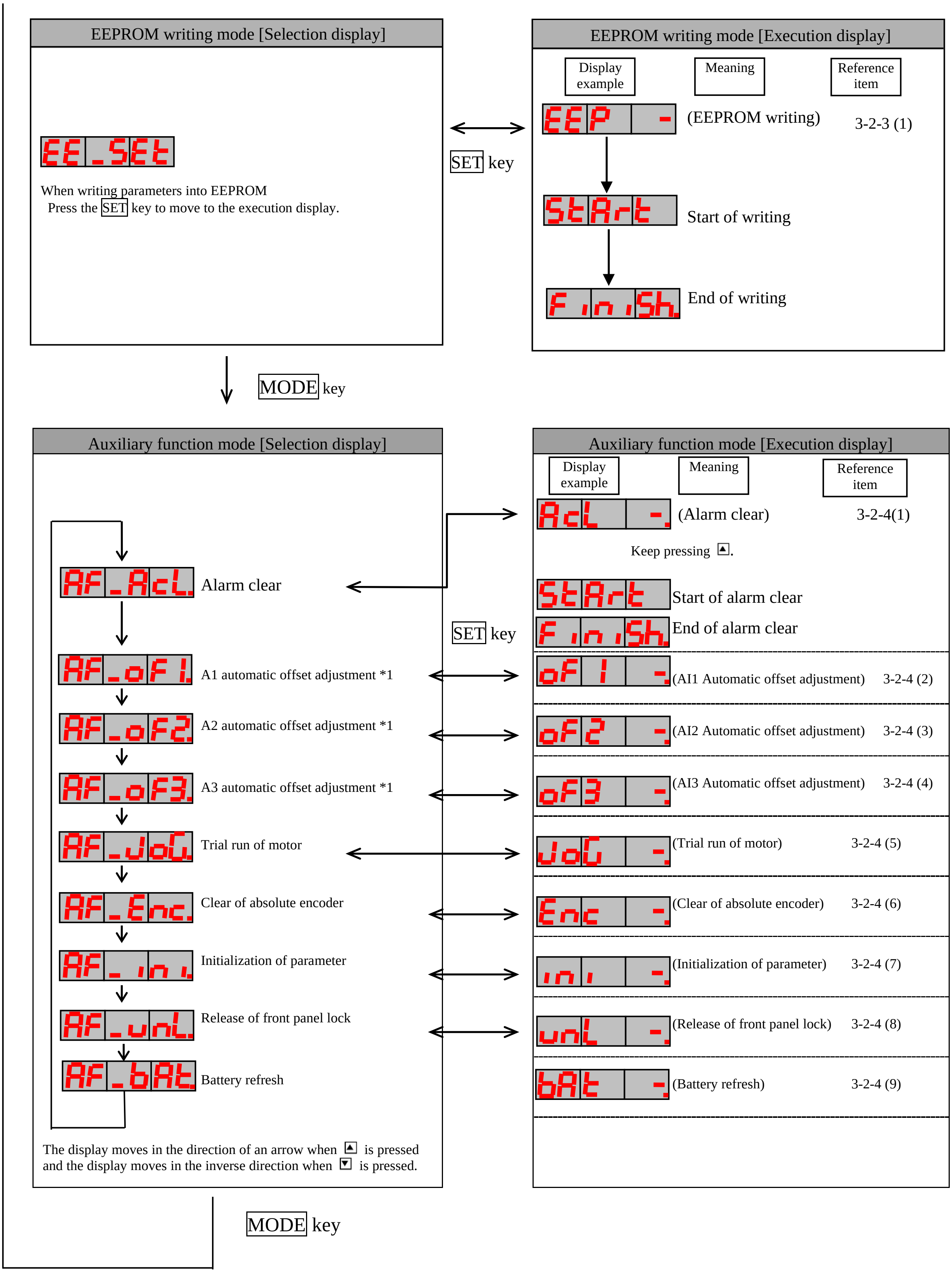
Parameter setting mode (execution display)

Display example	Meaning	Reference item
	(Parameter value: 1000)	3-2-2 (1)

Parameter can be set by using ▲, ▼ and ◄ keys.
It is possible to set and change the digit on which the flashing decimal point is displayed.

MODE key

Go to the next page.



- The display flashes slowly while a warning is occurring.
- The display part flashes and the error cause display appears while an error is occurring.
- If STO command is input, it will be switched safety state monitor and displays “St”

*1 This function cannot be used with [A6SE], [A6SG].

3-1-4 Front panel lock

It is possible to lock the front panel to prevent erroneous operation including unexpected parameter change.
The following table shows restriction items while the front panel is locked.

Mode	Front panel locked state
Monitor mode	All monitor data can be checked without any restrictions.
Parameter setting mode	Parameter cannot be changed. However, it is possible to check the setting value of parameter.
EEPROM writing mode	This function cannot be executed. (No display appears.)
Auxiliary function mode	Auxiliary functions other than “release of front panel lock ” cannot be executed. (No display appears.)

■ Relevant parameters

Class	No.	Parameter name	Setting range	Unit	Function
5	35	Front panel lock	0 to 1	-	Operations with the front panel are locked. 0: No restriction on front panel operation 1: Front panel operation lock

• Procedure to lock the front panel
[Common to set-up support software (PANATERM)/front panel operation]
1) Set 1 for Pr5.35 “Front panel lock ”and write it into EEPROM.
2) Restart the power of the driver.
3) The front panel is locked.

• Procedure to release the locked state of the front panel
[When using the set-up support software (PANATERM)]
1) Set 0 for Pr5.35 “Front panel lock ”and write it into EEPROM.
2) Restart the power of the driver.
3) The locked state of the front panel is released.

[When making operations on the front panel]
1) Execute the front panel lock release function in auxiliary function mode. (Refer to 3-2-4 (8).)
2) Restart the power of the driver.
3) The locked state of the front panel is released.

3-1-5 Exclusive functions by operations performed by communications

To prevent operations by communication (USB/RS232/RS485/Modbus) and operation from the front panel being in conflict with each other, the following exclusive functions will be triggered depending on their respective state:

State	Exclusive function details
The front panel is in “execution display” other than the monitor mode.	Parameter write and EEPROM write by communications will result in command error and not executed. In addition, connection of set-up support software, PANATERM (USB communication) cannot be established.
Execution right has been acquired by RS232/RS485/Modbus communications.	No operations other than monitor mode can be made from the front panel.
Set-up support software (PANATERM) (USB communication) is connected.	

Regarding the detail of RS232/RS485/Modbus communication refer to 9-3, Regarding the detail of Modbus communication, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction.”

3-2 Detailed specification of front panel

3-2-1 Details of monitor mode

Selection display

Monitor mode

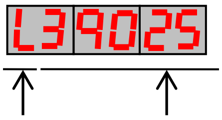
Display example	Meaning	Reference item
d00.uEP	Command position deviation	3-2-1(1)
d01.SPd	Motor velocity	3-2-1(2)
d02.cSP	Position command velocity	3-2-1(3)
d03.cUL	Velocity control command	3-2-1(4)
d04.trq	Torque command	3-2-1(5)
d05.nPS	Sum total of feedback scale pulse	3-2-1(6)
d06.cPS	Sum total of command pulse	3-2-1(7)
d08.FPS	Sum total of external scale feedback pulse	3-2-1(8)
d09.cnt	Control mode	3-2-1(9)
d10. io	Input/output signal status	3-2-1(10)
d11.A in	Analog input value	3-2-1(11)
d12.Err	Causes of errors and history of errors	3-2-1(12)
d13. rn	Warning number	3-2-1(13)
d14. rG	Regenerative resistance load factor	3-2-1(14)
d15. oL	Overload factor	3-2-1(15)
d16.Jrt	Inertia ratio	3-2-1(16)
d17. ch	Causes of no rotation	3-2-1(17)

Monitor mode

Display example	Meaning	Refeence item
d18.ict	Display of number of times of changes in input/output signal	3-2-1(18)
d20.Abs	Absolute encoder data	3-2-1(19)
d21.AES	Absolute feedback scale position	3-2-1(20)
d22.rEc	Feedback scale communication error counts monitor	3-2-1(21)
d23. id	Display of axis number for communication	3-2-1(22)
d24.PEP	Feedback Position deviation (Feedback scale unit)	3-2-1(23)
d25.PFE	External scale deviation (External scale unit)	3-2-1(24)
d26.hyb	Hybrid deviation	3-2-1(25)
d27. Pn	Voltage across PN	3-2-1(26)
d28. no	Software version	3-2-1(27)
d29.ASE	Driver serial number	3-2-1(28)
d30.nSE	Motor serial number	3-2-1(29)
d31. tE	Accumulated operating time	3-2-1(30)
d32.Aud	Motor automatic recognition function	3-2-1(31)
d33.Ath	Temperature information	3-2-1(32)
d35. SF	Safety status monitor	3-2-1(33)
d38. Po	Motor power consumption	3-2-1(38)
d39.cd1	Manufacturer use	
d40.cd2	Manufacturer use	
d41.cd3	Manufacturer use	
d42.cd4	Manufacturer use	

The display moves in the direction of an arrow when ▲ is pressed and the display moves in the inverse direction when ▼ is pressed.

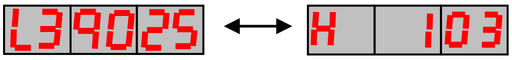
(1) Position command deviation [Command unit]
Position deviation in units of command is displayed with higher/lower.



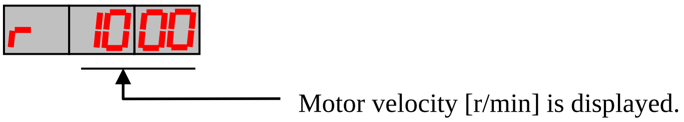
Lower (L) Position command deviation
Higher (H)

■ Press ◀ to switch between lower (L) and higher (H).

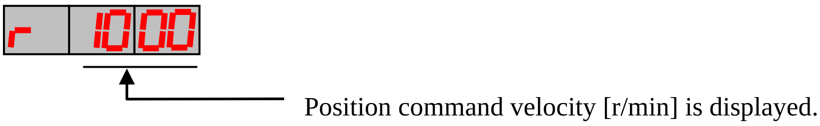
For the following example, position command deviation is 10339025.



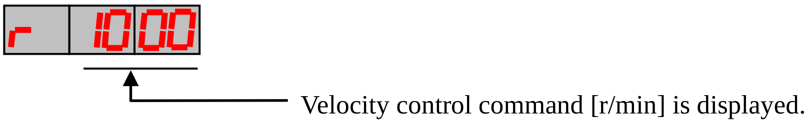
(2) Motor velocity [r/min]



(3) Position command velocity [r/min]

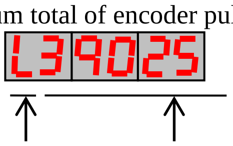


(4) Velocity control command [r/min]



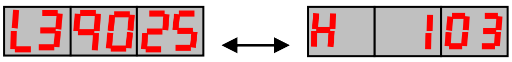
(5) Torque command [%]

(6) Sum total of encoder pulse [encoder pulse]

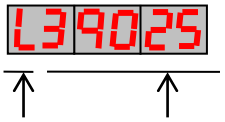


Lower (L) Sum total of encoder pulse
Higher (H)

■ Press ▶ to switch between lower (L) and higher (H).

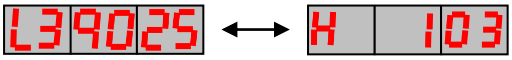


(7) Sum total of command pulse [command pulse]

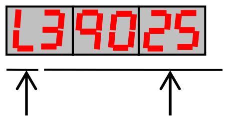


Lower (L) Sum total of command pulse
Higher (H)

■ Press ◀ to switch between lower (L) and higher (H).

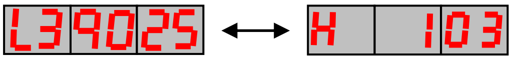


(8) Sum total of external scale feedback pulse

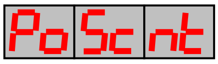


Lower (L) Sum total of external scale feedback pulse
Higher (H)

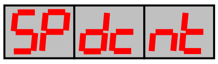
■ Press ◀ to switch between lower (L) and higher (H).



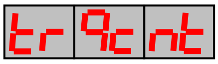
(9) Control mode



.......Position control mode



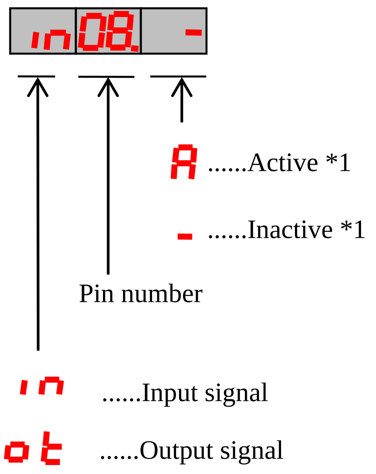
.......Velocity control mode



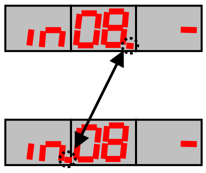
……Torque control mode

.......Full-closed control mode

(10) Input/output signal status



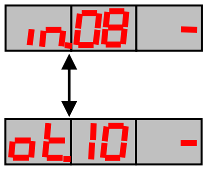
■ [◀] Move the flashing decimal point by using it.



(Left side of the decimal point: Selection of pin number)

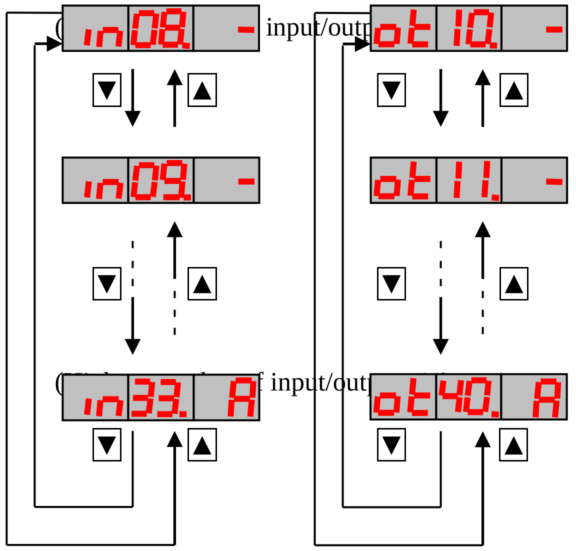
(Left side of the decimal point: Selection of input/output pin number)

■ Toggle input and output by pressing [▼] and [▲].

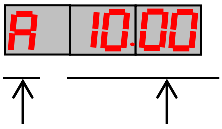


* For input, active = Input coupler is ON, inactive = OFF.
For output, active = Output Tr is ON, inactive = OFF.

■ Press [▼] [▲] to select the pin number to be monitored.

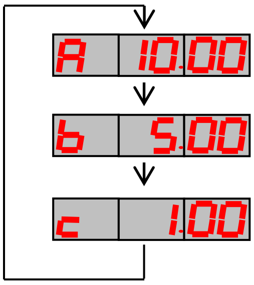


(11) Display of the analog input value [A6SE], [A6SG] 0 appears for all items.



Input signal   Input voltage value [V]

■ Press ▼ ▲ to select the signal to be monitored.



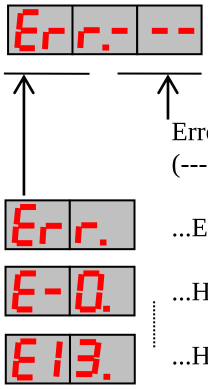
(Analog input 1 value   Unit [V]) The value after executing offset correction value is displayed.

(Analog input 2 value   Unit [V])

(Analog input 3 value   Unit [V])

Note) Voltage exceeding ±10V is not displayed correctly.

(12) Causes of errors and history of errors



Error code No.
(--- appears if no error has occurred.)

...Error that is currently occurring

...History 0

...History 13

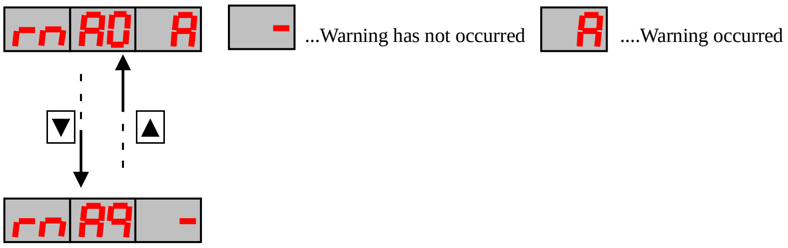
■ Causes of 14 errors including the current error can be referred.
Press ▲ ▼ to select the history number to be referred.

Note 1) There are alarms that are not recorded in the history. For more information about alarm number, etc., refer to 7-1.

Note 2) If an error that is recorded in the history is occurring, the same error number appears on the error that is currently occurring and history 0.

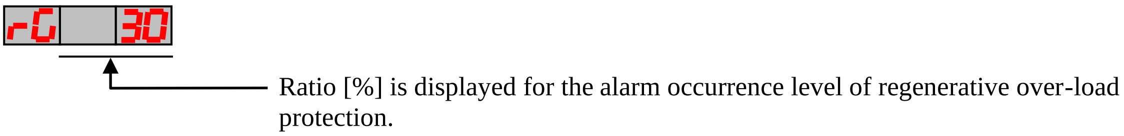
(13) Warning number

■ Press ▼ ▲ to display the occurrence status for each warning.

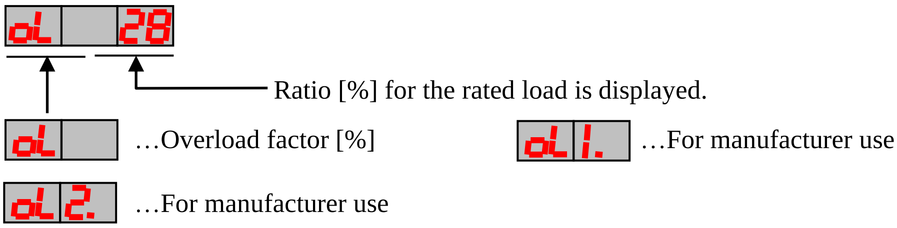


Note) Refer to 7-3 for warning number.

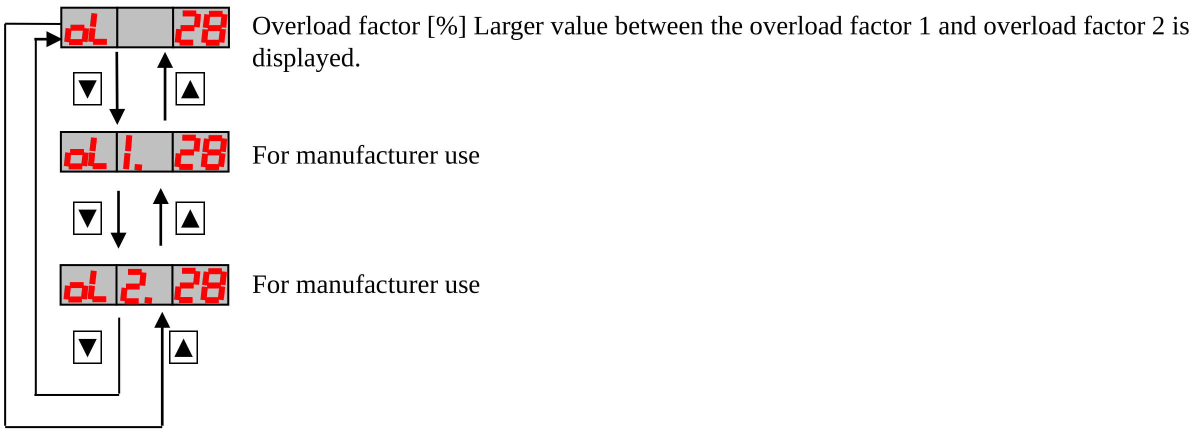
(14) Regenerative resistance load factor



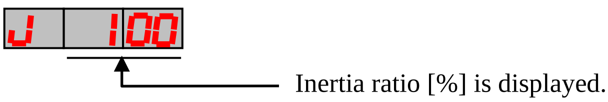
(15) Overload factor



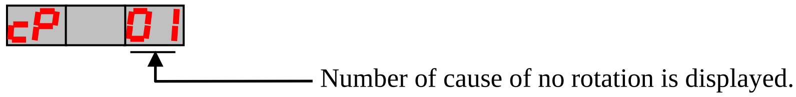
■ Press ▼ ▲ to select the overload factor to be monitored.



(16) Inertia ratio



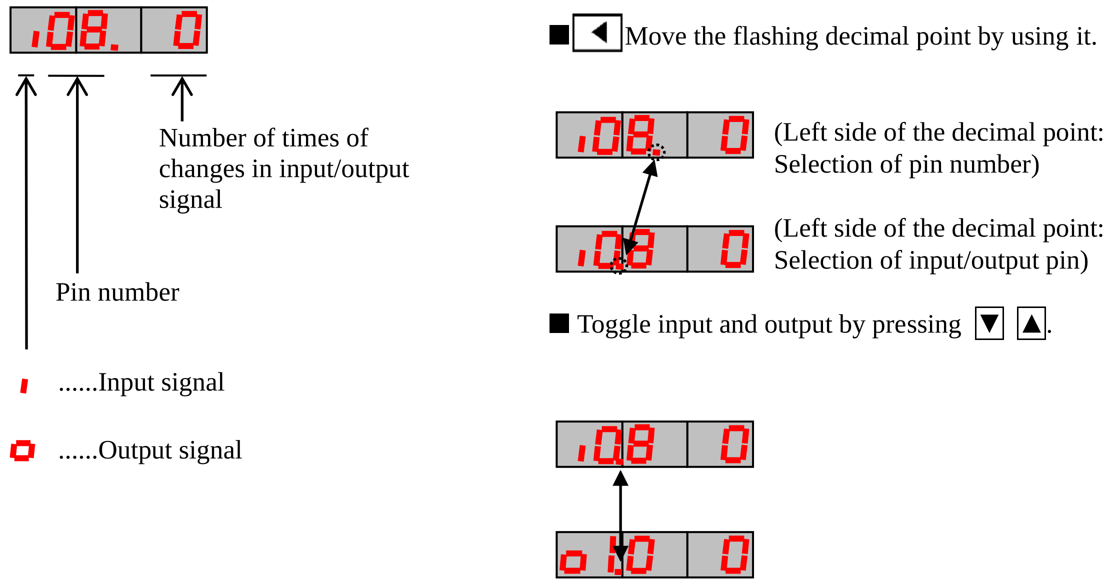
(17) Causes of no rotation



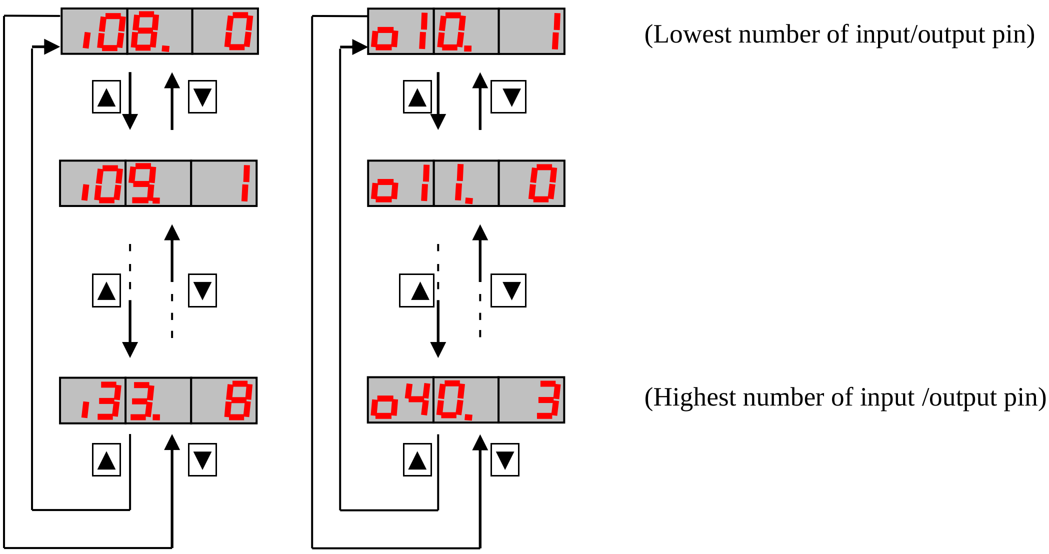
Relation between the number of cause of no rotation and cause of no rotation

Factor number of no rotation	Cause of no rotation	Factor number of no rotation	Cause of no rotation
0	There is no cause of no rotation.	7	Command pulse is not input.
1	Not in Servo-Ready state	8	Counter clear is valid.
2	Servo-on signal is not input.	9	Speed zero clamp is valid.
3	Drive prohibition input is valid.	10	Analog velocity command is small.
4	Analog torque limit is invalid. Torque limit of parameter is small.	11	Internal velocity command is 0.
		12	Analog velocity command is small.
5	Analog torque limit is valid and analog torque limit is small.	13	Velocity limit command is 0.
		14	Other factors
6	Command pulse input inhibit is valid.		

(18) Display of number of times of changes in input/output signal

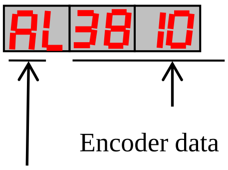


■ Press ▼ ▲ to select the pin number on which the number of change is displayed.



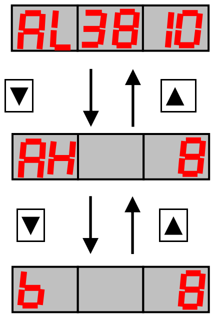
* Number of changes is counted by setting the timing that power is turned ON to 0.

(19) Absolute encoder data



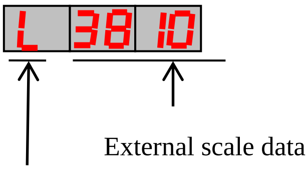
AL ...One rotation data, lower (L) AH ...One rotation data, higher (H) b ....Multiple rotation data

■Press ▼ ▲to select the data to be displayed.



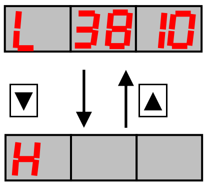
(20) Absolute external scale position

- For serial absolute scale, absolute position of the scale is displayed.
- For serial incremental scale, the scale position is displayed while the position at which the power is turned ON is set to 0.

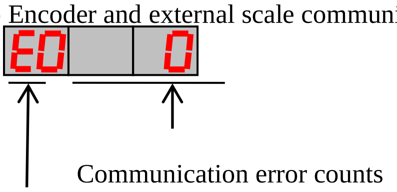


L ...Absolute external scale position, lower (L) H ..Absolute external scale position, higher (H)

■Press ▼ ▲to toggle between lower (L) and higher (H).

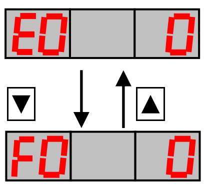


(21) Encoder and external scale communication error counts monitor

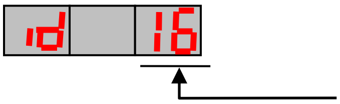


E0 ..Encoder F0 …External scale

■Press ▼ ▲to toggle between encoder and external scale.

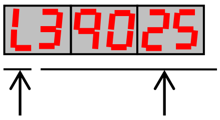


(22)Display of axis number for communication



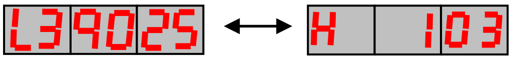
The value set for Pr5.31“ Axis number ”is displayed.

(23) Encoder position deviation (Encoder unit)

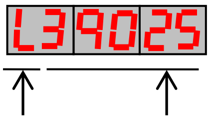


Lower (L) Encoder position deviation (Encoder unit)
Higher (H)

Press ◀ to switch between lower (L) and higher (H).

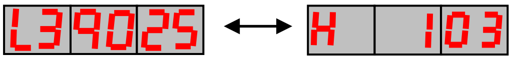


(24) External scale deviation [External scale unit]

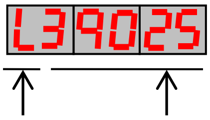


Lower (L) External scale deviation [External scale unit]
Higher (H)

■ Press ◀ to switch between lower (L) and higher (H).

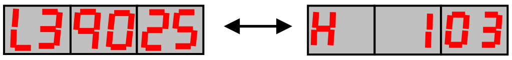


(25) Hybrid deviation [Command unit]

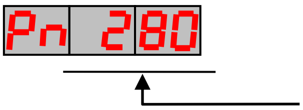


Lower (L) Hybrid deviation [Command unit]
Higher (H)

■ Press ◀ to switch between lower (L) and higher (H).

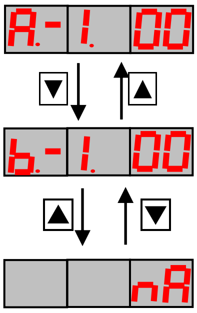


(26) Voltage across PN [V]



Voltage across PN [V] is displayed.

(27) Software version

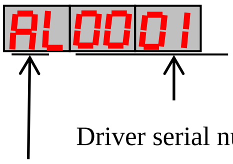


CPU1 software version of the driver is displayed. (Display example: If the version is Ver1.00)

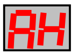
CPU2 software version of the driver is displayed. (Display example: If the version is Ver1.00)

This is display of manufacturer use.

(28) Driver serial number

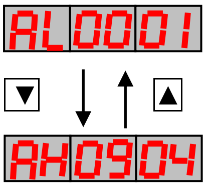


Driver serial number

 . Driver serial number, lower (L)  …Driver serial number, higher (H)

■Press ▼ ▲ to toggle between lower (L) and higher (H).

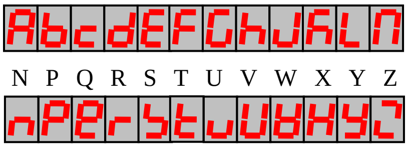
Display example) If the serial number is 09040001



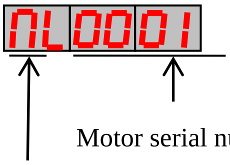
If the serial number contains alphabetic characters, it will be displayed as shown on the right.

A B C D E F G H J K L M

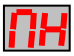
N P Q R S T U V W X Y Z



(29) Motor serial number

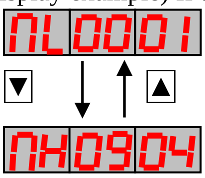


Motor serial number

 . Motor serial number, lower (L)  …Motor serial number, higher (H)

■Press ▼ ▲ to toggle between lower (L) and higher (H).

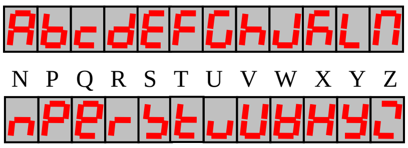
Display example) If the serial number is 09040001



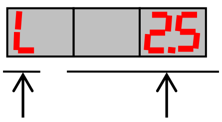
If the serial number contains alphabetic characters, it will be displayed as shown on the right.

A B C D E F G H J K L M

N P Q R S T U V W X Y Z

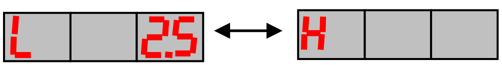


(30) Accumulated operating time

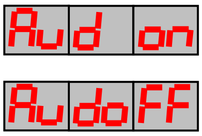


Lower (L) Accumulated operating time [h] is displayed.
Higher (H)

Press ◀ to switch between lower (L) and higher (H).



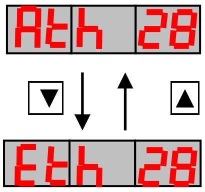
(31) Motor automatic recognition function



Automatic recognition enabled

Automatic recognition disabled

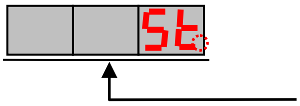
(32) Temperature information



Driver temperature [°C] is displayed.

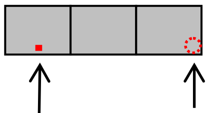
Encoder temperature [°C] is displayed.

(33) Safety status monitor [A6SE], [A6SG] Displays of SF1: A, SF2: A and EDM: - are fixed.



St : Safety state
SrVoFF: Servo-OFF state
SrVon : Servo-ON state
ALArM: Alarm state

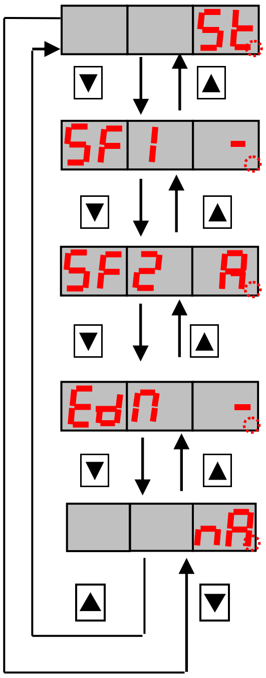
+ Dot information



Flashing display
Normal changeable state

Servo-Ready state
OFF: Dot turns off
ON: Dot turns on

■ Press ▼ ▲ to switch the monitor to be displayed.



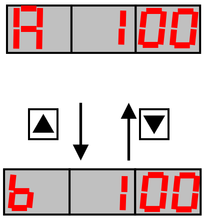
…Input photocoupler OFF …Input photocoupler ON

…Input photocoupler OFF …Input photocoupler ON

.. Output photocoupler OFF …Output photocoupler ON

This is display of manufacturer use.

(34) Motor power consumption



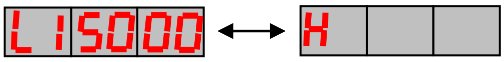
Motor power consumption [W]

Motor electrical power [Wh]

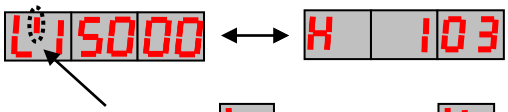
Precautions)

If the monitor data is displayed with lower (L) and higher (H), displays of the front panel are as follows.

Example 1) Monitor data = 15000 (within the display range of lower (L))



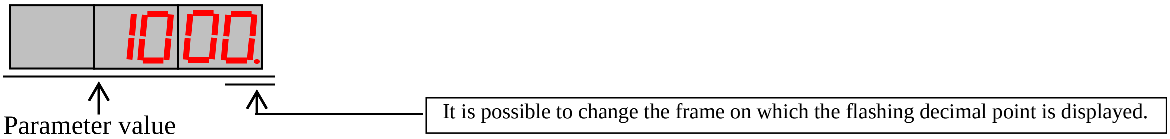
Example 2) Monitor data = 10315000 (if data exceeds the display range of lower (L))



Display of chan

3-2-2 Details of parameter setting mode

(1) Parameter setting



Parameter value

- Press [▲] [▼] to change the parameter value. (Value increases when pressing [▲] and value decreases when pressing [▼].)
- When [◀] is pressed, the flashing decimal point moves to the upper digit and the value on the digit can be changed.
- Parameter value in the driver is updated when the [SET] key is pressed and held.

(The parameter value is not reflected only by changing the value by pressing [▲] [▼].)
In this case, if Pr6.17 "Front panel parameter writing selection "is set to 1, processes until EEPROM writing are executed automatically.
(However, EEPROM writing is not executed while Err11.0 "Control power undervoltage protection "is occurring.)
If Pr6.17 is set to 0, EEPROM writing needs to be separately executed according to procedure described in 3-2-3.

- When canceling the change after making changes by pressing [▲] [▼], the parameter number display screen appears without updating the parameter in the driver if [MODE] is pressed without pressing SET.

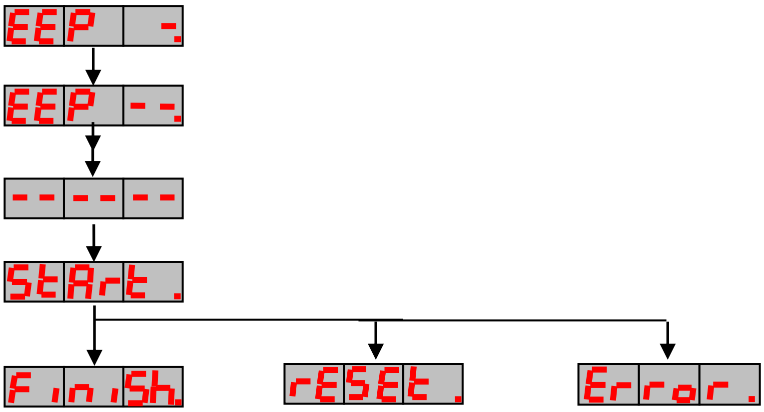
3-2-3 EEPROM writing mode

(1) Writing of EEPROM

- When executing the writing, [▲] needs to be pressed continuously until the display changes to .

* It may be difficult to check the "StArt "display because the display appears momentarily.

If [▲] is kept pressing (approximately 5 seconds), the bar increases as shown below.



Start of writing

End

End of writing

Occurrence of writing error

- If the setting of parameter that becomes valid after resetting changes is changed,  appears when writing is complete. Turn the control power OFF and reset EEPROM.

Note1) If writing error occurs, writing needs to be done again. If writing error occurs even if writing is executed repeatedly, failure may be occurring.

Note 2) Do not turn the power OFF while writing to EEPROM. Wrong data may be written. If this situation occurs, all parameters need to be set again and writing needs to be executed after checking the situation thoroughly.

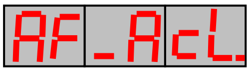
Note 3) However, "Error "appears and EEPROM writing is not executed while Err11.0 "Control power undervoltage protection "is occurring.

3-2-4 Auxiliary function mode

(1)Alarm clear

Alarm occurrence state is reset.
There are alarms that cannot be cleared with this input. For more information, refer to 7-1.

[Selection display]

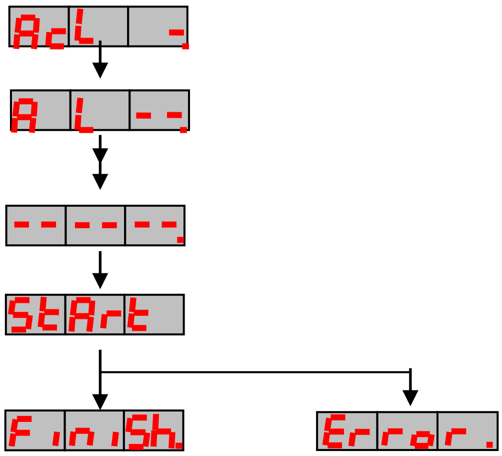


[Execution display]

■ Press SET to open the execution display of .

When executing alarm clear, ▲ needs to be pressed until the display changes to .

If ▲ is kept pressing (approximately 5 seconds), the bar increases as shown below.



Alarm clear starts.

End

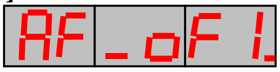
End of alarm clear

Alarm cannot be cleared.
Main power needs to be reset.

(2) Analog input 1 Automatic offset adjustment [A6SE], [A6SG] This function cannot be used.

Offset value Pr4.22 (analog input 1 (AI1) offset sett ing) is automatically adjusted so that analog input 1 (AI1) voltage is 0.

[Selection display]



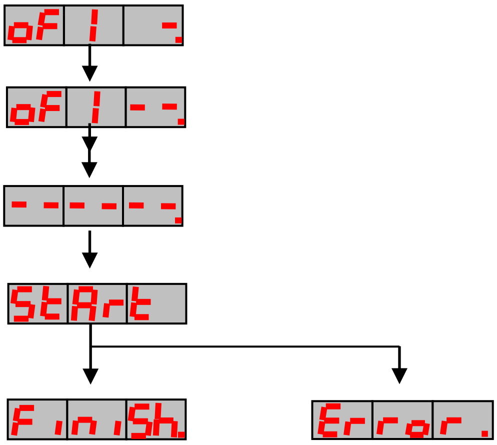
[Execution display]

■Press SET to open the execution display of .
When executing the automatic offset, set the command input to 0V first and then press ▲ until the display changes to .

If ▲ is kept pressing (approximately 5 seconds), the bar increases as shown below.

Start of automatic offset adjustment

End



Completion of automatic offset adjustment

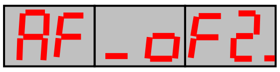
Occurrence of an error
(Invalid control mode or the offset value exceeded the parameter setting range.)

Note 1) Data cannot be written to EEPROM only with automatic offset adjustment.
To reflect results later, data needs to be written to EEPROM.

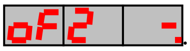
(3) Analog input 2 Automatic offset adjustment [A6SE], [A6SG] This function cannot be used.

Offset value Pr4.25 (analog input 2 (AI2) offset sett ing) is automatically adjusted so that analog input 2 (AI2) voltage is 0.

[Selection display]



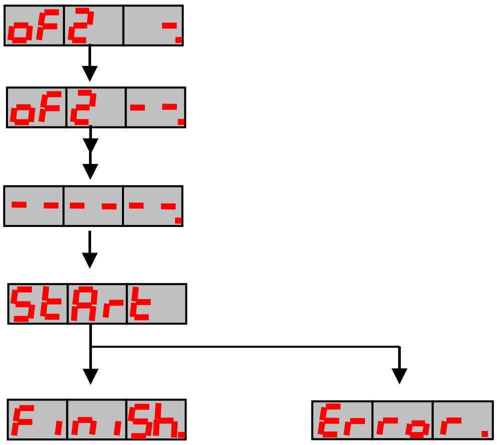
[Execution display]

■Press SET to open the execution display of .
When executing the automatic offset, set the command input to 0V first and then press ▲ until the display changes to .

If ▲ is kept pressing (approximately 5 seconds), the bar increases as shown below.

Start of automatic offset adjustment

End



Completion of automatic offset adjustment

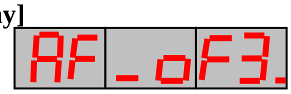
Occurrence of an error (Invalid control mode or the offset value exceeded the parameter setting range.)

Note 1) Data cannot be written to EEPROM only with automatic offset adjustment.
To reflect results later, data needs to be written to EEPROM.

(4) Analog input 3 Automatic offset adjustment [A6SE], [A6SG] This function cannot be used.

Offset value Pr4.28 (analog input 3 (AI3) offset sett ing) is automatically adjusted so that analog input 3 (AI3) voltage is 0.

[Selection display]



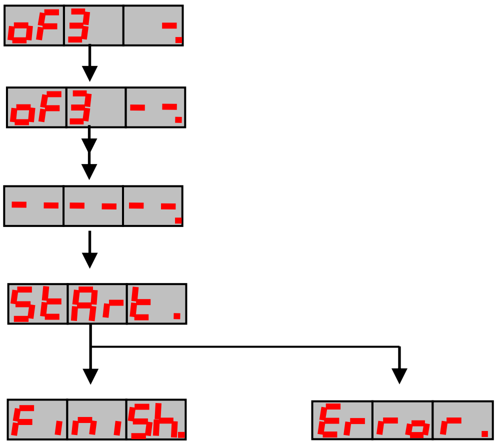
[Execution display]

■Press SET to open the execution display of oF3 -.
When executing the automatic offset, set the command input to 0V first and then press ▲ until the display changes to StArt.

If ▲ is kept pressing (approximately 5 seconds), the bar increases as shown below.

Start of automatic offset adjustment

End



Completion of automatic offset adjustment

Occurrence of an error
(Invalid control mode or the offset value exceeded the parameter setting range.)

Note 1) Data cannot be written to EEPROM only with automatic offset adjustment.
To reflect results later, data needs to be written to EEPROM.

(5) Trial run of motor

It is possible to execute the trial run of the motor without connecting the wire of the connector X4.

[Selection display] AF_JoG.

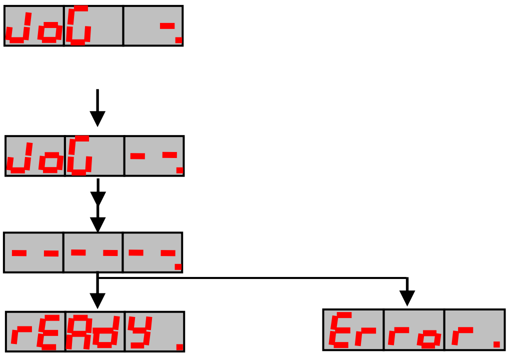
[Execution display]

■Press SET to open the execution display of doG .

When executing the trial run of motor, keep pressing ▲ until the display changes to rEAdy .

If ▲ is kept pressing (approximately 5 seconds). , the bar increases as shown below.

Preparatory stage 1

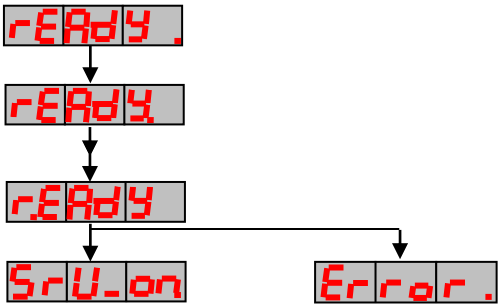


If not in Servo-Ready state
(Alarm is occurring or main power is disconnected),
or when block operation setting is valid. (Pr6.28 ≠ 0)

■Then, press ◀ until the display changes to Srv_on

If ◀ is kept pressing (approximately 5 seconds), the dot moves as shown in the figure at the right.

Preparatory stage 2



If not in Servo-Ready state or SRV-ON is valid

■ After turning the servo ON, press ▲ to make the motor rotate in the positive direction and press ▼ to make the motor rotate in the negative direction at the speed set with Pr6.04 "JOG trial command velocity".

Note 1) When executing the trial run, be sure to detach the motor from load and use the motor after disconnecting the connector X4.

Note 2) When executing the trial run, appropriate values need to be set for parameters related to gain to avoid malfunctions including oscillation. Especially, if load is detached, 0 needs to be set to Pr0.04 "Inertia ratio".

Note 3) During trial run, the motor operates in velocity control mode. For various settings including parameters, setting that the motor operates properly with velocity control needs to be applied.

Note 4) If SRV-ON becomes valid during trial run, the display becomes Error , trial run is paused and normal operation is executed with the external command.

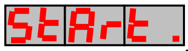
(6) Clear of absolute encoder

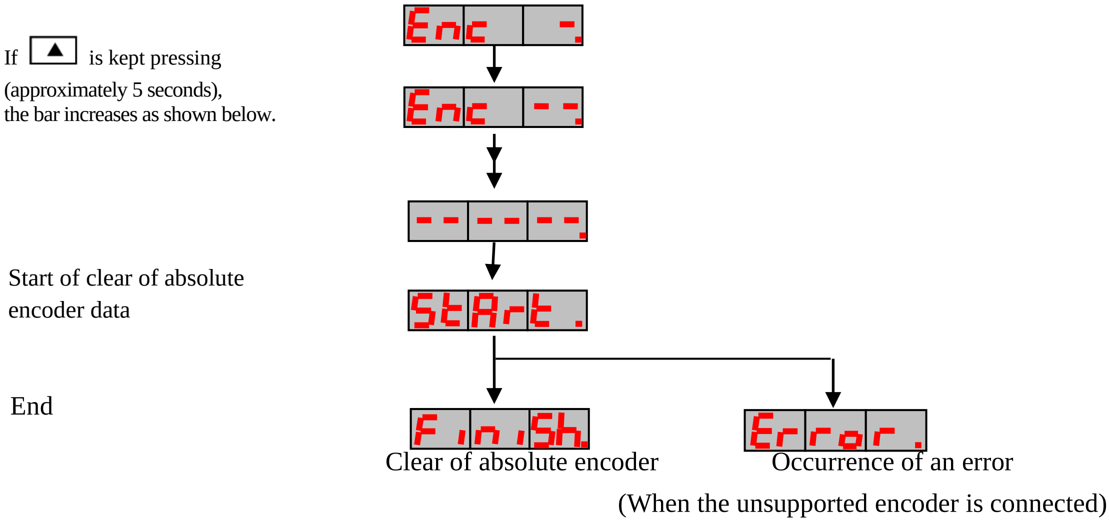
Multiple rotation data and error of the absolute encoder are cleared.

[Selection display]

[Execution display]

■Press SET to open the execution display of .

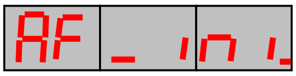
When executing the absolute encoder clear, ▲ needs to be pressed until the display changes to .



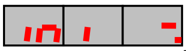
(7) Initialization of parameter

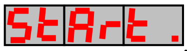
Parameters are initialized.

[Selection display]



[Execution display]

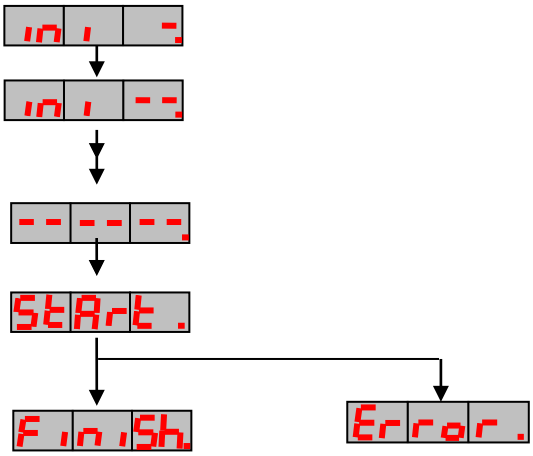
■Press SET to open the execution display of .

When initializing parameters, ▲ needs to be pressed until the display changes to .

If ▲ is kept pressing (approximately 5 seconds), the bar increases as shown below.

Start of parameter initialization

End



Parameter clear

Occurrence of an error (Some errors are occurring)

Note 1) Parameters cannot be initialized while errors related to EEPROM (Err36.0, Err36.1, Err37.0, Err37.1 and Err37.2) are occurring. “Error ”appears.

(8) Release of front panel lock

The front panel lock setting is released.

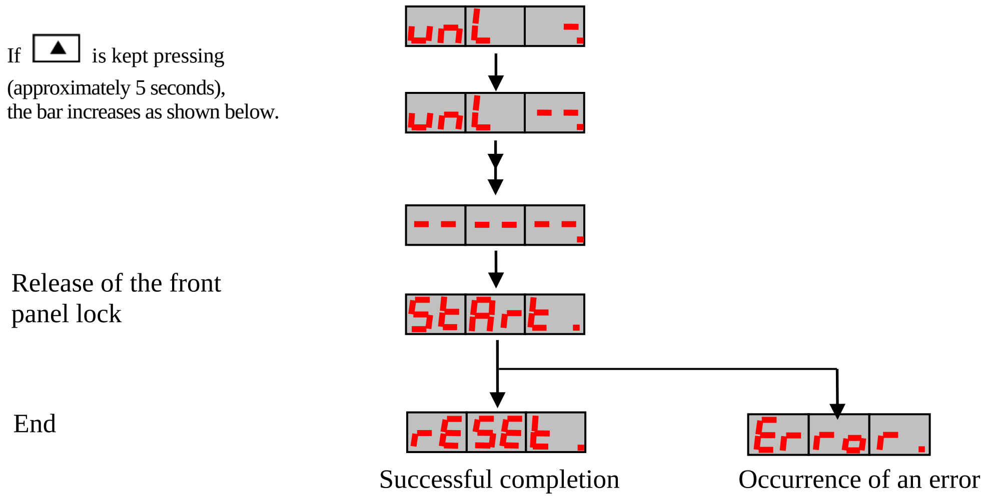
[Selection display]

AF_unL.

[Execution display]

■Press SET to open the execution display of unL -.

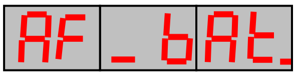
When release front panel lock, ▲ needs to be pressed until the display changes to StArt ..



(9) Battery refresh

Battery refresh action is conducted.

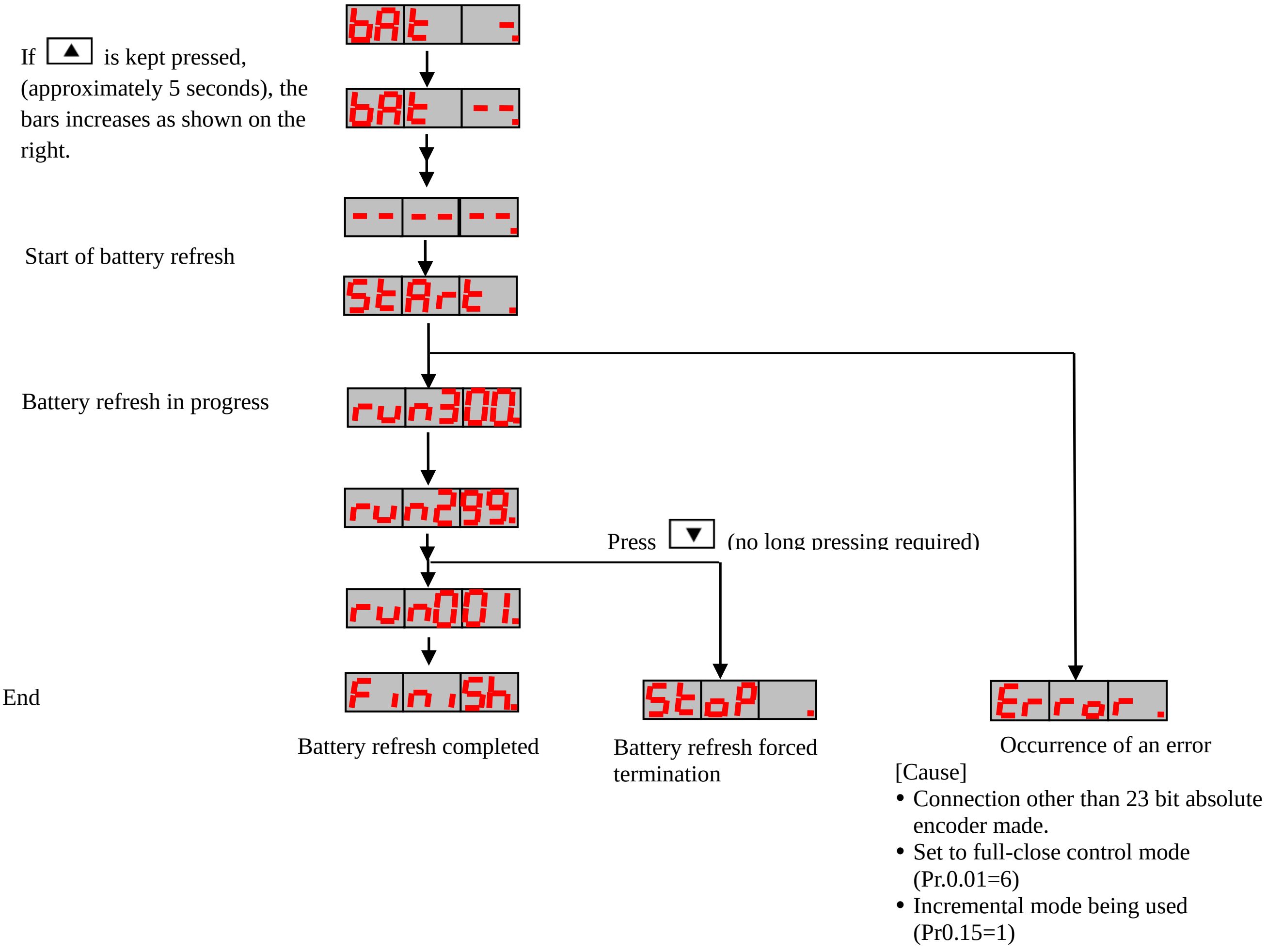
[Selection display]



[Execution display]

■ Press SET to open the execution display of bAt -.

When executing battery refresh, ▲ needs to be pressed and held until the display changes to StArt .



Note 1) When running Battely refresh, Battely alarm may occer in that case, please run the clear Battely alarm.

4. Basic function

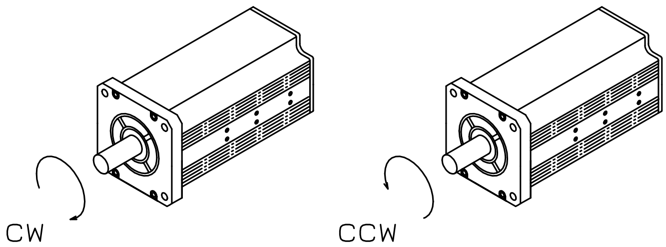
4-1 Setting the rotation direction

It is possible to switch the rotation direction of motor with position command, velocity command and torque command.

■Relevant parameters

Class	No.	Parameter name	Setting range	Unit	Function
0	0	Setting the rotation direction	0 to 1	-	Relation between the direction of command and rotation direction of the motor is set. 0: Motor rotation direction is CW direction when the positive direction command is issued. 1: Motor rotation direction is CCW direction when the positive direction command is issued.

For the rotation direction of the motor, clockwise direction viewed from the axis end at the load side is defined as CW and counterclockwise direction viewed from the axis end is defined as CCW.

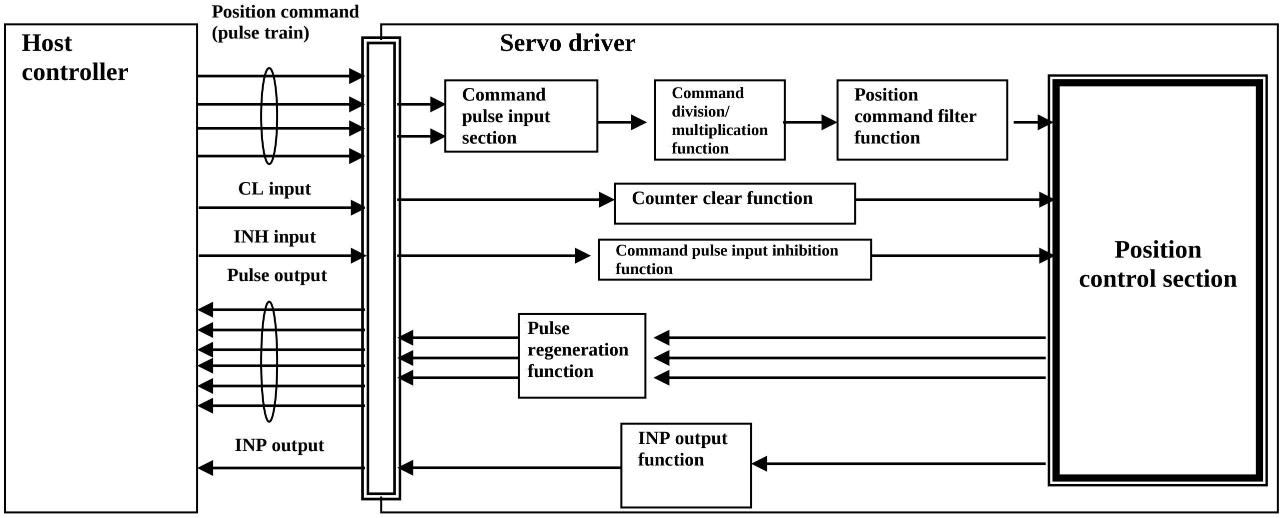


Positive direction and negative direction defined in this specification indicate directions defined here.
For example, relation between positive direction drive prohibition input and negative direction drive prohibition input is shown in the following table.

Pr0.00	Command direction	Motor rotation direction	Positive direction drive prohibition input	Negative direction drive prohibition input
0	Positive direction	CW direction	Available	-
0	Negative direction	CCW direction	-	Available
1	Positive direction	CCW direction	Available	-
1	Negative direction	CW direction	-	Available

4-2 Position control

Based on the position command (pulse train) input from the host controller, the position control is implemented. This section describes the basic setting when using the position control.



■ Precautions

Origin position data may be lost due to clearing of the positional deviation counter, command pulse inhibition, clearing the remnant pulses of the command division/multiplication function, clearing the accumulated pulses of the position command filter function and damping control, control mode switching, etc.
When restarting an operation that requires the position control, always conduct the return to origin.

4-2-1 Command pulse input processing

The input terminal of position command (pulse train) can be selected with Pr0.05 "Command pulse input selection" of two groups of "PULSH1, PULSH2, SIGNH1, SIGNH2" (hereinafter, referred to as Input 1) and "PULS1, PULS2, SIGN1, SIGN2" (hereinafter, referred to as Input 2). When the specification for position command output section of host controller is the line driver output, use the Input 1. In the case with the open collector output, use the Input 2. With the line driver output, you can also use with the Input 2; however, the Input 1 is recommended because the allowable input maximum frequency of Input 2 is inferior to that of Input 1.

When using the Input 2, it is recommended to set as Pr0.05 = 2 when the command pulse input frequency is 200 k[pulse/s] or less.

As for the command pulse form, the following three forms are supported: two-phase pulse, positive direction pulse train/negative direction pulse train, and pulse train + sign. Depending on the host controller specification and on the equipment installation status, a selection from above three configurations as well as setting of pulse count direction will become necessary.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
0	5	Command pulse input selection	0 to 2	--	Selects which of the photo-coupler input or line driver dedicated input is to be used as the command pulse input. 0: Photo-coupler input (PULS1, PULS2, SIGN1, SIGN2) 1: Line driver dedicated input (PULSH1, PULSH2, SIGNH1, SIGNH2) 2: Photo-coupler input (PULS1, PULS2, SIGN1, SIGN2) [200 k[pulse/s] or less]
0	6	Command pulse rotation direction setting	0 to 1	--	Sets the counting direction pertaining to the command pulse input. For the details, refer to the table in the next page.
0	7	Command pulse input mode setting	0 to 3	--	Sets the counting method for the command pulse input. For the details, refer to the table in the next page.
5	32	Command pulse input maximum setting/ digital filter setup	250 to 8000	Kpulse /s	Please set the maximum number to be used for command pulse input. When command pulse input frequency exceeds (this setting × 1.2), Err 27.0 “Command pulse input frequency abnormal protection” will occur.

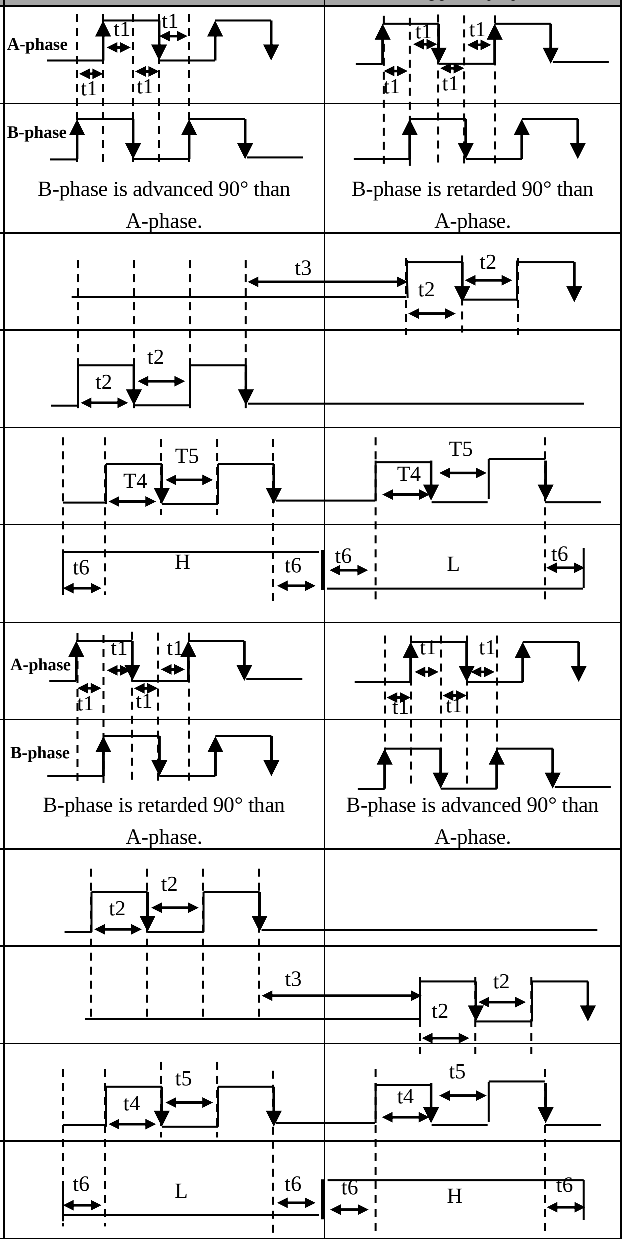
In accordance with the setting value of Pr5.32, the following digital filter for command pulse input is valid.

Pr5.32 Setting range	Digital filter	
	Pr0.05 = 0, 2	Pr0.05 = 1
250	400 [ns] × Two reading	400 [ns] × Two reading
251 to 499	200 [ns] × Two reading	200 [ns] × Two reading
500 to 999		100 [ns] × Two reading
100 to 2999		25 [ns] × Two reading
3000 to 8000		No action（Through setting)

Note) Detection of abnormal command pulse input frequency is conducted on the number of pulses received by the driver. It may not be able to detect normally, in case of a pulse frequency input farlarger than the set value.

The combination table of Pr0.06 "Command pulse rotation direction setting" and Pr0.07 "Command pulse input mode setting" is provided below. The pulse count is performed at the edges shown with arrows in the table.

Pr0.06	Pr0.07	Command pulse form	Signal name	Positive direction command	Negative direction command
0	0 or 2	90° phase difference Two-phase pulse (A-phase + B-phase)	PULS		
			SIGN	B-phase is advanced 90° than A-phase.	B-phase is retarded 90° than A-phase.
	1	Positive direction pulse train + Negative direction pulse train	PULS		
			SIGN		
	3	Pulse train + Sign	PULS		
			SIGN		
1	0 or 2	90° phase difference Two-phase pulse (A-phase + B-phase)	PULS		
			SIGN	B-phase is retarded 90° than A-phase.	B-phase is advanced 90° than A-phase.
	1	Positive direction pulse train + Negative direction pulse train	PULS		
			SIGN		
	3	Pulse train + Sign	PULS		
			SIGN		



PULS/SIGN signal name		Allowable input maximum frequency	Minimum required time width [μs]					
			t1	t2	t3	t4	t5	t6
PULSH1, 2, SIGNH1, 2	At A- and B-phase input, after × 4 multiplication	8 M[pulse/s]	0.125	0.125	0.125	0.125	0.125	0.125
	Other than A- and B-phase input	4 M[pulse/s]	0.25	0.125	0.125	0.125	0.125	0.125
PULS1, 2, SIGN1, 2	Line driver	500 k[pulse/s]	2	1	1	1	1	1
	Open collector	200 k[pulse/s]	5	2.5	2.5	2.5	2.5	2.5

4-2-2 Command division/multiplication (electronic gear) function

This function takes the value with which the pulse command input from host controller is multiplied by the predetermined division/multiplication ratio, and sets it as the position command to the position control section. By using this function, the setting can be performed arbitrarily with the motor rotation/movement per unit input command pulse. Also, the command pulse frequency can be increased if a required motor speed cannot be acquired due to the limitation with the host controller pulse output capability.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
0	08	Command pulse count per one motor rotation	0 to 8388608	pulse	Sets the command pulse count that is equivalent to one rotation of motor. When this value is set to 0, Pr0.09 "1st command division/multiplication numerator" and Pr0.10 "Command division/multiplication denominator" become effective. With the full-closed control, this setting becomes ineffective.
0	09	1st command division/multiplication numerator	0 to 1073741824	--	Sets the numerator of division/multiplication processing on the command pulse input. It becomes effective when Pr0.08 "Command pulse count per one motor rotation" = 0 is true, or when the full-closed control is performed. When the set value is 0, the encoder resolution is set to the numerator when the position control is performed, and the command division/multiplication ratio becomes 1:1 when the full-closed control is performed.
0	10	Command division/multiplication denominator	1 to 1073741824	--	Sets the denominator of division/multiplication processing on the command pulse input. It becomes effective when Pr0.08 "Command pulse count per one motor rotation" = 0 is true, or when the full-closed control is performed.
6	28	Special function selection	0 to 4	--	Selects between enabling and disabling the block operation function. 0: Block operation disabled(Pulse train enabled) 1: Block operation by Modbus communication enabled. (Pulse train disabled) 2: Block operations by input signal enabled(Pulse train disabled) 3: For manufacturer use 4: Block operations by input signal enabled(Pulse train enabled)

Relationship of Pr0.08, Pr0.09, and Pr0.10 with position control

Pr0.08	Pr0.09 *1	Pr0.10	Command division/multiplication processing
1 to 8388608	-- (Without effect)	-- (Without effect)	**Command pulse input** → $\dfrac{\textbf{Encoder resolution}}{\text{[Pr0.08 set value]}}$ → **Position command** * Regardless of the setting of Pr0.09 and Pr0.10, the above processing is executed based on the set value of Pr0.08.
0	0	1 to 1073741824	**Command pulse input** → $\dfrac{\textbf{Encoder resolution}}{\text{[Pr0.10 set value]}}$ → **Position command** * When both Pr0.08 and Pr0.09 are set to 0, the above processing is executed based on the set value of Pr0.10.
	1 to 1073741824	1 to 1073741824	**Command pulse input** → $\dfrac{\text{[Pr0.09 set value]}}{\text{[Pr0.10 set value]}}$ → **Position command** * When Pr0.08 = 0 and also Pr0.09 ≠ 0 are true, the above processing is executed based on the set values of Pr0.09 and Pr0.10.

Relationship of Pr0.08, Pr0.09, and Pr0.10 with full-closed control

Pr0.08	Pr0.09 *1	Pr0.10	Command division/multiplication processing
-- (Without effect)	0	-- (Without effect)	**Command pulse input** → $\frac{1}{1}$ → **Position command** * When Pr0.09 is set to 0, the above processing is executed with both the numerator and denominator set to 1.
	1 to 1073741824	1 to 1073741824	**Command pulse input** → $\frac{\text{[Pr0.09 set value]}}{\text{[Pr0.10 set value]}}$ → **Position command** * When Pr0.09 ≠ 0 is true, the above processing is executed based on the set values of Pr0.09 and Pr0.10.

*1 The set value of the numerator of command division/multiplication is switchable by input signals DIV 1 and DIV 2. For more information, refer to 6-4 “Command division/multiplication switching function”.

■Cautions

1) With the full-closed control, fix the command division/multiplication. Err25.0 (hybrid deviation excess error protection) may occur.
2) For the set value, an arbitrary value is set with the values of denominator and numerator. However, if the division ratio or multiplication ratio setting is extreme, a proper operation is not guaranteed. Regarding the possible range of division/multiplication ratio, use within the range between 1/1000 times and 8000 times.
Even within the above mentioned range, if the multiplication ratio is high, the fluctuation or noise of command pulse input may lead to an occurrence of Err27.2 (command pulse multiplication error protection).
3) When Pr6.28 “control mode setting” = 4” Block operations by input signal enabled(Pulse train enabled)” is true, commands of two systems, block operations and pulse train, are enabled. A set of is applied to only the input of pulse train, the electronic gear ratio will be 1 times fixed. Therefore, Pr5.20 "Position setting unit selection" is in the encoder unit (external scale unit) even if 0 (command unit) is set. The unit of Pr0.14 "Position deviation excess setting" and the unit of Pr4.31"Positioning completion range" are not the command unit but the encoder unit (the external scale unit). Please refer to section 3-2, 3-3 Technical Document "Modbus communication and Block operation Specification" for details.

4-2-3 Position command filter function

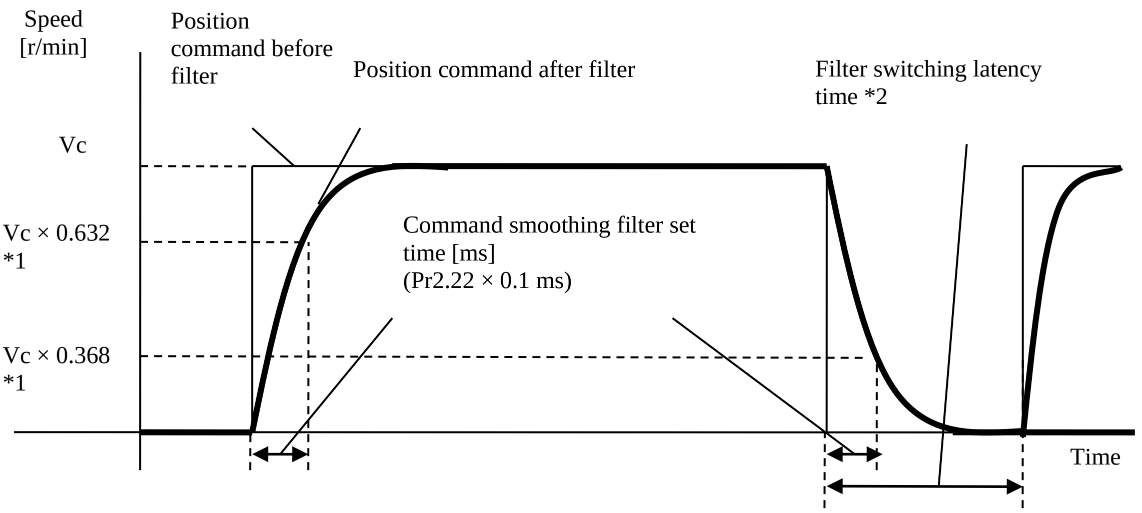
When a smoothing is desired with the position command after division/multiplication (electronic gear), perform the setting of command filter.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
2	22	Command smoothing filter	0 to 10000	0.1 ms	Sets the time constant of first order lag filter for the position command. With the two-degree-of-freedom control, it functions as the command response filter. For the details, refer to 5-2-15 "Two-degree-of-freedom control mode (With position control)" and 5-2-17 "Two-degree-of-freedom control mode (With velocity control)".
2	23	Command FIR filter	0 to 10000	0.1 ms	Sets the time constant of FIR filter for the position command.

• Regarding Pr2.22 "Command smoothing filter"

For the square-wave command of target speed Vc, the time constant of first order lag filter is set as shown with the figure below.

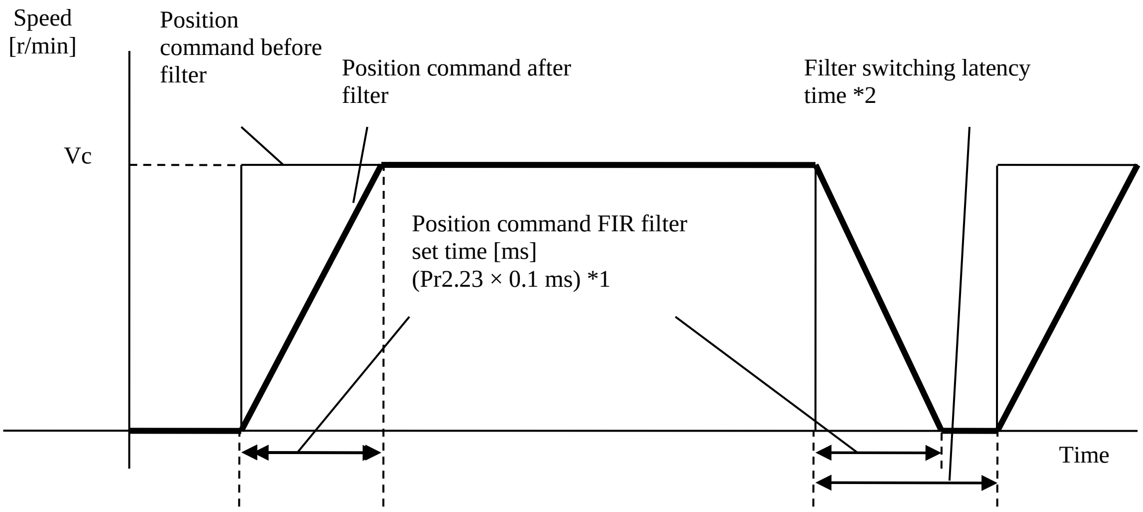


*1. The actual filter time constant (Set value × 0.1 ms) has an absolute error of up to 0.4 ms with less than 100 ms, and a relative error of up to 0.2% with 20 ms or more.

*2. The switching of Pr2.22 "Command smoothing filter" is performed during the positioning completion output, and also at rising of command with which the command pulse per specified duration (0.125 ms) changed from zero to other than zero.
In particular after the filter time constant is changed to become smaller, when a large positioning completion range is set, if there is remaining accumulated pulse (the area with which the value of after-filter position command is subtracted from before-filter position command, and then integrated by time) at the moment described above, the accumulated pulse in question becomes suddenly delivered immediately after the switching, and attempts to return to its original position. Use caution because the motor may temporarily operate at a speed higher than the intended command speed.

*3. With the change made to Pr2.22 "Command smoothing filter", a delay exists until it becomes applied to the internal calculation. When a switch timing of *2 is reached during that time, the change may be suspended.

• Regarding Pr2.23 "Command FIR filter"
For the square-wave command of target speed Vc, the attainment time until Vc is set as shown with the figure below.



*1. The actual movement average time for (Set value × 0.1 ms), has an absolute error of up to 0.2 ms with less than 10 ms, and a relative error of up to 1.6% with 10 ms or more.

*2. Make sure to change the Pr2.23 "Command FIR filter" after stopping the command pulse, and also after the filter switching latency time has elapsed. The filter switching latency time becomes as (Set value × 0.1 ms + 0.25 ms) with 10 ms or less, and as (Set value × 0.1 ms × 1.05) with 10 ms or more. When the Pr2.23 "Command FIR filter" is changed during a command pulse input, the contents of change will not be reflected immediately, but will be updated after the status without command pulse continues for the duration of filter switching latency time for the next time.

*3. With the change made to Pr2.23 "Command FIR filter", a delay exists until it becomes applied to the internal calculation. When a switch timing of *2 is reached during that time, the change may be suspended.

4-2-4 Pulse regeneration function

The movement can be communicated to the host controller from the servo driver by using the A- and B-phase pulses. Also, when the output source is the encoder, a Z-phase signal is output once per one motor rotation. In the case with the external scale, the output is made with absolute zero position. The output resolution, B-phase logic, and output source (encoder, external scale) for this circumstance can be set using parameters.

4-2-4-1 Pulse division function

■Relevant parameters

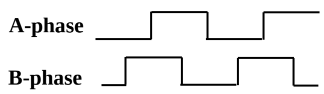
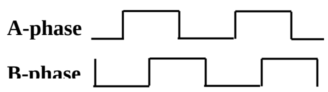
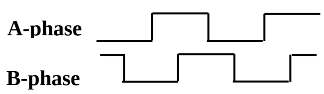
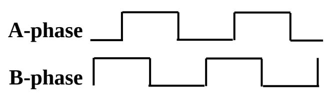
Category	No.	Parameter name	Setting range	Unit	Function
0	11	Output pulse count per one rotation	1 to 2097152	P/r	Sets the pulse output resolution with each of the output pulse count per one rotation of OA and OB. Consequently, the result of pulse count with host side ×4 multiplication processing becomes as follows. Pulse output resolution per one rotation = Pr0.11 set value × 4
0	12	Pulse output logic inversion/output source selection	0 to 3	--	Sets the B-phase logic and output source of pulse output. By inverting the B-phase pulse using this parameter, the phase relation of B-phase pulse to A-phase pulse can be inverted. With full-closed control or external scale position information monitor function is activated under semi-closed control, either the encoder or external scale can be selected as the output source. The encoder is selected in cases other than full-closed control and external scale position information monitor function is activated under semi-closed control.
4	47	Pulse output select	0 to 7	-	Selects the signal output from pulse output/Position compare output terminals: 0: OA/OB/OZ/CZ 1: OCMP1/OCMP2/OZ/CZ 2: OA/OB/OCMP3/OCMP3 3: OCMP1/OCMP2/OCMP3/OCMP3 4: OA/OB/OZ/OCMP4 5: OCMP1/OCMP2/OZ/OCMP4 6: OA/OB/OCMP3/OCMP4 7: OCMP1/OCMP2/OCMP3/OCMP4 * OA, OB, OZ, and CZ are pulse output signals, while OCMP1, OCMP2, OCMP3 and OCMP4 are position compare output signals.
5	3	Pulse output division denominator	0 to 8388608	--	With uses that the output pulse count per one rotation does not become as an integer, the setting can be performed by setting this value to other than zero, Pr0.11 as division numerator, and Pr5.03 as division denominator. Consequently, the result of pulse count with host side ×4 multiplication processing becomes as follows. Pulse output resolution per one rotation = (Pr0.11 set value / Pr5.03 set value) × Encoder resolution
5	33	Pulse regeneration output limit enable setting	0 to 1	--	Sets the enable/disable state of error detection (Err28.0 "Pulse regeneration output limit protection"). 0: Disabled 1: Enabled
6	20	External scale Z-phase expansion setting	0 to 400	μs	Sets the Z-phase regeneration width of external scale in unit of time. Even in cases such as the Z-phase signal width by movement from the external scale is too short and cannot be detected, the Z-phase signal is output at least for a duration that is set.
6	21	Serial absolute external scale Z-phase setting	0 to 268435456	pulse	With the full-closed control using the serial absolute external scale, or external scale position information monitor function valid under semi-closed control using serial absolute external scale, when pulse output is performed with the external scale as the output source, this parameter sets the Z-phase output interval with the output pulse count of external scale A-phase (before ×4 multiplication). 0: Z-phase is output only at the absolute zero position of external scale. 1 to 268435456: After the driver control power supply is turned on, the external scale Z-phase is output in synchronization with A-phase for the first time only when the external scale absolute position zero is traversed. Thereafter, the output is performed using the A-phase output pulse interval that is set with this parameter. * In case Pr6.58 ≠ 0, Z phase is output when the absolute position of external scale is equal to the set value for Pr6.58.

Category	No.	Parameter name	Setting range	Unit	Function
6	22	A- and B-phase external scale pulse output method selection	0 to 1	--	Selects the pulse regeneration method of ABZ parallel external scale. 0: The signal of ABZ parallel external scale is output as-is. 1: Signals of A- and B-phase from ABZ parallel external scale are regenerated, and then output. * With the Z-phase, the external scale signal is always output as-is.
6	58	Serial absolute external scale Z-phase shift amount	-2147483648 to 2147483647	pulse	Sets the absolute position to output external scale Z-phase when serial absolute external scale is used.

The combination table of Pr0.11 "Output pulse count per one rotation" and Pr5.03 "Pulse output division denominator" is provided below.

Pr0.11	Pr5.03	Pulse regeneration output processing
1 to 2097152	0	**[When output source is encoder]** Encoder pulse [pulse] → $\dfrac{\text{[Pr0.11 set value]} \times 4}{\text{Encoder resolution}}$ → Output pulse [pulse] * When Pr5.03 = 0 is true, the above processing is executed based on the Pr0.11 set value. As a result, each of OA and OB of pulse regeneration output becomes as the pulse count set with Pr0.11. The resolution of output pulse does not become more than the resolution of encoder pulse. **[When output source is external scale]** External scale pulse [pulse] → $\dfrac{1}{1}$ → Output pulse [pulse] * When Pr5.03 = 0 is true, the division ratio becomes as 1:1.
1 to 2097152	1 to 8388608	Encoder pulse or External scale pulse [pulse] → $\dfrac{\text{[Pr0.11 set value]}}{\text{[Pr5.03 set value]}}$ → Output pulse [pulse] * When Pr5.03 ≠ 0 is true, the above processing is executed based on the set values of Pr0.11 and Pr5.03. As a result, even any use, with which each of the OA or OB pulse count per one motor rotation of pulse regeneration output does not become as an integer, can be accommodated. However, when the pulse output resolution per one rotation does not become as a multiple of 4, the Z-phase output does not synchronize with A-phase, and the width may become smaller. The resolution of output pulse does not become more than the resolution of encoder pulse. Please use under the setting that satisfies "Set value for Pr0.11 ≤ Set value for Pr5.03."

The details of Pr0.12 "Pulse output logic inversion/output source selection" are described below.

Pr0.12	B-phase logic	Output source	At operation to CCW direction	At operation to CW direction
0	Non-inversion	Encoder		
2		External scale		
1	Inversion	Encoder		
3		External scale		

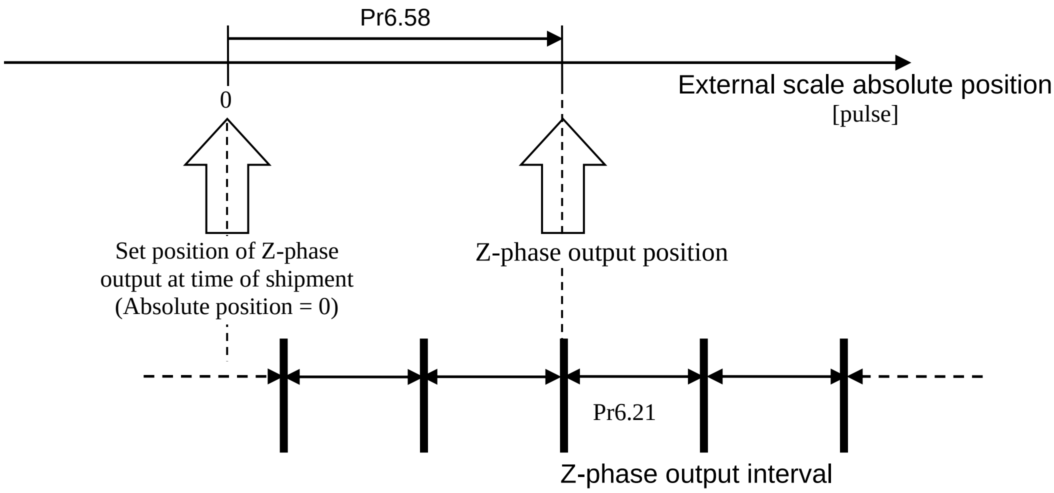
* Setting values 2 and 3 are effective only under one of the conditions below.
Under the conditions other than the below, set setting values to 0 and 1.
- In full-closed control
- In semi-closed control and when external scale position information monitor function is effective

[A6SE], [A6SG] This function is not available.

4-2-4-2 Pulse regeneration function of external scale

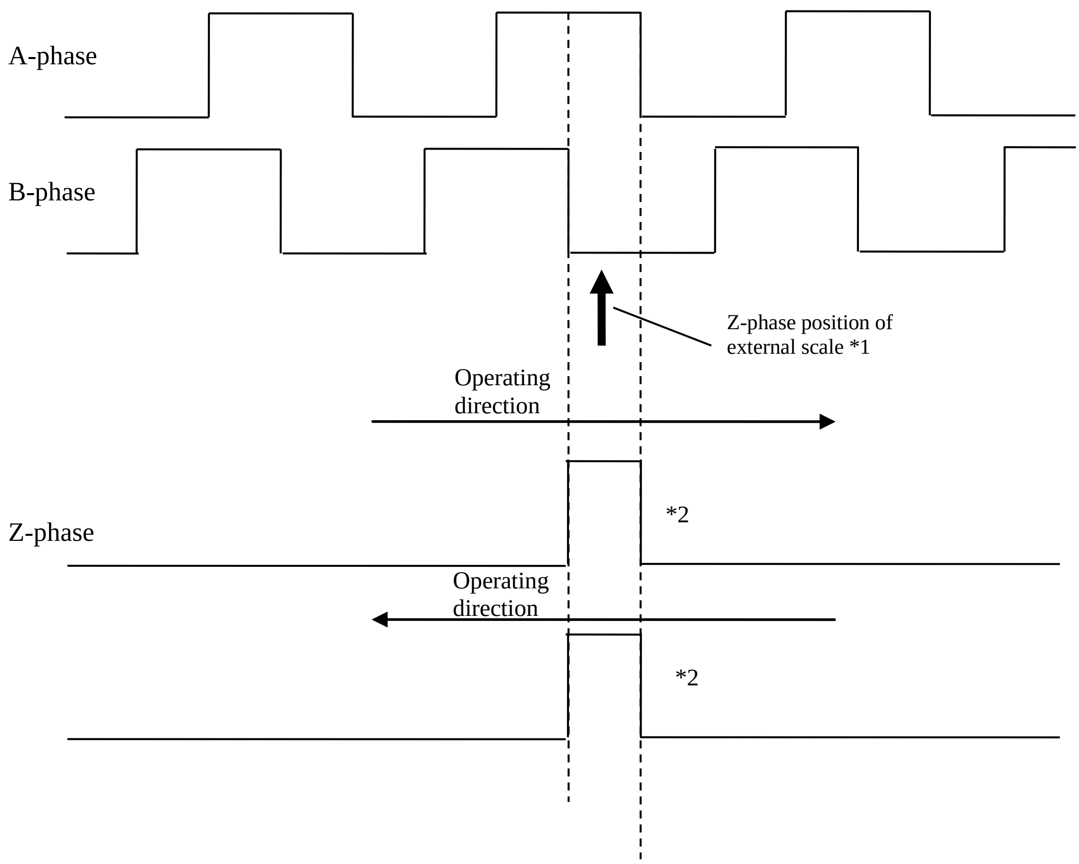
■Serial absolute external scale

- After the driver control power supply is turned on, the Z-phase is output for the first time only when the external scale absolute position zero is traversed, and, using this position as a datum, the Z-phase is output with the A-phase pulse interval that is set by Pr6.21. However, when Pr6.21 = 0 is true, the Z-phase is output only at the absolute zero position.
- The first Z-phase output after switching on the driver control power supply can be set to any external scale absolute position by the setting of Pr6.58. This function assumes use in case absolute zero position of external scale does not exist within the movable range of the machine.



■Serial incremental external scale

- With the Z-phase, the Z-phase of serial incremental external scale is through output (not divided). Also, pay attention because there are differences as shown in the figure below depending on the direction of traversing the Z-phase.



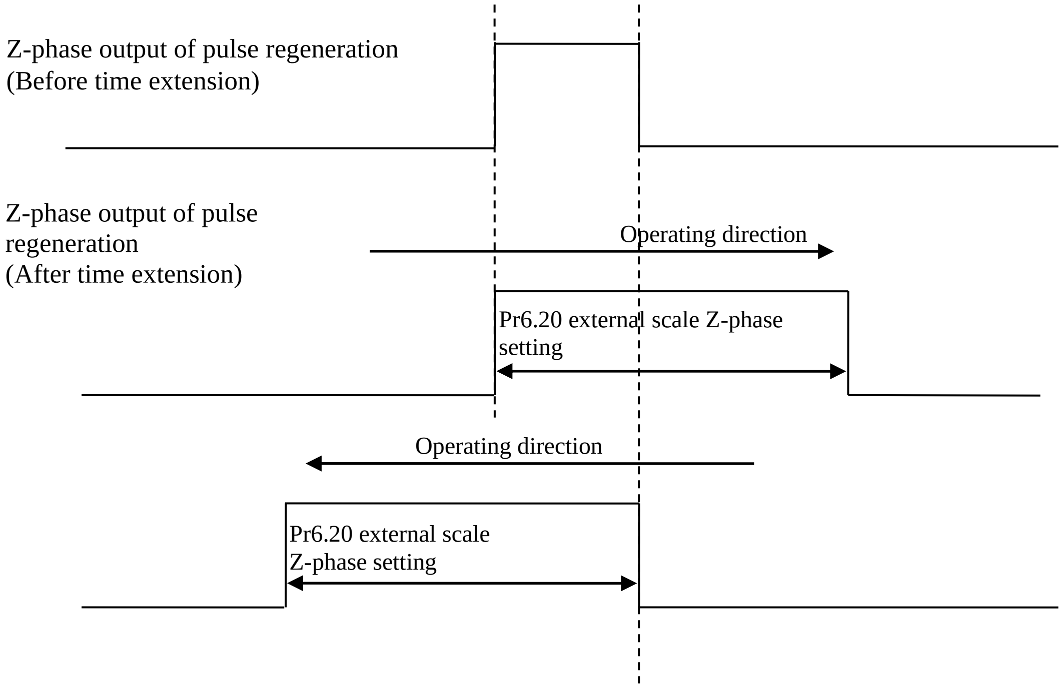
*1. The relationship between the Z-phase position and A-phase/B-phase differs depending on the scale. The above figure shows an example.
*2. The Z-phase is regenerated for an amount of one pulse of scale original signal. When the width is short, the output duration can be extended with Pr6.20 "External scale Z-phase setting".
*3. When using the Z-phase as a control signal, make sure to set the speed to 15 Mpulse/s or less using the external scale resolution as a datum (before pulse division). If the speed is exceeded, the Z-phase may not be output correctly.
Example) When the external scale resolution is 0.1 μm, the speed at 15 Mpulse/s becomes as described below.
15000000 [pulse/s] × 0.1 μm = 1.5 m/s
Use the Z-phase signal with the speed set to 1.5 m/s or less.
*4. When the power is turned on at immediately above the Z-phase, the Z-phase will not be output while the position remains unchanged. After the operation is performed once, and the scale side detects the Z-phase edge, the Z-phase is output.

■ABZ parallel external scale

- The Z-phase performs a through output of Z-signal input from the ABZ parallel external scale. (Will not be divided.)
- By setting as Pr6.22 "A- and B-phase external scale pulse output method selection" = 1, the signals of A- and B-phase are loaded into the driver, and the A- and B-phase signals can be regenerated. In this case, there will be a delay to the A- and B-phase regeneration compared to when Pr6.22 = 0 is true.

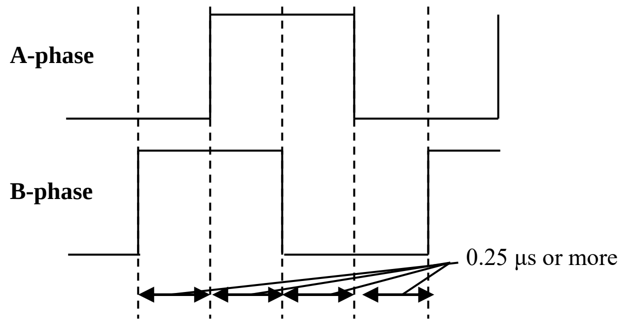
■Common items with external scale

- In cases such as the Z-phase signal width by movement from the external scale is too short and cannot be detected, setting the Z-phase signal output time to Pr6.20 "External scale Z-phase setting" allows the Z-phase to be output at least for a set duration. Because the output is performed for a set duration starting from the rising of Z-phase signal, pay attention that it differs from the actual Z-phase signal width. Also, use caution because, as shown in the figure below, the time is extended to different direction depending on the operating direction.



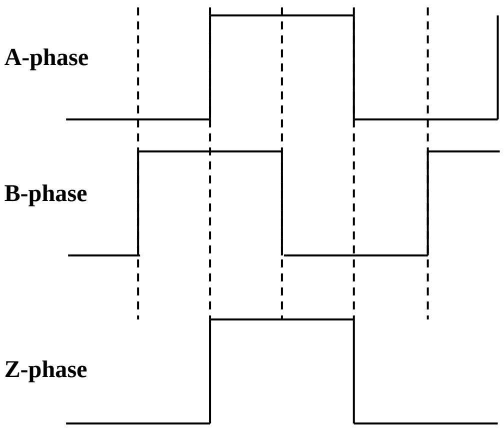
■Precautions on pulse regeneration function

- The maximum output frequency of pulse regeneration output becomes to 4 M[pulse/s] (after ×4 multiplication). If operated exceeding this speed, the regeneration function may not work correctly, and an accurate pulse is not returned to the host controller. So, pay attention because, depending on the use, it will lead to a positional displacement.

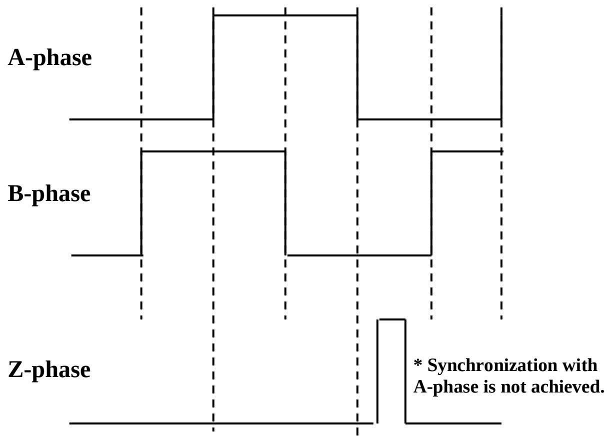


By Pr5.33 "Pulse regeneration output limit enable setting", a generation of Err28.0 "Pulse regeneration output limit protection" is possible when the pulse regeneration limit is reached. To note, because this error is set to occur upon a detection of pulse regeneration output limit, the error is not generated by the maximum output frequency. Depending on the motor rotating state (rotation irregularity), the error may occur by a detection of frequency that became instantaneously high.

- When the output source is set as the encoder, and also when the pulse output resolution per one rotation is a multiple of 4, the Z-phase does not synchronize with the A-phase, and the width may become smaller. Please use caution.



When division ratio is multiple of 4



When division ratio is not multiple of 4

* When Pr5.03 = 0 is true, and output resolution is set with Pr0.11, the ratio always becomes as a multiple of 4.

- When using an encoder of incremental specification, the initial Z-phase after the power is turned on may not become as the pulse width described above. When using the Z-phase signal, operate the motor for one rotation or more after turning on the power, confirm that the Z-phase regeneration is performed once, and then use the Z-phase of second time or later.

- Please note that pulse regeneration will not be output when block operation and full-closed control are valid.

4-2-5 Deviation counter clear (CL) function

This is a function that uses the deviation counter clear input (CL), and clears the position deviation counter value of position control to zero.
When Pr6.28 “control mode setting” ≠0 “block operation is valid” is true, the deviation counter clear input (CL) function is disabled.
Please refer to (Modbus communication specifications / Block operation function) for details.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
5	17	Counter clear input mode	0 to 4	--	Sets the clear condition of deviation counter clear input signal. 0: Disabled 1: Clear by level (Without read filter) 2: Clear by level (With read filter) 3: Clear at edge (Without read filter) 4: Clear at edge (With read filter)

For the necessary signal width/deviation clear timing of deviation counter clear input (CL), refer to the table below.

Pr5.17	CL signal width	Deviation clear timing
1	500 μs or more	Clear is continued while the state of deviation counter clear input is ON *1.
2	1 ms or more	
3	100 μs or more	Clear is performed only once at the deviation counter clear input OFF → ON edge*1.
4	1 ms or more	

*1. The OFF state of deviation counter clear input indicates the input photo-coupler OFF, and the ON state indicates the input photo-coupler ON.

4-2-6 Positioning completion output (INP/INP2) function

The positioning completion status can be checked by the positioning completion output (INP/INP2). It becomes ON when the absolute value of position deviation counter value with position control is at the positioning completion range or less which is set by the parameter. Also, additional settings are possible such as to add the existence of position command to the judgment criteria.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
4	31	Positioning completion range	0 to 2097152	Command unit	Sets the threshold of position deviation that is used to output the positioning completion signal (INP). Although the setting unit at shipment is on a command basis, it can be changed to the encoder unit or external scale unit using Pr5.20 "Position setting unit selection". In that case, however, pay attention because the unit of Pr0.14 "Position deviation excess setting" also becomes changed together.
4	32	Positioning completion output setting	0 to 10	--	Selects the condition with which the positioning completion signal (INP) is output. The existence of position command is judged using the command after the position command filter for the set values from 1 to 5 and using the command before the position command filter for set values from 6 to 10. 0: Becomes ON when the position deviation is Pr4.31 "Positioning completion range" or less before the position command filter. 1, 6: Becomes ON when the position command is absent, and also when the position deviation is Pr4.31 "Positioning completion range" or less. 2, 7: Becomes ON when the position command is absent, and also when the zero speed detection signal is ON, and also when position deviation is Pr4.31 "Positioning completion range" or less. 3, 8: Becomes ON when the position command is absent, and also when the position deviation is Pr4.31 "Positioning completion range" or less. Thereafter, the ON state is maintained until the Pr4.33 "INP hold time" elapses. After the INP hold time has elapsed, the INP output is turned ON/OFF depending on the circumstances with position command and position deviation. 4, 9: Starting at the change of position command state from “with” to “without”, after the positioning judgment delay time set with Pr4.33 "INP hold time" has elapsed, the positioning completion judgment commences. And the state becomes ON when the position command is absent, and also when the position deviation is Pr4.31 "Positioning completion range" or less. 5, 10: Starting at the change of position command state from “with” to “without”, when the positioning judgment delay time set with Pr4.33 "INP hold time" has elapsed after the positioning completion range is entered, the positioning completion judgment commences. And the state becomes ON when the position command is absent, and also when the position deviation is Pr4.31 "Positioning completion range" or less.
4	33	INP hold time	0 to 30000	1 ms	• When Pr4.32 "Positioning completion output setting" = 3 or 8 is true, this parameter sets the hold time. 0: The hold time becomes as infinite, and the ON state is continued until the next position command is input. 1 to 30000: The ON state is continued for the duration of set value [ms]. However, if a position command is input during the hold time, the state changes to OFF. • When Pr4.32 "Positioning completion output setting" = 4, 5, 9, or 10 is true, this parameter sets the positioning judgment delay time. 0: The positioning judgment delay time becomes disabled, and the judgment commences immediately without the position command. 1 to 30000: The positioning judgment start time becomes delayed for the duration of set value [ms]. However, if a position command is input during the delay time, the delay time is reset, then the delay time measurement is started from zero again after the position command in question becomes zero.
4	42	Positioning completion range 2	0 to 2097152	Command unit	Sets the threshold of position deviation that is used to output the positioning completion signal 2 (INP2). Independent of Pr4.32 "Positioning completion output setting", the INP2 always becomes ON when the position deviation is at the set value or less. (No judgment is made based on the existence of position command or on others.) Although the setting unit at shipment is on a command basis, it can be changed to the encoder unit or external scale unit using Pr5.20 "Position setting unit selection". In that case, however, pay attention because the unit of Pr0.14 "Position deviation excess setting" also becomes changed together.

(Continued)

Category	No.	Parameter name	Setting range	Unit	Function
5	20	Position setting unit selection	0 to 1	-	Select positioning complete range and set unit for excessive positioning deviation. 0: Command unit, 1: Encoder unit (external scale unit)

• For the details on position command filter, refer to 4-2-3 "Position command filter function".

4-2-7 Command pulse inhibition (INH) function

By using the command pulse inhibition input signal (INH), the command pulse input count processing can be forcibly stopped. When the INH input is turned ON, the servo driver ignores the command pulse input, and does not perform the pulse count. In addition, clears the accumulated pulses of the position command filter function as well as the remnant pulses of the command division/multiplication function.
This function is disabled with the factory setting. To use the function, change the setting of Pr5.18 "Command pulse prohibition input disable".
When Pr6.28 "control mode setting" ≠0 "block operation is valid" is true, the command pulse inhibition input signal (INH) function is disabled.
Please refer to (Modbus communication specifications / Block operation function) for details.

■Relevant parameters

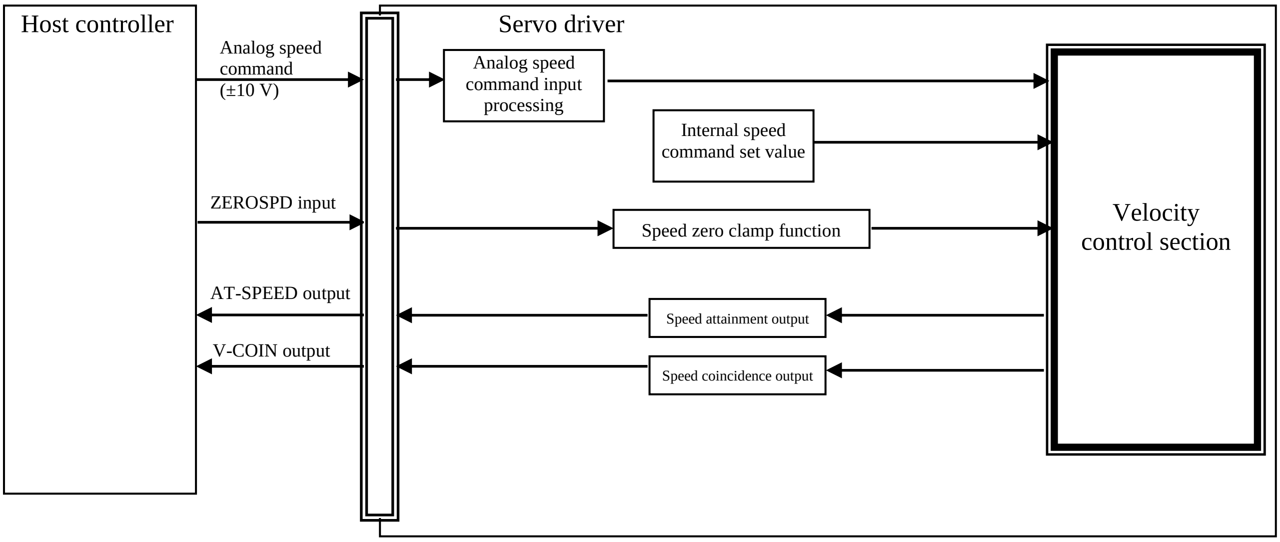
Category	No.	Parameter name	Setting range	Unit	Function
5	18	Command pulse prohibition input disable	0 to 2	--	Sets the enable/disable state of command pulse inhibition input. 0: Enabled (When INH input is ON, the servo driver ignores the command pulse,disabling pulse counting function,and, at the same time, clears the accumulated pulses of the position command filter function and damping control as well as the remnant pulses of the command division/multiplication function.) 1: Disabled 2: Enabled (When INH input is ON, the servo driver ignores the command pulse, disabling pulse counting function. In this setting, the servo driver keeps the accumulated pulses of the position command filter function and damping control as well as the remnant pulses of the command division/multiplication function.)
5	19	Command pulse prohibition input read setting	0 to 5	--	Selects the signal read cycle of command pulse inhibition input. When the signal status of each of the set read cycle matches for multiple times, the signal status is updated. 0: Three consecutive accordances with 0.250 ms cycle 1: Three consecutive accordances with 0.500 ms cycle 2: Three consecutive accordances with 1.0 ms cycle 3: Three consecutive accordances with 2.0 ms cycle 4: One reading with 0.250 ms cycle 5: Two consecutive accordances with 0.250 ms cycle By extending the read cycle, the likelihood of faulty operation caused by noise becomes smaller. However, pay attention because the responsiveness to signal input becomes diminished.

■ Precautions

When the INH input is turned ON, a discrepancy will occur between the position command data controlled by the higher-level device and the internal position command of the servo driver and, as a result, the origin position data before the INH input will be lost. When restarting an operation that requires the position control, always conduct the return to origin.

4-3 Velocity control

Based on the analog speed command input from the host controller, or on the internal speed command that is set internally in the servo driver, the velocity control is implemented.



4-3-1 Velocity control by analog speed command

[A6SE], [A6SG] This function is not available.

An analog-to-digital conversion of analog speed command input (voltage) is performed, and the obtained input is loaded as digital value, then converted into the speed command value. Also, a filter setting and offset adjustment for noise reduction can be performed.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	0	Inside/outside speed setting switching	0 to 3	--	Selects the speed command input method of velocity control mode. 0: Analog speed command (SPR) 1: Internal speed setting 1st speed to 4th speed 2: Internal speed setting 1st speed to 3rd speed, analog speed command (SPR) 3: Internal speed setting 1st speed to 8th speed
3	1	Speed command direction designation selection	0 to 1	--	Selects the method to designate the positive direction/negative direction of speed command. 0: Designates the direction via the sign of speed command. Example) Speed command input "+" → Positive direction; "-" → Negative direction 1: Designates the direction via the speed command sign selection (VC-SIGN). OFF: Positive direction ON: Negative direction
3	2	Speed command input gain	10 to 2000	(r/min)/V	Sets the conversion gain from the voltage impressed on analog speed command (SPR) to the motor command speed.
3	3	Speed command input inversion	0 to 1	--	Sets the polarity of voltage impressed on the analog speed command (SPR). 0: Non-inversion "Positive voltage" → "Positive direction"; "Negative voltage" → "Negative direction" 1: Inversion "Positive voltage" → "Negative direction"; "Negative voltage" → "Positive direction"
4	22	Analog input 1 (AI1) offset setting	-27888 to 27888	0.359 mV	Sets the offset adjustment value for the voltage impressed on the analog input 1.
4	23	Analog input 1 (AI1) filter setting	0 to 6400	0.01 ms	Sets the time constant of first order lag filter for the voltage impressed on the analog input 1.

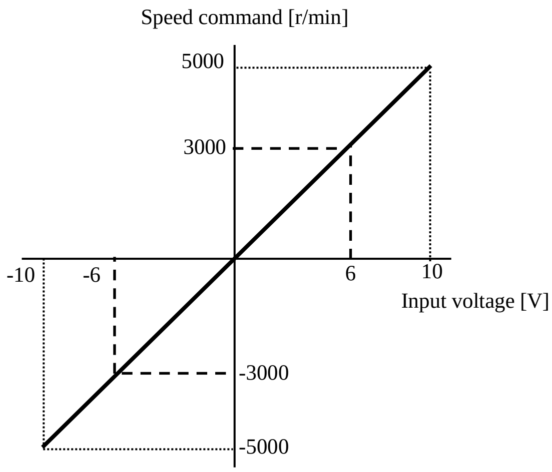
The table below shows the combinations of parameters Pr3.00 "Inside/outside speed setting switching", Pr3.01 "Speed command direction designation selection", Pr3.03 "Speed command input inversion", I/F connector analog speed command (SPR), speed command sign selection (VC-SIGN), as well as the relationship of motor rotation direction, and the corresponding conversion graphs for analog speed command input voltage to speed command.

Pr3.00	Pr3.01	Pr3.03	Analog speed command (SPR)	Speed command sign selection (VC-SIGN)	Motor rotation direction	Conversion graph
0	0	0	Positive voltage (0 to 10 V)	Without effect	Positive direction	(a)
			Negative voltage (-10 to 0 V)	Without effect	Negative direction	
		1	Positive voltage (0 to 10 V)	Without effect	Negative direction	(b)
			Negative voltage (-10 to 0 V)	Without effect	Positive direction	
	1	Without effect	Positive voltage (0 to 10 V)	OFF	Positive direction	(c)
			Negative voltage (-10 to 0 V)			
			Positive voltage (0 to 10 V)	ON	Negative direction	
			Negative voltage (-10 to 0 V)			

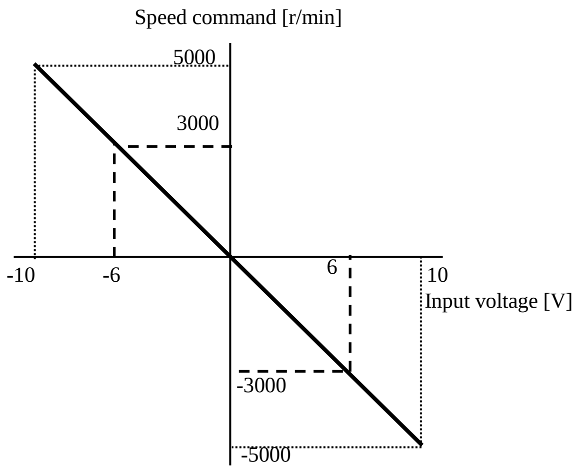
The conversion of the analog speed command input voltage [V] to the speed command [r/min] for motor takes three patterns of (a), (b), and (c) shown in the corresponding graph fields of the table above, and their representations are provided below.
The graph inclination represents the case of Pr3.02 = 500. Depending on the Pr3.02 set value, the inclination will change.

Speed command [r/min] = Pr3.02 set value × Input voltage [V]

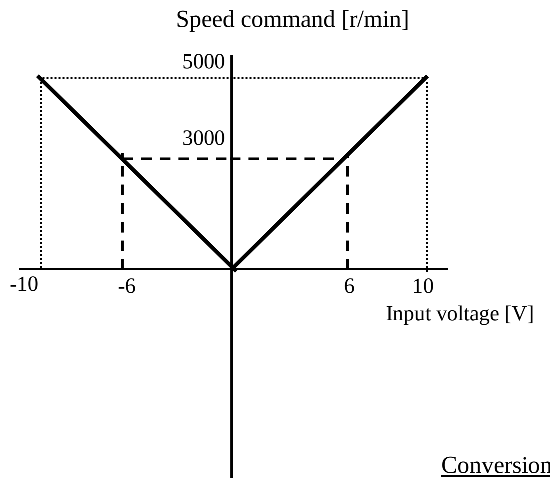
Speed command [r/min] = -(Pr3.02 set value × Input voltage [V])



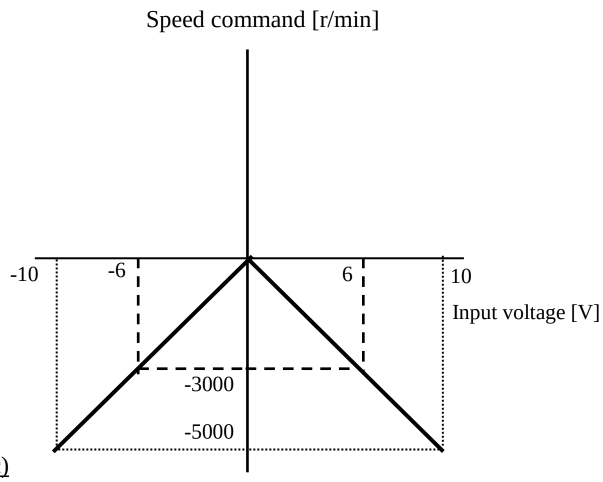
Conversion graph (a)



Conversion graph (b)



VC-SIGN OFF



VC-SIGN ON

Conversion graph (c)

4-3-2 Velocity control by internal speed command

In accordance with the internal speed command value set to the parameter, the velocity control is implemented. By using the internal command speed selection 1 to 3 (INTSPD1 to 3), a selection can be made from the maximum of eight internal speed command set values. With the factory setting, the analog speed command setting is adopted. Use this control after changing to the internal speed setting via Pr3.00 "Inside/outside speed setting switching".

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	0	Inside/outside speed setting switching	0 to 3	--	Selects the speed command input method of velocity control mode. 0: Analog speed command (SPR) 1: Internal speed setting 1st speed to 4th speed 2: Internal speed setting 1st speed to 3rd speed, analog speed command (SPR) 3: Internal speed setting 1st speed to 8th speed
3	1	Speed command direction designation selection	0 to 1	--	Selects the method to designate the positive direction/negative direction of speed command. 0: Designates the direction via the sign of speed command. Example) Speed command input "+" → Positive direction; "-" → Negative direction 1: Designates the direction via the speed command sign selection (VC-SIGN).
3	4	Speed setting 1st speed	-20000 to 20000	r/min	Sets the 1st speed of internal command speed.
3	5	Speed setting 2nd speed			Sets the 2nd speed of internal command speed
3	6	Speed setting 3rd speed			Sets the 3rd speed of internal command speed.
3	7	Speed setting 4th speed			Sets the 4th speed of internal command speed.
3	8	Speed setting 5th speed			Sets the 5th speed of internal command speed.
3	9	Speed setting 6th speed			Sets the 6th speed of internal command speed.
3	10	Speed setting 7th speed			Sets the 7th speed of internal command speed.
3	11	Speed setting 8th speed			Sets the 8th speed of internal command speed.

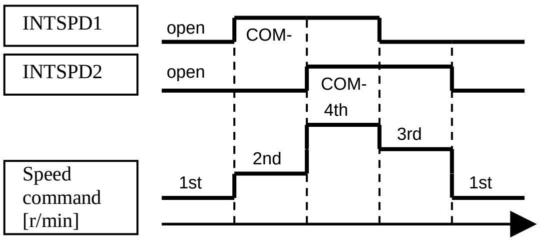
- Regarding relationship of Pr3.00 "Inside/outside speed setting switching", internal command speed selection 1 to 3 states, and selected speed command

Pr3.00	Internal command speed selection 1 (INTSPD1)	Internal command speed selection 2 (INTSPD2)	Internal command speed selection 3 (INTSPD3)	Speed command selection
1	OFF	OFF	Without effect	1st speed
	ON	OFF		2nd speed
	OFF	ON		3rd speed
	ON	ON		4th speed
2	OFF	OFF	Without effect	1st speed
	ON	OFF		2nd speed
	OFF	ON		3rd speed
	ON	ON		Analog speed command
3	Same as with "Pr3.00 = 1"		OFF	1st speed to 4th speed
	OFF	OFF	ON	5th speed
	ON	OFF	ON	6th speed
	OFF	ON	ON	7th speed
	ON	ON	ON	8th speed

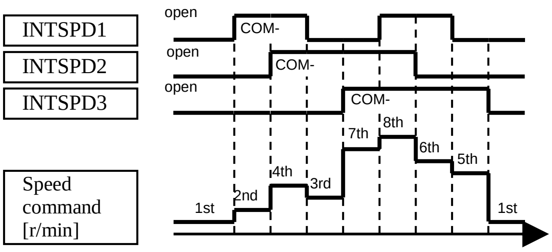
- Regarding relationship between Pr3.01 "Speed command direction designation selection" setting and speed command direction

Pr3.01	Internal speed set value (1st speed to 8th speed)	Speed command sign selection (VC-SIGN)	Speed command direction
0	+	Without effect	Positive direction
	-	Without effect	Negative direction
1	Not affected by sign	OFF	Positive direction
	Not affected by sign	ON	Negative direction

Note) Make sure to set so that the switching pattern of internal command speed changes with one input signal at a time as shown by the example in the figure on the next page.
If two or more input signals change, an internal command speed that is not specified may be selected, resulting in an unintended operation due to the set value or acceleration/deceleration setting involved.



Example 1) When Pr3.00 = 1 or 2



Example 2) When Pr3.00 = 3

4-3-3 Speed zero clamp (ZEROSPD) function

By using the speed zero clamp input, the speed command can be forcibly set to zero.

■Relevant parameters

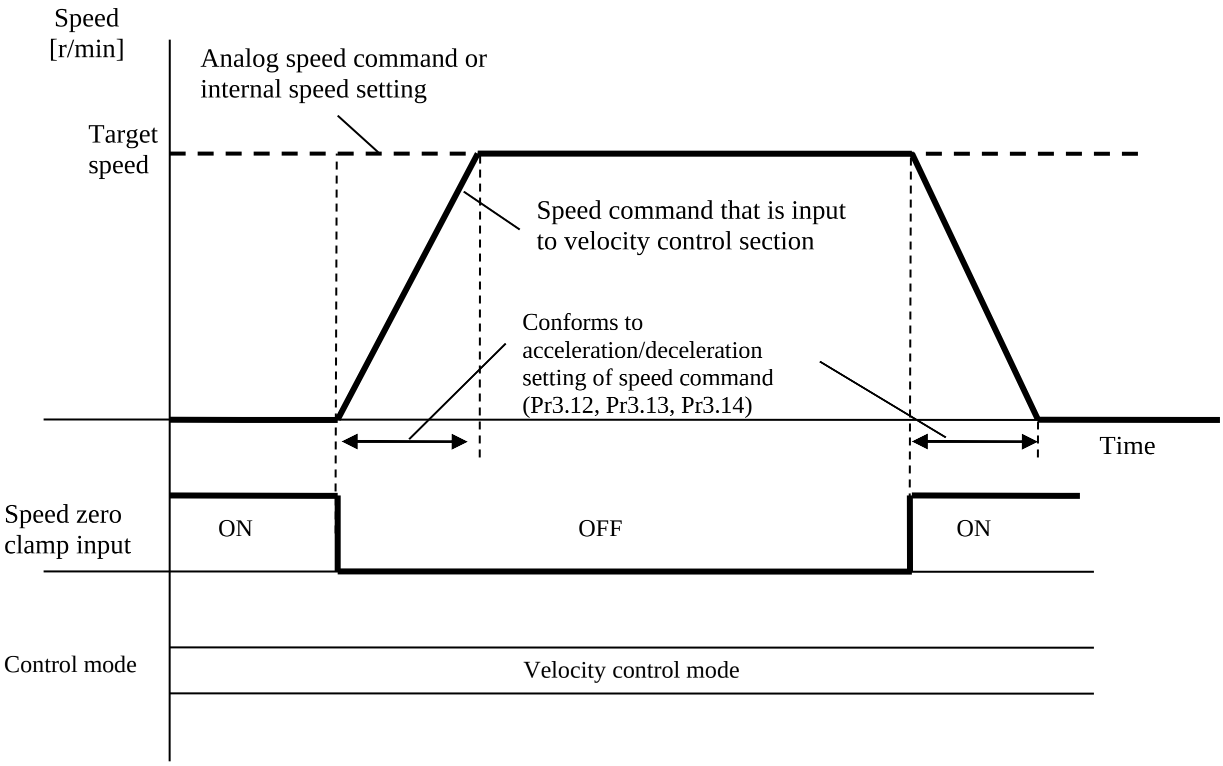
Category	No.	Parameter name	Setting range	Unit	Function
3	15	Speed zero clamp function selection	0 to 3	--	Sets the speed zero clamp function. 0: Disabled; The speed zero clamp input is ignored. 1: At the speed zero clamp input, the state becomes as speed command = 0. 2: At the speed zero clamp input, the state becomes as speed command = 0, and also the status becomes locked with position control when the actual speed is at Pr3.16 "Speed zero clamp level" or less. 3: At the speed zero clamp input, and also when speed command is at Pr 3.16"speed zero clamp level" or less,the state becomes locked with position control.
3	16	Speed zero clamp level	10 to 20000	r/min	Sets the threshold at which a change to position control is made when Pr3.15 "Speed zero clamp function selection" is set to 2 or 3. When Pr3.15 = 3 is true, a 10 r/min hysteresis is given to the detection.

Note) When Pr6.97(Function expansion setting 3) bit15 is set to 0 and Pr0.01(position/torque control) is set to 4, switching from torque control to position control by control mode switching input is not possible if the speed zero clamp input is ON. By turning OFF the speed zero clamp input, torque control can be switched to position control by the control mode switching input while the motor is stopped. When Pr6.97(Function expansion setting 3) bit15 is set to 1 and Pr0.01(position/ torque control) is set to 4 for function enhancement version 7 and later versions, switching from torque control to position control by control mode switching input is possible if the speed zero clamp input is ON.

• When Pr3.15 "Speed zero clamp function selection" = 1 is true

When the speed zero clamp (ZEROSPD) input signal is ON, the speed command is forcibly set to zero. For example, when it is desired to give a trapezoidal wave speed command, the speed zero clamp input signal is set to ON, and the trapezoidal wave target speed is input by the analog speed command or internal speed setting. Subsequently, when the speed zero clamp input signal is set from ON to OFF, the speed command is accelerated to the attainment speed. Also, when set from OFF to ON, the speed command is decelerated down to zero. As a result, while the status is kept with a specified value given as the speed command, a speed command with acceleration/deceleration can be easily generated by the changing of speed zero clamp input signal ON ⇔ OFF.

The acceleration and deceleration can be set using Pr3.12 "Acceleration time setting", Pr3.13 "Deceleration time setting", and Pr3.14 "S-shape acceleration/deceleration setting". Pay attention because, with the factory setting, they are all set to 0, and the speed command changes in steps.



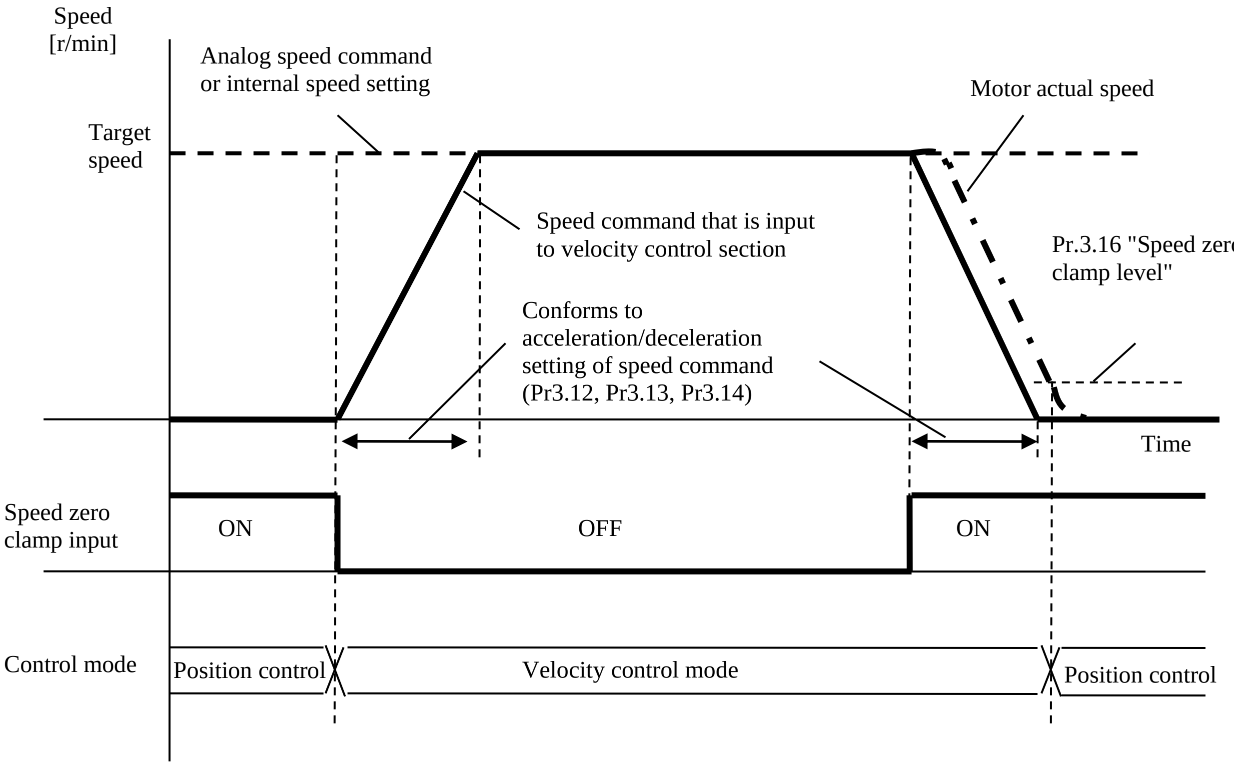
Note) Because the factory setting value for speed zero clamp input is the b contact, ON in the figure represents the input photo-coupler OFF state, and OFF as the input photo-coupler ON state.

• When Pr3.15 "Speed zero clamp function selection" = 2 is true

When the speed zero clamp (ZEROSPD) input signal is ON, the speed command is forcibly set to zero, and also when the motor actual speed becomes to Pr3.16 "Speed zero clamp level" or less, a change to position control is made, and the servo becomes locked at that position.

The basic operation other than the change to position control remains the same as with the operation of set value 1.

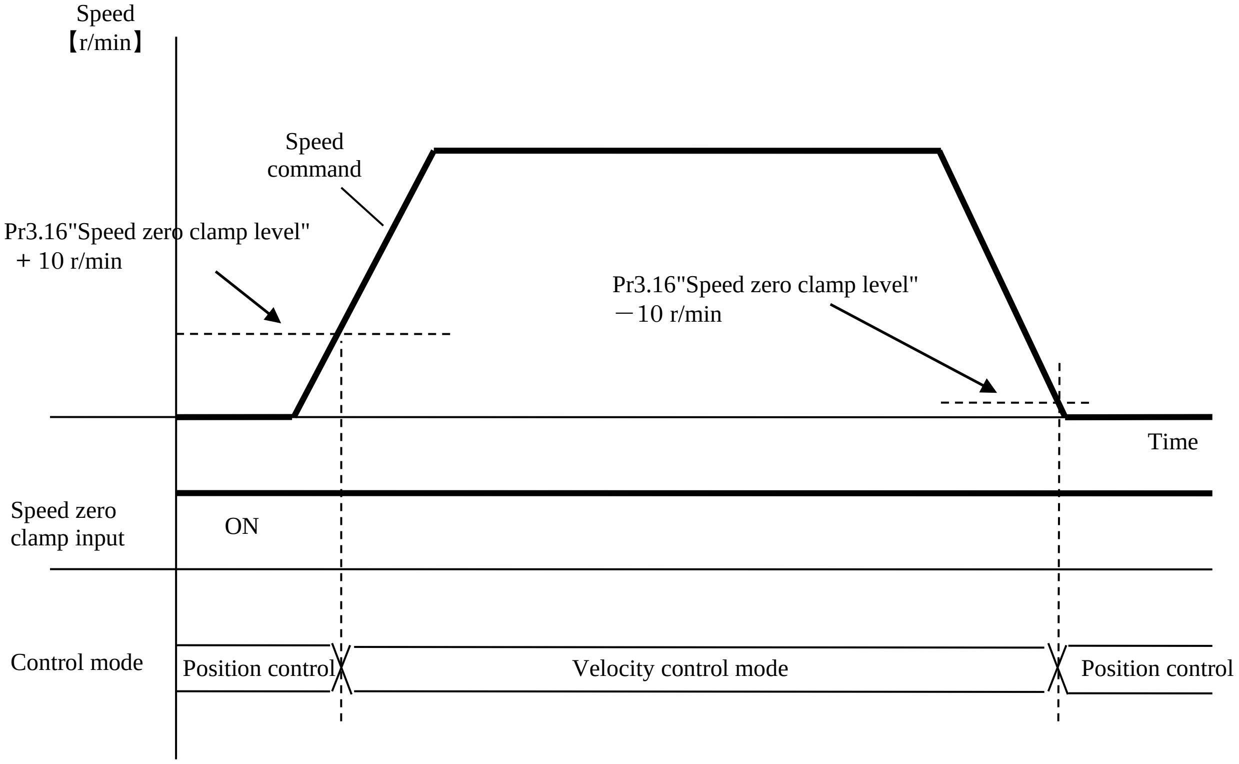
The change from velocity control to position control is made, as described above, when the speed zero clamp (ZEROSPD) input signal is ON, and also the actual speed is at Pr3.16 "Speed zero clamp level" or less. On the other hand, the change from position control to velocity control is made when the speed zero clamp (ZEROSPD) input signal is set to OFF. After a transition to servo lock with position control is made once, the servo lock with position control is maintained even when the actual speed increases to more than Pr3.16 "Speed zero clamp level" by an external force, provided that the state of speed zero clamp (ZEROSPD) is ON.



Note) The position command at position control shown in the above figure becomes forcibly set to zero. During the position control, it operates as a normal position control. Therefore, make sure to appropriately set the position loop gain, error detection function, and others. However, the allocation setting of control input signal conforms to the velocity control.

Note) Make sure to use with Pr0.01 "Control mode setting" = 1 (velocity control). If used concurrently with control mode switching with Pr0.01 = 3 or 4, the operation may not be performed correctly.

• When Pr3.15 "Speed zero clamp function selection" = 3 is true
When the Speed zero clamp(ZEROSPD) input signal is ON, and also when the speed command become to Pr 3.16 ”speed zero clamp level” -10r/min or less,aa change to position control is made, and the servo becomes locked at the position. In case this mode, when the speed zero clamp(ZEROSPD) input signam is ON, the speed command is not forcibly set to zero. It is necessary to change speed command input for that.



Note) The position command at position control shown in the above figure becomes forcibly set to zero.
During the position control, it operates as a normal position control. Therefore, make sure to appropriately set the position loop gain, error detection function, and others. However, the allocation setting of control input signal conforms to the velocity control.

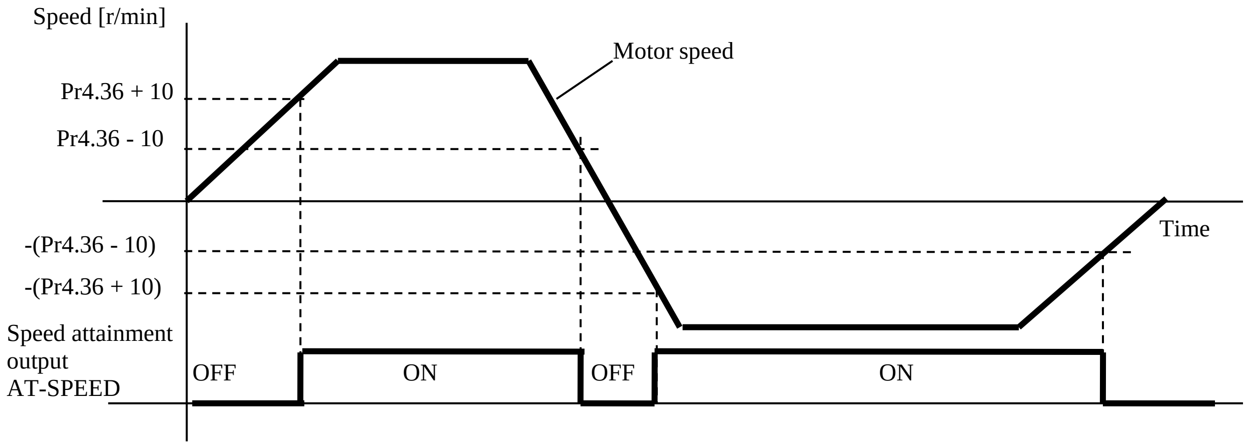
Note) Make sure to use with Pr0.01 "Control mode setting" = 1 (velocity control).
If used concurrently with control mode switching with Pr0.01 = 3 or 4, the operation may not be performed correctly.

4-3-4 Speed attainment output (AT-SPEED)

When the motor speed reaches the speed that is set with Pr4.36 "Attainment speed", the speed attainment output (AT-SPEED) signal is output.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
4	36	Attainment speed	10 to 20000	r/min	Sets the detection threshold of speed attainment output (AT-SPEED). When the motor speed exceeds the set value, the speed attainment output (AT-SPEED) is output. A hysteresis of 10 r/min is given to the detection.

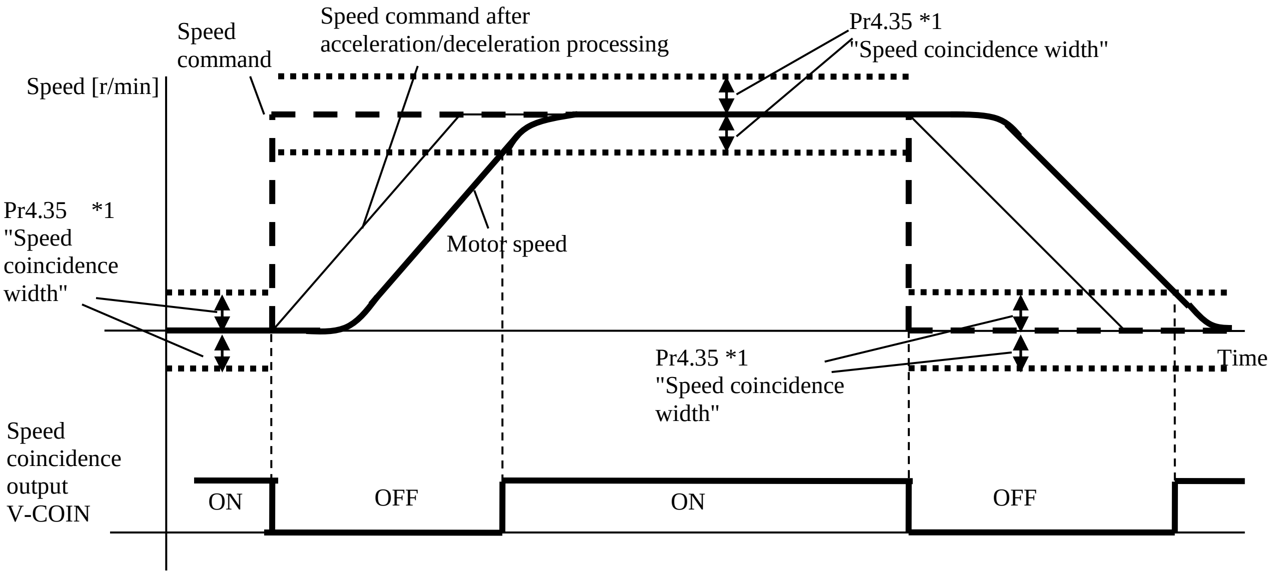


4-3-5 Speed coincidence output (V-COIN)

The output is performed when the speed command (before acceleration/deceleration processing) and the motor speed agree with each other. The coincidence judgment is made when the difference between the speed command and the motor speed before the acceleration/deceleration processing inside the driver is within the Pr4.35 "Speed coincidence width".

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
4	35	Speed coincidence width	10 to 20000	r/min	Sets the detection threshold of speed coincidence output (V-COIN). When the difference between the speed command and motor speed is the set value or less, the speed coincidence output (V-COIN) is output. A hysteresis of 10 r/min is given to the detection.



*1. Because the speed coincidence detection has hysteresis of 10 r/min, the actual detection width becomes as described below.

Speed coincidence output: Threshold at OFF → ON (Pr4.35 - 10) r/min

Threshold at ON → OFF (Pr4.35 + 10) r/min

4-3-6 Speed command acceleration/deceleration setting function

The velocity control is implemented using the speed command input to which acceleration/deceleration is given inside the driver as the speed command.

A soft starting becomes possible when inputting a step form speed command or when using with the internal speed setting. Also, when reducing of shock by acceleration change is desired, the S-shape acceleration/deceleration function can also be used.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	12	Acceleration time setting	0 to 10000	ms/ (1000 r/min)	Sets the acceleration time of acceleration processing on the speed command input.
3	13	Deceleration time setting	0 to 10000	ms/ (1000 r/min)	Sets the deceleration time of deceleration processing on the speed command input.
3	14	S-shape acceleration/ deceleration setting	0 to 1000	ms	Sets the S-shape time of acceleration/deceleration processing on the speed command input.

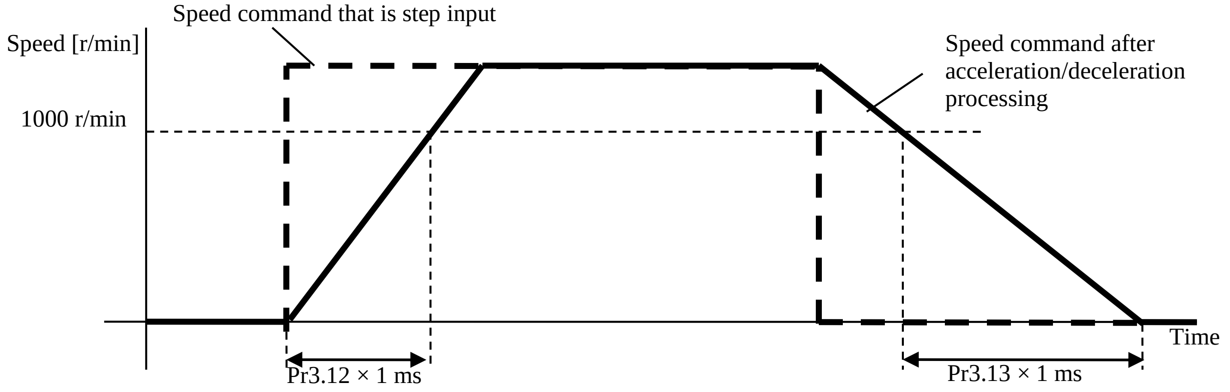
Note) When the position loop is configured outside the driver, do not use the acceleration/deceleration time setting.
Make sure to use with all the set values above at zero.

• Regarding Pr3.12 "Acceleration time setting" and Pr3.13 "Deceleration time setting"

To Pr3.12 "Acceleration time setting", the time is set with which the speed command reaches 1000 r/min when a step form speed command is input. Also, to Pr3.13 "Deceleration time setting", the time is set with which the speed command reaches from 1000 r/min to 0 r/min.

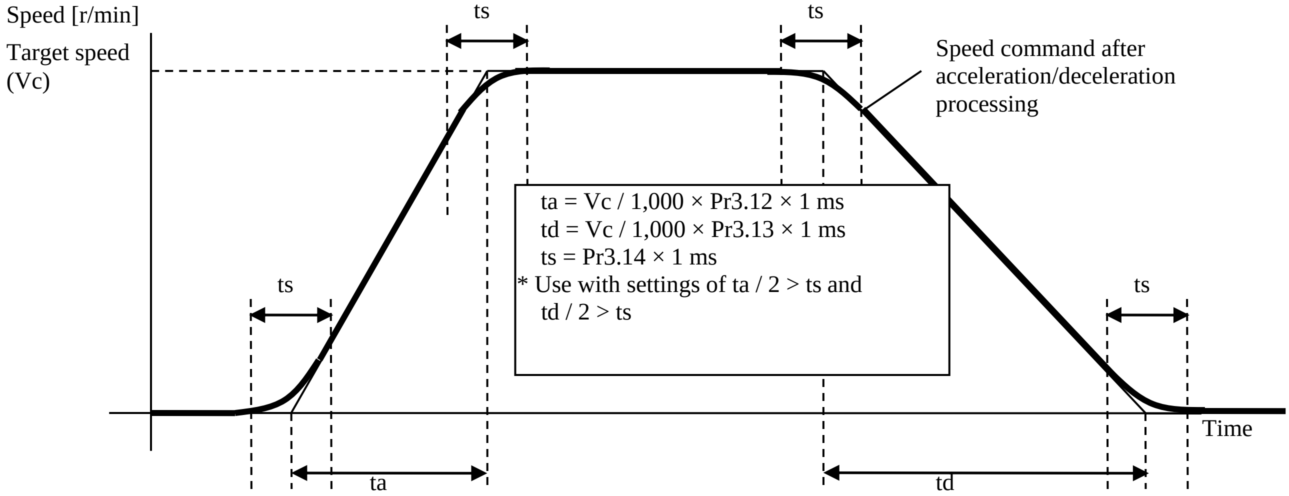
The time needed for acceleration/deceleration can be calculated using the equation below by giving Vc [r/min] as the speed command target value.

Acceleration time [ms] = Vc / 1000 × Pr3.12 × 1 ms
Deceleration time [ms] = Vc / 1000 × Pr3.13 × 1 ms



• Regarding Pr3.14 "S-shape acceleration/deceleration setting"

For the acceleration/deceleration time that is set with Pr3.12 "Acceleration time setting" and Pr3.13 "Deceleration time setting", the time for S-shape section is set using the time width centered at the inflection point of acceleration/deceleration.



[A6SE], [A6SG] This function is not available.

4-4 Torque control

In accordance with the torque command specified by the analog voltage, the torque control is implemented. For the torque control, the speed limit input is needed besides the torque command. The control is implemented to prevent the motor rotation speed from exceeding the speed limit value.
With the A6 series, there are three modes depending on the different torque commands/speed limits.
Their differences are described in the table below.

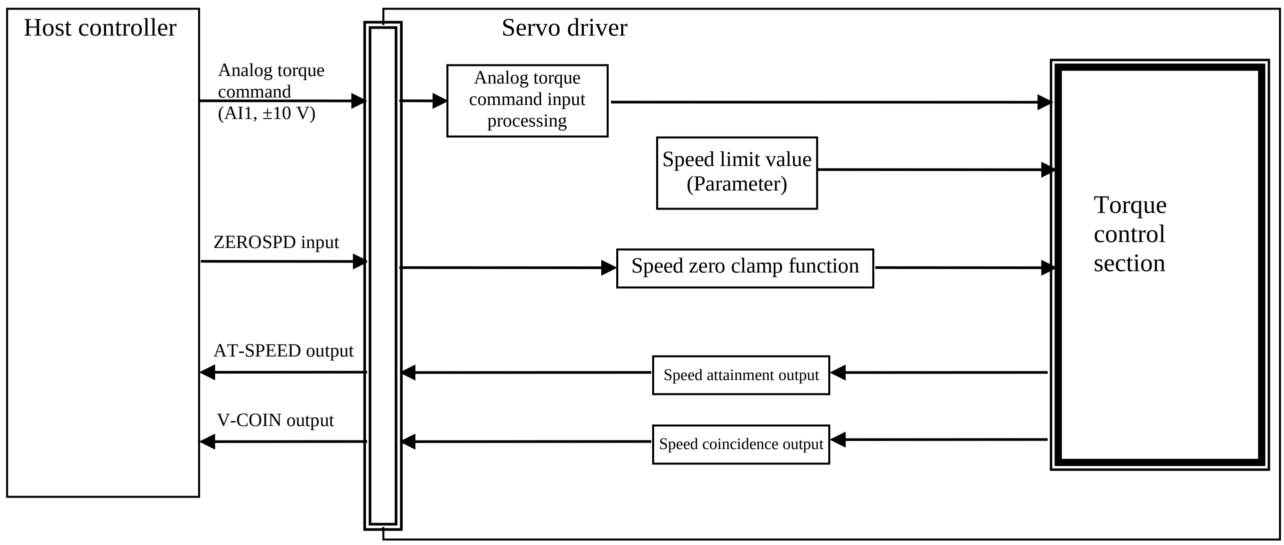
Torque command selection (Pr3.17)	Torque command input	Speed limit input
0	Analog input 1 *1 (AI1, 16-bit resolution)	Parameter value *2 (Pr3.21)
1	Analog input 2 (AI2, 12-bit resolution)	Analog input 1 (AI1, 16-bit resolution)
2	Analog input 1 *1 (AI1, 16-bit resolution)	Parameter value *2 (Pr3.21, Pr3.22)

*1. When Pr0.01 "Control mode setting" = 5 (speed/torque control) is true, the torque command input becomes as the analog input 2 (AI2, 12-bit resolution).
*2 As the value at shipment is 0, appropriately set it when the torque control mode is used.
For details, refer to 4-4-1-2.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	17	Torque command selection	0 to 2	--	Selects the input locations for torque command and speed limit value. 0: Torque command selection 1 Torque command: Analog input 1; Speed limit: Parameter × 1 1: Torque command selection 2 Torque command: Analog input 2; Speed limit: Analog input 1 2: Torque command selection 3 Torque command: Analog input 1; Speed limit: Parameter × 2

4-4-1 Torque command selection 1 and 3 (Speed limit parameter value)



* For the speed zero clamp function, refer to 4-4-1-2 Speed limit function.
The specifications of speed attainment output and speed coincidence output are the same as with the velocity control.

4-4-1-1 Analog torque command input processing

An analog-to-digital conversion of analog speed command input (voltage) is performed, and the obtained input is loaded as digital value, then converted into the torque command value. Also, a filter setting and offset adjustment for noise reduction can be performed.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	18	Torque command direction designation selection	0 to 1	--	Selects the method to designate the positive direction/negative direction of torque command. 0: Designates the direction via the sign of torque command. Example) Torque command input "+" → Positive direction; "-" → Negative direction 1: Designates the direction via the torque command sign selection (TC-SIGN). OFF: Positive direction ON: Negative direction
3	19	Torque command input gain	10 to 100	0.1 V /100%	Sets the conversion gain from the voltage [V] impressed on analog torque command (TRQR) to torque command [%]. Example) When setting to rated torque (100%) at 1 V input Set value = 10 becomes true.
3	20	Torque command input inversion	0 to 1	--	Sets the polarity of voltage impressed on the analog torque command (TRQR). 0: Non-inversion "Positive voltage" → "Positive direction"; "Negative voltage" → "Negative direction" 1: Inversion "Positive voltage" → "Negative direction"; "Negative voltage" → "Positive direction"
4	22	Analog input 1 (AI1) offset setting *1	-27888 to 27888	0.359 mV	Sets the offset adjustment value for the voltage impressed on the analog input 1.
4	23	Analog input 1 (AI1) filter setting *1	0 to 6400	0.01 ms	Sets the time constant of first order lag filter for the voltage impressed on the analog input 1.

*1. When Pr0.01 "Control mode setting" = 5 (speed/torque control) is true, the torque command input becomes as the analog input 2 (AI2). Therefore, perform the setting with Pr4.25 "Analog input 2 (AI2) offset setting" and Pr4.26 "Analog input 2 (AI2) filter setting".

The table below shows the combinations of Pr3.18 "Torque command direction designation selection", Pr3.20 "Torque command input inversion", I/F connector analog torque command (TRQR), and torque command sign selection (TC-SIGN), as well as the relationship of motor rotation direction, and the corresponding conversion graphs for analog torque command input voltage to torque command.

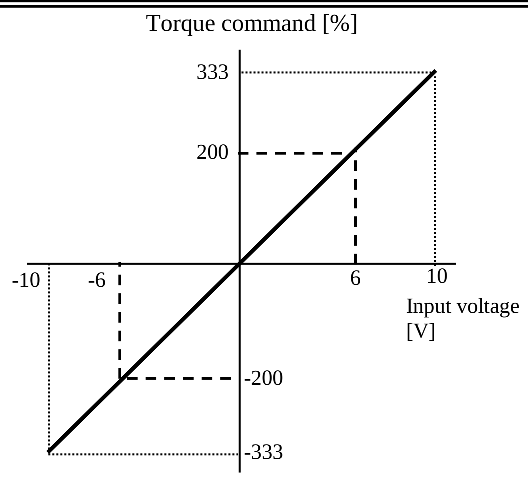
Pr3.18	Pr3.20	Analog torque command (TRQR)	Torque command sign selection (TC-SIGN)	Motor rotation direction	Conversion graph
0	0	Positive voltage (0 to 10 V)	Without effect	Positive direction	(a)
		Negative voltage (-10 to 0 V)	Without effect	Negative direction	
	1	Positive voltage (0 to 10 V)	Without effect	Negative direction	(b)
		Negative voltage (-10 to 0 V)	Without effect	Positive direction	
1	Without effect	Positive voltage (0 to 10 V)	OFF	Positive direction	(c)
		Negative voltage (-10 to 0 V)			
		Positive voltage (0 to 10 V)	ON	Negative direction	
		Negative voltage (-10 to 0 V)			

The conversion of the analog torque command input voltage [V] to the torque command [%] for motor takes three patterns of (a), (b), and (c) shown in the corresponding graph fields of the table above, and their representations are provided below.

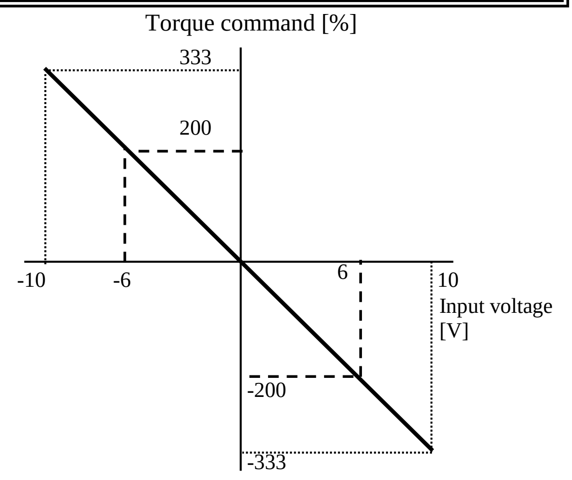
The graph inclination represents the case of Pr3.19 = 30. Depending on the Pr3.19 set value, the inclination will change.

Torque command [%] =
100 × Input voltage [V] / (Pr3.19 set value × 0.1)

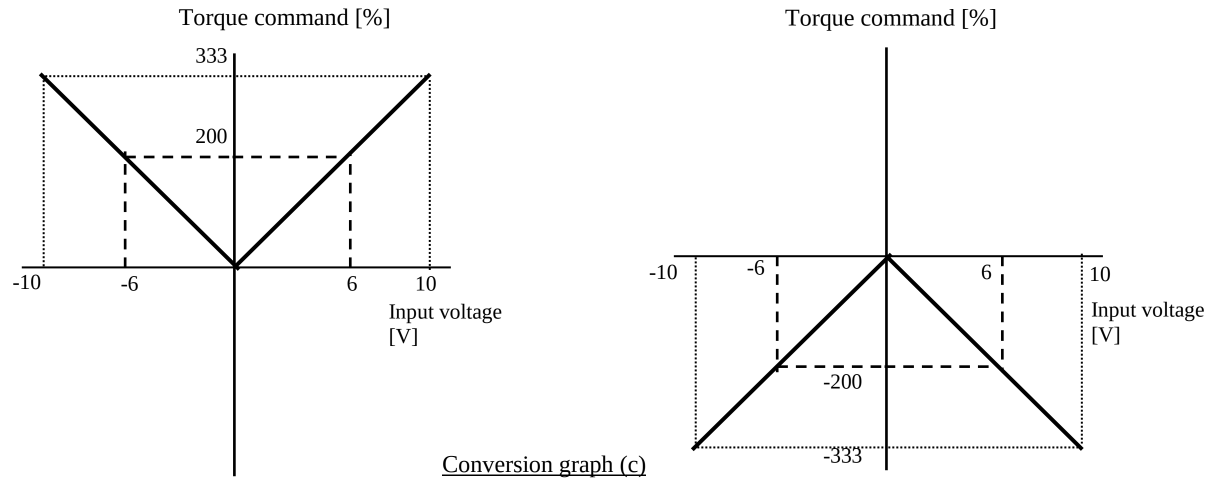
Torque command [%] =
-(100 × Input voltage [V] / (Pr3.19 set value × 0.1))



Conversion graph (a)



Conversion graph (b)



Conversion graph (c)

TC-SIGN OFF

TC-SIGN ON

4-4-1-2 Speed limit function

The speed limit is implemented for the protection during torque control.

The control is performed so as to prevent the speed from becoming larger than the speed limit value during the torque control.

Note) While the control is implemented by the speed limit, the torque command to motor will not conform to the analog torque command. The result of velocity control, with which the motor speed is controlled to the speed limit value, is used as the torque command to the motor.

Note) Speed limit will not function in case the motor is operating in the reverse direction of the torque command given by the superior controller, for external disturbances, such as gravity.
If this action is problematic, then set the speed to stop the motor to Pr5.13 (Overspeed level setting) or to Pr6.15 (Second overspeed level setting) to stop the motor by triggering Err26.0 (Overspeed protection) or Err26.1 (Second overspeed protection).
Please refer to 6-5-5 for details of overspeed protection.

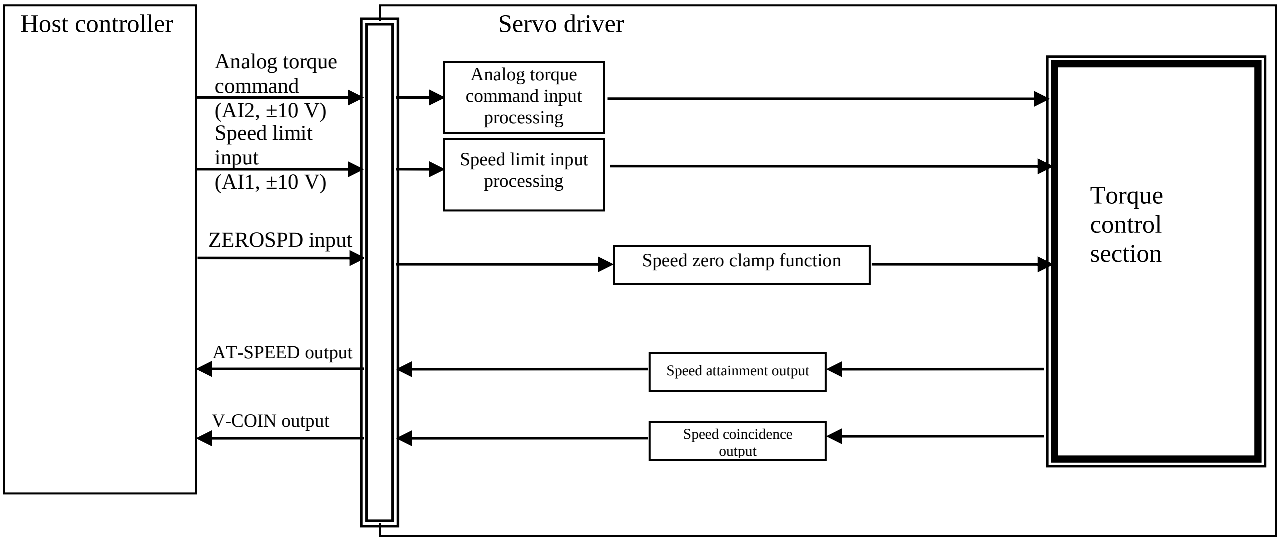
■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	21	Speed limit value 1	0 to 20000	r/min	Sets the speed limit value for the torque control. During the torque control, the control is implemented so that the speed set by the speed limit value is not exceeded. When Pr3.17 = 2 is true, the speed limit value with positive direction command is adopted.
3	22	Speed limit value 2	0 to 20000	r/min	The speed limit value with negative direction command at Pr3.17 = 2 is adopted.
3	15	Speed zero clamp function selection	0 to 2	--	Sets the speed zero clamp function. 0: Disabled; The speed zero clamp input is ignored. 1 to 2: At the speed zero clamp input, the state becomes as speed limit value = 0.

The table below shows the combinations of Pr3.17 "Torque command selection", Pr3.21 "Speed limit value 1", Pr3.22 "Speed limit value 2", Pr3.15 "Speed zero clamp function selection" , speed zero clamp input (ZEROSPD), and analog torque command direction, as well as the corresponding speed limit value that is applied.

<table>
<tr><th>Pr3.17</th><th>Pr3.21</th><th>Pr3.22</th><th>Pr3.15</th><th>Speed zero clamp (ZEROSPD)</th><th>Analog torque command direction</th><th>Speed limit value</th></tr>
<tr><td rowspan="3">0</td><td rowspan="3">0 to 20000</td><td rowspan="3">Without effect</td><td>0</td><td>Without effect</td><td rowspan="3">Without effect</td><td>Pr3.21 set value</td></tr>
<tr><td rowspan="2">1 to 3</td><td>OFF</td><td>Pr3.21 set value</td></tr>
<tr><td>ON</td><td>0</td></tr>
<tr><td rowspan="5">2</td><td rowspan="2">0 to 20000</td><td rowspan="2">0 to 20000</td><td rowspan="2">0</td><td rowspan="2">Without effect</td><td>Positive direction</td><td>Pr3.21 set value</td></tr>
<tr><td>Negative direction</td><td>Pr3.22 set value</td></tr>
<tr><td rowspan="2">0 to 20000</td><td rowspan="2">1 to 20000</td><td rowspan="2">1 to 3</td><td rowspan="2">OFF</td><td>Positive direction</td><td>Pr3.21 set value</td></tr>
<tr><td>Negative direction</td><td>Pr3.22 set value</td></tr>
<tr><td>0 to 20000</td><td>1 to 20000</td><td>1 to 3</td><td>ON</td><td>Without effect</td><td>0</td></tr>
</table>

4-4-2 Torque command selection 2 (Analog speed limit input)



* For the speed zero clamp function, refer to 4-4-2-2 Speed limit function.
The specifications of speed attainment output and speed coincidence output are the same as with the velocity control.

4-4-2-1 Analog torque command input processing

An analog-to-digital conversion of analog torque command input (voltage) is performed, and the obtained input is loaded as digital value, then converted into the torque command value. Also, a filter setting and offset adjustment for noise reduction can be performed.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	18	Torque command direction designation selection	0 to 1	--	Selects the method to designate the positive direction/negative direction of torque command. 0: Designates the direction via the sign of torque command. Example) Torque command input "+" → Positive direction; "-" → Negative direction 1: Designates the direction via the torque command sign selection (TC-SIGN). OFF: Positive direction ON: Negative direction
3	19	Torque command input gain	10 to 100	0.1 V /100%	Sets the conversion gain from the voltage [V] impressed on analog torque command (TRQR) to torque command [%]. Example) When setting to rated torque (100%) at 1 V input Set value = 10 becomes true.
3	20	Torque command input inversion	0 to 1	--	Sets the polarity of voltage impressed on the analog torque command (TRQR). 0: Non-inversion "Positive voltage" → "Positive direction"; "Negative voltage" → "Negative direction" 1: Inversion "Positive voltage" → "Negative direction"; "Negative voltage" → "Positive direction"
4	25	Analog input 2 (AI2) offset setting	-1707 to 1707	5.86 mV	Sets the offset adjustment value for the voltage impressed on the analog input 2.
4	26	Analog input 2 (AI2) filter setting	0 to 6400	0.01 ms	Sets the time constant of first order lag filter for the voltage impressed on the analog input 2.

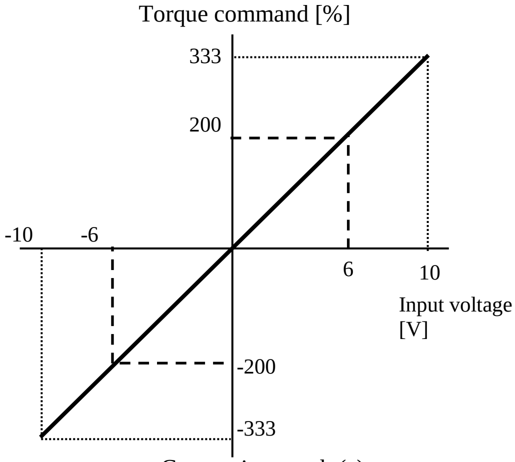
The table below shows the combinations of Pr3.18 "Torque command direction designation selection", Pr3.20 "Torque command input inversion", I/F connector analog torque command (TRQR), and torque command sign selection (TC-SIGN), as well as the relationship of motor rotation direction, and the corresponding conversion graphs for analog torque command input voltage to torque command.

Pr3.18	Pr3.20	Analog torque command (TRQR)	Torque command sign selection (TC-SIGN)	Motor rotation direction	Conversion graph
0	0	Positive voltage (0 to 10 V)	Without effect	Positive direction	(a)
		Negative voltage (-10 to 0 V)	Without effect	Negative direction	
	1	Positive voltage (0 to 10 V)	Without effect	Negative direction	(b)
		Negative voltage (-10 to 0 V)	Without effect	Positive direction	
1	Without effect	Positive voltage (0 to 10 V)	OFF	Positive direction	(c)
		Negative voltage (-10 to 0 V)			
		Positive voltage (0 to 10 V)	ON	Negative direction	
		Negative voltage (-10 to 0 V)			

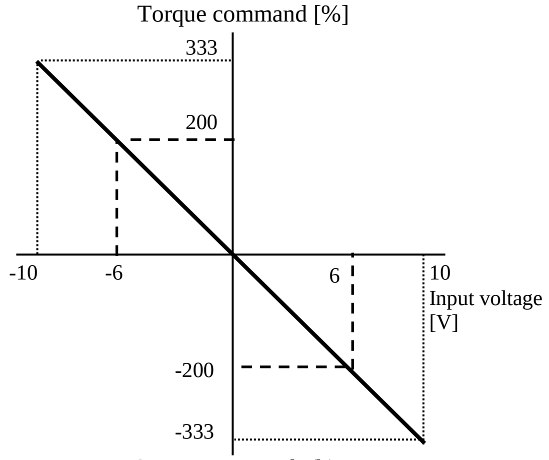
The conversion of the analog torque command input voltage [V] to the torque command [%] for motor takes three patterns of (a), (b), and (c) shown in the corresponding graph fields of the table above, and their representations are provided below.
The graph inclination represents the case of Pr3.19 = 30. Depending on the Pr3.19 set value, the inclination will change.

Torque command [%] =
100 × Input voltage [V] / (Pr3.19 set value × 0.1)

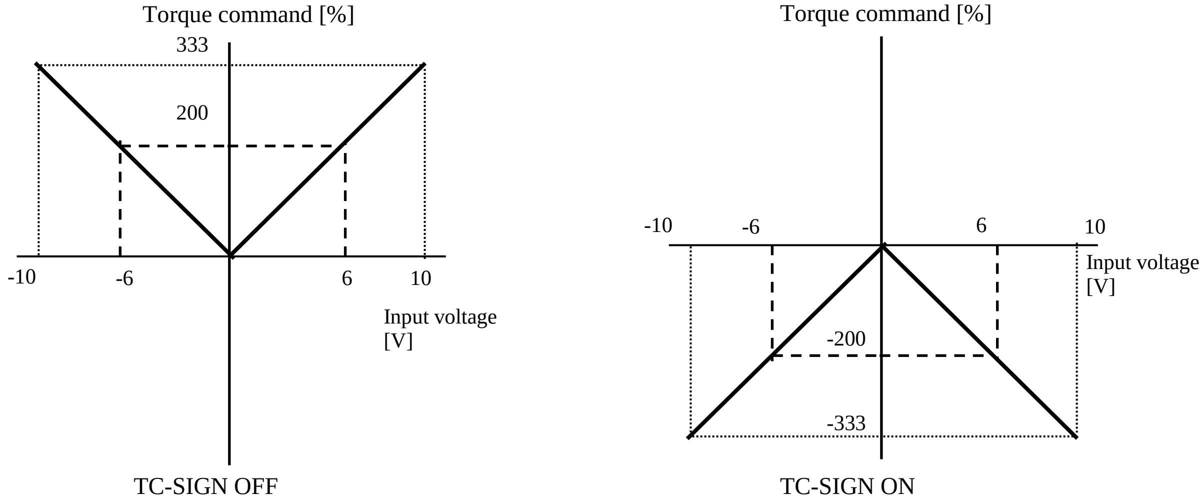
Torque command [%] =
-(100 × Input voltage [V] / (Pr3.19 set value × 0.1))



Conversion graph (a)



Conversion graph (b)



Conversion graph (c)

4-4-2-2 Speed limit function

The speed limit is implemented for the protection during torque control. The control is performed so as to prevent the speed from becoming larger than the speed limit value during the torque control. When Pr3.17 "Torque command selection" = 1 is true, the speed limit value is input with the analog input 1.

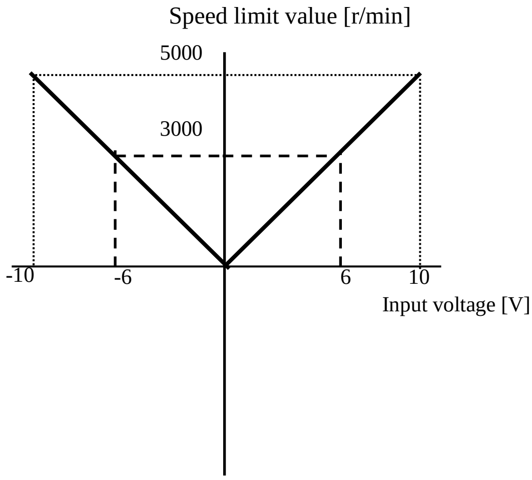
Note) While the control is implemented by the speed limit, the torque command to motor will not conform to the analog torque command. The result of velocity control, with which the motor speed is controlled to the speed limit value, is used as the torque command to the motor.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	02	Speed command input gain	10 to 2000	(r/min) /V	Sets the conversion gain from the voltage impressed on analog speed limit input (SPL) to the speed limit value.
4	22	Analog input 1 (AI1) offset setting	-27888 to 27888	0.359 mV	Sets the offset adjustment value for the voltage impressed on the analog input 1.
4	23	Analog input 1 (AI1) filter setting	0 to 6400	0.01 ms	Sets the time constant of first order lag filter for the voltage impressed on the analog input 1.
3	15	Speed zero clamp function selection	0 to 2	--	Sets the speed zero clamp function. 0: Disabled; The speed zero clamp input is ignored. 1 to 2: At the speed zero clamp input, the state becomes as speed limit value = 0.

The conversion graph for the analog speed limit from input voltage [V] to speed limit value [r/min] is shown below. The graph inclination represents the case of Pr3.02 = 500. Depending on the Pr3.02 set value, the inclination will change.

Speed limit value [r/min] = | Pr3.02 set value × Input voltage [V] |



[A6SE], [A6SG] This function is not available.

4-5 Full-closed control

The full-closed control directly detects the position of machine that is the subject of the control by using the external scale arranged externally, provides the feedback, and implements the position control. For example, implementing of control is possible which is not affected by ball screw irregularities or by temperature-induced positional fluctuations.

By configuring the full-closed control system, a high-precision positioning in sub-micron order can be achieved.

This section describes the settings of external scale ratio and hybrid deviation excess with the initial configuration of full-closed control.

Precautions

(1) One command pulse of when the command division/multiplication ratio is 1:1 becomes as one pulse of external scale.
With the full-closed control, the velocity control is implemented by the encoder feedback, and the position control by the external scale feedback.

(2) Make sure to set Pr3.28 "Hybrid deviation excess setting" and Pr3.29 "Hybrid deviation clear setting" to appropriate values.
When the hybrid deviation excess range is set excessively wide, a detection becomes delayed, and the effects of lag error detection becomes lost. Please refer to 4-5-3 for details.
Also, if set excessively narrow, the torsion of motor/equipment by normal operation may be detected as an error.

(3) The external scale of 1/40 ≤ External scale ratio ≤ 1280 is recommended.
However even within the range above, if the external scale ratio is set to a smaller value than 50/Position loop gain (Pr1.00, Pr1.05), a control with each pulse may become impossible. Furthermore, if the external scale ratio is increased, the operating noise may become louder.

(4) When a wrong external scale division ratio is set, even if the external scale and motor position agree with each other, the Err25.0 "Hybrid deviation excess error protection" may occur especially when the stroke distance is long with the movement. In that case, use with the external scale division ratio set to a value that is as close as possible, and the hybrid deviation excess range expanded.

(5) Origin position data may be lost due to clearing of the positional deviation counter, command pulse inhibition, clearing the remnant pulses of the command division/multiplication function, clearing the accumulated pulses of the position command filter function and damping control, control mode switching, etc.
When restarting an operation that requires the position control, always conduct the return to origin.

4-5-1 Selection of external scale type

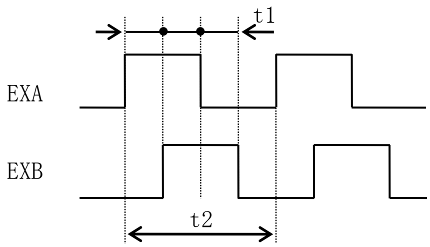
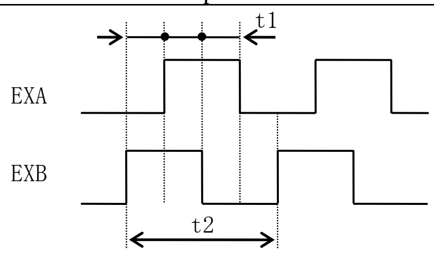
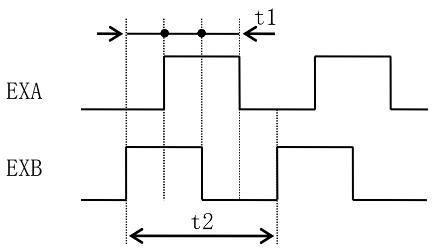
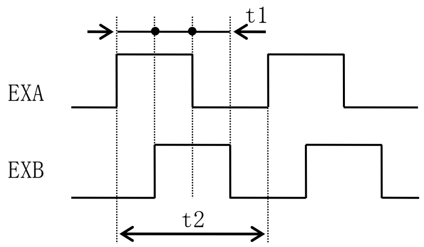
This section describes the selection of external scale type to be used and sets the direction.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	23	External scale type selection	0 to 6	--	Selects the type of external scale. 0: A- and B-phase output type 1: Serial communication type (Incremental specification) 2: Serial communication type (Absolute specification) 3: For manufacturer use 4: For manufacturer use 5: For manufacturer use 6: For manufacturer use When the A- and B-phase output type is connected, if the value is set to 1 or 2, Err50.0 "External scale connection error protection" occurs. Also, when the serial communication type is connected, if the value is set to 0, Err55.0-55.2 "A-phase or B-phase or Z-phase connection error protection" occurs.
3	26	External scale direction inversion	0 to 3	--	Sets the direction inversion of the external scale feedback counter. 0: Non-inversion 1: Inversion 2: For manufacturer use 3: For manufacturer use

Pr3.23	External scale type	Corresponding scale	Corresponding speed *3
0	A- and B-phase output type *1 *2	External scale of A- and B-phase output type	Up to 4 M[pulse/s] (After ×4 multiplication)
1	Serial communication type (Incremental specification) *2	Magnescale Co., Ltd. NIDEC Sankyo Corporation	Up to 4 G[pulse/s]
2	Serial communication type (Absolute specification) *2	Mitsutoyo Corporation Magnescale Co., Ltd. Heidenhein Renishaw PLC Fagor Automation S.Coop	Up to 4 G[pulse/s]
3 to 6	For manufacture use	-	

*1. The counting direction of driver internal processing on the A- and B-phase output type external scale is shown in the table below.

Pr3.26	Count-down direction	Count-up direction
0: Non-inversion	 EXB has 90º delay from EXA t1 > 0.25μs t2 > 1.0μs	 EXB is faster than EXA by 90º t1 > 0.25μs t2 > 1.0μs
1: Inversion	 EXB is faster than EXA by 90º t1 > 0.25μs t2 > 1.0μs	 EXB has 90º delay from EXA t1 > 0.25μs t2 > 1.0μs

*2. For the direction of external scale connection, make sure to connect so that the scale counting direction becomes as the count-up when the motor axis is rotated to the CCW direction, and as the count-down when the motor shaft is rotated to the CW direction. If the above mentioned directions are not possible depending on the installation conditions and others, the scale counting direction can be inverted using Pr3.26 "External scale direction inversion".

The installation direction can be checked on the front monitor or via communication, by checking the counting directions of external scale feedback pulse summation and encoder feedback pulse summation. When they are in agreement, the connection is established correctly. If they do not match, invert the set value of Pr3.26 "External scale direction inversion" (0 → 1 or 1 → 0).

*3. The term corresponding speed refers to the feedback speed [pulse/s] of external scale that can be processed in the driver side.
For the information on available range in the scale side, please check in the specification sheet for the scale.
For example, when using a serial communication type external scale having the resolution of 1 nm, the maximum speed is 4 m/s. When a use at the speed of 5 m/s is desired with the serial communication type, select a type whose external scale resolution is larger than 1.25 nm.
However even with the full-closed control, the overspeed protection occurs if the motor axis rotation speed exceeds the maximum speed.

4-5-2 Setting of external scale division ratio

This section describes the setting of division ratio with encoder resolution and external scale resolution.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	24	External scale division numerator	0 to 2^{23}	--	Sets the numerator of external scale division setting. When the set value = 0 is true, the operation is performed with the encoder resolution used as the division numerator.
3	25	External scale division denominator	1 to 2^{23}	--	Sets the denominator of external scale division setting.

- Check the encoder pulse count per one motor rotation and the external scale pulse count per one motor rotation, then set the external scale division numerator (Pr3.24) and external scale division denominator (Pr3.25) so that the equation below becomes true.

  Example) With 10mm ball screw pitch, 0.1μm/pulse scale, 23-bit (8,388,608pulse/r) encoder resolution

$$\frac{\text{Pr3.24} \quad \boxed{8388608}}{\text{Pr3.25} \quad \boxed{100000}} = \frac{\text{Encoder pulse count per one motor rotation [pulse]}}{\text{External scale pulse count per one motor rotation [pulse]}}$$

- If the ratio is incorrect, the difference increases between the position calculated from encoder pulse and the position calculated from external scale pulse, and the hybrid deviation excess error protection occurs especially when the movement distance is long.

- When Pr3.24 is set to 0, the encoder resolution is automatically set as the numerator.

4-5-3 Setting of hybrid deviation excess.

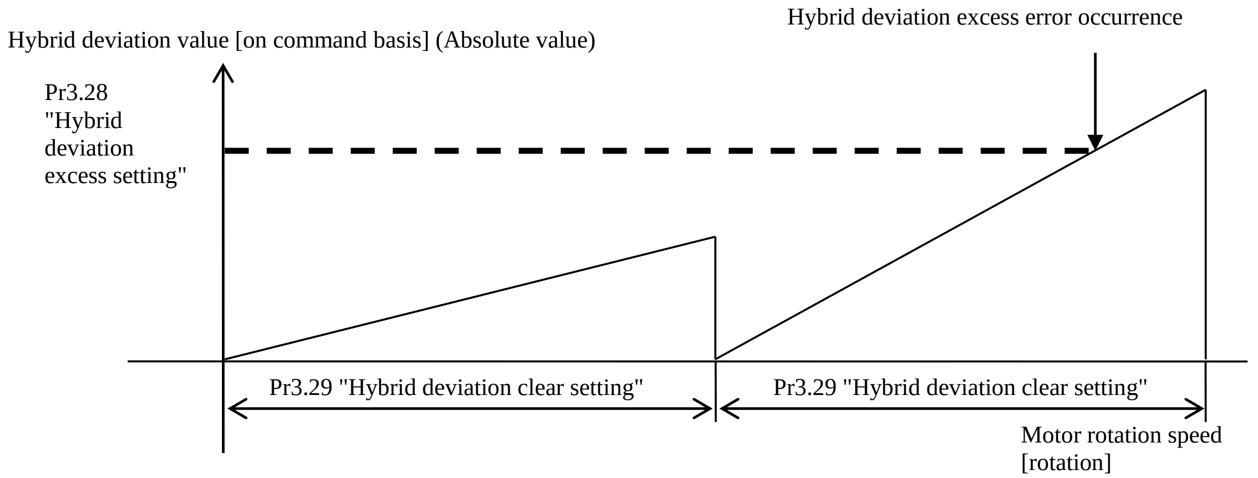
The difference between the motor (encoder) position and load (external scale) position is detected, and when the difference exceeds Pr3.28 "Hybrid deviation excess setting", the hybrid deviation excess error protection is activated. The hybrid deviation excess occurs mainly when there is an external scale error, external scale connection fault, and motor-load connection looseness.

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
3	28	Hybrid deviation excess setting	1 to 2^{27}	Command unit	Sets the allowance (hybrid deviation) between the motor (encoder) position and load (external scale) position on a command basis.
3	29	Hybrid deviation clear setting	0 to 100	Rotation	Each time the motor rotates for the amount of this set value, the hybrid deviation is cleared to zero. When the set value is zero, the hybrid deviation is not cleared.

• Regarding hybrid deviation clear specification

Each time the motor rotates for the amount set with Pr3.29 "Hybrid deviation clear setting", the hybrid deviation is cleared to zero. By this function, operation becomes possible even with uses with which an accumulation of hybrid deviation occurs due to slippage or other reasons.



Note) The rotation speed for hybrid deviation clear setting is detected by the use of encoder feedback pulse.

> When using the hybrid deviation clear, make sure to set the Pr3.29 "Hybrid deviation clear setting" to an appropriate value. If set to a significantly smaller value compared with the set value of Pr3.28 "Hybrid deviation excess setting", this function may not work correctly as a protection against an abnormal operation caused by improper connection of external scale or others.
>
> When using, pay close attention to safety, and install a limit sensor or implement other means.

4-6 Regeneration resistor setting

This section describes the settings relevant to regeneration resistor.
For the details on regeneration resistor specification, refer to the Specifications described in Chapter 1 “Introduction.”

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
0	16	Regeneration resistor external installation setting	0 to 3	--	This parameter is to be set depending on whether to use the built-in regeneration resistor in driver or to disconnect the built-in resistor and install the regeneration resistor externally. 0: Built-in resistor is used for regeneration overload protection. 1: External resistor is used for regeneration overload protection. 2: Although external resistor is used, regeneration overload protection is not performed. 3: To be used without regeneration resistor. (Regeneration overload protection is not performed.)
0	17	External regeneration resistor setting	0 to 4	--	When the external regeneration resistor is selected (Pr0.16 = 1 or 2), this parameter selects the calculation method for regeneration resistance load factor. 0: Operation factor of 10% with external regeneration resistor is equivalent to regeneration load factor of 100%. (A5 series compatible) 1 to 4: For manufacturer use (Do not change the setting.)

[A6SE] This function is not available.

4-7 Absolute setting

4-7-1 Absolute encoder

By setting Pr0.15 "Absolute encoder setup" to a value other than "1" (default), you can compose an absolute system that does not require homing operation after power-on.

With motors of absolute encoder specification, by connecting an absolute encoder battery, and by setting Pr0.15 "Absolute encoder setting" to value other than "1" (factory setting), can be setup that will not require an absolute system where return to origin is not required after reclosing of power supply.
Please refer to item 6-8 for details of infinite rotation absolute function.
Absolute data is transferred to a host controller using the communications function (RS232, RS485, or Modbus) of the servo driver.
Regarding the detail of Modbus communication, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction.”

■Relevant parameters

Category	No.	Parameter name	Setting range	Unit	Function
0	15	Absolute encoder setting	0 to 4	--	Sets the method of absolute encoder use. *1) 0: Used as absolute system (absolute mode). 1: Used as incremental system (incremental mode). 2: Used as absolute system (absolute mode)., but multirotation counter over is ignored. 3: For manufacturer use. (please do not set) 4: Used in absolute system (Absolute mode) to set the upper limit value of the multi-rotation counter. Ignores multi-rotation counter over. (Infinite rotation absolute mode)

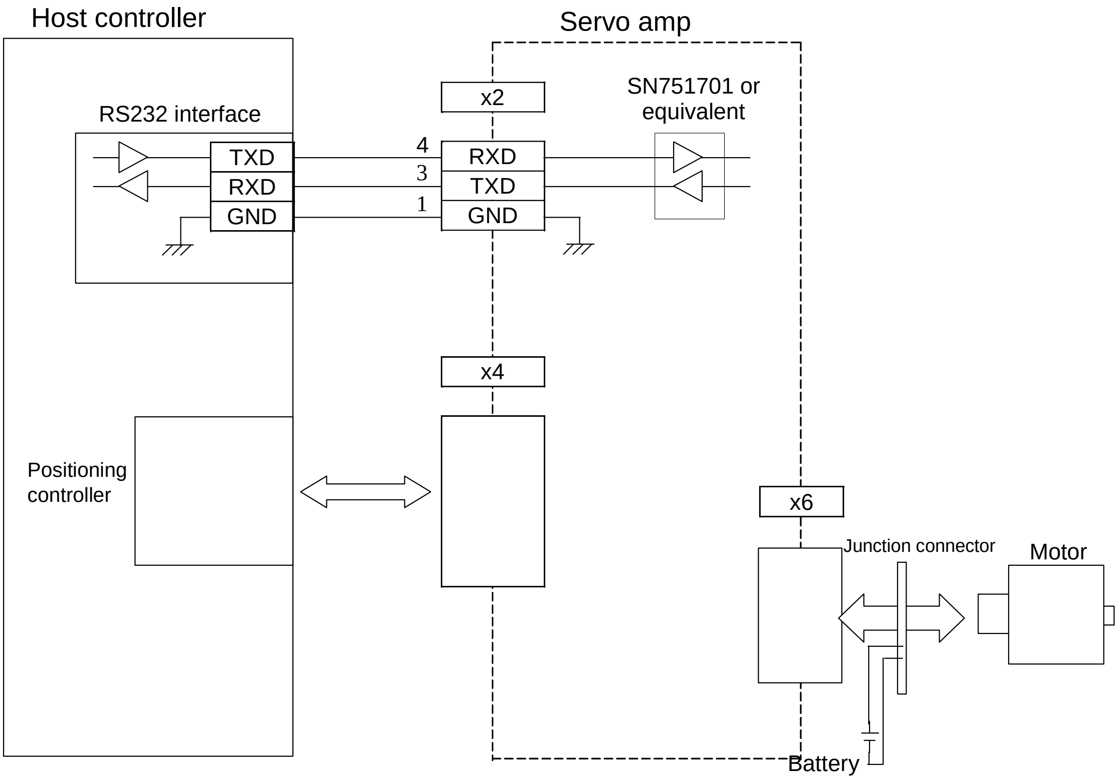
*1) When block operation is valid and full-closed controlling, treated as an incremental encoder (setting value = 1) for internal control.

Refer to the table below as to whether connection of the battery for absolute data according to Pr0.15 "Absolute encoder setup" is required or not.

Absolute encoder type	Pr0.15 “Absolute encoder setup”	
	0,2,4	1
Battery-powered	Required	Not required
Battery-less	Not required	

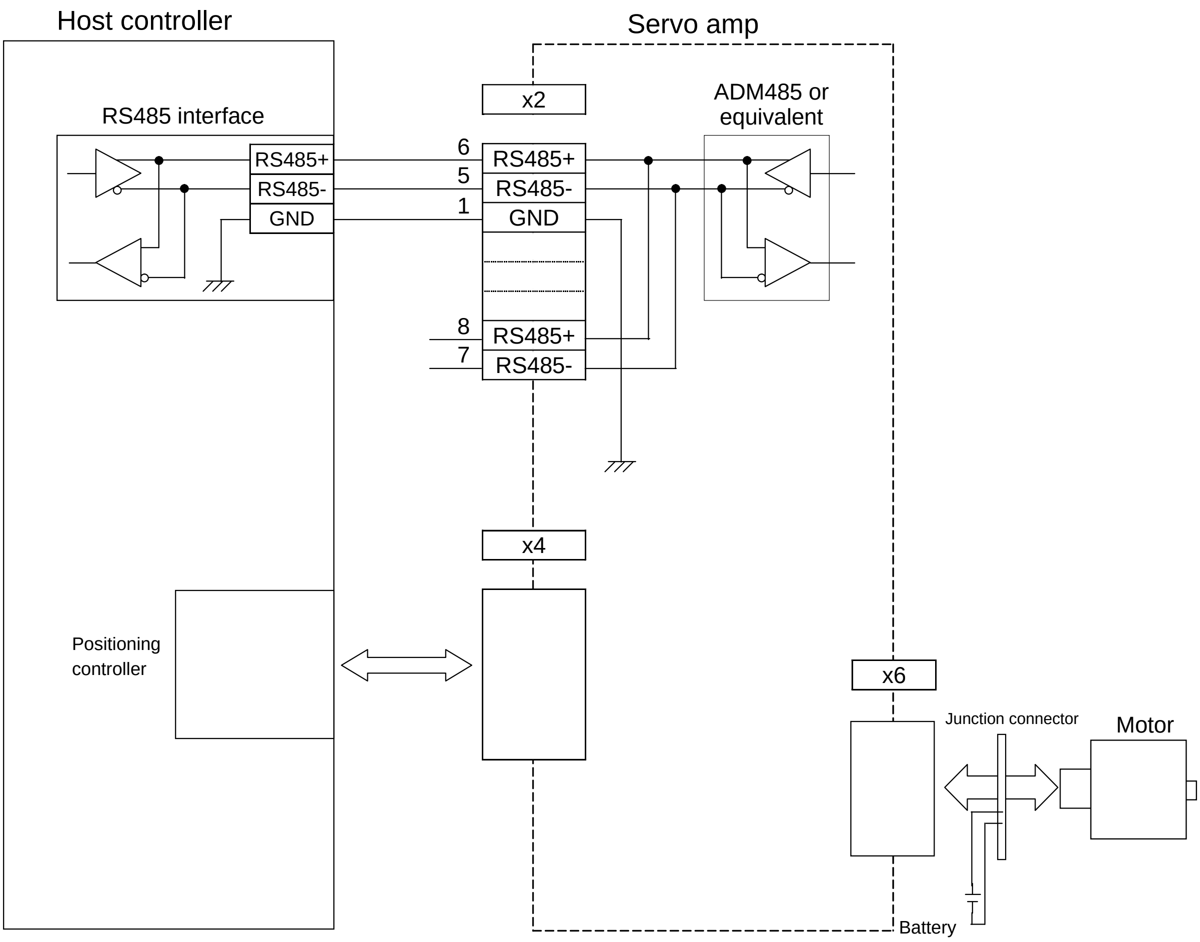
4-7-1-1 Absolute system configuration

Absolute system configuration using RS232 interface



By using the RS232 interface, the absolute system having multiple axes (up to 32 axes) can be setup.

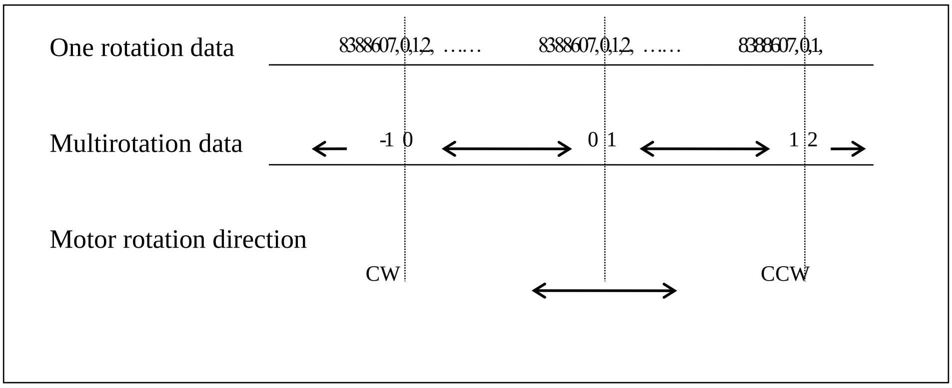
Absolute system configuration using RS485 interface



When using the RS485 interface, set the Pr5.31 "Axis number" to between 1 and 31.

4-7-1-2 Absolute data

The absolute data contains the one rotation data, which indicates the absolute position per one motor rotation, as well as the multirotation data, which counts the motor rotation speed of since the encoder clear is performed.



4-7-1-3 Installing battery for absolute data

Refer to the Specifications described in Chapter 1 “Introduction.”

4-7-1-4 Clearing of absolute encoder

Multi-turn data of the battery-powered absolute encoder is retained by the battery for absolute data, and multi-turn data of the battery-less absolute encoder is retained without using a battery. Therefore, after installing the absolute encoder battery, when starting the machine for the first time, it becomes necessary to perform the encoder clear operation at the home position, and set the value of multirotation data to zero. The encoder clear operation is performed by operating the front panel (refer to 3-2-4, (6) Clearing the absolute encoder) or using the PANATERM.
After performing the absolute encoder clear, turn the control power supply off once, then turn the power on again.

4-7-1-5 Transfer of absolute data

The absolute data is transferred from the servo driver to host controller in accordance with the steps described below.
Make sure to transfer the absolute data after confirming that the power is turned on, and that the servo ready output (S-RDY) is turned ON.

(1) Setting the serial communication interface of host controller

RS232

Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 bps
Data length	8 bits
Parity	No
Start bit	1 bit
Stop bit	1 bit

The baud rate is determined by Pr5.29 "RS232 communication baud rate setting".

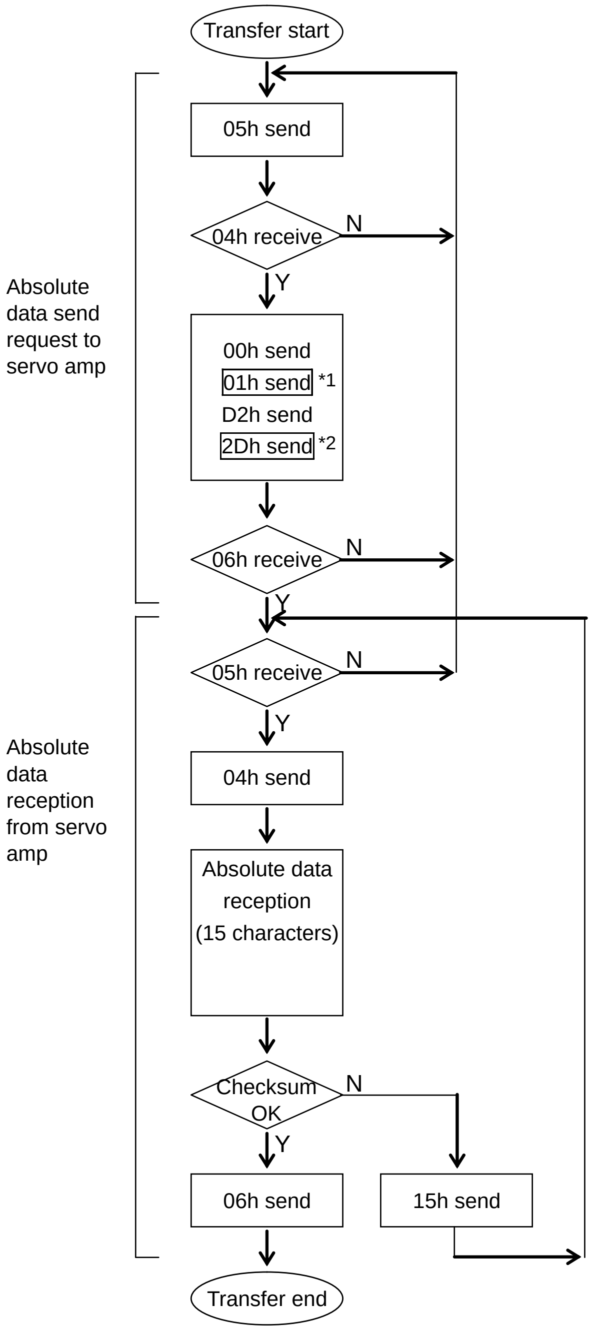
RS485

Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 bps
Data length	8 bits
Parity	No
Start bit	1 bit
Stop bit	1 bit

The baud rate is determined by Pr5.30 "RS485 communication baud rate setting".

(2) Absolute data transfer procedure

RS232



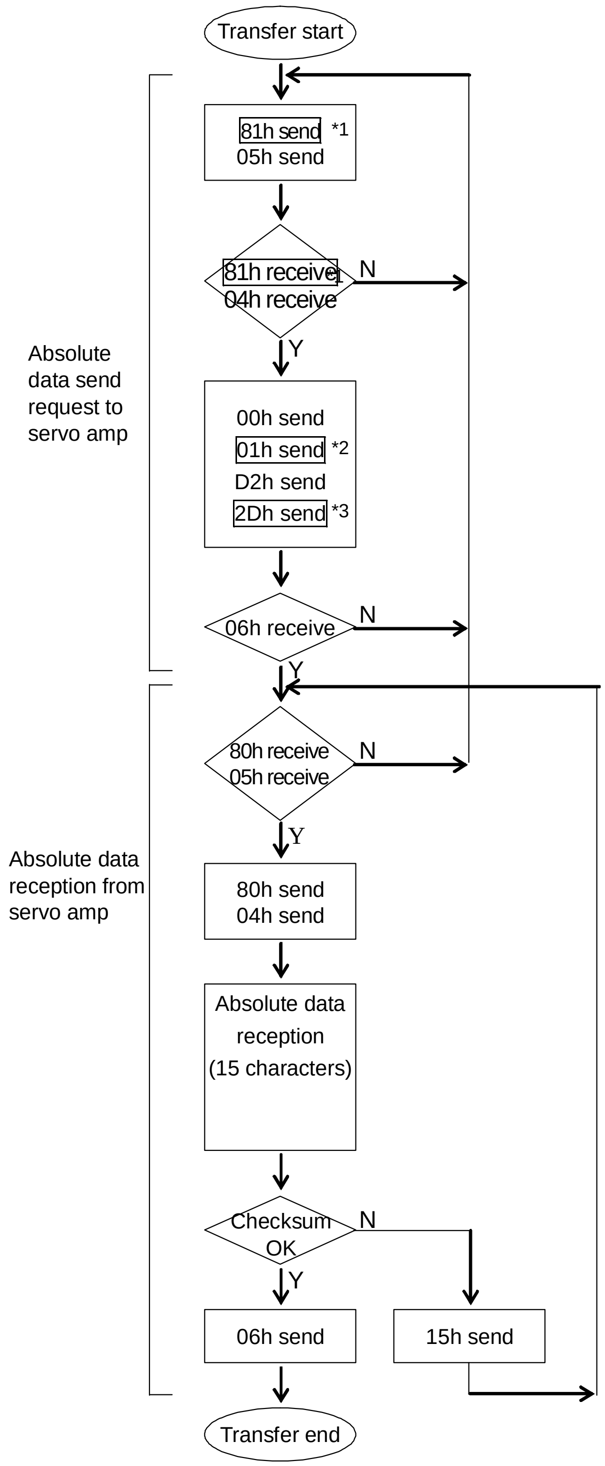
With *1 and *2, the data is determined by the setting of Pr5.31 "Axis number".

Axis number	Data for *1	Data for *2
0	00h	2Eh
1	01h	2Dh
2	02h	2Ch
3	03h	2Bh
4	04h	2Ah
5	05h	29h
6	06h	28h
7	07h	27h
8	08h	26h
9	09h	25h
10	0Ah	24h
11	0Bh	23h
12	0Ch	22h
13	0Dh	21h
14	0Eh	20h
15	0Fh	1Fh
16	10h	1Eh
17	11h	1Dh
18	12h	1Ch
19	13h	1Bh
20	14h	1Ah
21	15h	19h
22	16h	18h
23	17h	17h
24	18h	16h
25	19h	15h
26	1Ah	14h
27	1Bh	13h
28	1Ch	12h
29	1Dh	11h
30	1Eh	10h
31	1Fh	0Fh

The checksum is judged OK when the lower 8 bits of the sum of received absolute data (15 characters) is zero.

* To avoid faulty operation caused by accidental noise or others, it is recommended to perform the communication above for two times or more, and confirm the agreement of absolute data.

RS485



With *1, *2, and *3, the data is determined by the setting of Pr5.31 "Axis number".

Axis number	Data for *1	Data for *2	Data for *3
0	RS485 communication cannot be used.		
1	81h	01h	2Dh
2	82h	02h	2Ch
3	83h	03h	2Bh
4	84h	04h	2Ah
5	85h	05h	29h
6	86h	06h	28h
7	87h	07h	27h
8	88h	08h	26h
9	89h	09h	25h
10	8Ah	0Ah	24h
11	8Bh	0Bh	23h
12	8Ch	0Ch	22h
13	8Dh	0Dh	21h
14	8Eh	0Eh	20h
15	8Fh	0Fh	1Fh
16	90h	10h	1Eh
17	91h	11h	1Dh
18	92h	12h	1Ch
19	93h	13h	1Bh
20	94h	14h	1Ah
21	95h	15h	19h
22	96h	16h	18h
23	97h	17h	17h
24	98h	18h	16h
25	99h	19h	15h
26	9Ah	1Ah	14h
27	9Bh	1Bh	13h
28	9Ch	1Ch	12h
29	9Dh	1Dh	11h
30	9Eh	1Eh	10h
31	9Fh	1Fh	0Fh

The checksum is judged OK when the lower 8 bits of the sum of received absolute data (15 characters) is zero.

* To avoid faulty operation caused by accidental noise or others, it is recommended to perform the communication above for two times or more, and confirm the agreement of absolute data.

(3) Composing of absolute data

By using the 15 character data received via RS232 or RS485, the one rotation data or multirotation data is composed.

Received absolute data (15 characters)

0Bh
Axis number
D2h
03h
11h
Encoder status (L)
Encoder status (H)
One rotation data (L)
One rotation data (M)
One rotation data (H)
Multirotation data (L)
Multirotation data (H)
00h
Error code
Checksum

Axis number ← This is the set value of Pr5.31 "Axis number".

Error code ← Becomes as zero when communication is executed normally.
When the value is not zero, read the absolute data from the driver again.

<u>One rotation data ← One rotation data (H) × 10000h + One rotation data (M) × 100h + One rotation data (L)</u>

<u>Multirotation data ← Multirotation data (H) × 100h + Multirotation data (L)</u>

Encoder status (1 indicates an error occurrence.)

Encoder status (L)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
			0				

- Bit 0: Overspeed → Err42.0 "Absolute overspeed error protection"
- Bit 1: Full absolute status → Err47.0 "Absolute status error protection"
- Bit 2: Counting error → Err44.0 "Absolute one rotation counter error protection"
- Bit 3: Counter overflow → Err41.0 "Absolute counter over error protection"
- Bit 5: Multirotation error → Err45.0 "Absolute multirotation counter error protection"
- Bit 6: Battery error → Err40.0 "Absolute system down error protection"
- Bit 7: Battery alarm → Warning number A2 "Battery warning"

Encoder status (H)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0			0	0	0	0

- Bit 4: Battery error
- Bit 5: Any of battery alarm, multirotation error, counter overflow, counting error, full absolute status, or overspeed has occurred.

For the details on encoder status, refer to the specification sheet for the encoder.

> • Make sure to transfer the absolute data under a status that the motor is in the servo-off state, and is fixed by brake or other means.

4-7-1-6 Battery refreshment of the battery-powered absolute encoder

If batteries (lithium-thionyl chloride battery) are not discharged for a long time, including long storage, battery alarm may occur due to the phenomenon of transient voltage drop at the next discharge.
In order to prevent this, you can perform battery discharge treatment (refreshment).
Battery refreshment is performed by USB communication (setup support software).

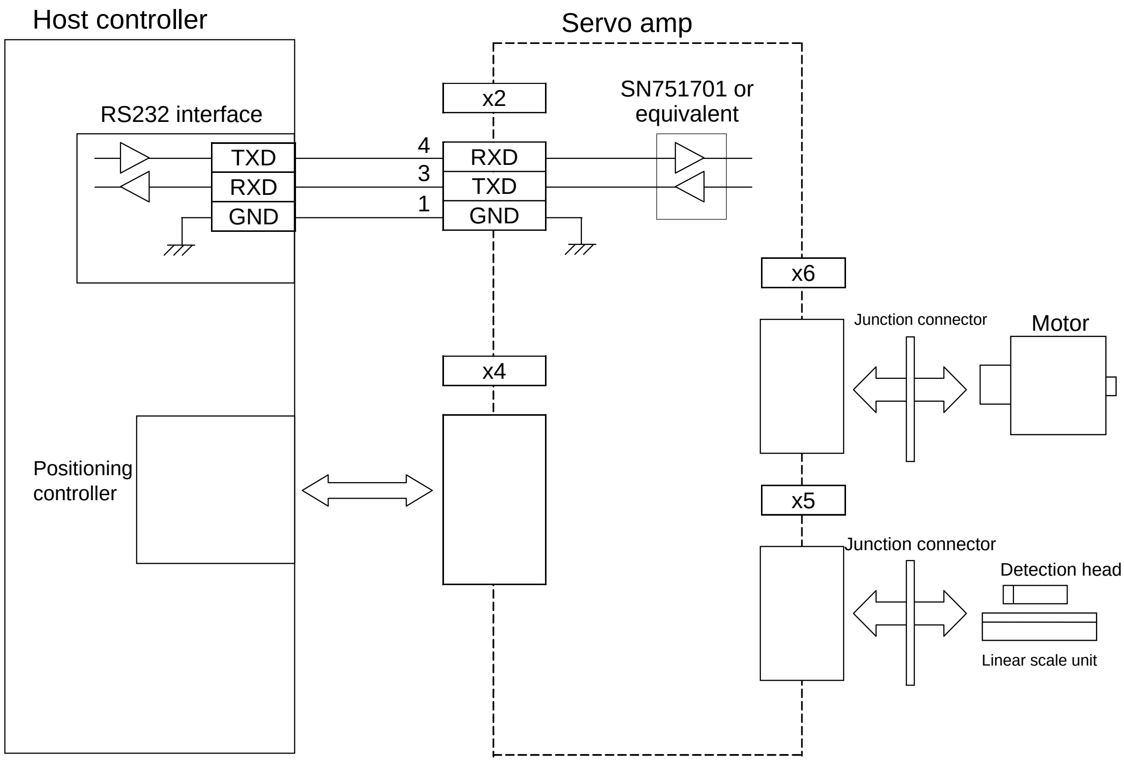
Note: When battery refreshment is executed, battery warning may occur.
In that case, clear the battery warning.
Note: Do not perform battery refresh when using the battery-less absolute encoder.

4-7-2 External scale

With the full-closed control, the absolute system can be setup with which any home position return operation is not necessary after the power is turned on.
Using the communication function (RS232, RS485, or Modbus) of servo driver, the absolute data of external scale is transferred to the host controller.
Regarding the detail of Modbus communication, refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction.”

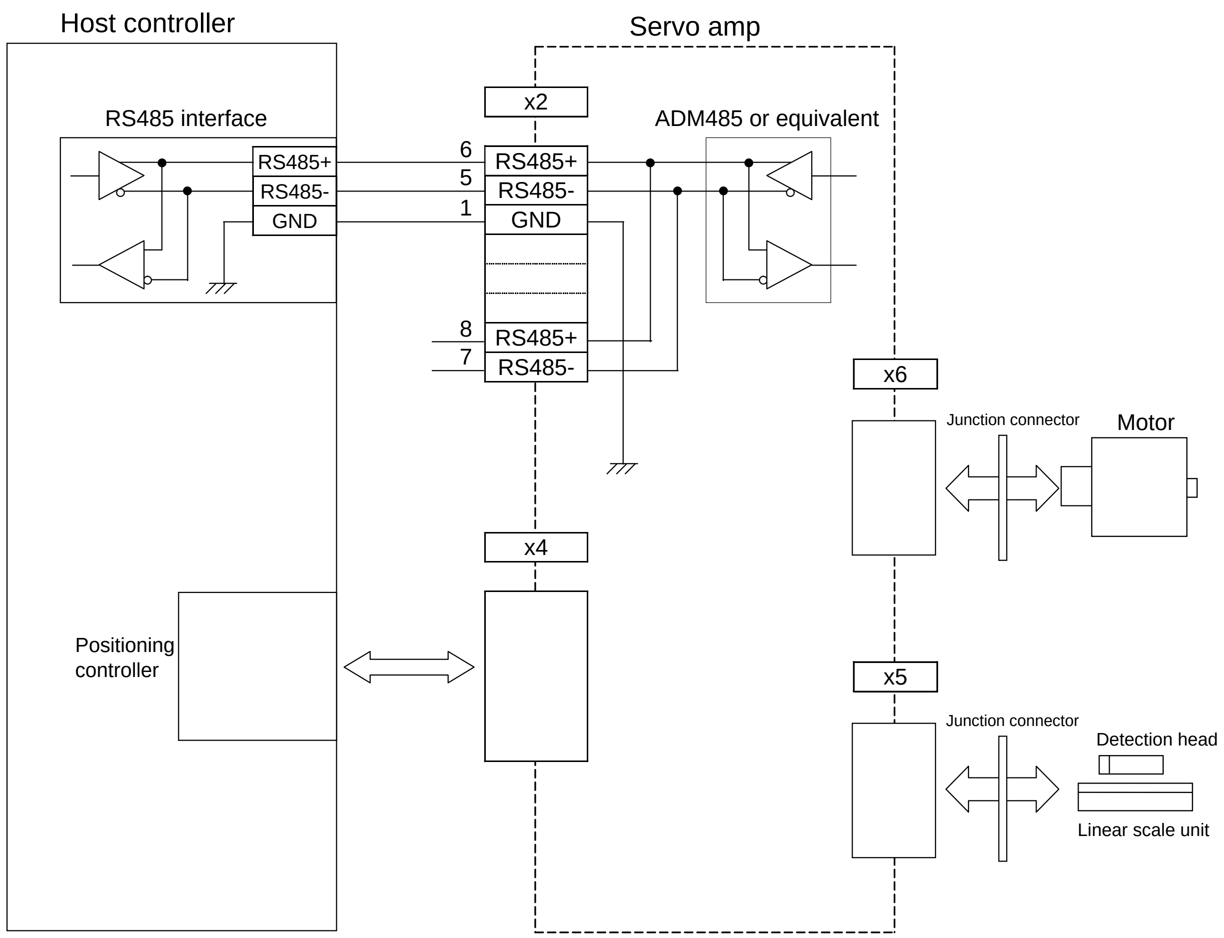
4-7-2-1 External scale absolute system configuration

External scale absolute system configuration using RS232 interface



By using the RS232 interface, the absolute system having multiple axes (up to 32 axes) can be setup.

External scale absolute system configuration using RS485 interface



When using the RS485 interface, set the Pr5.31 "Axis number" to between 1 and 31.

4-7-2-2 Transfer of external scale absolute data

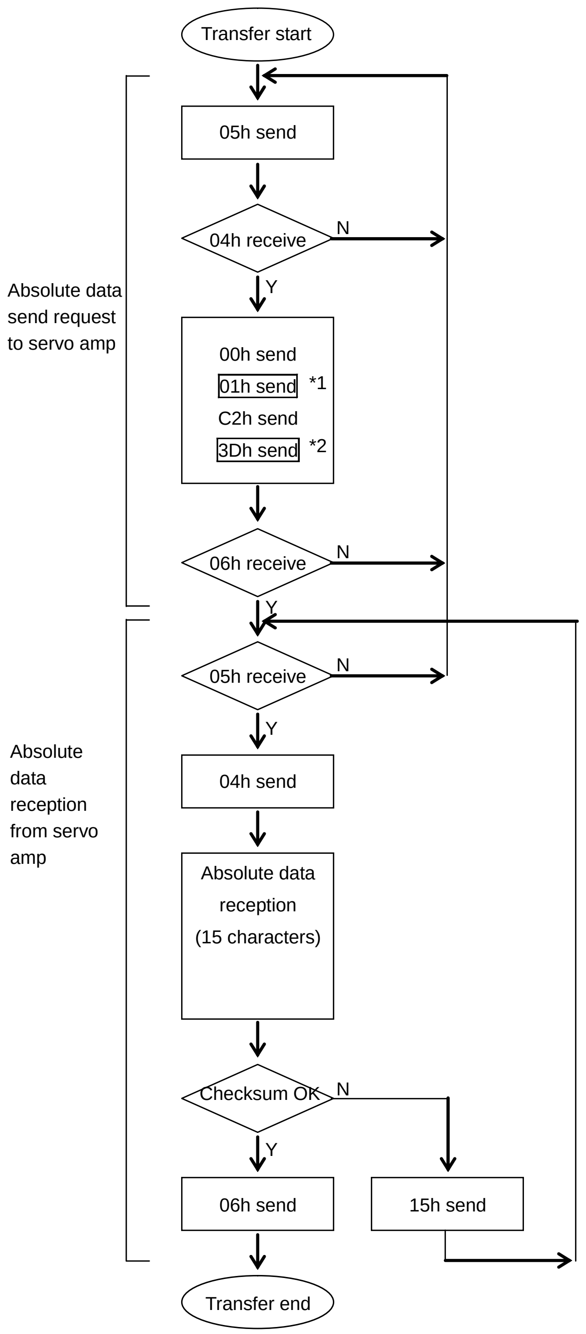
The absolute data of external scale is transferred from the servo driver to host controller in accordance with the steps described below.
Make sure to transfer the absolute data after confirming that the power is turned on, and that the servo ready output (S-RDY) is turned ON.

(1) Setting the serial communication interface of host controller

Same as with (1) in 4-7-1-5 Transfer of absolute data.

4-7-2-3 Procedure for transfer of external scale absolute data

RS232



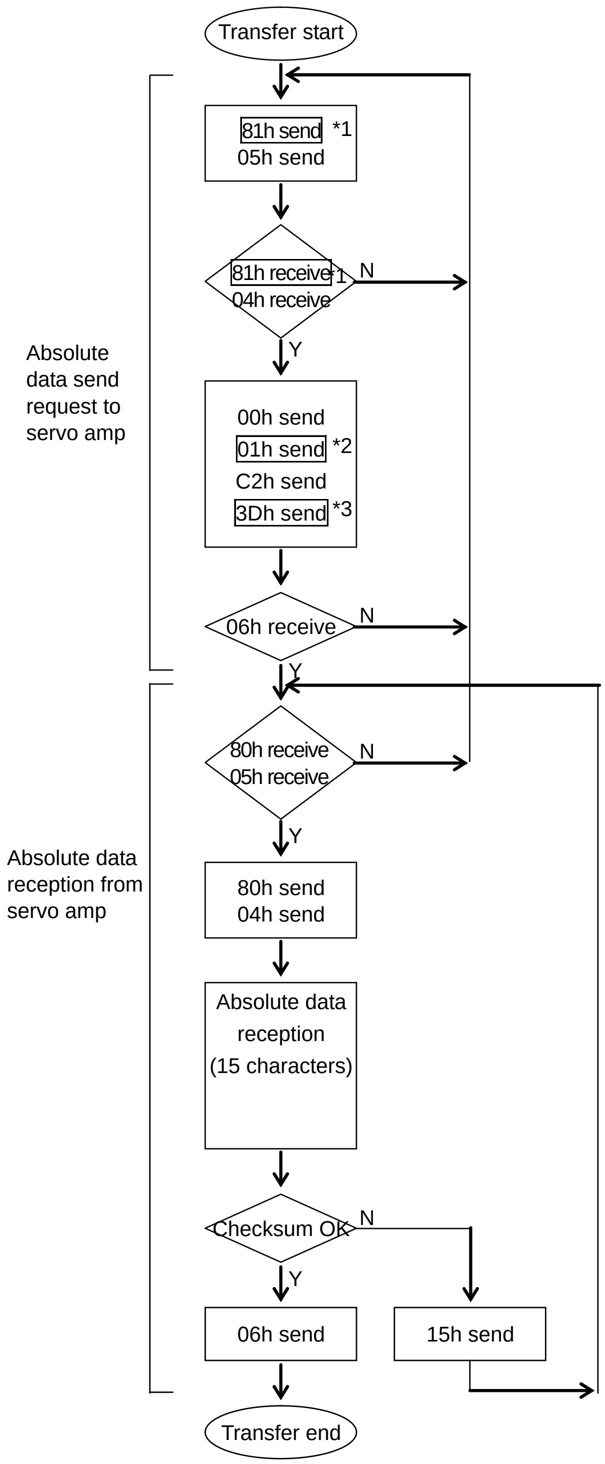
With *1 and *2, the data is determined by the setting of Pr5.31 "Axis number".

Axis number	Data for *1	Data for *2
0	00h	3Eh
1	01h	3Dh
2	02h	3Ch
3	03h	3Bh
4	04h	3Ah
5	05h	39h
6	06h	38h
7	07h	37h
8	08h	36h
9	09h	35h
10	0Ah	34h
11	0Bh	33h
12	0Ch	32h
13	0Dh	31h
14	0Eh	30h
15	0Fh	2Fh
16	10h	2Eh
17	11h	2Dh
18	12h	2Ch
19	13h	2Bh
20	14h	2Ah
21	15h	29h
22	16h	28h
23	17h	27h
24	18h	26h
25	19h	25h
26	1Ah	24h
27	1Bh	23h
28	1Ch	22h
29	1Dh	21h
30	1Eh	20h
31	1Fh	1Fh

The checksum is judged OK when the lower 8 bits of the sum of received absolute data (15 characters) is zero.

* To avoid faulty operation caused by accidental noise or others, it is recommended to perform the communication above for two times or more, and confirm the agreement of absolute data.

RS485



With *1, *2, and *3, the data is determined by the setting of Pr5.31 "Axis number".

Axis number	Data for *1	Data for *2	Data for *3
0	RS485 communication cannot be used.		
1	81h	01h	3Dh
2	82h	02h	3Ch
3	83h	03h	3Bh
4	84h	04h	3Ah
5	85h	05h	39h
6	86h	06h	38h
7	87h	07h	37h
8	88h	08h	36h
9	89h	09h	35h
10	8Ah	0Ah	34h
11	8Bh	0Bh	33h
12	8Ch	0Ch	32h
13	8Dh	0Dh	31h
14	8Eh	0Eh	30h
15	8Fh	0Fh	2Fh
16	90h	10h	2Eh
17	91h	11h	2Dh
18	92h	12h	2Ch
19	93h	13h	2Bh
20	94h	14h	2Ah
21	95h	15h	29h
22	96h	16h	28h
23	97h	17h	27h
24	98h	18h	26h
25	99h	19h	25h
26	9Ah	1Ah	24h
27	9Bh	1Bh	23h
28	9Ch	1Ch	22h
29	9Dh	1Dh	21h
30	9Eh	1Eh	20h
31	9Fh	1Fh	1Fh

The checksum is judged OK when the lower 8 bits of the sum of received absolute data (15 characters) is zero.

* To avoid faulty operation caused by accidental noise or others, it is recommended to perform the communication above for two times or more, and confirm the agreement of absolute data.

4-7-2-4 Composing of external scale absolute data

By using the 15 character data received via RS232 or RS485, the one rotation data or multirotation data is composed.

Received absolute data (15 characters)

0Bh
Axis number
C2h
FFh *1
31h *2
External scale status (L)
External scale status (H)
Absolute data (1)
Absolute data (2)
Absolute data (3)
Absolute data (4)
Absolute data (5)
Absolute data (6)
Error code
Checksum

Axis number: This is the set value of Pr5.31 "Axis number".
*1 becomes as undefined.
*2 differs depending on external scale.

Error code: Becomes as zero when communication is executed normally. When the value is not zero, read the absolute data from the driver again.

External scale absolute data ← Absolute data (6) × 10000000000h + Absolute data (5) × 100000000h + Absolute data (4) × 1000000h + Absolute data (3) × 10000h + Absolute data (2) × 100h + Absolute data (1)
The absolute data of external scale has 48 bits (negative value is a value described with the complement of 2).

External scale (1 indicates an error occurrence.)

External scale status (L)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit 0: Err51.0 "External scale status 0 error protection"
Bit 1: Err51.1 "External scale status 1 error protection"
Bit 2: Err51.2 "External scale status 2 error protection"
Bit 3: Err51.3 "External scale status 3 error protection"
Bit 4: Err51.4 "External scale status 4 error protection"
Bit 5: Err51.5 "External scale status 5 error protection"
Bit 6: Warning number A8 "External scale error warning"
Bit 7: Warning number A8 "External scale error warning"

External scale status (H)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0			0	0	0	0

Bit 4: Logical sum of external scale status (L) bit 6 and 7.
Bit 5: Logical sum of external scale status (L) bit 0 through 5.

For the details on external scale status, refer to the specification sheet for the external scale.

- **Make sure to transfer the absolute data under a status that the motor is in the servo-off state, and is fixed by brake or other means.**

This function cannot be used in [A6SE] [A6SG]

4-8 External scale position information monitor function under semi-closed control

Monitoring of external scale position information and external pulse regeneration can be made even under semi-closed control.

■ Related parameters

Class	No.	Parameter name	Set range	Units	Function
7	22	Special function enhancement setting 1	-32768 to 32767	-	Sets external scale position information monitor function under semi-closed control to bit 4. 0: Invalid 1: Valid *Under full-closed control, external scale position information can be monitored regardless of the setting of this bit.

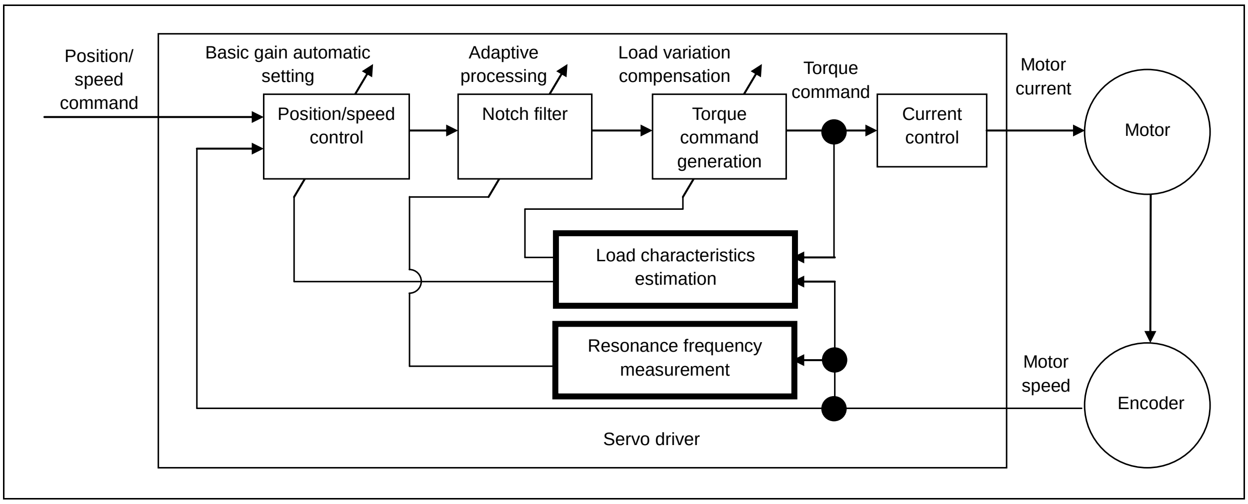
- By activating this function, the following functions will become valid not only for full-closed control but also for semi-closed control:
  - Communication command (Command 2 Mode C) [Read out of external scale]
  - External scale pulse regeneration function
  - External scale line disconnection, communication error, abnormal status alarm, warning detection function. (Err93.3, Err50.0 to 2, Err51.0 to 5, Err55.0 to 2, WarnA8h, and WarnA9h)

- Please set Pr3.23 “Selection of external scale” to an appropriate value to match the specifications for the external scale to be connected. Err93.3 “External scale connection error protection” will occur if the value is inappropriate.

5. Gain adjustment/vibration suppression function

5-1 Automatic adjustment function

An overview of A6 series automatic adjustment function is shown in the figure below.



1) Real-time automatic tuning

The load characteristics are estimated from the motor speed and torque command, and using the inertia estimation value as a base, the basic gains relevant to the position control and velocity control are set automatically. Moreover, by an addition of concurrently estimated friction torque to the torque command in advance or compensates as load variation , a reducing of positioning settling time is achieved.

2) Adaptive filter

By estimating the resonance frequency from the motor speed, and removing the frequency component in question from the torque command, any vibration caused by resonance phenomena is suppressed.

5-1-1 Real-time automatic tuning

The load characteristics of machine are estimated in real-time. From the estimation result, the basic gain setting and load variation compensation corresponding to the stiffness parameter are performed automatically.

In the case with the two-degree-of-freedom control mode, refer to 5-1-3/5-1-4.

1) Scope

This function operates under the conditions below.

	Condition under which real-time automatic tuning is operated
Control mode	Depending on the control mode, a different real-time automatic tuning mode is enabled. For the details, refer to the description of parameter Pr0.02 "Real-time automatic tuning mode setting".
Others	• Must be in the servo-on state. • Input signals for deviation counter clear, command input inhibition, etc., and parameters for other than the control such as torque limit setting are set appropriately, and any problem does not exist with the motor normal rotation.

2) Precautions

- After powering ON, until the operation data effective for the estimation of load characteristics gets sufficiently accumulated, the tracking of estimated value may become earlier despite the setting of Pr6.31 “real-time automatic tuning estimation speed”.
- In the case where the real-time automatic tuning is enabled, the estimated value may become abnormal as due to any external disturbance. If you would like to gain consistent operation from the moment of powering ON, it is recommended to disable the real-time automatic tuning.

Under conditions below, the real-time automatic tuning may not operate normally.
In such a case, change the load condition/operation pattern, or manually set the relevant parameters while referring to the description of manual adjustment function.

	Condition under which real-time automatic tuning operation is inhibited
Load condition	• The load inertia is smaller than, or larger than the rotor inertia. (Less than threefold, or twentyfold or more) • Fluctuation occurs with load inertia. • The machine stiffness is significantly low. • Nonlinear characteristics exist such as looseness by backlash.
Operation pattern	• Continuous use at the speed less than 100 [r/min] and at low speed. • The acceleration/deceleration is moderate such as by 2000 [r/min] or less per 1 [s]. • Conditions of speed at 100 [r/min] or more and acceleration/deceleration by 2000 [r/min] or more per 1 [s] do not continue for longer than 50 [ms]. • The acceleration/deceleration torque is smaller than the offset loading/viscous friction torque.

3) Parameters for controlling real-time automatic tuning

The operation of real-time automatic tuning is set with the parameters below.

<table>
<tr><th>Category</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>02</td><td>Real-time automatic tuning mode setting</td><td>0 to 6</td><td>--</td><td>Sets the operation mode of real-time automatic tuning.
<table>
<tr><th>Set value</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Disabled</td><td>The real-time automatic tuning function is disabled.</td></tr>
<tr><td>1</td><td>Standard</td><td>This mode emphasizes stability. The offset loading and friction compensation are not performed, also the gain switching is not used.</td></tr>
<tr><td>2</td><td>Positioning *1</td><td>This mode emphasizes positioning. The mode is used with, for example, ball screw driven equipment with horizontal axis, with which there is no offset loading and the friction is small.</td></tr>
<tr><td>3</td><td>Vertical axis *2</td><td>In addition to the positioning mode, the offset loading of such as vertical axis is compensated, and the fluctuation of positioning settling time is suppressed.</td></tr>
<tr><td>4</td><td>Friction compensation *3</td><td>In addition to the vertical axis mode, the positioning settling time is reduced with such as the belt driven axis having a large friction.</td></tr>
<tr><td>5</td><td>Load characteristics measurement</td><td>No change is made to the basic gain setting and friction compensation setting, and only the load characteristics estimation is performed. This is used in combination with the set-up support software (PANATERM).</td></tr>
<tr><td>6</td><td>Customize *4</td><td>By configuring in detail the combination of real-time automatic tuning function with Pr6.32 "Real-time automatic tuning custom setting", customization is possible to suit the use.</td></tr>
</table>
*1. With the speed/torque control, it becomes the same as standard mode.
*2. With the torque control, it becomes the same as standard mode.
*3. With the velocity control, it becomes the same as vertical axis mode. With the torque control, it becomes the same as standard mode.
*4. Depending on the control mode, some functions are unavailable. Refer to the description of Pr6.32.</td></tr>
<tr><td>0</td><td>03</td><td>Real-time automatic tuning stiffness setting</td><td>0 to 31</td><td>--</td><td>Sets the responsiveness for when the real-time automatic tuning is enabled. As the set value becomes higher, the speed responsiveness becomes higher and the servo stiffness is also increased, but vibration becomes more prone to occur. Change the value from low to high while checking the operation.</td></tr>
<tr><td>6</td><td>10</td><td>Function expansion setting</td><td>-32768 ～32768</td><td>--</td><td>When bit14=1, enable automatic adjustment of load variation suppression function</td></tr>
</table>

(Continued)

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</td><td>Real-time automatic tuning estimation speed</td><td>0 to 3</td><td>-</td><td>Sets the estimated velocity for load characteristics when the real-time automatic tuning is enabled. The higher the setting value is, the faster the tracking to the load characteristic change is, but estimated variations to disturbances become larger. The estimated result will be stored in EEPROM every 30 minutes.
<table>
<tr><th>Set value</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Stationary</td><td>Stops the load characteristic estimation.</td></tr>
<tr><td>1</td><td>Nearly stationary</td><td>Responds in the minute unit to the change of the load characteristic.</td></tr>
<tr><td>2</td><td>Gradual change</td><td>Responds in the second unit to the change of the load characteristic.</td></tr>
<tr><td>3
*</td><td>Abrupt change</td><td>Conducts an optimal estimation to the change of the load characteristics.</td></tr>
</table>
*: When the automatic oscillation detection is enabled via set-up support software (PANATERM), this setting is ignored and the operation follows the set value 3.</td></tr>
<tr><td>6</td><td>32</td><td>Real-time automatic tuning custom settings
(to be continued)</td><td>-32768
to 32767</td><td>-</td><td>When the customizing mode is selected as the operational mode for the real-time automatic tuning (Pr0.02 = 6), set the advanced settings for the automatic adjusting function.
<table>
<tr><th>Bit</th><th>Content</th><th>Description</th></tr>
<tr><td>1 to 0</td><td>Load characteristic estimation
*1, *2</td><td>Set enabled or disabled for the load characteristic estimation function.
Setting value = 0: Disabled
Setting value =1: Enabled</td></tr>
<tr><td>3 to 2</td><td>Inertia ratio update
*3</td><td>Set update subjected to the load characteristic estimation result of Pr0.04 "Inertia ratio."
Setting value = 0: Uses current settings.
Setting value = 1: Replace by an estimate value.</td></tr>
<tr><td>6 to 4</td><td>Torque compensation
*4</td><td>Set updates subjected to the load characteristic estimation result with Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction" and Pr6.09 "Torque compensation value in negative direction."
Setting value = 0: Uses current settings.
Setting value = 1: Disables the torque compensation.
Applies zero clear to parameters above.
Setting value = 2: Vertical axis mode
Updates Pr6.07 and applies zero clear to Pr6.08 and Pr6.09.
Setting value = 3: Friction compensation (few)
Updates Pr6.07 and sets less compensation to Pr6.08 and Pr6.09.
Setting value =4: Friction compensation (moderate)
Sets moderate compensation to Pr6.08 and Pr6.09.
Setting value = 5: Friction compensation (strong)
Sets strong compensation to Pr6.08 and Pr6.09.</td></tr>
</table>
*1: When the load characteristic estimation is disabled, the current settings do not change, even if the inertia ratio is replaced by the estimate value. In addition, if the torque compensation value is replaced by the estimate value, zero clear (disabled) applies.
*2: When the load characteristic measurement is enabled, at the same time, set Pr6.31 "Real-time automatic tuning estimation speed" to a value other than zero (stopping the estimation).</td></tr>
</table>

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>32</td><td>Real-time automatic tuning custom settings (continued)</td><td>-32768 to 32767</td><td>-</td><td>
<table>
<tr><th>Bit</th><th>Content</th><th>Description</th></tr>
<tr><td>7</td><td>Stiffness setting *5</td><td>Sets enabled or disabled for the basic gain setting by Pr0.03 "Real-time automatic tuning stiffness setting."
Setting value = 0: Disabled
Setting value = 1: Enabled</td></tr>
<tr><td>8</td><td>Fixed parameter setting *5</td><td>Sets the change availability to fix parameters which are usually fixed values.
Setting value = 0: Uses current settings
Setting value = 1: Sets fixed to values.</td></tr>
<tr><td>10 to 9</td><td>Gain switching setting *5</td><td>Selects a setting method for the relevant parameters of gain switching when the real-time automatic tuning is enabled.
Setting value = 0: Uses current settings
Setting value = 1: Gain switching is disabled.
Setting value = 2: Gain switching is enabled.</td></tr>
</table>
*3: When the inertia ratio update is enabled, set bits 1-0 (load characteristic estimation) to 1 (enabled) at the same time. If both are not enabled, the inertia ratio is not updated.
*4: When the torque compensation is enabled -- which means that this setting is set to 2-5 -- set bits 3-2 (inertia ratio update) to 1 (enabled) at the same time. The torque compensation alone cannot be updated.
*5: When this setting is set to a setting other than zero, set bits 3-2 (inertia ratio update) settings to 1 (enabled). At this moment, bits 1-0 (load characteristic estimation) can set whether the inertia ratio update is enabled or not.

Note: This parameter needs the settings in bit unit. The operation in the case of wrong setting gives no guarantee. Therefore, we recommend using the set-up support software (PANATERM) when editing parameters.

Note: Do not change this parameter while the motor is running. In addition, the parameter is actually changed when the motor stops after the establishment of the load characteristic measurement result.

* Setting method for parameters in bit unit
Calculate the setting value of Pr6.32 according to the following procedure when each setting is set to a value other than zero.
1. Check the least significant bit of each setting.
Ex.: The least significant bit of the torque compensation function is 4.
2. Multiply the "least significant bit" power of 2 by the setting value.
Ex.: When the torque compensation function is set to the friction compensation (moderate),
2^4 x 4 = 64
3. Calculate each setting in accordance with sections 1 and 2. The setting of Pr6.32 shall be the value that all are added.
Ex.: In the following case: load characteristic measurement is enabled; inertia ration update is enabled; torque compensation is friction compensation (moderate); stiffness setting is enabled; fixed parameters are set to fixed values; gain switching setting is enabled;
$2^0\times1+2^2\times1+2^4\times4+2^7\times1+2^8\times1+2^9\times2 = 1477$
</td></tr>
</table>

4. Parameters that are changed by the real-time automatic tuning

The real-time automatic tuning updates the following parameters using the load characteristic estimates, depending on Pr0.02 "Real-time automatic tuning mode setting" and Pr6.32 "Real-time automatic tuning custom setting."

Class	No.	Parameter name	Setting range	Unit	Function
0	04	Inertia ratio	0 to 10000	%	Updates this parameter when the inertia ration update of real-time automatic tuning is enabled.
6	07	Additional value to torque command	-100 to 100	%	Updates this parameter when the vertical axis mode of real-time automatic tuning is enabled.
6	08	Torque compensation value in positive direction	-100 to 100	%	Updates this parameter when the friction compensation mode of real-time automatic tuning is enabled.
6	09	Torque compensation value in negative direction	-100 to 100	%	Updates this parameter when the friction compensation mode of real-time automatic tuning is enabled.

The real-time automatic tuning updates the following basic gain setting parameters, depending on Pr0.03 "Real-time automatic tuning stiffness setting." For more information, see the setting table for the basic gain parameters in section 7.

Class	No.	Parameter name	Setting range	Unit	Function
1	00	First position loop gain	0 to 30000	0.1/s	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	01	First velocity loop gain	1 to 32767	0.1 Hz	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	02	1st velocity loop integration time constant	1 to 10000	0. 1ms	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	04	Filter time constant for the first torque	0 to 2500	0.01 ms	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	05	Second position loop gain	0 to 30000	0.1/s	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	06	Second velocity loop gain	1 to 32767	0.1 Hz	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	07	2nd velocity loop integration time constant	1 to 10000	0.1 ms	Updates to a setting depending on the stiffness when the stiffness setting is enabled.
1	09	Filter time constant for the second torque	0 to 2500	0.01 ms	Updates to a setting depending on the stiffness when the stiffness setting is enabled.

The real-time automatic tuning sets the following parameters to fixed values.

Class	No.	Parameter name	Setting range	Unit	Function
1	03	First velocity detection filter	0 to 5	-	Sets to 0 when the fixed parameter setting is enabled.
1	08	Second velocity detection filter	0 to 5	-	Sets to 0 when the fixed parameter setting is enabled.
1	10	Velocity feedforward gain	0 to 4000	0.1 %	Sets to 300 (30%) when the fixed parameter setting is enabled.
1	11	Velocity feedforward filter	0 to 6400	0.01 ms	Sets to 50 (0.5 ms) when the fixed parameter setting is enabled.
1	12	Torque feedforward gain	0 to 2000	0.1 %	Sets to 0 when the fixed parameter setting is enabled.
1	13	Torque feedforward filter	0 to 6400	0.01 ms	Sets to 0 when the fixed parameter setting is enabled.

(To be continued)

The real-time automatic tuning sets the following parameters in accordance with the gain switching setting.

Class	No.	Parameter name	Setting range	Unit	Function
1	14	Second gain setting	0 to 1	-	Sets to 1 except to hold the current setting.
1	15	Position control switching mode	0 to 10	-	Sets to 10 when the gain switching is enabled. Sets to zero when the gain switching is disabled.
1	16	Position control switching delay time	0 to 10000	0.1 ms	Sets to 50 except to hold the current setting.
1	17	Position control switching level	0 to 20000	-	Sets to 50 except to hold the current setting.
1	18	Position control switching hysteresis	0 to 20000	-	Sets to 33 except to hold the current setting.
1	19	Position gain switching time	0 to 10000	0.1 ms	Sets to 33 except to hold the current setting.
1	20	Velocity control switching mode	0 to 5	-	Sets to 0 except to hold the current setting.
1	21	Velocity control switching delay time	0 to 10000	0.1 ms	Sets to 0 except to hold the current setting.
1	22	Velocity control switching level	0 to 20000	-	Sets to 0 except to hold the current setting.
1	23	Velocity control switching hysteresis	0 to 20000	-	Sets to 0 except to hold the current setting.
1	24	Torque control switching mode	0 to 3	-	Sets to 0 except to hold the current setting.
1	25	Torque control switching delay time	0 to 10000	0.1 ms	Sets to 0 except to hold the current setting.
1	26	Torque control switching level	0 to 20000	-	Sets to 0 except to hold the current setting.
1	27	Torque control switching hysteresis	0 to 20000	-	Sets to 0 except to hold the current setting.

The following settings are always disabled when Pr0.02 "Real-time automatic tuning mode setting" is a value other than zero. Note that the parameter setting itself is not changed.

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function expansion setting	-32768 to 32767	-	The bit (bit 3) for inertia ratio switching function permission is internally invalidated.
6	13	Second inertia ratio	0 to 10000	%	Parameter settings can be changed, but the inertia ratio switching function is invalidated.

The following settings and parameters are set automatic for enable/disable state of Pr 6.10 “Function expansion setting” load variation suppression function automatic adjustment.

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function extension setting	-32768 to 32767	-	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, load fluctuation suppression function will become enabled (bit1 = 1). When set to Pr 6.10 bit14=0,it is disabled(bit1 = 1).
6	23	Load fluctuation compensation gain	-100 to 100	%	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 90%. When set to Pr 6.10 bit14=0, set to 0%.
6	24	Load fluctuation compensation filter	10 to 2500	0.01 ms	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, updates to match rigidity. When set to Pr 6.10 bit14=0, value is held.
6	73	Load estimation filter	0 to 2500	0.01 ms	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 0.13 ms. When set to Pr 6.10 bit14=0, set to 0 ms.
6	74	Torque compensation frequency 1	0 to 5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.

(To be continued)

Class	No.	Parameter name	Setting range	Unit	Function
6	75	Torque compensation frequency 2	0 to 5000	0.1 Hz	Regardless value of the Pr 6.10 bit14 , sets to 0.
6	76	Load estimate numbers	0 to 8	-	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 4. When set to Pr 6.10 bit14=0, set to 0.

5. How to use

If Pr0.02 "Real-time automatic tuning mode setting" is set to a value other than zero, control parameters are automatically set depending on Pr0.03 "Real-time automatic tuning stiffness setting" and Pr 6.10 “Function expansion setting” bit 14.

Input an operating command after turning the servo on. Success for the load characteristic estimation updates Pr0.04 "Inertia ratio." Depending on the mode settings, Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction" and Pr6.09 "Torque compensation value in negative direction" also change.

Increasing Pr0.03 "Real-time automatic tuning stiffness setting" can enhance motor response. Adjust to an optimum value while considering the vibrating condition and the positioning setting time.

6. Other cautions

A. Although oscillation or an abnormal noise may occur until the load characteristic estimation becomes stable immediately after the servo first turns on following the start or when Pr0.03 "Real-time automatic tuning stiffness setting" is increased, it is not abnormal if it soon becomes stabilized. However, if oscillation or the continuous abnormal noise for three reciprocating motions or more occurs very often, take the following measures:
   1. Decrease Pr0.03 "Real-time automatic tuning stiffness setting."
   2. Set Pr0.02 "Real-time automatic tuning mode setting" to zero and disable the real-time automatic tuning.
   3. Set Pr0.04 "Inertia ratio" to a calculated value on the equipment, and set Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction" and Pr6.09 "Torque compensation value in negative direction" to zero.
   4. Disabale load variation suppression function. (bit1=0 after Pr 6.10 bit14=0)

B. Pr0.04 "Inertia ratio," Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction" and Pr6.09 "Torque compensation value in negative direction" may enormously change after oscillation or an abnormal noise occurs. In such a case, implement measures in item 3 above.

C. Pr0.04 "Inertia ratio," Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction" and Pr6.09 "Torque compensation value in negative direction" which are results by the real-time automatic gain tuning are written in EEPROM every 30 minutes. When the power is restored, the automatic tuning is executed with these data as defaults. Note that the real-time automatic gain tuning results are not stored if the power is turned off before 30 minutes pass. In this case, manually write the parameters in EEPROM and turn the power off.

D. Since the control gain update is implemented at the time of shutdown, the change of the setting value of Pr0.03 Real-time automatic tuning stiffness setting" may not be reflected when the motor does not stop such as the cases that the gain is extremely-low and the command in one direction is continuously given. In this case, oscillation or an abnormal noise may occur depending on the stiffness setting reflected after the stop.

When changing the stiffness, stop the motor once, be sure to confirm that the stiffness setting has been reflected, and conduct the next operation.

7. Setting table for the basic gain parameters

Stiffness	First gain				Second gain				For load fluctuation suppression function
	Pr1.00	Pr1.01	Pr1.02	Pr1.04	Pr1.05	Pr1.06	Pr1.07	Pr1.09	Pr 6.24
	Position [0.1/s]	Velocity [0.1 Hz]	Velocity integration [0.1 ms]	Torque [0.01 ms]	Position [0.1/s]	Velocity [0.1 Hz]	Velocity integration [0.1 ms]	Torque [0.01 ms]	Load fluctuation compensation filter [0.01/ms]
0	20	15	3700	1500	25	15	10000	1500	2500
1	25	20	2800	1100	30	20	10000	1100	2500
2	30	25	2200	900	40	25	10000	900	2500
3	40	30	1900	800	45	30	10000	800	2500
4	45	35	1600	600	55	35	10000	600	2500
5	55	45	1200	500	70	45	10000	500	2500
6	75	60	900	400	95	60	10000	400	2500
7	95	75	700	300	120	75	10000	300	2120
8	115	90	600	300	140	90	10000	300	1770
9	140	110	500	200	175	110	10000	200	1450
10	175	140	400	200	220	140	10000	200	1140
11	320	180	310	126	380	180	10000	126	880
12	390	220	250	103	460	220	10000	103	720
13	480	270	210	84	570	270	10000	84	590
14	630	350	160	65	730	350	10000	65	450
15	720	400	140	57	840	400	10000	57	400
16	900	500	120	45	1050	500	10000	45	320
17	1080	600	110	38	1260	600	10000	38	270
18	1350	750	90	30	1570	750	10000	30	210
19	1620	900	80	25	1880	900	10000	25	180
20	2060	1150	70	20	2410	1150	10000	20	140
21	2510	1400	60	16	2930	1400	10000	16	110
22	3050	1700	50	13	3560	1700	10000	13	90
23	3770	2100	40	11	4400	2100	10000	11	80
24	4490	2500	40	9	5240	2500	10000	9	60
25	5000	2800	35	8	5900	2800	10000	8	60
26	5600	3100	30	7	6500	3100	10000	7	50
27	6100	3400	30	7	7100	3400	10000	7	50
28	6600	3700	25	6	7700	3700	10000	6	40
29	7200	4000	25	6	8400	4000	10000	6	40
30	8100	4500	20	5	9400	4500	10000	5	40
31	9000	5000	20	5	10500	5000	10000	5	40

5-1-2 Adaptive filter

With actual operating condition, estimate the resonance frequency from vibration components which are included in the motor velocity, and remove the resonance to reduce the oscillation.

1. Scope

This function operates under the following conditions.

	Conditions in which the adaptive filter operates
Control mode	The control mode shall be one other than the torque control mode.
Others	• The servo shall be on. • Elements other than control parameters, such as torque limit and input inhibit to the deviation counter clear command, shall be properly set, and the normal revolution of motor shall be trouble-free.

2. Cautions

In the following conditions, the motor may be inoperative. In this case, manually set the notch filter and suppress the resonance.

	Conditions in which the operation of adaptive filter is blocked.
Resonance point	• If the resonance frequency is three times or less velocity response frequency (Hz). • When the resonance peak or the control gain is low, if the effect on the motor velocity does not appear. • If more than two resonance points exist.
Load	• If motor velocity fluctuation which includes high-frequency content occurs by non-linear elements such as backlash.
Command pattern	• If the acceleration and deceleration are rapid as 30000 (r/min) or more per one second.

3. Relevant parameters

The following parameters can set the operations of adaptive filter.

Class	No.	Parameter name	Setting range	Unit	Function
2	00	Adaptive filter mode	0 to 6	-	Sets the operational mode of adaptive filter. Set to zero (disabled) or four (clear) temporarily when changing the mode. Setting value is 0: Adaptive filter is disabled. Adaptive filter is disabled. Parameters related to the third and fourth notch filters hold the current values. Setting value is 1: One adaptive filter is enabled. One adaptive filter is enabled. Parameters related to the third notch filter are updated depending on the adaptive result. Setting value is 2: Two adaptive filters are enabled. Two adaptive filters are enabled. Parameters related to the third and fourth notch filters are updated depending on adaptive results. Setting value is 3: Resonance frequency measurement mode The resonance frequency is measured. The result can be confirmed in PANATERM. Parameters related to the third and fourth notch filters hold the current values. Setting value is 4: Adaptive results are cleared. Parameters related to the third and fourth notch filters are disabled and adaptive results are cleared. Setting value is 5: High accurate adaptive filter Two adaptive filters are enabled. Parameters related to the third and fourth notch filter are updated depending on adaptive results. We recommend this setting when using two adaptive filters. Setting value is 6: Maker uses. It is the fit gain function of PANATERM, and internally used. Do not use this setting in normal conditions.

(To be continued)

The adaptive filter automatically sets the following parameters.

Class	No.	Parameter name	Setting range	Unit	Function
2	07	Third notch frequency	50 to 5000	Hz	The first resonance frequency which the adaptive filter estimates is automatically set. When a resonance point is not found, 5000 is set.
2	08	Third notch width	0 to 20	-	Is automatically set when the adaptive filter is enabled.
2	09	Third notch depth	0 to 99	-	Is automatically set when the adaptive filter is enabled.
2	10	Fourth notch frequency	50 to 5000	Hz	The second resonance frequency which the adaptive filter estimates is automatically set. When a resonance point is not found, 5000 is set.
2	11	Fourth notch width	0 to 20	-	Is automatically set when two adaptive filters are enabled (Pr2.00 =2) or in case of high accurate adaptive filter (Pr2.00 = 5).
2	12	Fourth notch depth	0 to 99	-	Is automatically set when two adaptive filters are enabled (Pr2.00 =2) or in case of high accurate adaptive filter (Pr2.00 = 5).

4. How to use

Input an operating command with the condition in which Pr2.00 "Adaptive filter mode" is set to a value other than zero.
When the resonance point has an effect on the motor velocity, the parameters of the third notch filter and/or the fourth notch filter are automatically set depending on the number of adaptive filters.

5. Other cautions

A. Although oscillation or an abnormal noise may occur until the adaptive filter becomes stable immediately after the servo first turns on following the start or when the stiffness setting is increased in the case that the real-time automatic tuning is enabled, it is not abnormal if it soon becomes stabilized. However, if oscillation or the continuous abnormal noise for three reciprocating motions or more occurs very often, take the following measures.

1. Write the parameters in normal operating into EEPROM once.
2. Decrease Pr0.03 "Real-time automatic tuning stiffness."
3. Set Pr2.00 "Adaptive filter mode" to zero, and disable the adaptive filter.
4. Set the notch filter manually.

B. The settings of the third and fourth notch filters may enormously change after oscillation or an abnormal noise occurs. In such a case, disable the adaptive filter as mentioned in the third item above temporarily, set Pr2.07 "The third notch frequency" and Pr2.10 "The fourth notch frequency" to 5000 (disabled), and enable the adaptive filter again.

C. The third notch filter frequency (Pr2.07) and the fourth notch filter frequency (Pr2.10) are written in EEPROM every 30 minutes. When the power is restored, the process is executed with these data as defaults.

5-1-3 Real-time automatic tuning (two degrees of freedom control mode: standard type)

Two-degree-of-freedom control mode has the standard type and synchronization type.

Standard type: Is standard mode. Use this type usually.

Synchronization type: Use in the case of trajectory control for multiple axes such as articulated robots.

This section is for the automatic tuning function dedicated to the standard type.

The results from the real-time estimation of the machine load characteristics automatically implement the basis gain setting and load variation compensation depending on the stiffness parameter.

1. Scope

This function operates under the following conditions.

	Conditions in which the real-time automatic tuning operates
Control mode	Pr0.01 = 0: Position control; Pr0.01 = 1: Velocity control ; Pr0.01=6 Full-closed control Bit 0 = 1 and bit 3 = 0 in Pr6.47: Two-degree-of-freedom control mode standard type
Others	• The servo shall be on. • Parameters other than control, such as the torque limit setting, and input signals, such as deviation counter clear and command input inhibit, shall be properly set, and the normal revolution of motor shall be trouble-free.

2. Cautions

- After powering ON, until the operation data effective for the estimation of load characteristics gets sufficiently accumulated, the tracking of estimated value may become earlier despite the setting of Pr6.31 “real-time automatic tuning estimattion speed”.
- In the case where the real-time automatic tuning is enabled, the estimated value may become abnormal as due to any external disturbance. If you would like to gain consistent operation from the moment of powering ON, it is recommended to disable the real-time automatic tuning.

In the following conditions, the real-time automatic tuning may be inoperative. In this case, change the load conditions and moving pattern or manually set relevant parameters referring to the explanation of manual adjusting function.

	Conditions in which the operation of real-time automatic tuning is blocked
Load condition	• If the load inertia is small or large compared to the rotor inertia. (Less than three times or twenty times or more) • If the load inertia fluctuates. • If the machine stiffness is extremely low. • If non-linear characteristics such as looseness due to backlash exist.
Moving pattern	• If the operation continues at a low velocity less than 100 (r/min). • If the acceleration and deceleration are gradual 2000 (r/min) or less per one second. • If the condition that the velocity is 100 (r/min) or more and the acceleration and deceleration are 2000 (r/min) or more per one second does not continue for 50 (ms) or more. • If the acceleration and deceleration torques are small compared to the offset load and viscous friction torques.

3. Parameters which control the operation of the real-time automatic tuning

Set the operation of real-time automatic tuning with the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>02</td><td>Real-time automatic tuning mode setting</td><td>0 to 6</td><td>-</td><td>Sets an operational mode on the real-time automatic tuning.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Disabled</td><td>The function of real-time automatic tuning is disabled.</td></tr>
<tr><td>1</td><td>Standard response mode</td><td>Mode which puts weight on stability. It does not implement an offset load and friction compensation, or use the gain switching.</td></tr>
<tr><td>2</td><td>High response mode 1</td><td>Mode which puts weight on positioning. Use for devices of small ball screw drive with low friction and without any offset load on the horizontal axis.</td></tr>
<tr><td>3</td><td>High response mode 2</td><td>In addition to the high response mode 1, restrains the positioning setting time from varying by applying the third gain and the offset load compensation.</td></tr>
<tr><td>4</td><td>High response mode 3
*1</td><td>In addition to the high response mode 2, reduces the positioning setting time using a load with large friction.</td></tr>
<tr><td>5</td><td>Load characteristic measurement</td><td>Does not change the settings of the basic gain and friction compensation, and estimates only the load characteristics. Use in combination with set-up support software (PANATERM).</td></tr>
<tr><td>6</td><td>Fit gain mode</td><td>To be used for fine adjustment of rigidity setting after completion of fit gain.</td></tr>
</table>
*1: In velocity control, it is the same as high response mode 2.
In addition, Parameters of Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation in negative direction" and Pr6.50 "Viscous friction compensation gain" are updated, but not reflected in the operation.</td></tr>
<tr><td>0</td><td>03</td><td>Real-time automatic tuning stiffness setting</td><td>0 to 31</td><td>-</td><td>Sets responsivity when the real-time automatic tuning is enabled. The higher the setting is, the better the velocity response is, and the servo stiffness increases, but oscillation is easier to occur. Change the value from a low value to a high value while checking the operation.</td></tr>
<tr><td>6</td><td>10</td><td>Function expansion setting</td><td>-32768
～32768</td><td>--</td><td>When bit14=1, enable automatic adjustment of load variation suppression function</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</td><td>Real-time automatic tuning estimation speed</td><td>0 to 3</td><td>-</td><td>Sets the estimated velocity of load characteristic when the real-time automatic tuning is enabled. The higher the setting is, the faster the tracking to the load characteristic change is, but the estimated variation to disturbance becomes larger. The estimation result is stored in EEPROM every 30 minutes.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Stationary</td><td>Stops the load characteristic estimation.</td></tr>
<tr><td>1</td><td>Nearly stationary</td><td>Responds in the minute unit to the change of the load characteristic.</td></tr>
<tr><td>2</td><td>Gradual change</td><td>Responds in the second unit to the change of the load characteristic.</td></tr>
<tr><td>3
*</td><td>Abrupt change</td><td>Conducts an optimal estimation to the change of the load characteristics.</td></tr>
</table>
*: When the automatic oscillation detection is enabled via set-up support software (PANATERM), this setting is ignored and the operation follows the setting 3.</td></tr>
<tr><td>6</td><td>32</td><td>Real-time automatic tuning custom setting</td><td>-32768 to 32767</td><td>-</td><td>You cannot use in two-degree-of-freedom control mode.
Use with the setting 0.</td></tr>
</table>

4. Parameters which are changed in the real-time automatic tuning

The real-time automatic tuning updates the following parameters using the load characteristic estimates, depending on Pr0.02 "Real-time automatic tuning mode setting."

Class	No.	Parameter name	Setting range	Unit	Function
0	04	Inertia ratio	0 to 10000	%	Updates this parameter when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
6	07	Additional value to torque command	-100 to 100	%	Updates this parameter in the case of the high response mode 2 or 3 of real-time automatic tuning.
6	08	Torque compensation value in positive direction	-100 to 100	%	Updates this parameter in the case of the high response mode 3 of real-time automatic tuning.
6	09	Torque compensation value in negative direction	-100 to 100	%	Updates this parameter in the case of the high response mode 3 of real-time automatic tuning.
6	50	Viscous friction compensation gain	0 to 10000	0.1%/(10 000 r/min)	Updates this parameter in the case of the high response mode 3 of real-time automatic tuning.

The real-time automatic tuning updates the following basic gain setting parameters, depending on Pr0.03 "Real-time automatic tuning stiffness setting." For more information, see the setting table for the basic gain parameters in section 7.

Class	No.	Parameter name	Setting range	Unit	Function
1	00	First position loop gain	0 to 30000	0.1/s	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	01	First velocity loop gain	1 to 32767	0.1 Hz	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	02	1st velocity integration time constant	1 to 10000	0.1 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	04	Filter time constant for the first torque	0 to 2500	0.01 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	05	Second position loop gain	0 to 30000	0.1/s	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	06	Second velocity loop gain	1 to 32767	0.1 Hz	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	07	2nd velocity integration time constant	1 to 10000	0.1 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	09	Filter time constant for the second torque	0 to 2500	0.01 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
2	22	Command smoothing filter	0 to 10000	0.1 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4). *: In velocity control, it is fixed to primary filter.
6	48	Adjustment filter	0 to 2000	0.1 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6). *: In velocity control, it is fixed to primary filter.

The real-time automatic tuning sets the following parameters to fixed values.

Class	No.	Parameter name	Setting range	Unit	Function
1	03	First velocity detection filter	0 to 5	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	08	Second velocity detection filter	0 to 5	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	10	Velocity feedforward gain	0 to 4000	0.1 %	Sets to 1000 (100%) when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	11	Velocity feedforward filter	0 to 6400	0.01 ms	Set to 0 (disabled) when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	12	Torque feedforward gain	0 to 2000	0.1 %	Sets to 1000 (100%) when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	13	Torque feedforward filter	0 to 6400	0.01 ms	Sets to 0 (disabled) when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).

(To be continued)

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function expansion setting	-32768 to 32767	-	Sets bit 4 to 1 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
6	49	Command response filter/adjustment filter damping term setting	0 to 99	-	Sets to 15 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).

The real-time automatic tuning sets the following parameters depending on Pr0.02 "Real-time automatic tuning mode setting."

Class	No.	Parameter name	Setting range	Unit	Function
1	14	Second gain setting	0 to 1	-	Sets to 1 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	15	Position control switching mode	0 to 10	-	Sets to 0 in the case of the standard response mode (Pr0.02 = 1). Sets to 7 in the cases of high response modes 1-3 (Pr0.02 = 2 to 4).
1	16	Position control switching delay time	0 to 10000	0.1 ms	Sets to 10 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	17	Position control switching level	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	18	Position control switching hysteresis	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	19	Position gain switching time	0 to 10000	0.1 ms	Sets to 10 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	20	Velocity control switching mode	0 to 5	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	21	Velocity control switching delay time	0 to 10000	0.1 ms	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	22	Velocity control switching level	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	23	Velocity control switching hysteresis	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	24	Torque control switching mode	0 to 3	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	25	Torque control switching delay time	0 to 10000	0.1 ms	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	26	Torque control switching level	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
1	27	Torque control switching hysteresis	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4).
6	05	Position control third gain effective time	0 to 10000	0.1 ms	Sets to 0 (disabled) in the cases of the standard response mode and the high response mode 1 (Pr0.02 = 1 and 2). Sets to "Pr2.22 x 20" in the cases of high response modes 2 or 3 (Pr0.02 = 3, 4). (However, the maximum value is limited to 10000.)
6	06	Position control third gain scale factor	50 to 1000	%	Sets to 100 (100%) in the cases of the standard response mode and the high response mode 1 (Pr0.02 = 1 and 2). Sets to 200 (200%) in the cases of the high response modes 2 or 3 (Pr0.02 = 3, 4).

The following settings are always disabled when Pr0.02 "Real-time automatic tuning mode setting" is a value other than zero. Note that the parameter setting itself is not changed.

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function expansion setting	-32768 to 32767	-	The bit (bit 3) for inertia ratio switching function permission is internally invalidated.
6	13	Second inertia ratio	0 to 10000	%	Parameter settings can be changed, but the inertia ratio switching function is invalidated.

The following settings and parameters are set automatic for enable/disable state of Pr 6.10 “Function expansion setting” load variation suppression function automatic adjustment.

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function extension setting	-32768 to 32767	-	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, load variation suppression function will become enabled (bit1 = 1). When set to Pr 6.10 bit14=0,it is disabled(bit1 = 1).
6	23	Load variation compensation gain	-100 to 100	%	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 90%. When set to Pr 6.10 bit14=0, set to 0%.
6	24	Load variation compensation filter	10 to 2500	0.01 ms	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, updates to match rigidity. When set to Pr 6.10 bit14=0, value is held.
6	73	Load estimation filter	0 to 2500	0.01 ms	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 0.13 ms. When set to Pr 6.10 bit14=0, set to 0 ms.
6	74	Torque compensation frequency 1	0 to 5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	75	Torque compensation frequency 2	0 to 5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	76	Load estimation numbers	0 to 8	-	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 4. When set to Pr 6.10 bit14=0, set to 0.

5. How to use

If Pr0.02 "Real-time automatic tuning mode setting" is set to a value other than zero, control parameters are automatically set depending on Pr0.03 "Real-time automatic tuning stiffness setting" and Pr 6.10 “Function expansion setting” bit 14.

Input an operating command after turning the servo on. Success for the load characteristic estimation updates Pr0.04 "Inertia ratio." Depending on the mode settings, Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" also change.

Increasing Pr0.03 "Real-time automatic tuning stiffness setting" can enhance motor response. Adjust to an optimum value while considering the vibrating condition and the positioning setting time.

6. Other cautions

1. Although oscillation or an abnormal noise may occur until the load characteristic estimation becomes stable immediately after the servo first turns on following the start or when Pr0.03 "Real-time automatic tuning stiffness setting" is increased, it is not abnormal if it soon becomes stabilized. However, if oscillation or the continuous abnormal noise for three reciprocating motions or more occurs very often, take the following measures.
   1). Decrease Pr0.03 "Real-time automatic tuning stiffness setting."
   2). Set Pr0.02 "Real-time automatic tuning mode setting" to zero and disable the real-time automatic tuning.
   3). Set Pr0.04 "Inertia ratio" to a calculated value on the equipment, and set Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" to zero.
   4). Disabale load variation suppression function. (bit1=0 after Pr 6.10 bit14=0)

2. Pr0.04 "Inertia ratio," Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" may enormously change after oscillation or an abnormal noise occurs. In such a case, implement measures in item 3 above.

3. Pr0.04 "Inertia ratio," Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" which are results by the real-time automatic gain tuning are written in EEPROM every 30 minutes. When the power is restored, the automatic tuning is executed with these data as defaults. Note that the real-time automatic gain tuning results are not stored if the power is turned off before 30 minutes pass. In this case, manually write the parameters in EEPROM and turn the power off.

4. Since the control gain update is implemented at the time of shutdown, the change of Pr0.03 "Real-time automatic tuning stiffness setting" may not be reflected when the motor does not stop such as the cases that the gain is extremely-low and the command in one direction is continuously given. In this case, oscillation or an abnormal noise may occur depending on the stiffness setting reflected after the stop.

   When changing the stiffness, stop the motor once, be sure to confirm that the stiffness setting has been reflected, and conduct the next operation.

7. Setting table for the basic gain parameters

Stiffness	First gain/Second gain				Command response		Adjustment filter	For load fluctuation suppression function
	Pr1.00 Pr1.05	Pr1.01 Pr1.06	Pr1.02 Pr1.07	Pr1.04 Pr1.09	Pr2.22		Pr6.48 *1	Pr6.24
	Position [0.1/s]	Velocity [0.1 Hz]	Velocity integration [0.1 ms]	Torque [0.01 ms]	Time constant [0.1 ms]		Time constant [0.1 ms]	Load fluctuation compensation filter [0.01/ms]
					Standard response mode	High response modes 1-3		
0	20	15	3700	1500	1919	764	155	2500
1	25	20	2800	1100	1487	595	115	2500
2	30	25	2200	900	1214	486	94	2500
3	40	30	1900	800	960	384	84	2500
4	45	35	1600	600	838	335	64	2500
5	55	45	1200	500	668	267	54	2500
6	75	60	900	400	496	198	44	2500
7	95	75	700	300	394	158	34	2120
8	115	90	600	300	327	131	34	1770
9	140	110	500	200	268	107	24	1450
10	175	140	400	200	212	85	23	1140
11	320	180	310	126	139	55	16	880
12	390	220	250	103	113	45	13	720
13	480	270	210	84	92	37	11	590
14	630	350	160	65	71	28	9	450
15	720	400	140	57	62	25	8	400
16	900	500	120	45	50	20	7	320
17	1080	600	110	38	41	17	6	270
18	1350	750	90	30	33	13	5	210
19	1620	900	80	25	28	11	5	180
20	2060	1150	70	20	22	9	4	140
21	2510	1400	60	16	18	7	4	110
22	3050	1700	50	13	15	6	3	90
23	3770	2100	40	11	12	5	3	80
24	4490	2500	40	9	10	4	3	60
25	5000	2800	35	8	9	4	2	60
26	5600	3100	30	7	8	3	2	50
27	6100	3400	30	7	7	3	2	50
28	6600	3700	25	6	7	3	2	40
29	7200	4000	25	6	6	2	2	40
30	8100	4500	20	5	6	2	2	40
31	9000	5000	20	5	5	2	2	40

*1 There is that Pr6.48 “Adjust filter” adds 1 to by a combination of driver and motor.

5-1-4 Real-time automatic tuning (two-degree-of-freedom control mode: synchronization type)

Two-degree-of-freedom control mode has the standard type and synchronization type.

Standard type: It is standard mode. Use this type usually.

Synchronization type: Use in the case of trajectory control for multiple axes such as articulated robots.

This section is for the automatic tuning function dedicated to the synchronization type.

However, this function is available only for position control.

The results from the real-time estimation of the machine load characteristics automatically implement the basis gain setting and load variation compensation depending on the stiffness parameter.

1. Scope

This function operates under the following conditions.

	Conditions in which the real-time automatic tuning operates
Control mode	Pr0.01 = 0: Position control Bit 0 = 1 and bit 3 = 1 in Pr6.47: Two-degree-of-freedom control mode synchronization type
Others	• The servo shall be on. • Parameters other than control, such as the torque limit setting, and input signals, such as deviation counter clear and command input inhibit, shall be properly set, and the normal revolution of motor shall be trouble-free.

2. Cautions

• After powering ON, until the operation data effective for the estimation of load characteristics gets sufficiently accumulated, the tracking of estimated value may become earlier despite the setting of Pr6.31 “real-time automatic tuning estimattion speed”.

• In the case where the real-time automatic tuning is enabled, the estimated value may become abnormal as due to any external disturbance. If you would like to gain consistent operation from the moment of powering ON, it is recommended to disable the real-time automatic tuning.

In the following conditions, the real-time automatic tuning may be inoperative. In this case, change the load conditions and moving pattern or manually set relevant parameters referring to the explanation of manual adjusting function.

	Conditions in which the operation of real-time automatic tuning is blocked
Load condition	• If the load inertia is small or large compared to the rotor inertia. (Less than three times or twenty times or more) • If the load inertia fluctuates. • If the machine stiffness is extremely low. • If non-linear characteristics such as looseness due to backlash exist.
Moving pattern	• If the operation continues at a low velocity less than 100 (r/mini). • If the acceleration and deceleration are gradual 2000 (r/min) or less per one second. • If the condition that the velocity is 100 (r/min) or more and the acceleration and deceleration are 2000 (r/min) or more per one second does not continue for 50 (ms) or more. • If the acceleration and deceleration torques are small compared to the offset load and viscous friction torques.

3. Parameters which control the operation of the real-time automatic tuning

Set the operation of real-time automatic tuning with the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th colspan="3">Function</th></tr>
<tr><td rowspan="9">0</td><td rowspan="9">02</td><td rowspan="9">Real-time automatic tuning mode setting</td><td rowspan="9">0 to 6</td><td rowspan="9">-</td><td colspan="3">Sets an operational mode on the real-time automatic tuning.</td></tr>
<tr><td>Setting</td><td>Mode</td><td>Description</td></tr>
<tr><td>0</td><td>Disabled</td><td>The function of real-time automatic tuning is disabled.</td></tr>
<tr><td>1</td><td>Synchronization</td><td>Mode for the synchronization control. The offset load and friction compensation is not implemented. The command response filter is held. In any case, use this mode. If there is any difficulty, use other mode.</td></tr>
<tr><td>2</td><td>Synchronized friction compensation</td><td>In addition to the synchronization mode, the kinetic friction and viscous friction compensation is applied. Use this mode in the case of the load with friction large.</td></tr>
<tr><td>3</td><td>Stiffness setting</td><td>The inertia ratio estimation, offset load and friction compensation are not implemented. Only the gain filter setting is updated depending on the stiffness table.
In the load that the inertia variation is large, use this mode after estimating the inertia by the synchronization mode etc.</td></tr>
<tr><td>4</td><td>Load characteristic update</td><td>The gain filter setting is held, and only the inertia ratio and the kinetic friction and viscous friction compensation among load characteristics are applied.</td></tr>
<tr><td>5</td><td>Load characteristic measurement</td><td>The settings of the basic gain and friction compensation are not changed, and only the load characteristics estimation is executed. Use in combination with set-up support software (PANATERM).</td></tr>
<tr><td>6</td><td>Load fluctuation response mode</td><td>Use this mode when you wish to make robust adjustments for fluctuating loads.</td></tr>
<tr><td>0</td><td>03</td><td>Real-time automatic tuning stiffness setting</td><td>0 to 31</td><td>-</td><td colspan="3">Sets responsivity when the real-time automatic tuning is enabled. The higher the setting is, the better the velocity response is, and the servo stiffness increases, but oscillation is easier to occur. Change the value from a low value to a high value while checking the operation.</td></tr>
<tr><td>6</td><td>10</td><td>Function expansion setting</td><td>-32768～32768</td><td>--</td><td colspan="3">When bit14=1, enable automatic adjustment of load variation suppression function</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Setting range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</td><td>Real-time automatic tuning estimation speed</td><td>0 to 3</td><td>-</td><td>Sets the estimated velocity of load characteristic when the real-time automatic tuning is enabled. The higher the setting is, the faster the tracking to the load characteristic change is, but the estimated variation to disturbance becomes larger. The estimation result is stored in EEPROM every 30 minutes.
<table>
<tr><th>Set value</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Stationary</td><td>Stops the load characteristic estimation.</td></tr>
<tr><td>1</td><td>Nearly stationary</td><td>Responds in the minute unit to the change of the load characteristic.</td></tr>
<tr><td>2</td><td>Gradual change</td><td>Responds in the second unit to the change of the load characteristic.</td></tr>
<tr><td>3
*</td><td>Abrupt change</td><td>Conducts an optimal estimation to the load characteristics.</td></tr>
</table>
*: When the automatic oscillation detection is enabled via set-up support software (PANATERM), this setting is ignored and the operation follows the set value 3.</td></tr>
<tr><td>6</td><td>32</td><td>Real-time automatic tuning custom setting</td><td>-32768 to 32767</td><td>-</td><td>You cannot use in two-degree-of-freedom control mode.
Use with the set value 0.</td></tr>
</table>

4. Parameters which are changed in the real-time automatic tuning

The real-time automatic tuning updates the following parameters using the load characteristic estimates, depending on Pr0.02 "Real-time automatic tuning mode setting."

Class	No.	Parameter name	Setting range	Unit	Function
0	04	Inertia ratio	0 to 10000	%	Updates this parameter in the case of the synchronous mode (Pr 0.02=1), synchronous friction compensation mode (Pr 0.02=2) and load characteristics update mode (Pr 0.02~=4). Fixed to 100 in case of load fluctuation response mode (Pr 0.02 = 6).
6	08	Torque compensation value in positive direction	-100 to 100	%	Updates this parameter in the cases of the synchronized friction compensation mode (Pr0.02 = 2) and load characteristic update mode (Pr0.02 = 4).
6	09	Torque compensation value in negative direction	-100 to 100	%	Updates this parameter in the cases of the synchronized friction compensation mode (Pr0.02 = 2) and load characteristic update mode (Pr0.02 =4).
6	50	Viscous friction compensation gain	0 to 10000	0.1%/ (10000r/ min)	Updates this parameter in the cases of the synchronized friction compensation mode (Pr0.02 = 2) and load characteristic update mode (Pr0.02 = 4).

The real-time automatic tuning updates the following basic gain setting parameters, depending on Pr0.03 "Real-time automatic tuning stiffness setting." For more information, see the setting table for the basic gain parameters in section 7.

Class	No.	Parameter name	Setting range	Unit	Function
1	00	First position loop gain	0 to 30000	0.1/s	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4). In the case of Pr 0.02 = 6, updates to position loop gain of load fluctuation response.
1	01	First velocity loop gain	1 to 32767	0.1 Hz	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	02	First velocity integration time constant	1 to 10000	0.1 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4). Sets to 10000 (disabled) in the case of Pr 0.02 = 6.
1	04	Filter time constant for the first torque	0 to 2500	0.01 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	05	Second position loop gain	0 to 30000	0.1/s	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4). In the case of Pr 0.02 = 6, updates to position loop gain of load fluctuation response.
1	06	Second velocity loop gain	1 to 32767	0.1 Hz	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	07	Second velocity integration time constant	1 to 10000	0.1 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4). Sets to 10000 (disabled) in the case of Pr 0.02 = 6.
1	09	Filter time constant for the second torque	0 to 2500	0.01 ms	Updates the setting depending on the stiffness when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
6	48	Adjustment filter	0 to 2000	0.1 ms	Updates the setting depending on the stiffness in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).

The real-time automatic tuning sets the following parameters to fixed values, or uses the current settings.

Class	No.	Parameter name	Setting range	Unit	Function
1	03	First velocity detection filter	0 to 5	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	08	Second velocity detection filter	0 to 5	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	10	Velocity feedforward gain	0 to 4000	0.1 %	Sets to 1000 (100%) in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	11	Velocity feedforward filter	0 to 6400	0.01 ms	Sets to 0 (disabled) in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	12	Torque feedforward gain	0 to 2000	0.1 %	Sets to 1000 (100%) in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	13	Torque feedforward filter	0 to 6400	0.01 ms	Sets to 0 (disabled) in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
2	22	Command smoothing filter	0 to 10000	0.1 ms	Uses the current settings when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
6	07	Additional value to torque command	-100 to 100	%	Sets this parameter to 0 (disabled) in the cases of the synchronized friction compensation mode (Pr0.02 = 2) and load characteristic update mode (Pr0.02 = 4).
6	10	Function expansion setting	-32768 to 32767	-	Sets bit 4 = 1 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
6	49	Command response filter/compensation filter damping term setting	0 to 99	-	Sets the tens digit to 1 and holds the ones digit, in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).

The real-time automatic tuning sets the following parameters or uses the current settings, depending on Pr0.02 "Real-time automatic tuning mode setting."

Class	No.	Parameter name	Setting range	Unit	Function
1	14	Second gain setting	0 to 1	-	Sets to 1 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	15	Position control switching mode	0 to 10	-	Sets to 0 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	16	Position control switching delay time	0 to 10000	0.1 ms	Sets to 10 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	17	Position control switching level	0 to 20000	-	Sets to 0 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	18	Position control switching hysteresis	0 to 20000	-	Sets to 0 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	19	Position gain switching time	0 to 10000	0.1 ms	Sets to 10 in the cases of the synchronization mode, synchronized friction compensation mode and stiffness setting mode (Pr0.02 = 1 to 3,6).
1	20	Velocity control switching mode	0 to 5	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	21	Velocity control switching delay time	0 to 10000	0.1 ms	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	22	Velocity control switching level	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	23	Velocity control switching hysteresis	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	24	Torque control switching mode	0 to 3	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	25	Torque control switching delay time	0 to 10000	0.1 ms	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).

(To be continued)

Class	No.	Parameter name	Setting range	Unit	Function
1	26	Torque control switching level	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
1	27	Torque control switching hysteresis	0 to 20000	-	Sets to 0 when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
6	05	Position control third gain effective time	0 to 10000	0.1 ms	Uses the current settings when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).
6	06	Position control third gain scale factor	50 to 1000	%	Uses the current settings when the real-time automatic tuning is enabled (Pr0.02 = 1 to 4,6).

The following settings are always disabled when Pr0.02 "Real-time automatic tuning mode setting" is a value other than zero. Note that the parameter setting itself is not changed.

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function expansion setting	-32768 to 32767	-	The bit (bit 3) for inertia ratio switching function permission is internally invalidated.
6	13	Second inertia ratio	0 to 10000	%	Parameter settings can be changed, but the inertia ratio switching function is invalidated.

The following settings and parameters are set automatic for enable/disable state of Pr 6.10 “Function expansion setting” load variation suppression function automatic adjustment.

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function extension setting	-32768 to 32767	-	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, load variation suppression function will become enabled (bit1 = 1). When set to Pr 6.10 bit14=0,it is disabled(bit1 = 1).
6	23	Load fluctuation compensation gain	-100 to 100	%	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 90%. When set to Pr 6.10 bit14=0, set to 0%.
6	24	Load fluctuation compensation filter	10 to 2500	0.01 ms	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, updates to match rigidity. When set to Pr 6.10 bit14=0, value is held.
6	73	Load estimation filter	0 to 2500	0.01 ms	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 0.13 ms. When set to Pr 6.10 bit14=0, set to 0 ms.
6	74	Torque compensation frequency 1	0 to 5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	75	Torque compensation frequency 2	0 to 5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	76	Load estimate numbers	0 to 8	-	When set to Pr 6.10 bit14=1 in case of stiffness setting is enabled, sets to 4. When set to Pr 6.10 bit14=0, set to 0.

In case Pr 0.02 “Real-time automatic tuning mode setting” = 6, (load fluctuation response mode), the setting will be changed to the following:

Class	No.	Parameter name	Setting range	Unit	Function
6	10	Function extension setting	-32768 to 32767	-	Load fluctuation suppression function always become enabled (bit1 = 1)
6	23	Load fluctuation compensation gain	-100 to 100	%	Sets to 100%.
6	24	Load fluctuation compensation filter	10 to 2500	0.01 ms	Updates to match rigidity.
6	73	Load estimation filter	0 to 2500	0.01 ms	Sets to 0.13 ms.
6	74	Torque compensation frequency 1	0 to 5000	0.1 Hz	Updates to match rigidity.
6	75	Torque compensation frequency 2	0 to 5000	0.1 Hz	Updates to match rigidity.
6	76	Load estimate numbers	0 to 8	-	Sets to 4.

5. How to use

If Pr0.02 "Real-time automatic tuning mode setting" is set to a value other than zero, control parameters are automatically set depending on Pr0.03 "Real-time automatic tuning stiffness setting" and Pr 6.10 “Function expansion setting” bit 14.

Input an operating command after turning the servo on. Success for the load characteristic estimation updates Pr0.04 "Inertia ratio." Depending on the mode settings, Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" also change.

Increasing Pr0.03 "Real-time automatic tuning stiffness setting" can enhance motor response. Adjust to an optimum value while considering the vibrating condition and the positioning setting time.

6. Other cautions

A. Although oscillation or an abnormal noise may occur until the load characteristic estimation becomes stable immediately after the servo first turns on following the start or when Pr0.03 "Real-time automatic tuning stiffness setting" is increased, it is not abnormal if it soon becomes stabilized. However, if oscillation or the continuous abnormal noise for three reciprocating motions or more occurs very often, take the following measures.
   1. Decrease Pr0.03 "Real-time automatic tuning stiffness."
   2. Set Pr0.02 "Real-time automatic tuning mode setting" to zero and disable the real-time automatic tuning.
   3. Set Pr0.04 "Inertia ratio" to a calculated value on the equipment, and set Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" to zero.
   4. Disabale load variation suppression function. (bit1=0 after Pr 6.10 bit14=0)

B. Pr0.04 "Inertia ratio," Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" may enormously change after oscillation or an abnormal noise occurs. In such a case, implement measures in item 3 above.

C. Pr0.04 "Inertia ratio," Pr6.07 "Additional value to torque command," Pr6.08 "Torque compensation value in positive direction," Pr6.09 "Torque compensation value in negative direction" and Pr6.50 "Viscous friction compensation gain" which are results by the real-time automatic gain tuning are written in EEPROM every 30 minutes. When the power is restored, the automatic tuning is executed with these data as defaults. Note that the real-time automatic gain tuning results are not stored if the power is turned off before 30 minutes pass. In this case, manually write the parameters in EEPROM and turn the power off.

D. Since the control gain update is implemented at the time of shutdown, the change of Pr0.03 "Real-time automatic tuning stiffness setting" may not be reflected when the motor does not stop such as the cases that the gain is extremely-low and the command in one direction is continuously given. In this case, oscillation or an abnormal noise may occur depending on the stiffness setting reflected after the stop. When changing the stiffness, stop the motor once, be sure to confirm that the stiffness setting has been reflected, and conduct the next operation.

7. Setting table for the basic gain parameters

Stiffness	First gain/Second gain				Adjustment filter	For load fluctuation suppression function	For load variation support mode (Pr0.02 = 6) only			
	Pr1.00 Pr1.05	Pr1.01 Pr1.06	Pr1.02 Pr1.07	Pr1.04 Pr1.09	Pr6.48 *1	Pr6.24	Pr1.00 Pr1.05	Pr6.24	Pr6.74	Pr6.75
	Position [0.1/s]	Velocity [0.1 Hz]	Velocity integration [0.1 ms]	Torque [0.01 ms]	Time constant [0.1 ms]	Load fluctuation compensation filter [0.01/ms]	Load fluctuation position loop gain 0.1 [1/s]	Load fluctuation compensation filter [0.01/ms]	Torque compensation frequency L 0.1 [Hz]	Torque compensation frequency H 0.1 [Hz]
0	20	15	3700	1500	155	2500	15	1330	25	7
1	25	20	2800	1100	115	2500	20	990	34	10
2	30	25	2200	900	94	2500	25	800	42	12
3	40	30	1900	800	84	2500	30	660	51	15
4	45	35	1600	600	64	2500	35	570	59	17
5	55	45	1200	500	54	2500	45	440	76	22
6	75	60	900	400	44	2500	60	330	104	30
7	95	75	700	300	34	2120	75	270	129	37
8	115	90	600	300	34	1770	90	220	153	44
9	140	110	500	200	24	1450	110	180	184	53
10	175	140	400	200	23	1140	140	140	231	66
11	320	180	310	126	16	880	180	110	290	83
12	390	220	250	103	13	720	220	90	346	99
13	480	270	210	84	11	590	270	70	413	118
14	630	350	160	65	9	450	350	60	512	146
15	720	400	140	57	8	400	400	50	570	163
16	900	500	120	45	7	320	500	40	678	194
17	1080	600	110	38	6	270	600	40	678	194
18	1350	750	90	30	5	210	750	40	678	194
19	1620	900	80	25	5	180	900	40	678	194
20	2060	1150	70	20	4	140	1150	40	678	194
21	2510	1400	60	16	4	110	1400	40	678	194
22	3050	1700	50	13	3	90	1700	40	678	194
23	3770	2100	40	11	3	80	2100	40	678	194
24	4490	2500	40	9	3	60	2500	40	678	194
25	5000	2800	35	8	2	60	2800	40	678	194
26	5600	3100	30	7	2	50	3100	40	678	194
27	6100	3400	30	7	2	50	3400	40	678	194
28	6600	3700	25	6	2	40	3700	40	678	194
29	7200	4000	25	6	2	40	4000	40	678	194
30	8100	4500	20	5	2	40	4500	40	678	194
31	9000	5000	20	5	2	40	5000	40	678	194

*1 There is that Pr6.48 “Adjust filter” adds 1 to by a combination of driver and motor.

5-2 Manual adjusting function

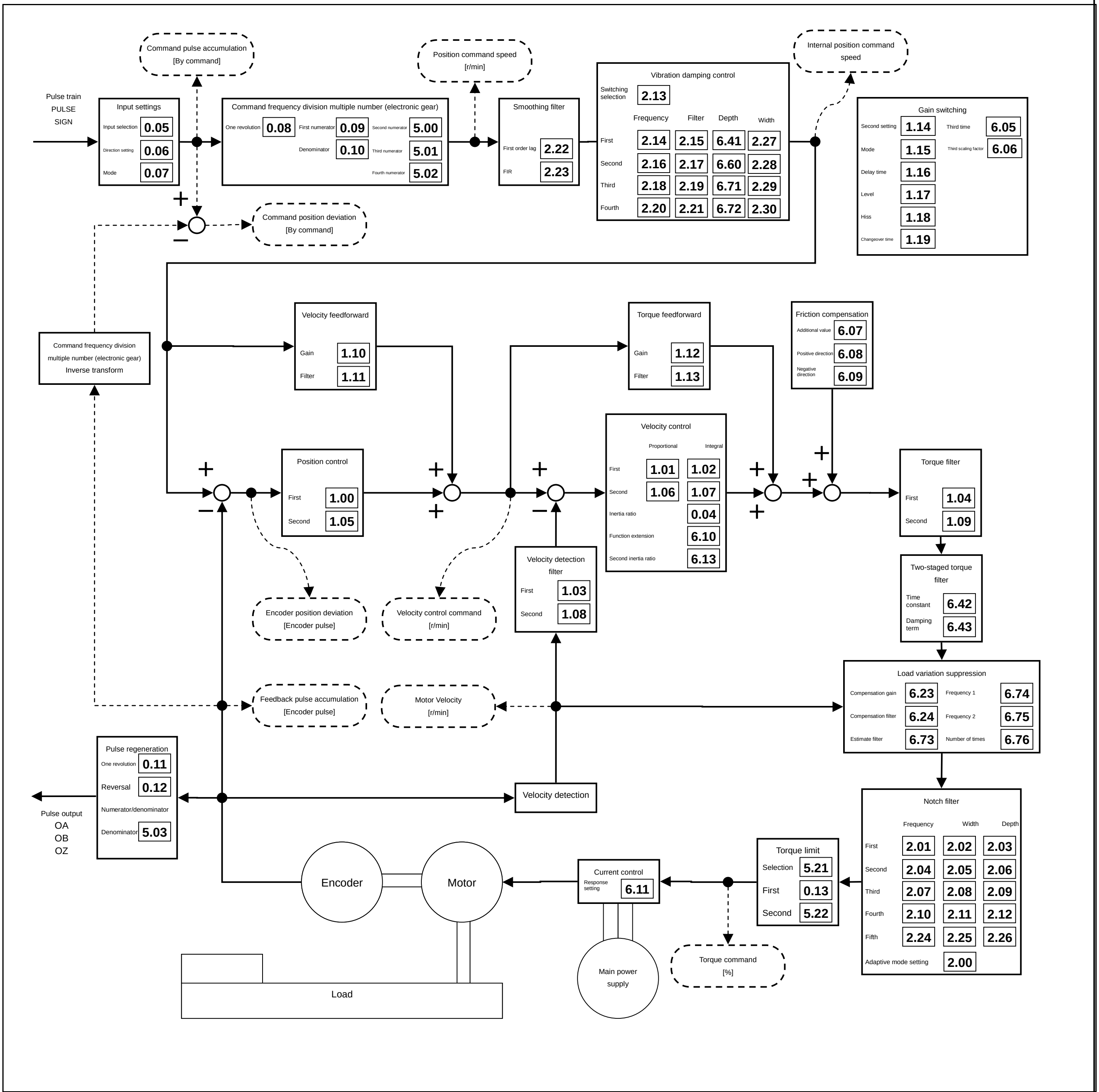
Although A6 series has the automatic adjusting functions described above, the series may require manual readjustment when the functions cannot be used because of load conditions and the operating pattern restriction, or when the best response and stability are desired.

Here, the manual adjusting functions are described by being divided by the following functions and control modes.

1. Block diagram for position control mode (5-2-1)
2. Block diagram for velocity control mode (5-2-2)
3. Block diagram for torque control mode (5-2-3)
4. Block diagram for full-closed control mode (5-2-4)
5. Gain switching function (5-2-5)
6. Notch filter (5-2-6)
7. Damping function (5-2-7)
8. Feedforward function (5-2-8)
9. Load variation suppression function (5-2-9)
10. Third gain switching function (5-2-10)
11. Friction torque compensation (5-2-11)
12. Inertia ratio switching function (5-2-12)
13. Hybrid vibration suppression function (5-2-13)
14. Two-staged torque filter (5-2-14)
15. Quadrant projection suppression function (5-2-15)
16. Two-degree-of-freedom control mode (during position control) (5-2-16)
17. Block diagram for two-degree-of-freedom control mode (during position control) (5-2-17)
18. Two-degree-of-freedom control mode (during velocity control) (5-2-18)
19. Block diagram for two-degree-of-freedom control mode (during velocity control) (5-2-19)
20. Two-degree-of-freedom control mode (during full-closed control) (5-2-20)
21. Block diagram for two-degree-of-freedom control mode (during full-closed control) (5-2-21)
22. High response current control (5-2-22)

5-2-1 Block diagram for position control mode

The following diagram shows the scheme of A6 series position control.

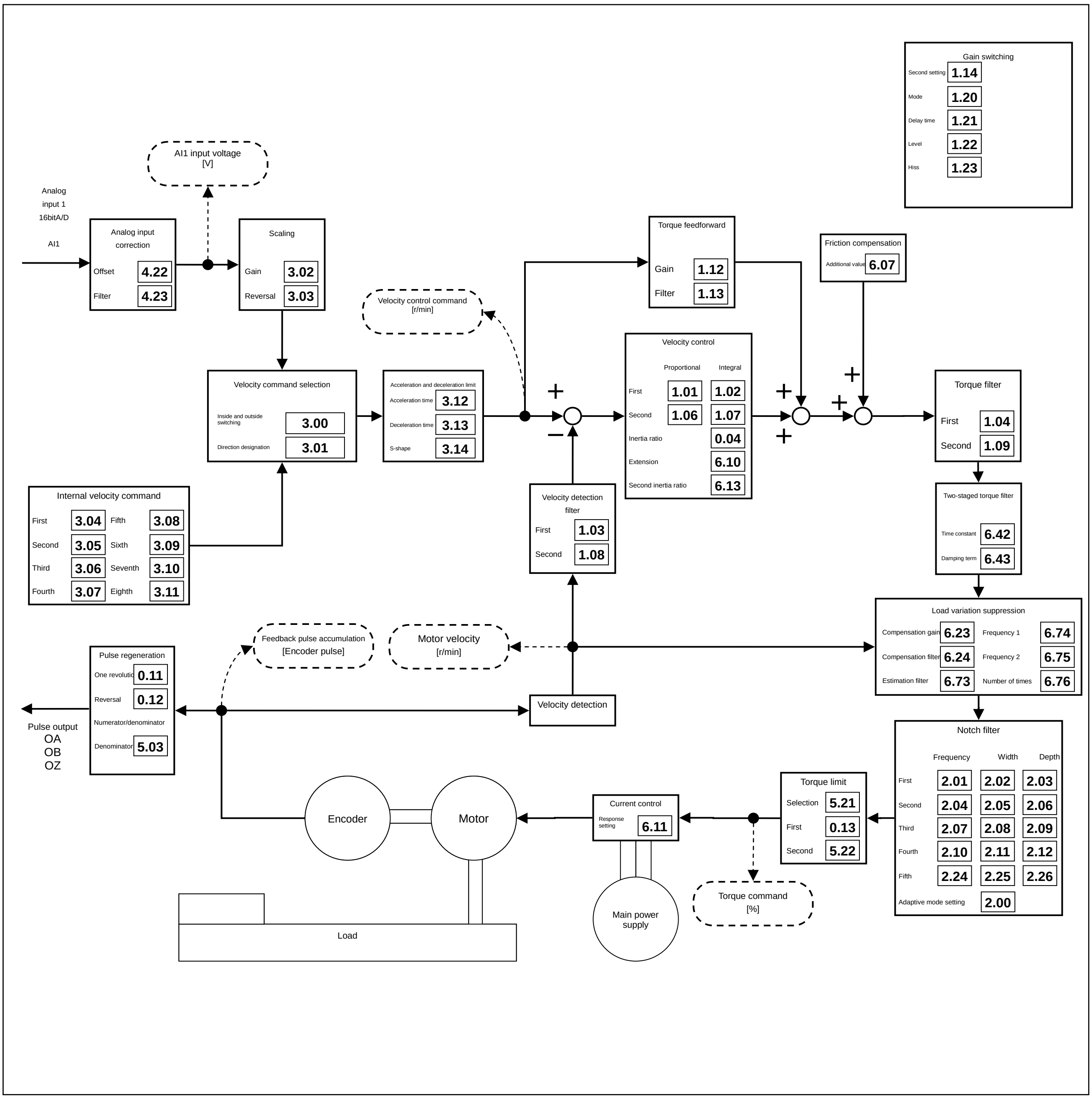


Position control block diagram

[A6SE], [A6SG] Internal velocity alone is available.

5-2-2 Block diagram for velocity control mode

The following diagram shows the scheme of A6 series velocity control.

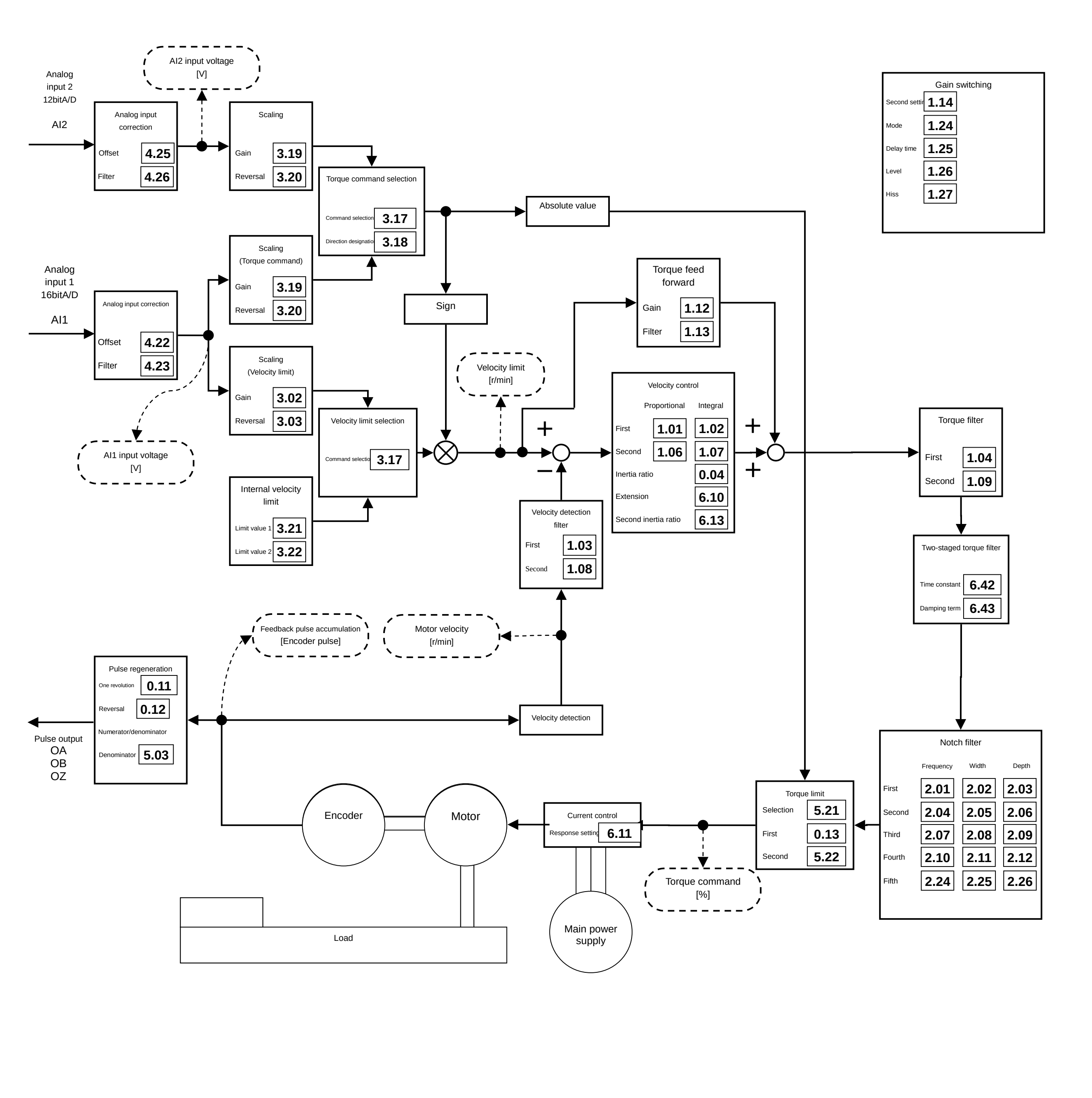


Velocity control block diagram

[A6SE], [A6SG] This function cannot be used.

5-2-3 Block diagram for torque control mode

The following diagram shows the scheme of A6 series torque control.

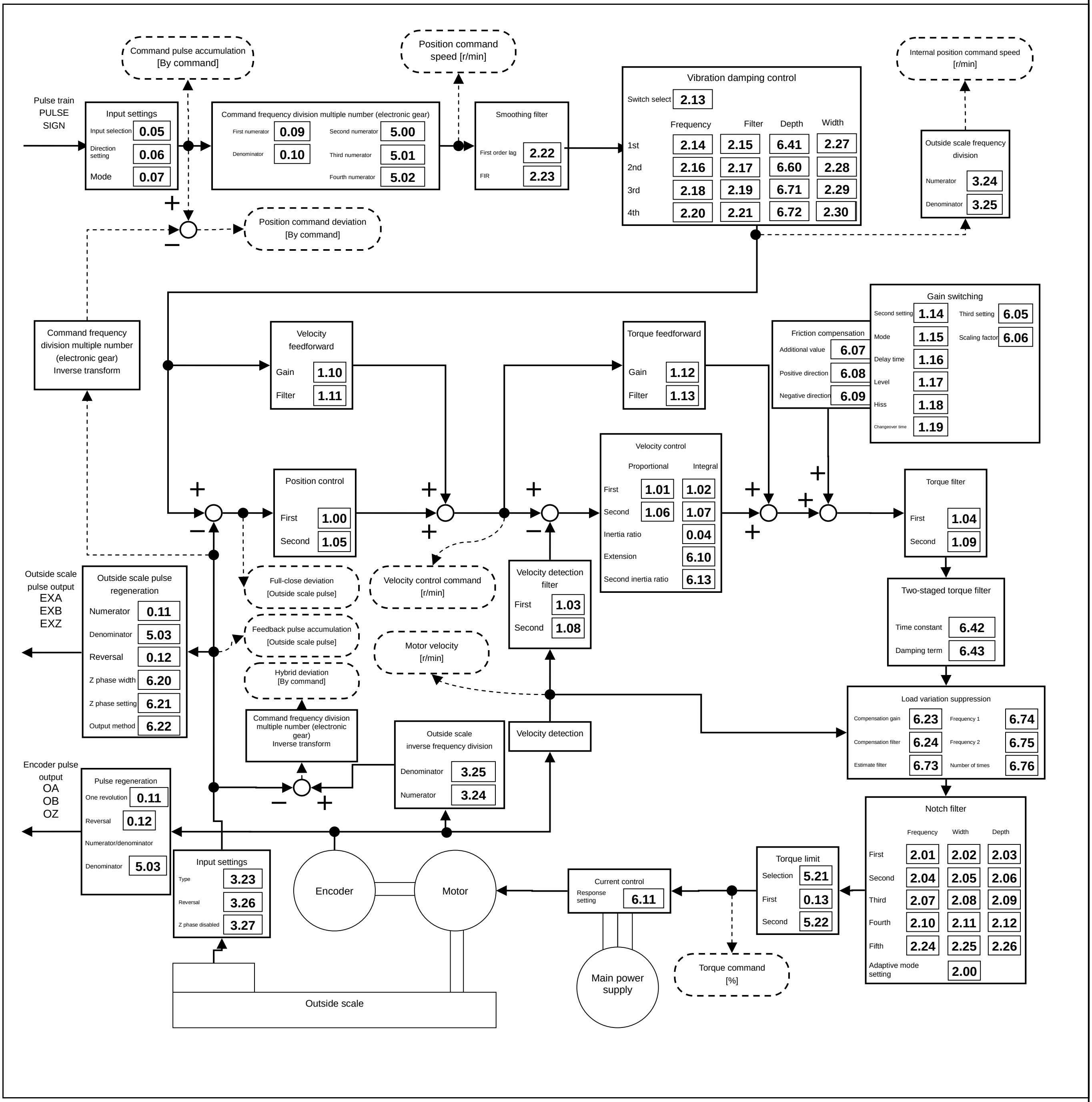


Torque control block diagram

[A6SE], [A6SG] This function cannot be used.

5-2-4 Block diagram for full-closed control mode

The following diagram shows the scheme of A6 series full-closed control.



Full-closed control block diagram

5-2-5 Gain switching function

Gain switching using internal data or external signals provides the following effects:
• Suppresses vibrations by decreasing the gain during stop time (servo lock)
• Reduces settling time by increasing the gain during stop time (during settling)
• Improves command follow-up performance by increasing the gain during operating time
• Switches the gain through external signals according to the condition of the equipment

1) Relevant parameters

Set up the gain switching function using the following parameters.

Class	No.	Parameter name	Range	Unit	Function
1	14	2nd gain setting	0 to 1	-	Set to make optimum adjustments using the gain switching function. 0: Fixed to 1st gain. Speed loop operations are switched between PI and P through gain switching input (GAIN). GAIN input photocoupler OFF → PI operation GAIN input photocoupler ON → P operation * The above case assumes that the logical setting for GAIN input is a-contact. For b-contact setting, OFF and ON are reversed. 1: Enables gain switching between 1st gain (Pr. 1.00 to Pr. 1.04) and 2nd gain (Pr. 1.05 to Pr. 1.09)
1	15	Position control switching mode	0 to 10	-	Defines trigger conditions for gain switching during position control. Setup value / Switching condition: 0: Fixed to 1st gain 1: Fixed to 2nd gain 2: Gain switching input 3: Torque command 4: Disabled (fixed to 1st gain) 5: Speed command 6: Position deviation 7: Positional command available 8: Positioning not complete 9: Actual velocity 10: Positional command available + actual velocity
1	16	Position control switching delay time	0 to 10000	0.1 ms	Defines the time duration from trigger detection to actual gain switching from the 2nd gain to the 1st gain when the switching mode is set to 3, 5 to 10 during position control.
1	17	Position control switching level	0 to 20000	Mode dependent	Defines the level of trigger determination when the switching mode is set to 3, 5, 6, 9 or 10 during position control. The unit differs depending on the switching mode setting. Note) Specify as "level ≥ hysteresis."
1	18	Position control switching hysteresis	0 to 20000	Mode dependent	Defines the hysteresis of trigger determination when the switching mode is set to 3, 5, 6, 9 or 10 during position control. The unit differs depending on the switching mode setting. Note) If "level < hysteresis," then it will be reset to "hysteresis = level" internally.
1	19	Position gain switching time	0 to 10000	0.1 ms	Can be set to suppress a rapid rise in the position loop gain when there is a large difference between Pr. 1.00 (1st position loop gain) and Pr. 1.05 (2nd position loop gain) during position control. When the position loop gain increases, the gain change lasts for the time indicated by the setup value.

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>1</td><td>20</td><td>Velocity control switching mode</td><td>0 to 5</td><td>-</td><td>Defines trigger conditions for gain switching during velocity control.
<table>
<tr><th>Setup value</th><th>Switching condition</th></tr>
<tr><td>0</td><td>Fixed to 1st gain</td></tr>
<tr><td>1</td><td>Fixed to 2nd gain</td></tr>
<tr><td>2</td><td>Gain switching input</td></tr>
<tr><td>3</td><td>Torque command</td></tr>
<tr><td>4</td><td>Speed command variation</td></tr>
<tr><td>5</td><td>Speed command</td></tr>
</table></td></tr>
<tr><td>1</td><td>21</td><td>Velocity control switching delay time</td><td>0 to 10000</td><td>0.1 ms</td><td>Defines the time duration from trigger detection to actual gain switching from the 2nd gain to the 1st gain when the switching mode is set to 3 to 5 during velocity control.</td></tr>
<tr><td>1</td><td>22</td><td>Velocity control switching level</td><td>0 to 20000</td><td>Mode dependent</td><td>Defines the level of trigger determination when the switching mode is set to 3 to 5 during velocity control.
The unit differs depending on the switching mode setting.
Note) Specify as "level ≥ hysteresis."</td></tr>
<tr><td>1</td><td>23</td><td>Velocity control switching hysteresis</td><td>0 to 20000</td><td>Mode dependent</td><td>Defines the hysteresis of trigger determination when the switching mode is set to 3 to 5 during velocity control.
The unit differs depending on the switching mode setting.
Note) If "level < hysteresis," then it will be reset to "hysteresis = level" internally.</td></tr>
<tr><td>1</td><td>24</td><td>Torque control switching mode</td><td>0 to 3</td><td>-</td><td>Defines trigger conditions for gain switching during torque control.
<table>
<tr><th>Setup value</th><th>Switching condition</th></tr>
<tr><td>0</td><td>Fixed to 1st gain</td></tr>
<tr><td>1</td><td>Fixed to 2nd gain</td></tr>
<tr><td>2</td><td>Gain switching input</td></tr>
<tr><td>3</td><td>Torque command</td></tr>
</table></td></tr>
<tr><td>1</td><td>25</td><td>Torque control switching delay time</td><td>0 to 10000</td><td>0.1 ms</td><td>Defines the time duration from trigger detection to actual gain switching from the 2nd gain to the 1st gain when the switching mode is set to 3 during torque control.</td></tr>
<tr><td>1</td><td>26</td><td>Torque control switching level</td><td>0 to 20000</td><td>Mode dependent</td><td>Defines the level of trigger determination when the switching mode is set to 3 during torque control.
The unit differs depending on the switching mode setting.
Note) Specify as "level ≥ hysteresis."</td></tr>
<tr><td>1</td><td>27</td><td>Torque control switching hysteresis</td><td>0 to 20000</td><td>Mode dependent</td><td>Defines the hysteresis of trigger determination when the switching mode is set to 3 during torque control.
The unit differs depending on the switching mode setting.
Note) If "level < hysteresis," then it will be reset to "hysteresis = level" internally.</td></tr>
</table>

2) How to use
After setting the gain switching mode for each control mode to be used, enable the gain switching function using Pr. 1.14 "2nd gain setting"(Pr. 1.14 = 1).

Switching mode setup value	Switching condition	Description of gain switching
0	Fixed to 1st gain	Fixed to 1st gain (Pr. 1.00 to Pr. 1.04).
1	Fixed to 2nd gain	Fixed to 2nd gain (Pr. 1.05 to Pr. 1.09).
2	Gain switching input available	1st gain when the gain switching input (GAIN) is open. 2nd gain when the gain switching input (GAIN) is connected to COM-. * It will be fixed to the 1st gain if the gain switching input (GAIN) is not allocated to input signals.
3	Large torque command	Switched to the 2nd gain when the absolute value of the torque command during the previous 1st gain has exceeded the set level plus hysteresis [%]. Switched back to the 1st gain when the absolute value of the torque command during the previous 2nd gain was kept at or below the set level minus hysteresis [%] for the delay time.
4	Large velocity command variation	Enabled only during velocity control. Switched to the 2nd gain when the absolute value of the velocity command variation during the previous 1st gain has exceeded the set level plus hysteresis [10 r/min/s]. Switched back to the 1st gain when the absolute value of the velocity command variation during the previous 2nd gain was kept the set level minus hysteresis [10 r/min/s] or below for the delay time. * Except for velocity control, it is fixed to the 1st gain.
5	Large velocity command	Enabled for position, velocity and full-closed control. Switched to the 2nd gain when the absolute value of the velocity command during the previous 1st gain has exceeded the set level plus hysteresis [r/min]. Switched back to the 1st gain when the absolute value of the velocity command during the previous 2nd gain was kept the set level minus hysteresis [r/min] or below for the delay time.
6	Large position deviation	Enabled for position and full-closed control. Switched to the 2nd gain when the absolute value of the position deviation during the previous 1st gain has exceeded the set level plus hysteresis [pulse]. Switched back to the 1st gain when the absolute value of the position deviation during the previous 2nd gain was kept the set level minus hysteresis [pulse] or below for the delay time. * The unit [pulse] used for level and hysteresis is defined as encoder resolution for position control and external scale resolution for full-closed control.

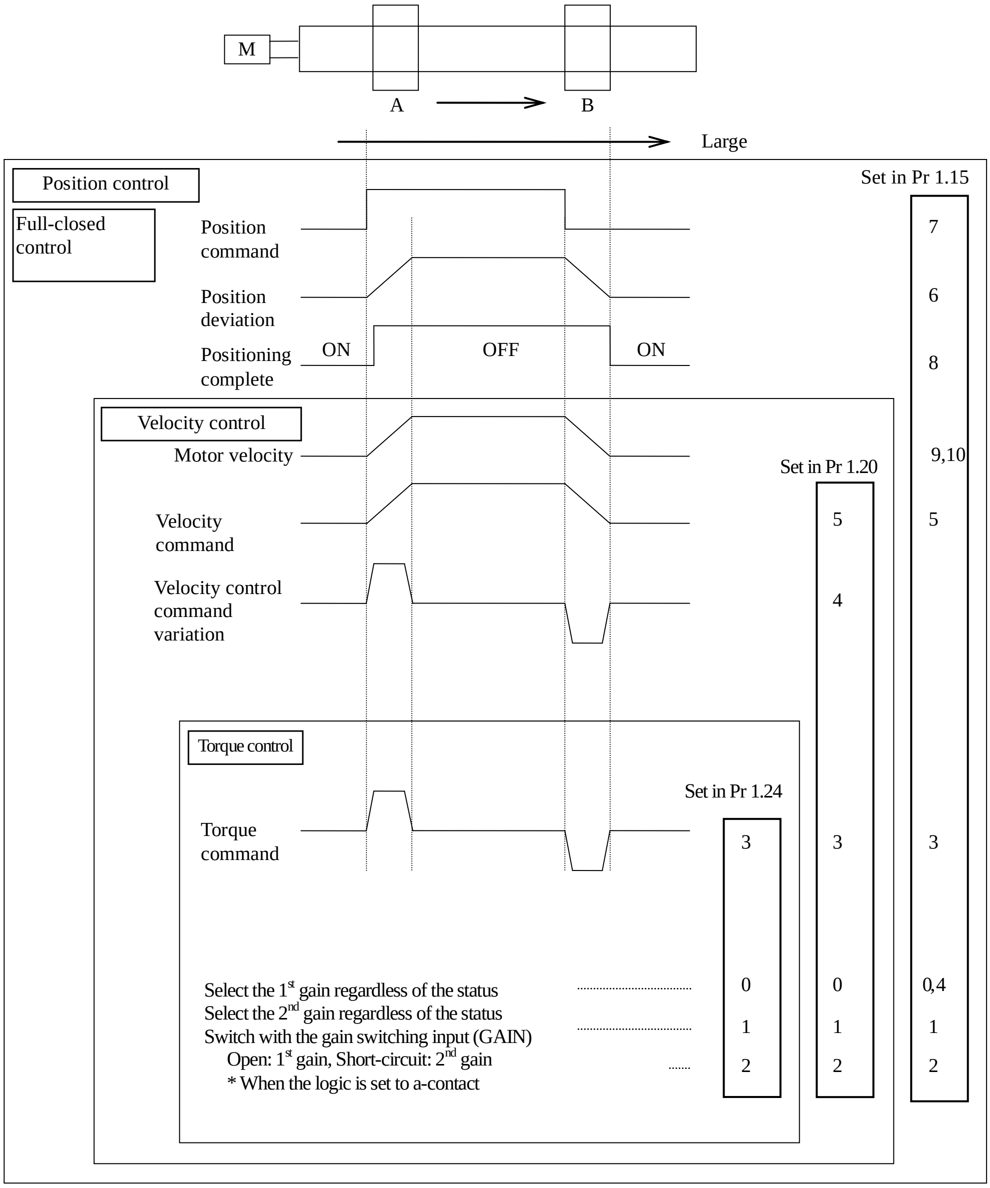
(To be continued)

switching mode setup value	Switching condition	Description of gain switching
7	Positional command available	Enabled during position and full-closed control. Switched to the 2nd gain when the positional command is not 0 during the previous 1st gain. Switched back to the 1st gain when the positional command is kept at 0 for the delay time during the previous 2nd gain.
8	Positioning not complete	Enabled during position and full-closed control. Switched to the 2nd gain when the positioning was incomplete during the previous 1st gain. Switched back to the 1st gain when the positioning complete status was kept for the delay time during the previous 2nd gain.
9	High actual velocity	Enabled during position and full-closed control. Switched to the 2nd gain when the absolute value of the actual velocity during the previous 1st gain has exceeded the set level plus hysteresis [r/min]. Switched back to the 1st gain when the absolute value of the actual velocity during the previous 2nd gain was kept the set level minus hysteresis [r/min] or below for the delay time.
10	Positional command available + actual velocity	Enabled during position and full-closed control. Switched to the 2nd gain when the positional command is not 0 during the previous 1st gain. Switched back to the 1st gain when the positional command is kept at 0 for the delay time during the previous 2nd gain and the absolute value of the actual velocity is the set level minus hysteresis [r/min] or below.

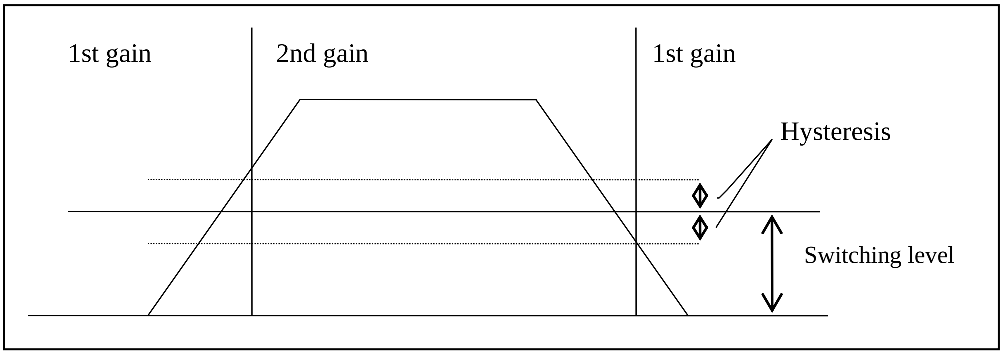
3) Setup procedure

Assume that the servo driver's internal status changes as shown in the following figure, when the load moves from Position A to Position B. To use the gain switching function under this condition, set up the relevant parameters according to the procedure described below.

[1] Set up the gain switching conditions with the following parameters.
Pr. 1.15 "Position control switching mode"
Pr. 1.20 "Velocity control switching mode"
Pr. 1.24 "Torque control switching mode"

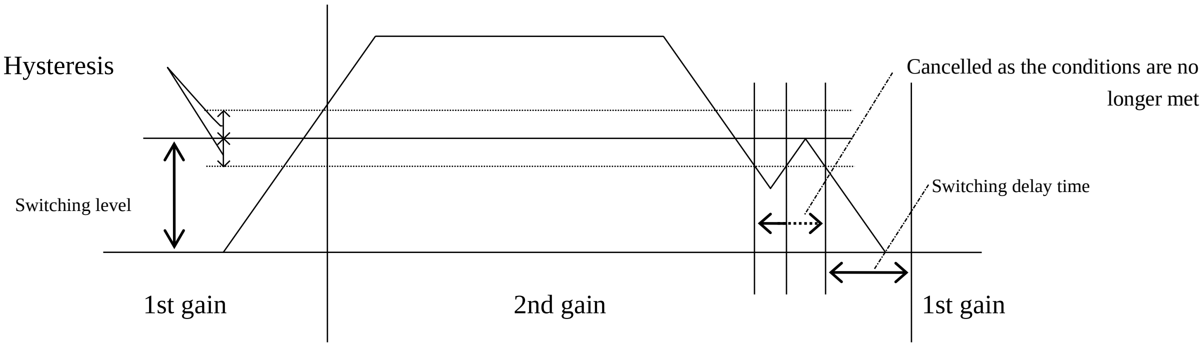


[2] Define the switching level and hysteresis according to the switching conditions.



[3] Define the switching delay time.

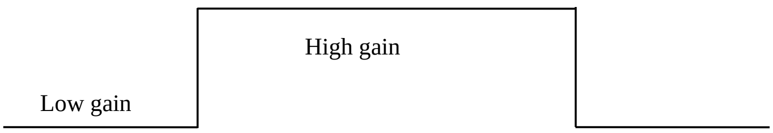
The switching delay time defines the time delay for switching from the 2nd gain to the 1st gain.
To switch from the 2nd gain to the 1st gain, the specified switching conditions must be satisfied continuously during the switching delay time.



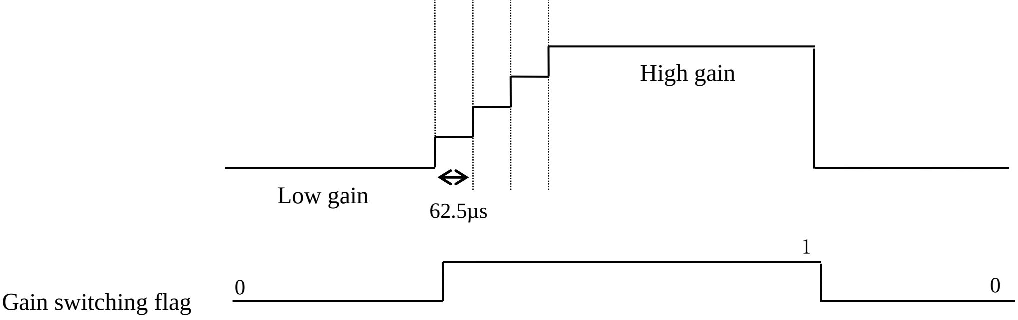
[4] Define the position gain switching time.

When the gain is switched, the velocity loop gain, velocity integration time constant, velocity detection filter and torque filter time constant will be instantaneously switched. The position loop gain, however, can be changed gradually to avoid any trouble resulting from a rapid increase to a higher gain.
* The gain switching flag changes immediately when switching from low gain.

When Pr 1.19 "Position gain switching time" is 0,



When Pr 1.19 "Position gain switching time" is 2,



5-2-6 Notch filter

When machine rigidity is low, vibrations and sounds may be caused by a shaft twisting resonance, which inhibits increasing the gain. In such a case, a notch filter can be used to suppress resonant peaks, thus allowing the setting of a higher gain or reducing vibrations.

1) Relevant parameters

For A6 Series, five notch filters are available, which are adjustable in frequency, width and depth.

Class	No.	Parameter name	Range	Unit	Function
2	1	1st notch frequency	50 to 5000	Hz	Defines the center frequency of the 1st notch filter. * If set to 5000, the notch filter becomes disabled.
2	2	1st notch width	0 to 20	-	Defines the frequency span of the 1st notch filter.
2	3	1st notch depth	0 to 99	-	Defines the depth of the 1st notch filter in the center frequency.
2	4	2nd notch frequency	50 to 5000	Hz	Defines the center frequency of the 2nd notch filter. * If set to 5000, the notch filter becomes disabled.
2	5	2nd notch width	0 to 20	-	Defines the frequency span of the 2nd notch filter.
2	6	2nd notch depth	0 to 99	-	Defines the depth of the 2nd notch filter in the center frequency.
2	7	3rd notch frequency *1	50 to 5000	Hz	Defines the center frequency of the 3rd notch filter. * If set to 5000, the notch filter becomes disabled.
2	8	3rd notch width *1	0 to 20	-	Defines the frequency span of the 3rd notch filter.
2	9	3rd notch depth *1	0 to 99	-	Defines the depth of the 3rd notch filter in the center frequency.
2	10	4th notch frequency *1	50 to 5000	Hz	Defines the center frequency of the 4th notch filter. * If set to 5000, the notch filter becomes disabled.
2	11	4th notch width *1	0 to 20	-	Defines the frequency span of the 4th notch filter.
2	12	4th notch depth *1	0 to 99	-	Defines the depth of the 4th notch filter in the center frequency.
2	24	5th notch frequency	50 to 5000	Hz	Defines the center frequency of the 5th notch filter. * If set to 5000, the notch filter becomes disabled.
2	25	5th notch width	0 to 20	-	Defines the frequency span of the 5th notch filter.
2	26	5th notch depth	0 to 99	-	Defines the depth of the 5th notch filter in the center frequency.

*1 When the adaptive filter function is used, the parameter value is automatically set.

2) How to use

Identify the resonance frequency using the frequency characteristic measuring function, resonance frequency monitor or operating waveforms on the waveform graphic function of the setup support software (PANATERM), and set it to the notch frequency for use.

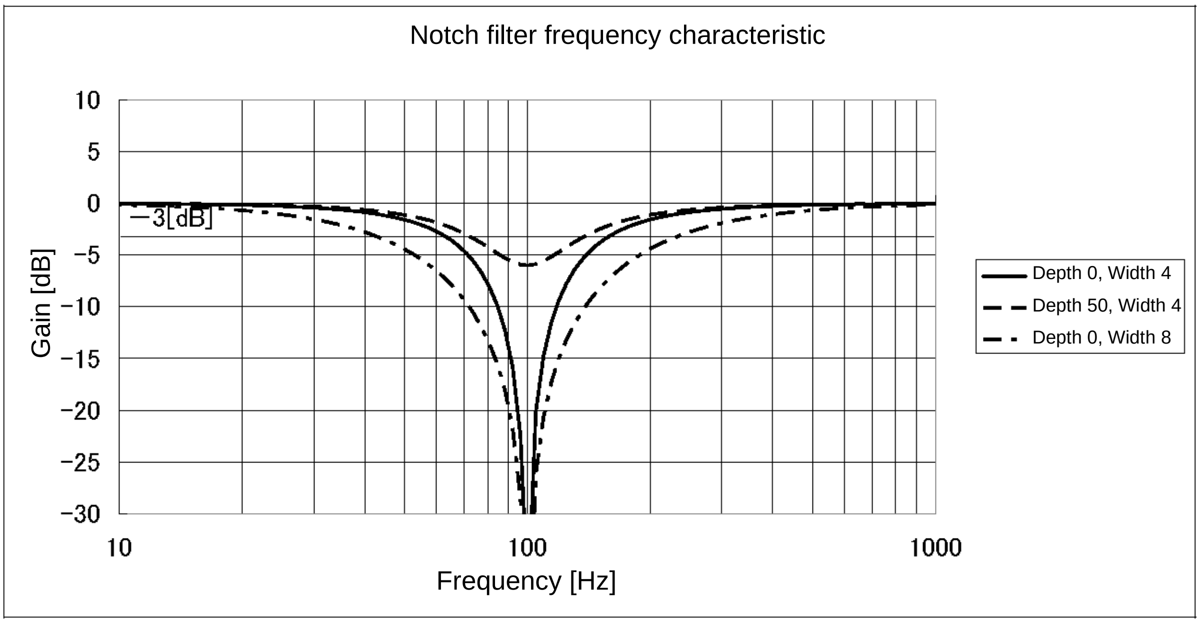
3) Width/depth of the notch

The width of the notch filter is represented as the ratio of frequency bandwidth, whose attenuation rate is -3[dB], against the notch center frequency when the depth is 0 as shown on the left in the following table.

The depth of the notch filter is represented as the input/output ratio in which the center frequency input is completely shut out with the set value 0 or completely flowed with the set value 100. Values in [dB] notation are shown on the right in the following table.

Notch width	Bandwidth/Center frequency
0	0.25
1	0.30
2	0.35
3	0.42
4	0.50
5	0.59
6	0.71
7	0.84
8	1.00
9	1.19
10	1.41
11	1.68
12	2.00
13	2.38
14	2.83
15	3.36
16	4.00
17	4.76
18	5.66
19	6.73
20	8.00

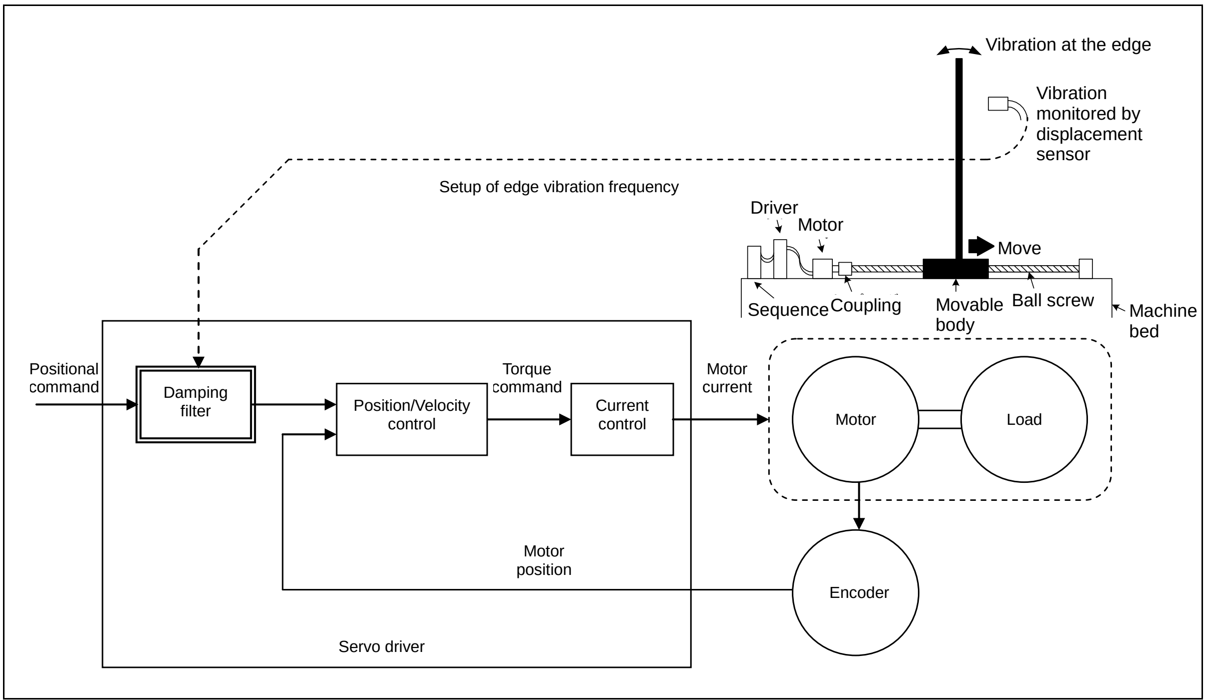
Notch depth	Input/output ratio	[dB] notation
0	0.00	-∞
1	0.01	-40.0
2	0.02	-34.0
3	0.03	-30.5
4	0.04	-28.0
5	0.05	-26.0
6	0.06	-24.4
7	0.07	-23.1
8	0.08	-21.9
9	0.09	-20.9
10	0.10	-20.0
15	0.15	-16.5
20	0.20	-14.0
25	0.25	-12.0
30	0.30	-10.5
35	0.35	-9.1
40	0.40	-8.0
45	0.45	-6.9
50	0.50	-6.0
60	0.60	-4.4
70	0.70	-3.1
80	0.80	-1.9
90	0.90	-0.9
100	1.00	0.0



5-2-7 Damping function

5-2-7-1 Damping control

This function reduces vibration at the edge or over the entire equipment by removing the vibration frequency components specified by the positional command. Among the four frequency settings, up to three can be used at the same time.



1) Applicable range

Damping control is activated under the following conditions.

	Conditions under which damping control is activated
Control mode	Should be position control or full-closed control. Pr 0.01=0: Position control Pr 0.01=3: 1st control mode of position/velocity control Pr 0.01=4: 1st control mode of position/torque control Pr 0.01=6: Full-closed control

2) Caution

Damping control may not work properly or no effect can be obtained under the following conditions.

	Conditions hindering damping control
Load condition	• Vibrations are excited by factors other than commands (such as external forces). • The ratio of resonance frequency and anti-resonance frequency is large. • The vibration frequency is out of the range between 0.5 and 300.0 [Hz].

3) Relevant parameters

Set up damping control operation using the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>2</td><td>13</td><td>Damping filter switching selection</td><td>0 to 6</td><td>-</td><td>
Defines how to switch among the four filters used for damping control.
• When set to 0: Up to two filters can be used simultaneously.
• When set to 1 or 2: To be switched by external input (VS-SEL1, VS-SEL2)
<table>
<tr><th>Pr. 2.13</th><th>VS-SEL2</th><th>VS-SEL1</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>0</td><td>-</td><td>-</td><td>Enabled</td><td>Enabled</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td rowspan="2">1</td><td>-</td><td>OFF</td><td>Enabled</td><td>Disabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>-</td><td>ON</td><td>Disabled</td><td>Enabled</td><td>Disabled</td><td>Enabled</td></tr>
<tr><td rowspan="4">2</td><td>OFF</td><td>OFF</td><td>Enabled</td><td>Disabled</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td>OFF</td><td>ON</td><td>Disabled</td><td>Enabled</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td>ON</td><td>OFF</td><td>Disabled</td><td>Disabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>ON</td><td>ON</td><td>Disabled</td><td>Disabled</td><td>Disabled</td><td>Enabled</td></tr>
</table>
• When set to 3: To be switched by command direction
<table>
<tr><th>Pr. 2.13</th><th>Position command direction</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td rowspan="2">3</td><td>Positive direction</td><td>Enabled</td><td>Disabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>Negative direction</td><td>Disabled</td><td>Enabled</td><td>Disabled</td><td>Enabled</td></tr>
</table>
Contents of setup values 4 to 6 will differ with enabled/disabled switching of two degree-of-freedom control mode.
• Position control (Two degree-of-freedom control mode disabled)
<table>
<tr><th>Pr 2.13</th><th>VS-SEL1</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>4</td><td>-</td><td>Enabled</td><td>Enabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>5, 6</td><td colspan="5">Same action as set value 0</td></tr>
</table>
• Position control (Two degree-of-freedom control mode enabled)
<table>
<tr><th>Pr. 2.13</th><th>VS-SEL1</th><th>1st model-type damping</th><th>2nd model-type damping</th></tr>
<tr><td>4</td><td>-</td><td>Enabled</td><td>Enabled</td></tr>
<tr><td rowspan="2">5</td><td>OFF</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>ON</td><td>Disabled</td><td>Enabled</td></tr>
</table>
<table>
<tr><th>Pr. 2.13</th><th>Position command direction</th><th>1st model-type damping</th><th>2nd model-type damping</th></tr>
<tr><td rowspan="2">6</td><td>Positive direction</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>Negative direction</td><td>Disabled</td><td>Enabled</td></tr>
</table>
• full-closed control
<table>
<tr><th>Pr 2.13</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>4～6</td><td colspan="4">Same action as set value 0</td></tr>
</table>
</td></tr>
</table>

*1 Switching of damping frequency and damping filter setting is performed on the rising edge of the command when the number of command pulses (before positional command filter) per command pulse detection frequency (0.125 ms) changes from 0 to a value other than 0 while the positioning complete is being output.
In particular, in a case where the damping frequency is increased or changed to be disabled, and the positioning complete range is set large, if a large number of pulses are accumulated in the filter (the area equivalent of the value of positional command before filter minus the value of positional command after filter integrated over the time) at the time of the above switching, these pulses are discharged rapidly right after the switching, which causes the motor to return to the previous position, making the motor run at a velocity higher than the original command velocity temporarily, to which care must be taken.

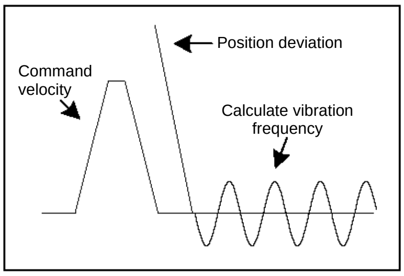
*2 There will be a delay after changing the damping frequency or damping filter setting until it is applied to the internal calculation. If the switching as described in *1 occurs during this delay time, the change may be suspended.

Class	No.	Parameter name	Range	Unit	Function
2	14	1st damping frequency	0 to 3000	0.1 Hz	Defines the 1st damping frequency of damping control that suppresses vibration at the load edge. Measure the frequency of vibration at the load edge and set up a value in unit of 0.1[Hz]. The valid frequency range is between 0.5 and 300.0 [Hz]. Disabled when set to 0 to 4.
2	15	1st damping filter setting	0 to 1500	0.1 Hz	If torque saturation occurs with the 1st damping frequency enabled, decrease the value. When you need faster operation, increase the value. In normal cases, set to 0. Note) The maximum setup value is internally limited to the corresponding damping frequency or “3000 - damping frequency,” whichever is smaller.
6	41	1st damping depth	0 to 1000	-	Defines the depth against the 1st damping frequency. The depth becomes maximum when the setup value is 0. The larger the setup value, the smaller the depth. Although the damping effect increases as the depth becomes larger, the delay becomes large. While the delay decreases as the depth becomes smaller, the damping effect decreases. Use this parameter to fine tune the damping effect and delay.
2	27	1st damping width setting	0 to 1000	-	Sets the width for the 1st damping frequency. The enabled range of setup is between 10 to 1000 and will operate as set to 100 between the range of 0 to 9. Within the setup range, the width will increase with the increase in the setup value, increasing robustness against vibration fluctuation.
2	16	2nd damping frequency	0 to 3000	0.1 Hz	Defines the 2nd damping frequency of damping control that suppresses vibration at the load edge. Measure the frequency of vibration at the load edge and set up a value in unit of 0.1[Hz]. The valid frequency range is between 0.5 and 300.0[Hz]. Disabled when set to 0 to 4.
2	17	2nd damping filter setting	0 to 1500	0.1 Hz	If torque saturation occurs with the 2nd damping frequency enabled, decrease the value. When you need faster operation, increase the value. In normal cases, set to 0. Note) The maximum setup value is internally limited to the corresponding damping frequency or “3000 - damping frequency,” whichever is smaller.
6	60	2nd damping depth	0 to 1000	-	Defines the depth against the 2nd damping frequency. The depth becomes maximum when the setup value is 0. The larger the setup value, the smaller the depth. Although the damping effect increases as the depth becomes larger, the delay becomes large. While the delay decreases as the depth becomes smaller, the damping effect decreases. Use this parameter to fine tune the damping effect and delay.
2	28	2nd damping width setting	0 to 1000	–	Sets the width for the 2nd damping frequency. The enabled range of setup is between 10 to 1000 and will operate as set to 100 between the range of 0 to 9.Within the setup range, the width will increase with the increase in the setup value, increasing robustness against vibration fluctuation.
2	18	3rd damping frequency	0 to 3000	0.1 Hz	Defines the 3rd damping frequency of damping control that suppresses vibration at the load edge. Measure the frequency of vibration at the load edge and set up a value in unit of 0.1[Hz]. The valid frequency range is between 0.5 and 300.0[Hz].Disabled when set to 0 to 4.
2	19	3rd damping filter setting	0 to 1500	0.1 Hz	If torque saturation occurs with the 3rd damping frequency enabled, decrease the value. When you need faster operation, increase the value. In normal cases, set to 0. Note) The maximum setup value is internally limited to the corresponding damping frequency or “3000 - damping frequency,” whichever is smaller.
6	71	3rd damping depth	0 to 1000	-	Defines the depth against the 3rd damping frequency. The depth becomes maximum if the setup value is 0. The larger the setup value, the smaller the depth. Although the damping effect increases as the depth becomes larger, the delay becomes large. While the delay decreases as the depth becomes smaller, the damping effect decreases. Use this parameter to fine tune the damping effect and delay.
2	29	3rd damping width setting	0 to 1000	–	Sets the width for the 3rd damping frequency. The enabled range of setup is between 10 to 1000 and will operate as set to 100 between the range of 0 to 9. Within the setup range, the width will increase with the increase in the setup value, increasing robustness against vibration fluctuation.
2	20	4th damping frequency	0 to 3000	0.1 Hz	Defines the 4th damping frequency of damping control that suppresses vibration at the load edge. Measure the frequency of vibration at the load edge and set up a value in unit of 0.1[Hz]. The valid frequency range is between 0.5 and 300.0 [Hz]. Disabled when set to 0 to 4.

Class	No.	Parameter name	Range	Unit	Function
2	21	4th damping filter setting	0 to 1500	0.1 Hz	If torque saturation occurs with the 4th damping frequency enabled, decrease the value. When you need faster operation, increase the value. In normal cases, set to 0. Note) The maximum setup value is internally limited to the corresponding damping frequency or “3000 - damping frequency,” whichever is smaller.
6	72	4th damping depth	0 to 1000	-	Defines the depth against the 4th damping frequency. The depth becomes maximum if the setup value is 0. The larger the setup value, the smaller the depth. Although the damping effect increases as the depth becomes larger, the delay becomes large. While the delay decreases as the depth becomes smaller, the damping effect decreases. Use this parameter to fine tune the damping effect and delay.
2	30	4th damping width setting	0 to 1000	-	Sets the width for the 4th damping frequency. The enabled range of setup is between 10 to 1000 and will operate as set to 100 between the range of 0 to 9. Within the setup range, the width will increase with the increase in the setup value, increasing robustness against vibration fluctuation.

4) How to use

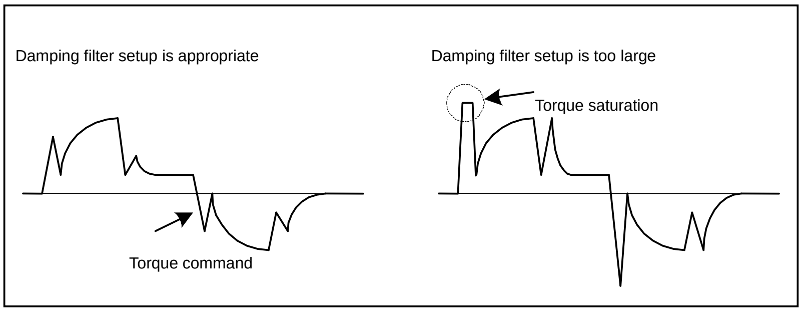
[1] Setup of damping frequency (Pr 2.14, Pr 2.16, Pr 2.18, Pr.2.20)
Measure the vibration frequency at the top of the equipment. When you can use such instrument as a laser displacement meter to directly measure the top end vibration, read out the vibration frequency from the measured waveform in unit of 0.1[Hz] and set it to the parameter.
If no measuring device is available, measure the frequency based on the residual vibration of the position deviation waveform measured using the vibration frequency monitor or the waveform graphic function of the setup support software (PANATERM).



[2] Setup of damping filter (Pr 2.15, Pr 2.17, Pr 2.19, Pr 2.21)

First set to 0 and check the torque waveform during operation.

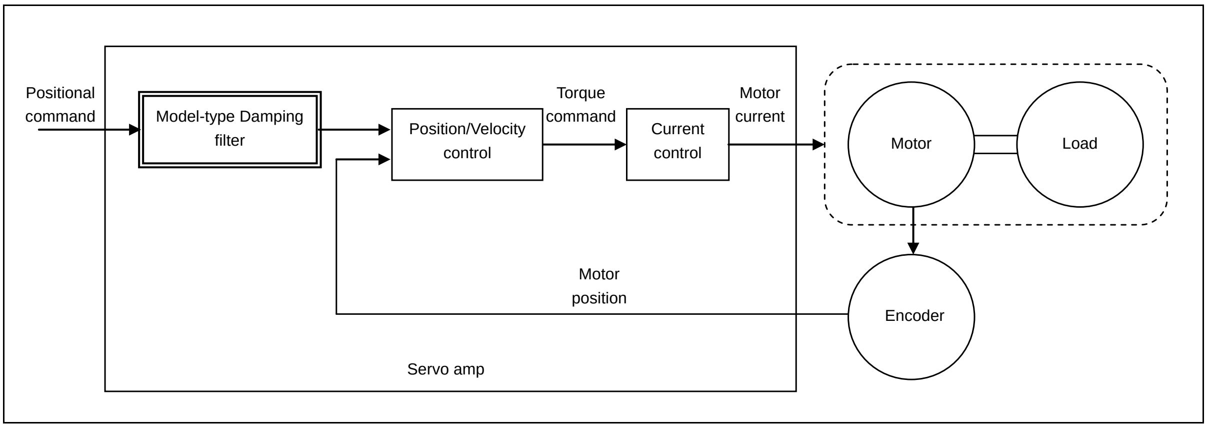
Although you can reduce the settling time by specifying a larger value, the torque ripple increases at the command changing point as shown in the following figure. Set up a value within the range where no torque saturation occurs under the actual condition. If torque saturation occurs, the vibration suppression effect will be lost.



[3] Damping depth setting (Pr. 6.14, Pr. 6.60, Pr. 6.71, Pr. 6.72)
Damping width setting (Pr. 2.27, Pr. 2.28, Pr. 2.29, Pr. 2.30)
If further aims to vibration suppression, set optimum value that most vibration is redused by increase (shallow) depth setting value little by little from 0.
Also if reducing the control delay is desired, reduce (narrow) width setting. When support variation of vibration frequency, increase (widen) width setting.

5-2-7-2 Model-type damping filter

This function reduces vibration at the edge or over the entire equipment by removing the vibration frequency components specified by the positional command.
The model-type damping filter can also remove resonance frequency components as well as anti-resonance frequency components, enhancing the effect of a conventional damping filter to generate smooth torque commands and offering a better damping effect.
In addition, the removal of anti-resonance frequency components and resonance frequency components can increase the responsiveness of the command response filter, which improves the settling time.
However, unlike a conventional damping filter, the model-type damping filter cannot obtain vibration components from the position sensor for the measurement of anti-resonance frequency components and resonance frequency components, which thus requires frequency characteristics analysis and the setting of optimum parameter values.



1) Applicable range

The model-type damping filter is activated under the following conditions.

	Conditions under which the model-type damping filter is activated
Control mode	• Must be position controlled with two degree-of-freedom control enabled.

2) Caution

The model-type damping filter may not work properly or no effect can be obtained under the following conditions.

	Conditions hindering the model-type damping filter
Load condition	• Vibrations are excited by factors other than commands (such as external forces). • The resonance frequency and the anti-resonance frequency are out of the range between 5.0 and 300.0 [Hz].

The damping filter works in a conventional manner under the following conditions.

	Conditions under which the damping filter works in a conventional manner
Parameter setting	• In case the resonance frequency and anti-resonance frequency does not satisfy the following condition: 5.0 [Hz] ≤ anti-resonance frequency < resonance frequency ≤ 300.0 [Hz] • In case the response frequency and anti-resonance frequency does not satisfy the following condition: 5.0 [Hz] ≤ anti-resonance frequency ≤ response frequency ≤ anti-resonance frequency × 4 ≤ 300.0 [Hz] • With the value in Pr. 2.13 "Damping filter switching selection" set to 4, the 1st and 2nd model-type damping filters are both enabled, and multiplying the 1st and 2nd response frequency/anti-resonance frequency ratios gives a value larger than 8. (In this case, only the 2nd model-type damping filter works as a conventional damping filter.)

When the damping filter works in a conventional manner, the three parameters of anti-resonance frequency, anti-resonance attenuation ratio and response frequency will be used for damping frequency, damping depth and damping filter setting.

To completely disable this function, all of the five parameters of resonance frequency, resonance attenuation ratio, anti-resonance frequency, anti-resonance attenuation ratio and response frequency should be set to 0.

3) Relevant parameters

Set up the model-type damping filter using the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>2</td><td>13</td><td>Damping filter switching selection</td><td>0 to 6</td><td>-</td><td>
Defines the switching method for the 4 filters used for damping control.
• When set to 0: Up to two filters can be used simultaneously.
• When set to 1 or 2: To be switched by external input (VS-SEL1, VS-SEL2)
<table>
<tr><th>Pr 2.13</th><th>VS-SEL2</th><th>VS-SEL1</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>0</td><td>-</td><td>-</td><td>Enabled</td><td>Enabled</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td rowspan="2">1</td><td>-</td><td>OFF</td><td>Enabled</td><td>Disabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>-</td><td>ON</td><td>Disabled</td><td>Enabled</td><td>Disabled</td><td>Enabled</td></tr>
<tr><td rowspan="4">2</td><td>OFF</td><td>OFF</td><td>Enabled</td><td>Disabled</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td>OFF</td><td>ON</td><td>Disabled</td><td>Enabled</td><td>Disabled</td><td>Disabled</td></tr>
<tr><td>ON</td><td>OFF</td><td>Disabled</td><td>Disabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>ON</td><td>ON</td><td>Disabled</td><td>Disabled</td><td>Disabled</td><td>Enabled</td></tr>
</table>
• When set to 3: To be switched by command direction
<table>
<tr><th>Pr 2.13</th><th>Position command direction</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td rowspan="2">3</td><td>Positive direction</td><td>Enabled</td><td>Disabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>Negative direction</td><td>Disabled</td><td>Enabled</td><td>Disabled</td><td>Enabled</td></tr>
</table>
Contents of setup values 4 to 6 will differ with enabled/disabled switching of two degree-of-freedom control mode.
• Position control (Two degree-of-freedom control mode disabled)
<table>
<tr><th>Pr 2.13</th><th>VS-SEL1</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>4</td><td>-</td><td>Enabled</td><td>Enabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>5, 6</td><td colspan="5">Same action as set value 0</td></tr>
</table>
• Position control (Two degree-of-freedom control mode enabled)
<table>
<tr><th>Pr 2.13</th><th>VS-SEL1</th><th>1st model type damping</th><th>2nd model type damping</th></tr>
<tr><td>4</td><td>-</td><td>Enabled</td><td>Enabled</td></tr>
<tr><td rowspan="2">5</td><td>OFF</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>ON</td><td>Disabled</td><td>Enabled</td></tr>
</table>
<table>
<tr><th>Pr 2.13</th><th>Position command direction</th><th>1st model type damping</th><th>2nd model type damping</th></tr>
<tr><td rowspan="2">6</td><td>Positive direction</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>Negative direction</td><td>Disabled</td><td>Enabled</td></tr>
</table>
• Full-closed control
<table>
<tr><th>Pr 2.13</th><th>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>4 to 6</td><td colspan="4">Same action as set value 0</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>61</td><td>1st resonance frequency</td><td>0 to 3000</td><td>0.1Hz</td><td>Defines the resonance frequency of the model-type damping filter's load.
The unit is [0.1 Hz].</td></tr>
<tr><td>6</td><td>62</td><td>1st resonance damping ratio</td><td>0 to 1000</td><td>-</td><td>Defines the resonance attenuation ratio of the model-type damping filter's load.
The attenuation ratio can be set as the setup value multiplied by 0.001.
The value of 1000 results in an attenuation of 1 (no peak). The smaller the setup value, the smaller the attenuation ratio (higher resonance peak).</td></tr>
<tr><td>6</td><td>63</td><td>1st anti-resonance frequency</td><td>0 to 3000</td><td>0.1Hz</td><td>Defines the anti-resonance frequency of the model-type damping filter's load.
The unit is [0.1 Hz].</td></tr>
<tr><td>6</td><td>64</td><td>1st anti-resonance damping ratio</td><td>0 to 1000</td><td>-</td><td>Defines the anti-resonance attenuation ratio of the model-type damping filter's load.
The attenuation ratio can be set as the setup value multiplied by 0.001.
The value of 1000 results in an attenuation of 1 (no peak). The smaller the setup value, the smaller the attenuation ratio (higher resonance peak).</td></tr>
<tr><td>6</td><td>65</td><td>1st response frequency</td><td>0 to 3000</td><td>0.1Hz</td><td>Defines the response frequency of the model-type damping filter's load.
The unit is [0.1 Hz].</td></tr>
</table>

(To be continued)

Class	No.	Parameter name	Range	Unit	Function
6	66	2nd resonance frequency	0 to 3000	0.1Hz	Defines the 2nd resonance frequency of the model-type damping filter's load. The unit is [0.1 Hz].
6	67	2nd resonance damping ratio	0 to 1000	-	Defines the 2nd resonance attenuation ratio of the model-type damping filter's load. The attenuation ratio can be set as the setup value multiplied by 0.001. The value of 1000 results in an attenuation of 1 (no peak). The smaller the setup value, the smaller the attenuation ratio (higher resonance peak).
6	68	2nd anti-resonance frequency	0 to 3000	0.1Hz	Defines the 2nd anti-resonance frequency of the model-type damping filter's load. The unit is [0.1 Hz].
6	69	2nd anti-resonance damping ratio	0 to 1000	-	Defines the 2nd anti-resonance attenuation ratio of the model-type damping filter's load. The attenuation ratio can be set as the setup value multiplied by 0.001. The value of 1000 results in an attenuation of 1 (no peak). The smaller the setup value, the smaller the attenuation ratio (higher resonance peak).
6	70	2nd response frequency	0 to 3000	0.1Hz	Defines the 2nd response frequency of the model-type damping filter's load. The unit is [0.1 Hz].

*1) For parameter attributes, refer to Section 9-1.

4) How to use

[1] As preparation, measure the resonance frequency and anti-resonance frequency using the frequency characteristic measuring function of PANATERM with torque velocity mode.

Ex.) The figure below shows the measurement result with a belt device. Ignoring small resonances, the resonance frequency at the gain peak and the anti-resonance frequency at the gain valley are as follows:

1st resonance frequency = 130 [Hz], 1st anti-resonance frequency = 44 [Hz]

2nd resonance frequency = 285 [Hz], 2nd anti-resonance frequency=180 [Hz]

[2] The resonance attenuation ratio and anti-resonance attenuation ratio should have initial values of around 50 (0.050).

[3] The response frequency should start with the same value as the anti-resonance frequency.

[4] Specify a value of 4 to 6 in Pr. 2.13 "Damping filter switching selection" to enable model-type damping control.

[5] Activate the motor and fine tune the parameters in the following sequence so that vibration components including command position deviation become small.

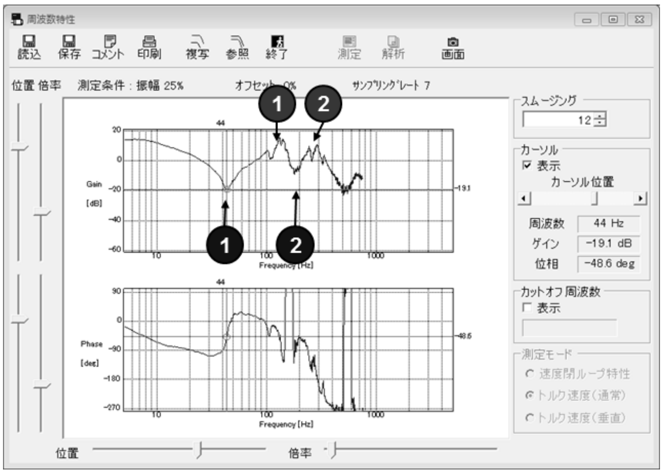
(1) Anti-resonance frequency

(2) Anti-resonance attenuation ratio

(3) Resonance frequency

(4) Resonance attenuation ratio

[6] Once the setting where vibration is minimized was found, increase the setup value of response frequency. The response frequency increases from one to four times the anti-resonance frequency, and the higher the frequency, the smaller the delay due to damping control. However, the damping effect decreases gradually, so a balanced setting should be chosen.



Example of frequency characteristic measurement with setup support software PANATERM

5-2-8 Feed forward function

Instead of using feedback control only, the velocity feed forward function can be used during position control or full-closed control to reduce position deviation and improve responsiveness, by calculating the velocity control command necessary for operation based on the internal positional command and adding the result to the velocity command calculated from the comparison with position feedback.

Also, the torque feed forward function can improve the response time of the velocity control system by calculating the torque command necessary for operation based on the velocity control command and adding the result to the torque command calculated from the comparison with velocity feedback.

1) Relevant parameters

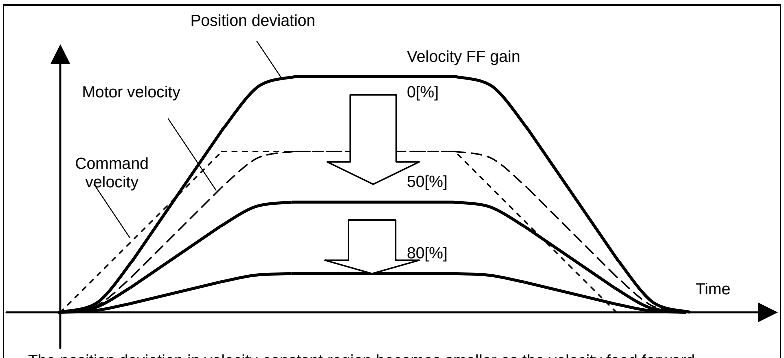
In A6 Series, two feed forward functions, velocity feed forward and torque feed forward, are available for use.

Class	No.	Parameter name	Range	Unit	Function
1	10	Velocity feed forward gain	0 to 4000	0.1%	Multiplies the velocity control command calculated from the internal positional command by the ratio of this parameter and adds the result to the velocity command resulting from the positional control process.
1	11	Velocity feed forward filter	0 to 6400	0.01 ms	Defines the time constant of 1st delay filter which affects the input of velocity feed forward. *it is disabled the two degree of freedom control mode
1	12	Torque feed forward gain	0 to 2000	0.1%	Multiplies the torque command calculated from the velocity control command by the ratio of this parameter and adds the result to the torque command resulting from the velocity control process.
1	13	Torque feed forward filter	0 to 6400	0.01 ms	Defines the time constant of 1st delay filter which affects the input of torque feed forward.
6	00	Analog torque feed forward gain setting * Not available with [A6SE], [A6SG].	0 to 100	0.1 V/ 100%	Defines the input gain of analog torque FF. Disabled when set to 0 to 9.
6	10	Function expansion setting	-32768 to 32767	-	Defines the bit related to analog torque FF. bit5 0: Analog torque FF disabled 1: Analog torque FF enabled * The least significant bit is bit0.

2) Usage example of velocity feed forward

With the velocity feed forward filter set at approx. 50 (0.5 ms), gradually increasing the velocity feed forward gain will enable velocity feed forward. The position deviation during operation at a constant velocity is reduced as shown in the following equation in proportion to the value of velocity feed forward gain.

Position deviation [unit of command] = command velocity [unit of command/s] / position loop gain [1/s] x (100 - velocity feed forward gain [%]) / 100



The position deviation in velocity-constant region becomes smaller as the velocity feed forward gain is increased.

Although calculatory position deviation is 0 with the gain set at 100%, significant overshoot occurs during acceleration/deceleration.

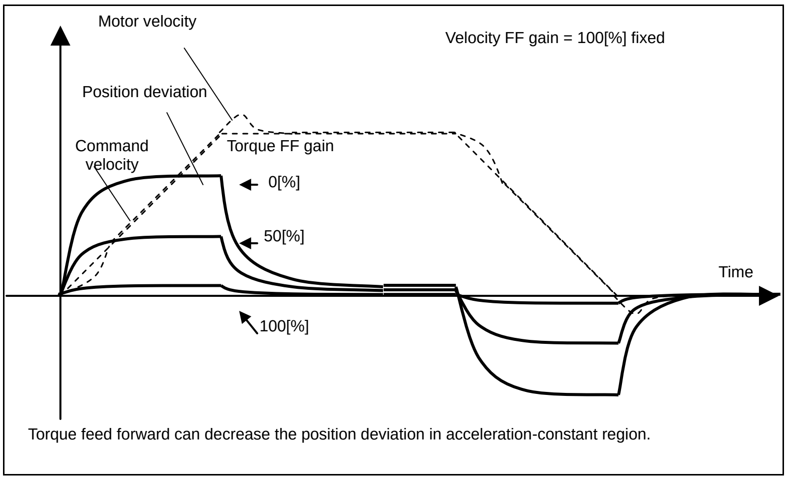
If the updating cycle of the positional command input is longer than the driver control cycle, or the pulse frequency varies, the operating noise may increase while velocity feed forward is active. If this is the case, use the positional command filter (1st delay/FIR smoothing), or increase the velocity feed forward filter setup value.

3) Usage example of torque feed forward

To use torque feed forward, the inertia ratio must be correctly configured. Use the value estimated upon execution of real time auto tuning, or specify the inertia ratio that can be calculated from the machine specification in Pr. 0.04 "Inertia ratio."

With the torque feed forward filter set at approx. 50 (0.5 ms), gradually increasing the torque feed forward gain will enable torque feed forward.

Position deviation at a constant acceleration/deceleration can be minimized close to 0 by increasing the torque forward gain. This means that position deviation can be maintained at near 0 over the entire operation area while driving in trapezoidal speed pattern under an ideal condition where disturbance torque is not active.



Zero position deviation is impossible in actual situation because of disturbance torque.

As with the velocity feed forward, increasing the time constant pf torque feed forward filter suppresses the operating noise but increases position deviation at the acceleration change point.

4) Usage example of analog torque feed forward [A6SE], [A6SG] This function is not usable.

When bit5 is set to 1 in Pr. 6.10 "Function expansion setting," analog torque feed forward is enabled. Also, when the analog input 3 is used for other function (for example, analog torque limit), the function is disabled.

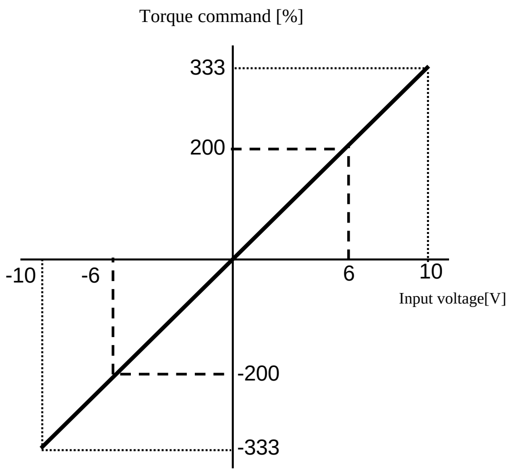
With Pr. 6.00 "Analog torque feed forward gain setting," the voltage [V] applied on the analog input 3 is converted to torque, which is added to the torque command [%]. This will be torque in CCW direction at positive voltage [V], and in CW direction at negative voltage [V].

The following graph shows the process of conversion from the input voltage [V] at the analog input 3 into the torque command [%] applied to the motor.

The inclination of the graph indicates the case with Pr. 6.00=30. The inclination varies depending on the set value in Pr. 6.00.

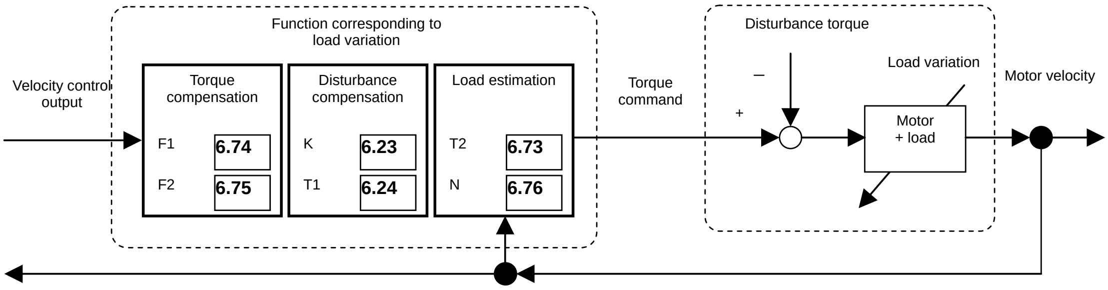
Torque command [%] =

100 x input voltage [V] / (Pr. 6.00 setup value x 0.1)



5-2-9 Load variation suppression function

This function improves stability by suppressing motor velocity variation due to disturbance torque or load variation.
This is effective when real-time auto tuning cannot handle load variation sufficiently.



1) Applicable range

☐ This function is only applicable when the following conditions are met.

	Conditions under which the load variation suppression function is activated
Control mode	• Should be either position control, velocity control, or full-closed control.
Other	• Should be in servo-on condition • Elements other than control parameters, such as deviation counter clear command inhibit and torque limit, are appropriately set, enabling the motor to run normally.

2) Caution

☐ No effect may be obtained under the following conditions.

	Conditions hindering the load variation suppression function
Load	• The rigidity is low (the anti-resonance point is at low frequency range of 10 Hz or below) • The load shows a clear non-linear trend with friction and backlash.

3) Relevant parameters

Class	No.	Parameter name	Range	Unit	Function
6	10	Function expansion setting	-32768 to 32767	-	Enables or disables the load variation suppression function. bit1 0: Disables the load variation suppression function 1: Enables the load variation suppression function bit2 0:Disables the load variation stabilization setting 1: Enables the load variation stabilization setting bit4 0: Disables the load variation suppression function automatic adjustment 1: Enables the load variation suppression function automatic adjustment * The least significant bit is bit0.
6	23	Load variation compensation gain	-100 to 100	%	Defines the compensation gain against load variation.
6	24	Load variation compensation filter	10 to 2500	0.01 ms	Defines the filter time constant against load variation.
6	73	Load estimation filter	0 to 2500	0.01 ms	Defines the filter time constant for load estimation.
6	74	Torque compensation frequency 1	0 to 5000	0.1 Hz	Defines the filter frequency 1 against the velocity control output. Torque compensation is enabled when the relation between Pr. 6.74 "Torque compensation frequency 1" and Pr. 6.75 "Torque compensation frequency 2" satisfies the following formula. (Pr. 6.75 x 32) ≥ Pr. 6.74 > Pr. 6.75 ≥ 1.0 Hz

Class	No.	Parameter name	Range	Unit	Function
6	75	Torque compensation frequency 2	0 to 5000	0.1 Hz	Defines the filter frequency 2 against the velocity control output. Torque compensation is enabled when the relation between Pr. 6.74 "Torque compensation frequency 1" and Pr. 6.75 "Torque compensation frequency 2" satisfies the following formula. (Pr. 6.75 x 32) ≥ Pr. 6.74 > Pr. 6.75 ≥ 1.0 Hz
6	76	Load estimation count	0 to 8	-	Defines the load estimation count.

* The symbols in parenthesis indicate the parameter symbols in the figure on the previous page.

4) How to use

There are two methods below for adjusting the load variation suppression function.

■ When there is no load inertia variation (disturbance suppression setting)

[1] Make normal gain adjustment in advance.
Use real-time auto tuning (Pr. 0.02=1) with the load variation suppression function automatic adjustment disabled (Pr. 6.10 bit14=0), and set stiffness (Pr. 0.03) as high as possible.

[2] Set bit14 to 1 in Pr. 6.10 "Function expansion setting" to enable the load variation suppression function automatic adjustment, and check disturbance suppression effect with the motor rotate.
* Before enabling or disabling the load variation suppression function, turn off the servo first.
* If this change causes the motor to oscillate or generates an abnormal sound, return to Step [1] and decrease the servo rigidity by one or two levels before repeating the subsequent steps.

[3] If further aims to adjust, set bit14 to 0 in Pr. 6.10 to disable the automatic adjustment of load variation suppression function.

[4] Specify a small value as possible in Pr. 6.24 "Load variation compensation filter."
Decreasing the filter setup value within the range that does not produce any significant abnormal sound or torque command variation will improve disturbance suppression performance and reduce motor velocity variation and encoder position deviation.
* When an abnormal sound at high frequency (1 kHz or above) is generated, increase the value in Pr. 6.76 "Load estimation count."
* When vibration at low frequency (10 Hz or below) is produced after operation stops, increase the value in Pr. 6.23 "Load variation compensation gain".
* No change is required for Pr. 6.73 "Load estimation filter" in normal cases, but you can set the optimum point by fine-tuning within the range between around 0.00 and 0.20 ms.

■ When there is load inertia variation (load variation stabilization setting)

[1] Turn ON the control power in two-degree-of-freedom position control (synchronization type) (Pr. 0.01=0, Pr. 6.47 bit0=1 bit3=1).

[2] Set the command response filter (Pr. 2.22) to 10ms.

[3] Set real-time auto tuning to load variation support mode, and operate the motor in a pattern as large as possible load variation occurs in this state.

[4] Set the stiffness setting (Pr. 0.03) as large as possible.

[5] Set the command response filter to appropriate value to continue to derease while checking response of the motor.
(*In case of need to the multi-axis trajectory control, change all axes Pr. 2.22 to the same value and adjust.)

5-2-10 Third gain switching function

In addition to the normal gain switching function shown in 5-2-5, the 3rd gain can be further set to switch gains on the point of stopping. By increasing the gain on the point of stopping for a given time, the positioning steady state can be shortened.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions under which the 3rd gain switching function is operated.
Control mode	• Either position control or full-closed control.
Miscellaneous	• In the servo ON condition. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Related parameters

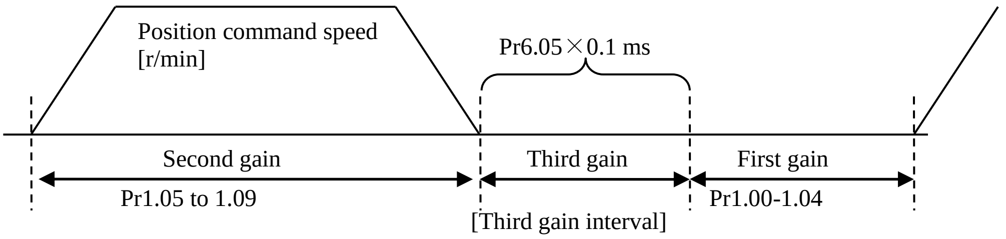
Class.	No.	Parameter name	Setting range	unit	Function
6	05	Position control third gain effective time	0-10000	0.1 ms	Set the time when third gain becomes effective.
6	06	Position control third gain scale factor	50-1000	%	Set third gain at the scale factor against first gain. Third gain = first gain x Pr6.06/100

(3) How to use

Under the condition in which the regular gain switching function operates normally, set the time for applying the third gain to Pr6.05 “Position control third gain effective time, and set the third gain for Pr6.06 “Position control third gain scale factor” at the scale factor against the first gain.

- When the third gain is not used, set Pr6.05=0 and Pr6.06=100.
- The third gain is effective only at the time of position control/full-closed control.
- In the third gain interval, the position loop gain/speed proportional gain only become the third gain, and for all others, the settings of first gain are applied.
- When the second gain switching conditions are established in the third gain interval, the gain is switched to the second gain.
- At the time of switching the second gain to the third gain, Pr1.19 “Position gain switching time” is applied.
- Even when the gain is switched from the second gain to the first gain because of parameter changes, the third gain interval is generated, to which care must be taken.

Ex.) Pr1.15 “position command switching mode: = 7 Switching conditions: with position command



[Third gain interval]
Position loop gain = Pr1.00×Pr6.06/100
Speed proportional gain = Pr1.01×Pr6.06/100
For speed integration time constant, speed detection filter and torque filter, first gain values are used as they are.

5-2-11 Friction torque compensation

As functions for reducing effects of friction which exists in the mechanical system, three kinds of friction torque compensations are available: eccentric load compensation that compensates the constantly working offset torque, dynamic friction compensation whose direction varies in accord with the operation direction, and viscous friction torque compensation amount that is varied by the command speed.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions for activating friction torque compensations.
Control mode	• Varies in accord with respective functions. See the parameter description in (2) below.
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

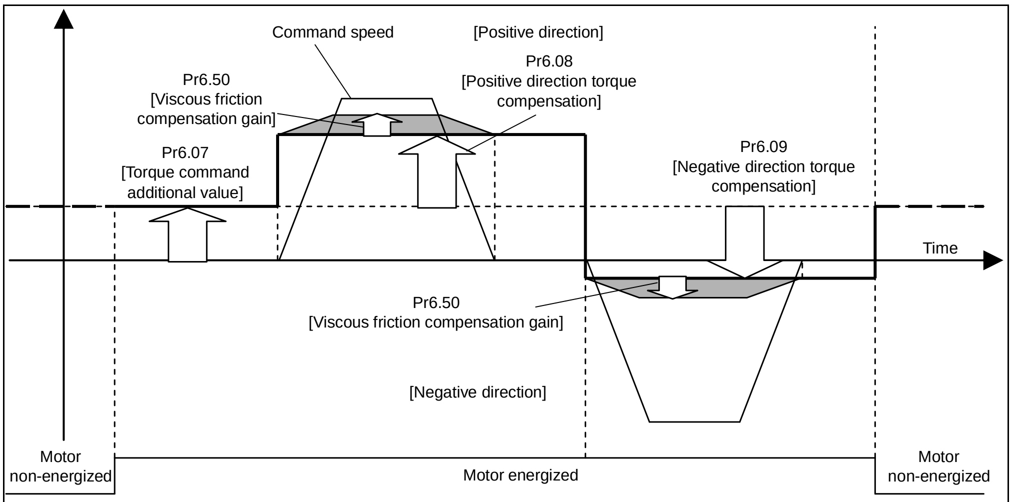
(2) Related parameters

By combining the following four parameters, friction torque compensation is set.

Class.	No.	Parameter name	Setting range	unit	Functions
6	07	Additional value to torque command	-100 - 100	%	In a control mode other than torque control, eccentric compensation value constantly added to the torque command is set.
6	08	Torque compensation value in positive direction	-100 - 100	%	Dynamic friction compensation value to be added to the torque command at the time of position control and full-closed control and when forward direction position command is entered.
6	09	Torque compensation value in negative direction	-100 - 100	%	Dynamic friction compensation value to be added to the torque command at the time of position control and full-closed control and when reverse direction position command is entered.
6	50	Viscous friction compensation gain	0 - 10000	0.1 %/ (10000 r/min)	When 2-degree-of-freedom control mode is effective, the result multiplying the command speed by this setting is added to the torque command as the viscous friction torque compensation amount. By setting the estimated viscous friction coefficient of real-time auto tuning, there are cases in which the feedback scale position deviation in the vicinity of steady state may be improved.

(3) How to use

The friction torque compensation is added as illustrated below in accordance with the entered position command direction.



The total of eccentric compensation set by constantly fixed torque command additional value, dynamic friction compensation set by positive torque compensation or negative torque compensation, which is added in accordance with the command speed direction lastly entered, and viscous friction compensation added in accordance with command speed becomes the friction compensation torque. Command speed direction is reset when power supply is turned ON and with motor non-energized.

Pr6.07 “Additional value to torque command” reduces variations of positioning action caused by the moving direction by setting the torque command value when a constant eccentric load torque is constantly applied to the motor by gravity in the vertical axis, etc.

Pr6.08 “Torque compensation value in positive direction” and Pr6.09 “Torque compensation value in negative direction” are loads that require a large dynamic friction torque due to radial load, such as belt driving shaft, and degradation and variations of positioning steady state time due to dynamic friction can be reduced by setting the friction torque in each rotating direction to each parameter.

Pr6.50 “viscous friction compensation gain” reduces response delay at the time of acceleration by setting a torque command value against viscous load. Because of its properties, the compensation is proportional to the speed command value.

There is no problem in which eccentric load compensation and dynamic friction compensation are used in combination or individually but the following restrictions are applied depending on the control mode switching or the servo ON state.

• At the time of torque control: Irrespective of parameter settings, the eccentric load compensation and dynamic friction compensation are zero.

• At the time of velocity control and the servo OFF: The eccentric load compensation is effective in accordance with Pr6.07. The dynamic friction compensation becomes zero irrespective of parameter settings.

• At the time of position control or full-closed control and the servo ON: Until the first position command is entered, the previous eccentric load compensation and dynamic friction compensation values are maintained. When the command is changed from without position command to with position command, the eccentric load compensation is updated in accordance with Pr6.07. In addition, in response to the command direction, the dynamic friction compensation value is updated in accordance with parameter Pr6.08 or Pr6.09.

5-2-12 Inertia ratio switching function

By the inertia ratio switching input (J-SEL), the inertia ratio can be changed over between first and second. This is useful for applications where the load inertia is changed in two stages.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions under which inertia ratio switching function is operated
Control mode	• Able to be used in all control modes.
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation. • Real-time auto tuning must be invalid (Pr0.02 = 0). • Adaptive filter function must be invalid (Pr2.00 = 0). • Load fluctuation suppressing function must be invalid (Pr6.10 bit 1 = 0).

(2) Precaution

- Carry out inertia ratio switching with the motor stopped. If the inertia ratio is switched while the motor is in motion, vibrations, oscillations, or other phenomena may occur.
- In the event that the difference between the first inertia ratio and the second inertia ratio is large, vibrations, etc. may occur even when the motor is stopped. Be sure to use this after such vibrations, etc. do not pose any problem on the actual machine.

(3) Related parameters

By combining the following three parameters, the inertia ratio switching function is set.

Class.	No.	Parameter name	Setting range	unit	Functions
6	10	Function expansion setting	-32768 - 32767	-	Set the bits related to inertia ratio switching. bit3 0: Inertia ratio switching invalid 1: Valid *The least significant bit is designated as bit0. Ex.) When inertia ratio switching is made valid: Setting = 8
0	04	Inertia ratio	0-10000	%	Set the first inertia ratio. Set the ratio of load inertia to motor rotor inertia.
6	13	Second inertia ratio	0-10000	%	Set the second inertia ratio. Set the ratio of load inertia to the motor rotor inertia.

(4) How to use

By the inertia ratio switching input (J-SEL), the first inertia ratio and the second inertia ratio are switched.

Inertia ratio switching input (J-SEL)	Adaptive inertia ratio
OFF	First inertia ratio (Pr0.04)
ON	Second inertia ratio (Pr6.13)

5-2-13 Hybrid vibration suppressing function

A function to suppress vibration arising from the twist amount between the motor and the load in the full-closed control mode. This function enables high setting of gains.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which hybrid vibration suppression functions are activated.
Control mode	• Full-closed control mode
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Precautions

- This function is effective when the twist amount between the motor shaft and the load is great. When the twist amount is small, there are cases in which the effect may be small.

(3) Related parameters

Combining the following parameters, hybrid vibration suppression function is set.

Class.	No.	Parameter name	Setting range	unit	Functions
6	34	Hybrid vibration suppression gain	0-30000	0.1/s	Set hybrid vibration suppression gain. Basically, set the same value as the position loop gain and finely adjust while monitoring the conditions.
6	35	Hybrid vibration suppression filter	0-32000	0.01 ms	Set the hybrid vibration suppression filter.

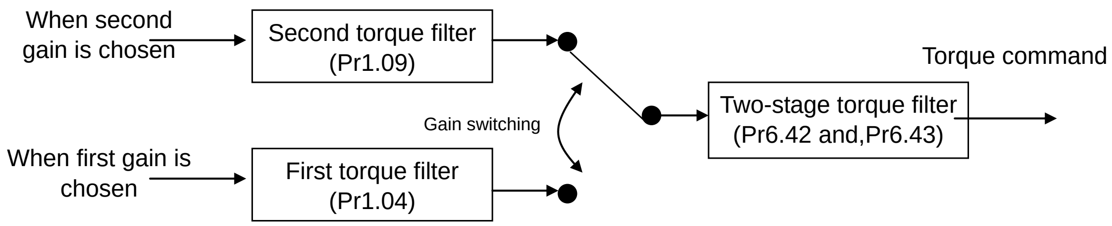
(4) How to use

[1] Set Pr6.34 [Hybrid vibration suppression gain] to be same as the position loop gain.

[2] While driving in the full-closed control, increase the setting of Pr6.35 [hybrid vibration suppression filter] gradually and check changes of response.
If response seems to be improved, while adjusting Pr6.34 and Pr6.35, find a combination that can achieve the optimum response.

5-2-14 Two-stage torque filter

In addition to conventional first and second torque filters (Pr1.04 and Pr1.09), still another torque filter is able to be set. Using this two-stage torque filter, suppression effects of high-pass vibration components can be increased.



(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which two-stage torque filter function is activated.
Control mode	• This can be used in all control modes.
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Precautions

- Excessively large setting causes control to be unstable, possibly generating vibration. Set to an appropriate value while checking the apparatus for conditions.
- Changing Pr6.43 “Two-stage torque filter damping terms” may generate vibration. Change Pr6.43 while the motor stands still.

(3) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
6	42	Two-stage torque filter time constant	0 to 2500	0.01 ms	Set the time constant of two-stage torque filter. The time constant becomes invalid when the setting is zero. [When the time constant is used in the second filter at Pr6.43≥50] The corresponding time constant becomes 4 to 159 (0.04 to 1.59 ms). (Equivalent to 100 to 4000 Hz in terms of frequency.) Motor operates with the settings from 1 through 3 as 4 (4000 Hz), and with the settings from 159 to 2500 as 159 (100 Hz).
6	43	Two-stage torque filter damping term	0 to 1000	-	Set the damping term of two-stage torque filter. By this setting, the filter degree of two-stage torque filter is changed over. 0 to 49: To operate as a primary filter. 50 to 1000: To operate as a second filter and at the setting of 1000, the filter becomes a second filter of ζ = 1.0. The smaller the setting, the more vibratory. Basically, it is recommended to use at the setting of 1000.

(4) How to use

In the event that the high-pass vibration is unable to be removed by conventional first and second torque filters, set the two-stage torque filter. With Pr6.43 “Two-stage torque filter damping term” = 1000 (□ = 1.0), Pr6.42 “Two-stage torque filter time constant” shall be adjusted by increasing it gradually, from its minimum value of 4.

5-2-15 Quadrant projection suppression function

Control configuration can be switched to suppress quadrant projection occurring during arc interpolation of 2 or more axes. To be used in conjunction with load fluctuation suppression function.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied:

	Conditions in which quadrant projection suppression function is triggered
Control mode	• To be in either position control or full-closed control mode.
Others	• To be in Servo-On state. • Elements other than control parameters, such as prohibition of deviation counter clear command input and torque limit, etc. are set appropriately, in a state where there are no obstructions in normal motor revolutions.

(2) Points to note

☐ There are cases where effects cannot be observed under the following conditions:

	Conditions where the effects of quadrant projection suppression function is disrupted
Load	· When rigidity is low (anti-resonance point exists in the low frequency range of 10 Hz or lower) · When non-linearity of load is strong from existence of backlash, etc. · When action patterns are changed.

(3) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	45	Quadrant projection positive direction compensation amount	-1000 to 1000	0.1%	Sets amount of compensation to be added to torque command when the position command is in positive direction and quadrant projection compensation function is enabled.
5	46	Quadrant projection negative direction compensation amount	-1000 to 1000	0.1%	Sets amount of compensation to be added to torque command when the position command is in negative direction and quadrant projection compensation function is enabled.
5	47	Quadrant projection compensation delay time	0 to 1000	ms	Sets the length of delay time for switching of amount of compensation after position command has been reversed, when quadrant projection compensation function is enabled.
5	48	Quadrant projection compensation filter setting L	0 to 6400	0.01 ms	Sets time constant for low-pass filter on the amount of compensation on torque command when quadrant projection compensation function is enabled.
5	49	Quadrant projection compensation filter setting H	0 to 10000	0.1 ms	Sets time constant for high-pass filter on the amount of compensation on torque command when quadrant projection compensation function is enabled.
6	47	Function expansion setting 2	0 to 5000	0.1 Hz	Bit14: Enables/disables quadrant projection compensation function. (0: disabled, 1: enabled)
6	97	Function expansion setting 3	-2147483648 to 2147483647	-	Bit 0 : Enables/disables quadrant projection compensation function. (0: disabled, 1: enabled) * Please set to 1 to set the amount of quadrant projection compensation for each reversed direction when traveling direction is reversed.

(4) How to use

Load fluctuation suppression function is adjusted through disturbance suppression setting referencing Item 5-2-9 to measure quadrant projection.
If the level is unsatisfactory, fine adjustment can be conducted using the quadrant projection suppression function.

[1] Reclose control power supply after enabling quadrant projection suppression function (Pr 6.47 bit14 = 1)
[2] Set initial values to: Pr 5.47 = 0, Pr 5.48 = Pr 1.04, Pr 5.49 =0.
[3] Measure the magnitude of quadrant projection and conduct fine adjustments to Pr 5.45 and Pr 5.46 of each axis.
 * In case of delay in quadrant projection from travelling direction reversing timing, try changing Pr 5.47 and Pr5.48.
 * To set the amount of quadrant projection compensation to the revised direction when the traveling direction is reversed, try chanting Pr6.97 bit 0 to 1 and changing Pr 5.49.

5-2-16 Two-degree-of-freedom control mode (with position control)

The two-degree-of-freedom control mode is an extended function of position control mode to improve the responsiveness by making it possible to independently set the command response and servo rigidity.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which two-degree-of-freedom control mode is activated.
Control mode	• Position control
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Related parameters

First of all, with Pr6.47 “Function expansion setting 2” = 1, fill in EEPROM, and then, make the 2-degree-of-freedom control mode effective by resetting the control power supply.
Thereafter, adjust by the real-time auto-tuning (see 5-1-3). Only when further improvement is required, while checking responses, finely adjust the following parameters manually.

Class.	No.	Parameter name	Setting range	unit	Functions
6	47	Function expansion setting 2	-32768 - 32767	-	Various functions are set in bit units. bit0 2-degree-of-freedom mode 0: Invalid 1: Valid bit3 Choose 2-degree-of-freedom control real-time auto-tuning. 0: Standard type 1: Synchronous type *The least significant bit is set to bit0. *bit3 (2-degree-of-freedom control real-time auto-tuning chosen) becomes enabled only when bit0 is set to 1: Valid.
2	22	Command smoothing filter	0 - 10000	0.1 ms	At the time of the 2-degree-of-freedom control, the time constant of command response filter is used. The maximum value is restricted to 2000 (=200.0 ms). (The parameter value itself is not restricted but the applied value inside the driver is restricted. The damping term is set by Pr6.49 “Command response filter and adjustment filter damping term setting.”) Making this parameter smaller can quicken the command response, whereas making it larger can slow the command response.
6	48	Adjustment filter	0 - 2000	0.1 ms	To set the time constant of adjustment filter. When the torque filter setting is changed, set the adjustment filter to a near value while referring to setting of real-time auto-tuning. In addition, by finely adjusting the adjustment filter while monitoring the encoder position deviation in the vicinity of steady state, overshoot or vibration waveforms may be sometimes improved.

(to be continued)

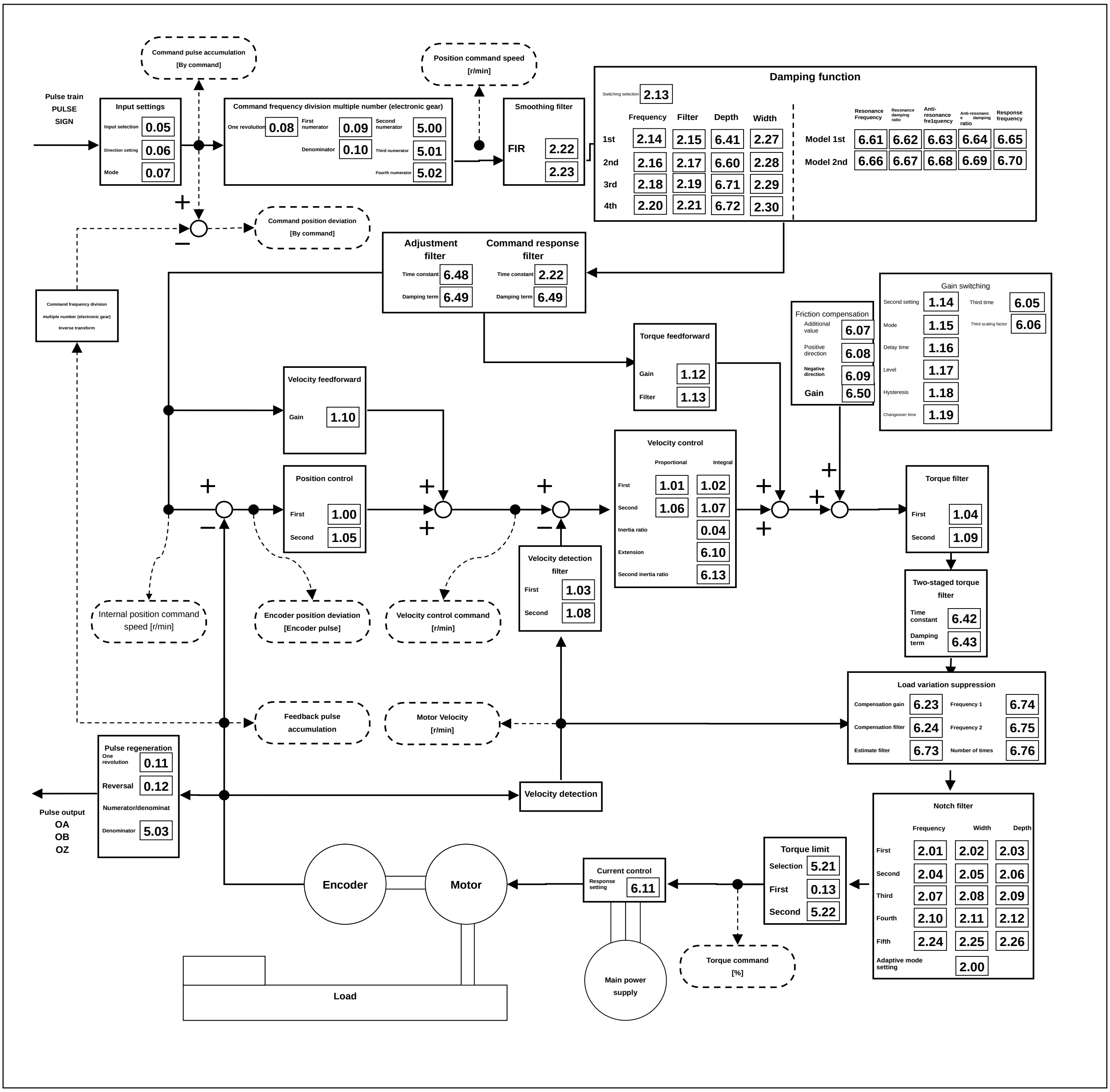
Class.	No.	Parameter name	Setting range	unit	Functions
6	49	Command response filter and adjustment filter damping term setting	0 to 99	-	Set the damping terms of command response filter and adjustment filter. In the decimal number system, the first digit indicates the command response filter setting and the second digit the adjustment filter setting. Target digits: 0 to 4: No damping term (operates as a first filter). 5 to 9: Secondary filter (damping term ζ becomes 1.0. 0.86. 0.71. 0.5, 0, and 0.35). However, when Pr2.13 “Damping filter switching selection” is 4 (two of model type damping controls are valid), the damping ratio is fixed to 1.0 when the secondary filter is chosen. Ex.) In the event that you want to have ζ = 1.0 for the command response filter and ζ = 0.71 for the adjustment filter 1, the setting should be 75 (5 for the first digit (ζ = 1.0) and the second digit is 7 (ζ = 0.71)). For the time constant of command response filter, Pr2.22 “Command smoothing filter” is applied.
6	50	Viscous friction compensation gain	0 to 10000	0.1 %/ (10000 r/min)	Add the result of multiplying the command speed by this setting to the torque command as the viscous friction torque compensation value. Setting the estimated value of viscous friction coefficient of real time auto-tuning may sometimes improve the encoder position deviation near the steady state.

*1 Switching of Adjustment filter, Command response filter and adjustment filter damping term setting is performed on the rising edge of the command when the number of command pulses (before positional command filter) per command pulse detection frequency (0.125 ms) changes from 0 to a value other than 0 while the positioning complete is being output.
The setting is not changed even if the control mode is switched to position control after changing the setting values of "Switching of Adjustment filter, Command response filter and adjustment filter damping term setting" during speed control or torque control.
In particular, in the case where the adjustment filter time constant is changed to a smaller value and the positioning completion range is set to a larger value, if a large accumulation pulse (the area obtained by integrating the value obtained by subtracting the position command after the filter from the position command before the filter with time) remains in the filter at the time of the above switching, the motor may temporarily move at a speed higher than the original command speed because the pulse is suddenly discharged immediately after the switching and it tries to return to the original position. Use caution.

*2 There will be a delay after changing Adjustment filter, Command response filter and adjustment filter damping term setting until it is applied to the internal calculation. If the switching as described in *1 occurs during this delay time, the change may be suspended.

5-2-17 Block diagram for two degree-of-freedom control mode (with position control)

Two degree-of-freedom control mode (with position control) shall be as per the block diagram indicated below:



Two degree-of-freedom control mode (with position control) block diagram

5-2-18 Two-degree-of-freedom control mode (with velocity control)

The two-degree-of-freedom control mode is an extended function of velocity control mode to improve the responsiveness by making it possible to independently set the command response and servo rigidity.

Only the standard type of two-degree -of-freedom control is available. It will be set internally to standard type in case it is set to synchronized type.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which two-degree-of-freedom control mode is activated.
Control mode	• Velocity control
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Related parameters

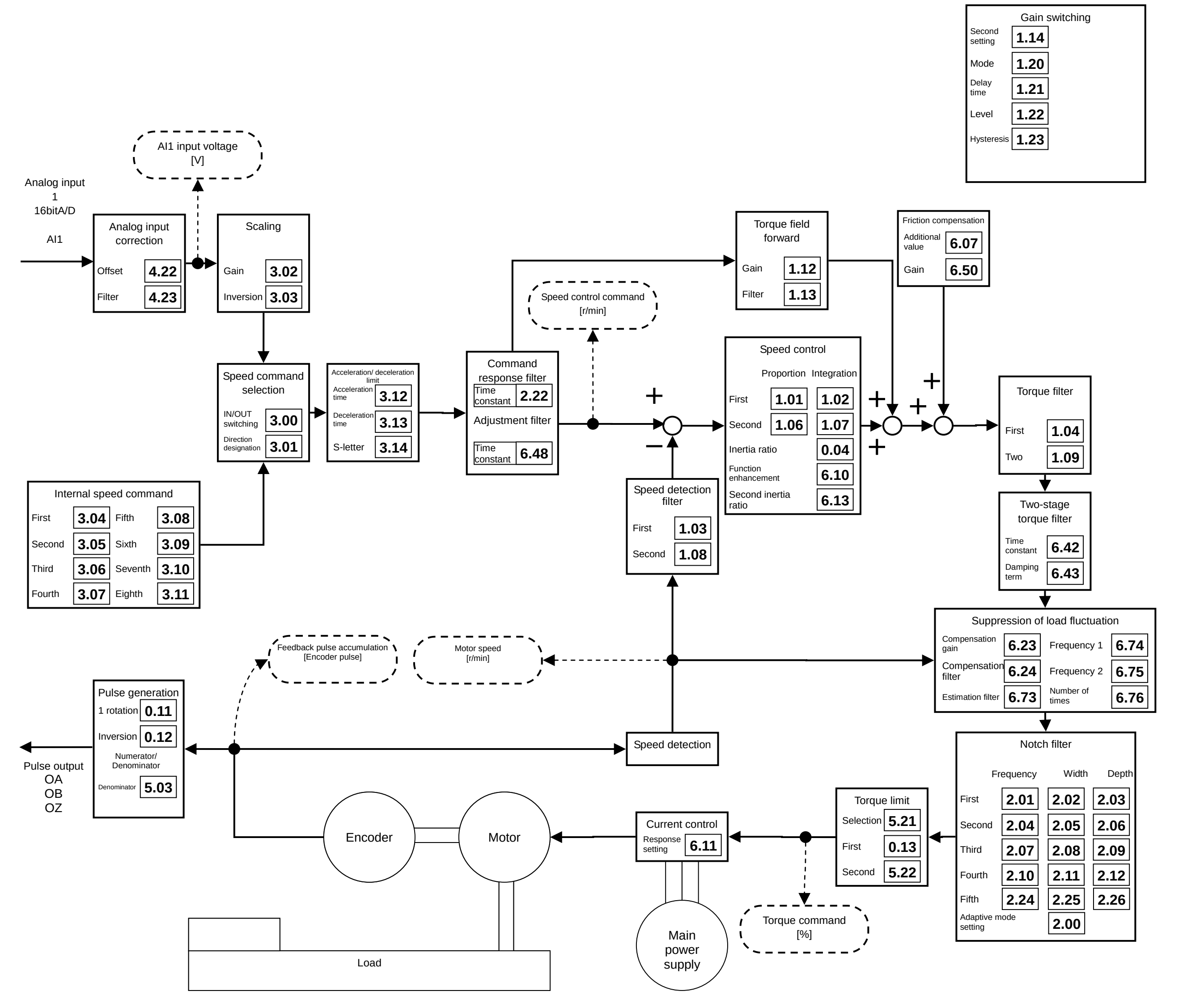
First of all, set Pr6.47 “Function expansion setting 2” to 1 and write in EEPROM; then, reset the control power supply to enable the 2-degree-of-freedom mode.

Thereafter, adjust the related parameters by real-time auto-tuning (see 5-1-3). Only when further improvement is required, manually finely adjust the following parameters while confirming responses.

Class.	No.	Parameter name	Setting range	unit	Functions
6	47	Function expansion setting 2	-32768 to 32767	-	Various functions are set in bit units. bit0 2-degree-of-freedom mode 0: Invalid 1: Valid bit3 Choose 2-degree-of-freedom control real-time auto-tuning. Fix to 0(Standard type). *The least significant bit is set to bit0.
2	22	Command smoothing filter	0 to 10000	0.1 ms	At the time of the 2-degree-of-freedom control, the time constant of command response filter is used. The maximum value is restricted to 640 (=64.0 ms). (The parameter value itself is not restricted but the applied value inside the driver is restricted.) Making this parameter smaller can quicken the command response, whereas making it larger can slow the command response.
6	48	Adjustment filter	0 to 2000	0.1 ms	To set the time constant of adjustment filter. When the torque filter setting is changed, set the adjustment filter to a near value while referring to setting of real-time auto-tuning. At the time of velocity control mode, The maximum value is restricted to 640 (=64.0 ms). (The parameter value itself is not restricted but the applied value inside the driver is restricted.)

5-2-19 Block diagram for two degree-of-freedom control mode (with velocity control)

Two degree-of-freedom control mode (with velocity control) shall be as per the block diagram indicated below.



Two degree-of-freedom control mode (with velocity control) block diagram

5-2-20 Two degree-of-freedom control mode (full-closed control)

The two degree-of-freedom control mode is an extended function of full-closed control mode to improve the responsiveness by making it possible to independently set the command response and servo rigidity.

Only the standard type of two-degree -of-freedom control is available. It will be set internally to standard type in case it is set to synchronized type.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied:

	Conditions in which two-degree-of-freedom control mode is activated
Control mode	• Full-closed control
Others	• To be in the servo ON state • Elements other than control parameters, such as torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Related parameters

First of all, with Pr6.47 write “Function expansion setting 2” = 1 into EEPROM, and then, make the two degree-of-freedom control mode enabled by resetting the control power supply.
Thereafter, adjust by the real-time auto-tuning (refer to 5-1-3). Only when further improvement is required, finely adjust the following parameters manually while checking the responses.

Class.	No.	Parameter name	Setting range	unit	Functions
6	47	Function expansion setting 2	-32768 to 32767	-	Various functions are set in bit units. bit 0 Two degree-of-freedom control mode 0: Invalid 1: Valid bit 3 Two degree-of-freedom control real-time auto-tuning select Fix to 0(Standard type). *The least significant bit is set to bit 0.
2	22	Command smoothing filter	0 to 10000	0.1 ms	At the time of the two degree-of-freedom control, the time constant of command response filter is used. The maximum value is restricted to 2000 (= 200.0 ms). (The parameter value itself is not restricted but the applied value inside the driver is restricted. The damping term is set by Pr6.49 “Setting of command response filter and adjustment filter damping terms.”) Making this parameter smaller can quicken the command response, whereas making it larger can slow the command response.
6	48	Adjustment filter	0 to 2000	0.1 ms	Sets the time constant of adjustment filter. When the torque filter setting is changed, set the adjustment filter to a near value while referring to setting of real-time auto-tuning. In addition, by finely adjusting the adjustment filter while monitoring the encoder position deviation in the vicinity of steady state, overshoot or vibration waveforms may be sometimes improved.

(to be continued)

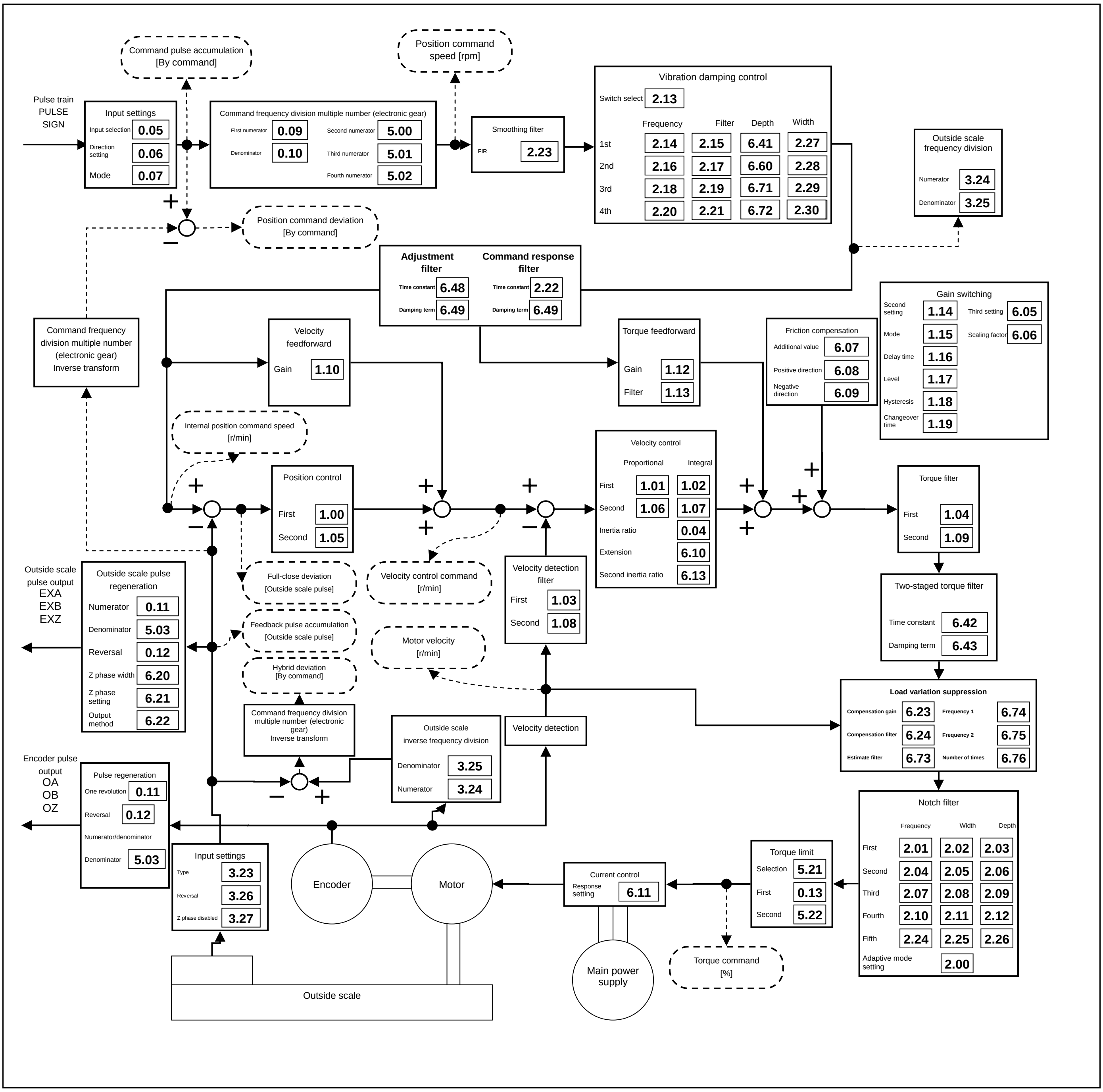
Class.	No.	Parameter name	Setting range	unit	Functions
6	49	Command response filter / adjustment filter damping term setting	0 to 99	-	Sets the damping term of command response filter and adjustment filter. In the decimal number system, the first digit indicates the command response filter setting and the second digit the adjustment filter setting. Target digits: 0-4: No damping term (operates as a primary filter). 5-9: Secondary filter (damping term ζ becomes 1.0, 0.86, 0.71, 0.50, and 0.35 in sequence). However, when Pr 2.13 “Damping filter switching select” is 4 (when two of model type damping controls are valid), the damping ratio is fixed to 1.0 when the secondary filter is chosen. Ex.) In the event that you want to have ζ = 1.0 for the command response filter and ζ = 0.71 for the adjustment filter 1, the setting value is 75 (5 for the first digit (ζ = 1.0) and 7 for the second digit (ζ= 0.71)). Pr 2.22 “Command smoothing filter” is applied for the time constant of command response filter,
6	50	Viscosity friction compensation gain	0 to 10000	0.1 %/ (10000 r/min)	Adds the result of multiplying the command speed by this setting to the torque command as the viscous friction torque compensation value. Setting the estimated value of viscous friction coefficient of real time auto-tuning may sometimes improve the encoder position deviation near the steady state.

*1 Switching of Adjustment filter, Command response filter and adjustment filter damping term setting is performed on the rising edge of the command when the number of command pulses (before positional command filter) per command pulse detection frequency (0.125 ms) changes from 0 to a value other than 0 while the positioning complete is being output.
The setting is not changed even if the control mode is switched to position control after changing the setting values of "Switching of Adjustment filter, Command response filter and adjustment filter damping term setting" during speed control or torque control.
In particular, in the case where the adjustment filter time constant is changed to a smaller value and the positioning completion range is set to a larger value, if a large accumulation pulse (the area obtained by integrating the value obtained by subtracting the position command after the filter from the position command before the filter with time) remains in the filter at the time of the above switching, the motor may temporarily move at a speed higher than the original command speed because the pulse is suddenly discharged immediately after the switching and it tries to return to the original position. Use caution.

*2 There will be a delay after changing Adjustment filter, Command response filter and adjustment filter damping term setting until it is applied to the internal calculation. If the switching as described in *1 occurs during this delay time, the change may be suspended.

5-2-21 Block diagram for two-degree-of-freedom control mode (full-closed control)

The two degree-freedom control mode (with full-closed control) is configured as follows:



Two degree-of-freedom control mode (with full-closed control) block diagram

5-2-22 High response current control

High response current control is a function to improve the responsiveness of the current control part by changing Pr6.11 “Current response setup” to a value larger than the shipment value 100%.
Because it may be prone to generate vibration and noise, adjust to an appropriate value depending on the operating situation of an applicable unit just like the adjustment of the position control part/velocity control part.

(1) Scope

□ This function works under the following condition.

	Operating conditions for high response current control
Control mode	・Can be used in all control modes.
Miscellaneous	・The software version shall be function extended version 5 or later. ・Should be in servo-on condition ・The elements other than control parameters such as torque limit settings are correctly set, assuring that the motor can run smoothly.

(2) Related parameters

Class	No.	Attribute *1)	Title	Range	Unit	Function
6	11	B	Current response setup	10～300	%	Adjust the current response with the level at shipment considered as 100%. Setting this setting value at a value larger than 100 can improve current responsiveness. (Note) The setting range is 10 to 100% for function enhancement version 4 or earlier.

(3) Points to note

・Also in the function enhancement version 5 and later versions, when Pr6.11 “Current response setup” value is 99 or smaller, it is possible to make current responsiveness lower than that at shipment as before.

・The settable maximum value differs depending on the connected motor and the value is limited to 300% or lower (100% for some motors).

6. Applied functions

6-1 Torque limit switching function

A function to switch the torque limit value by operating direction or torque limit switching input (TL-SEL).

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which the torque limit switching function is activated.
Control mode	• Position control, velocity control, and full-closed control
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

* At the time of torque control and at the time of measuring frequency response characteristics (torque speed (regular) mode) by PANATERM, the switching function is invalidated and Pr0.13 "First torque limit" only is validated.

(2) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
0	13	First torque limit	0 to 500	%	Set the first limit value of motor output torque.
5	21	Torque limit selection	0 to 6	-	Set the torque limit choosing system. 0: Positive direction →P-ATL(0 to 10 V), negative direction →N-ATL (-10 to 0 V) 1: Positive direction/negative direction → Pr0.13 2: Positive direction → Pr0.13, negative direction → Pr5.22 3: TL-SEL OFF→Pr0.13, TL-SEL ON→Pr5.22 4: Positive direction →P-ATL(0 to 10 V), negative direction →N-ATL (0 to 10 V) 5: Positive direction/negative direction →P-ATL (0 to 10 V) 6: TL-SEL OFF Positive direction → Pr0.13, negative direction → Pr5.22 TL-SEL ON Positive direction → Pr5.25, negative direction → Pr5.26
5	22	Second torque limit	0 to 500	%	Set the second limit value of motor output torque.
5	23	Torque limit switching setting 1	0 to 4000	ms/100 %	Set the change rate (gradient) from first to second at the time of torque limit switching.
5	24	Torque limit switching setting 2	0 to 4000	ms/100 %	Set the change rate (gradient) from second to first at the time of torque limit switching.
5	25	Positive direction torque limit for external input	0 to 500	%	Set the positive direction torque limit at the time of torque limit switching input.
5	26	Negative direction torque limit for external input	0 to 500	%	Set the negative direction torque limit at the time of torque limit switching input.

(3) Content

• The torque limit switching mode is shown in the table below:

Pr5.21	Torque limit switching input (TL-SEL)	Torque limit switching setting (Pr5.23 and Pr5.24)	Positive direction torque limit	Negative direction torque limit
0			Analog input[*1]	
1	-	-	Pr0.13	
2	-	-	Pr0.13	Pr5.22
3	OFF	Effective	Pr0.13	
	ON		Pr5.22	
4			Analog input[*1]	
5				
6	OFF	-	Pr0.13	Pr5.22
	ON		Pr5.25	Pr5.26

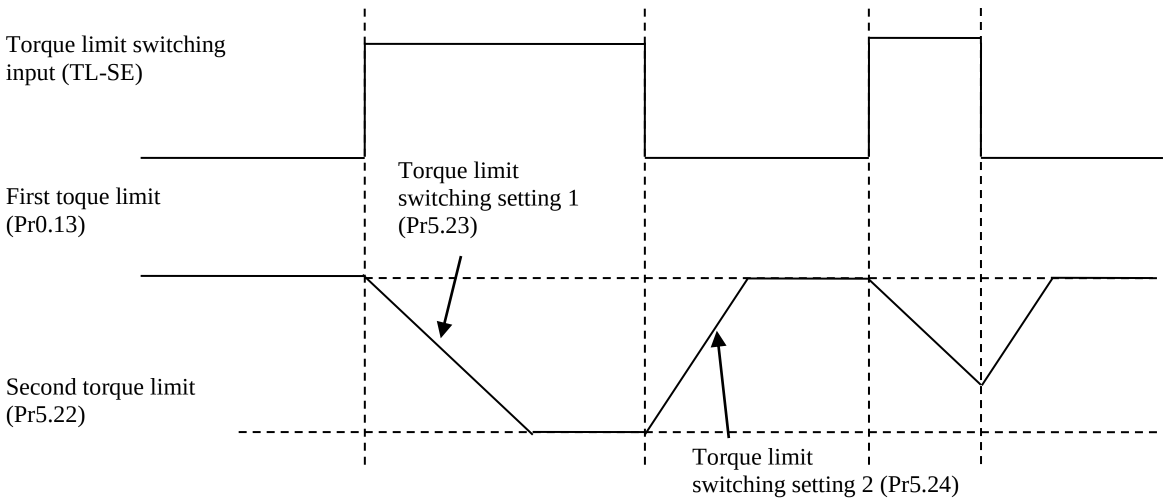
*1: In the event that the torque limit value is designated by the analog input, see 6-2 “Analog torque limit function.”

- Setting of change rate at the time of torque limit switching:

When the motor is used with Pr5.21 “Torque limit selection” = 3, an gradient is able to be provided to the change when the torque limit is switched. This function is invalid in other settings.

The change rate (gradient) set by Pr5.23 “Torque limit switching setting 1” is applied when the first torque limit is switched to the second torque limit and the change rate (gradient) set by Pr5.24 “Torque limit switching setting 2” is applied when the second torque limit is switched to the first torque limit. The sign of the change rate (gradient) is automatically switched in the driver in accordance with the magnitude relationship between the first torque limit and the second torque limit.

Setting Pr5.23 “Torque limit switching setting 1” or Pr5.24 “Torque limit switching setting 2” to 0 instantaneously switches the torque limit.



Note) When the first torque limit (Pr0.13) and the second torque limit (Pr5.22) is changed from the front panel or communication, the change rate setting is ignored and the torque limit value after the change is immediately applied. The change rate setting becomes effective only at the time of switching by the torque limit switching input (TL-SEL).

[A6SE], [A6SG] This function is unable to be used.

6-2 Analog torque limit function

The torque limit is set by the use of analog input 2 and 3.
The maximum torque limit value is restricted by Pr0.13 “First torque limit.”

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which analog torque limit function is activated.
Control mode	• Position control,velocity control, and full-closed control
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
0	13	First torque limit	0 to 500	%	To set the first limit value of motor output torque.
5	21	Torque limit selection	0 to 6	-	To set the torque limit selection system. 0: Positive direction→P-ATL (0 to 10 V), negative direction→ N-ATL (-10 to 0 V) 4: Positive direction→P-ATL (0 to 10 V), negative direction→ N-ATL (0-10 V) 5: Positive direction and negative direction→P-ATL (0-10 V) For settings 1, 2, 3 and 6, see 6-1 “Torque limit switching functions.”
5	27	Analog torque limit input gain	10 to 100	0.1 V /100%	To set the conversion gain from voltage [V] applied to the analog torque limit input (P-ATL, N-ATL) to the torque limit [%].
4	25	Analog input 2 (AI2) offset setting	-1707 to 1707	5.86 mV	To set the offset adjustment value against the voltage applied to analog input 2.
4	26	Analog input 2 (AI2) filter setting	0 to 6400	0.01 ms	To set the time constant of the primary delay filter against the voltage applied to analog input 2.
4	28	Analog input 3 (AI3) offset setting	-1707 to 1707	5.86 mV	To set the offset adjustment value against the voltage applied to analog input 3.
4	29	Analog input 3 (AI3) filter setting	0 to 6400	0.01 ms	To set the time constant of primary delay filter against the voltage applied to the analog input 3.

(3) Content

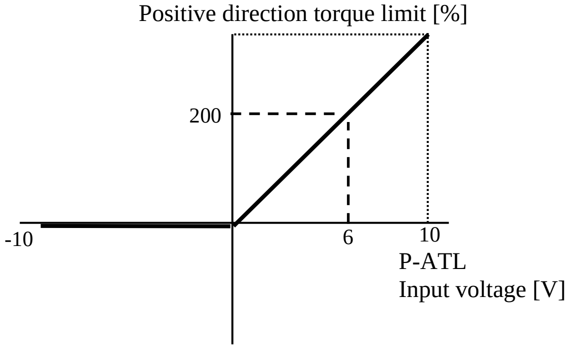
Pr5.21	Positive direction analog torque limit input (P-ATL)	Negative direction analog torque limit input (N-ATL)	Positive direction torque limit	Negative direction torque limit
0	0 to 10 V	-10 to 0 V	P-ATL	N-ATL
1			Set by parameters*1	
2				
3				
4	0 to 10 V	0 to 10 V	P-ATL	N-ATL
5	0 to 10 V	Not affected.	P-ATL	
6			Set by parameters*1	

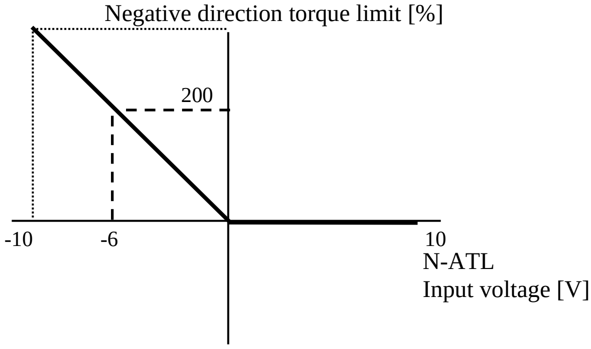
Note 1: When the torque limit value is designated by parameters, see 6-1 “Torque limit switching functions.”

Conversion graphs from analog torque limit input voltage [V] to torque command [%] to motors are shown as follows. The gradients of the graphs show the case of Pr5.27=30. The gradients vary in accord with the Pr5.27 settings.

• Pr5.21 “Torque limit selection” = 0

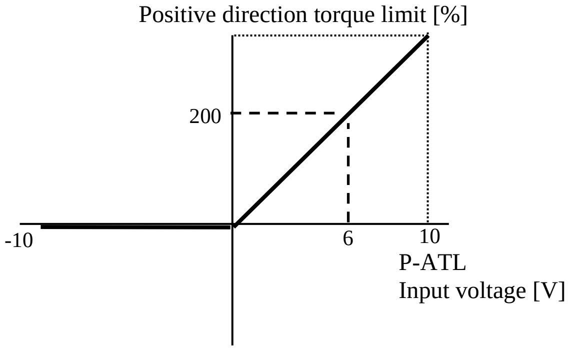
Positive direction analog torque limit [%] = 100 × input voltage [V]/(Pr5.27 setting × 0.1)	Negative direction analog torque limit [%] = 100 × (-input voltage [V])/(Pr5.27 setting × 0.1))

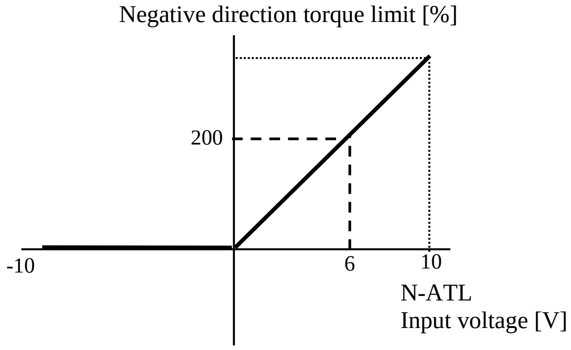




• Pr5.21 “Torque limit selection” = 4

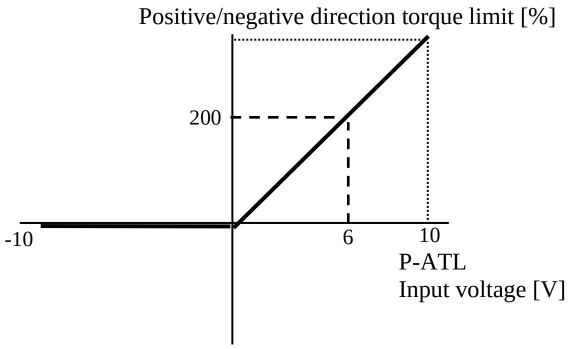
Positive direction analog toque limit [%] = 100×input voltage [V]/(Pr5.27 setting ×0.1)	Negative direction analog toque limit [%] = 100×input voltage [V]/(Pr5.27 setting ×0.1)





• Pr5.21 “Torque limit selection”= 5

Forward/reverse direction analog torque limit [%] =100×input voltage [V]/(Pr5.27 setting×0.1)



6-3 Allowable motor operating range setting function

The motor is set for the range of the position command input by Pr5.14 "Allowable motor operating range."
When the motor exceeds the allowable operating range of motor, the motor is able to be stopped by issuing an alarm by the allowable motor operating range setting protection.

The allowable motor operating range is calculated internally by the amplifier under the following formula:
- Positive direction allowable motor operating range = Positive direction position command entry input range + Pr5.14
- Negative direction allowable motor operating range = Negative direction position command entry input range - Pr5.14

In case the actual motor position for judgment exceeds this range, Err34.0 "Allowable motor operating range abnormal protection" will be detected.

(1) Scope

☐ This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which allowable motor operating range setting function is activated.
Control mode	• Position control and full-closed control
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation.

(2) Precaution

- Take care that this function is not the protection against the abnormal position command.

- When the allowable motor operating range setting protection is activated, the motor is decelerated and stopped in conformity to Pr5.10 "Sequence at alarm."
  Because depending on a load, the load may come in contact with the machine edge and break during deceleration, the range of setting of Pr5.14 shall be the setting with the deceleration action taken into account.

- Err34.0 "Allowable motor operating range abnormal protection" detection processing will be invalid when the allowable motor operating range ([Encoder pulse] or [External scale pulse] units) exceeds $\pm 2^{31}$. *1

- Position command input range and actual motor position for judgment managed inside the amplifier will be cleared and Err34.0 "Allowable motor operating range abnormal protection" detection processing will become invalid, in case any of the following conditions are satisfied:
  - Servo OFF state
  - Speed control state or torque control state
  - During motor test run conducted from front panel
  - During frequency response characteristics are being measured by Set-up support software (PANATERM)
  - Deviation clear state (When deviation counter clear (CL) is entered or when the deviation is cleared in various sequence actions)
  - During test run by Set-up support software (PANATERM) or start of Z-phase search operation
  - Pr5.14 = 0
  - When the value of Pr5.14, under full-close control, satisfies the following formula
    (in case the value of Pr5.14 converted into [External scale pulse] units exceed $\pm 2^{31}$) *1
    Pr5.14 > ((2^{31} -1) * Pr3.24 * 10) / (encoder resolution * Pr3.25)

*1 However in such cases, by enabling the following setting, Err34.0 will occur compulsory regardless of actual motor position for judgment.
Pr6.97 "Function expansion setting 3"
bit2 Expansion of Allowable motor operating range abnormal protection 0: Invalid, 1: Valid

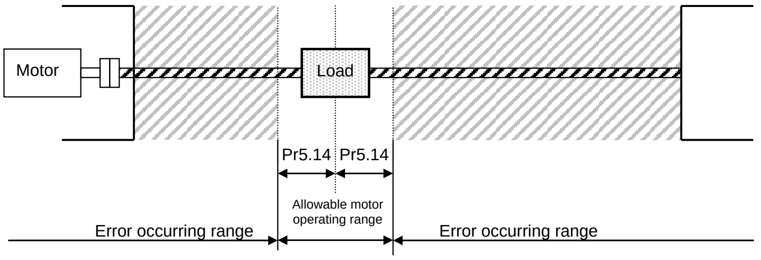
(3) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	14	Allowable motor operating range	0 to 1000	0.1 rotation	Sets allowable motor operating range corresponding to position command input range. In case the set value is exceeded, Err34.0 “Allowable motor operating range abnormal protection” will occur. Protection function invalid when set value = 0. In addition, protection function will be invalid for each condition indicated in the aforementioned precaution.
6	97	Function expansion setting 3	-2147483648 to 2147483647	-	Sets various function in bit units: bit 2: Expansion of Allowable motor operating range abnormal protection 0: Invalid, 1: valid

(4) Action examples

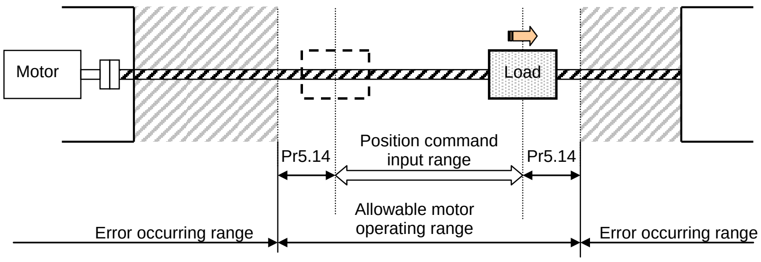
[1] When position command is not entered (with servo ON)

Because the position command is not entered, the allowable motor operating range is the amount of movement set by Pr5.14 on both sides of the motor position. When the motor enters the error occurring range (lightly shaded area) due to oscillation, etc., the allowable motor operating range setting protection occurs.



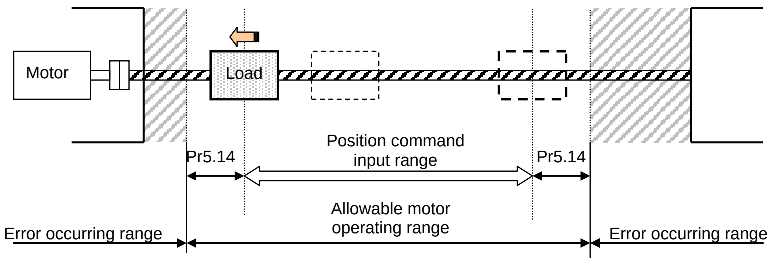
[2] When moving to the positive direction (with servo ON)

When the position command to the positive direction is entered, the allowable motor operating range expands just as much as the position command entered, and becomes the range of rotating speed set by Pr5.14 on both sides of the position command input range.



[3] When moving to the negative direction (with servo ON)

When the position command to the negative direction is entered, the position command input range is further expanded.



6-4 Command division/multiplication switching function

The numerator of command division/multiplication can be switched to four at maximum using DIV1 and DIV2. For the command division/multiplication functions, see 4-2-2 “Command division/multiplication multiplication (electronic gear) function.”

(1) Scope

This function is unable to be applied unless the following conditions are satisfied.

	Conditions in which command division/multiplication switching function is activated.
Control mode	• Position control and full-closed control
Miscellaneous	• To be in the servo ON state. • Elements other than control parameters, such as deviation counter clear command input prohibition, torque limit, etc. are properly set and the motor is free of obstacle to normal motor rotation. • Pr6.28=0 Must be (Block operations disabled (Pulse train enabled)) or = 4 (Block operations enabled by input signal enabled (Pulse train enabled)).

(2) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
0	08	Number of command pulses per one motor rotation	0 to 8388608	pulse	To set the number of command pulses corresponding to one motor rotation. In the case of zero setting or full-closed control, Pr0.09 “First command division/multiplication numerator,” Pr0.10 “Command division/multiplication denominator,” Pr5.00 “Second command division/multiplication numerator,” Pr5.01 “Third command division/multiplication numerator,” and Pr5.02 “Fourth command f division/multiplication numerator” become valid.
0	09	First command division/multiplication numerator	0 to 1073741824	-	To set the numerator of division/multiplication processing for the command pulse input. This becomes valid when Pr0.08 “Number of command pulses per motor rotation” is zero. When the setting is zero at the time of position control, encoder resolution capabilities are set to the numerator. When the setting is zero at the time of full-closed control, the command division/multiplication ratio is forcibly set to 1 to 1.
0	10	Command division/multiplication denominator	1 to 1073741824	-	To set the denominator of division/multiplication processing for the command pulse input. This becomes valid when Pr0.08 “Number of command pulses per motor rotation” is zero.
5	00	Second command division/multiplication numerator	0 to 1073741824	-	To set the second numerator of division/multiplication processing for the command pulse input. This becomes valid when Pr0.08 “Number of command pulses per motor rotation” is zero. When the setting is zero at the time of position control, encoder resolution capabilities are set to the numerator. When the setting is zero at the time of full-closed control, the command division/multiplication ratio is forcibly set to 1 to 1.
5	01	Third command division/multiplication numerator	0 to 1073741824	-	To set the third numerator of division/multiplication processing for the command pulse input. This becomes valid when Pr0.08 “Number of command pulses per motor rotation” is zero. When the setting is zero at the time of position control, encoder resolution capabilities are set to the numerator. When the setting is zero at the time of full-closed control, the command division/multiplication ratio is forcibly set to 1 to 1.
5	02	Fourth command division/multiplication numerator	0 to 1073741824	-	To set the fourth numerator of division/multiplication processing for the command pulse input. This becomes valid when Pr0.08 “Number of command pulses per motor rotation” is zero. When the setting is zero at the time of position control, encoder resolution capabilities are set to the numerator. When the setting is zero at the time of full-closed control, the command f division/multiplication ratio is forcibly set to 1 to 1.

- The correspondence table of DIV1 and DIV2 to the numerator and denominator of command division/multiplication processing to be chosen is shown as follows:

DIV1	DIV2	Command division/multiplication processing	
		Numerator	Denominator
OFF	OFF	Pr0.09	Pr0.10
ON	OFF	Pr5.00	Pr0.10
OFF	ON	Pr5.01	Pr0.10
ON	ON	Pr5.02	Pr0.10

■ Precautions

When the DIV1/DIV2 input has been changed over to change the division numerator, the relationship will change between the position command data controlled by the higher-level device and the internal position command after the position command filter of the servo driver. When conducting an operation that requires the position control, carry out the return to origin.

6-5 Settings of various sequence actions

Sequences in various action states can be optionally set.

6-5-1 Sequence at the time of drive prohibition inputs (POT and NOT)

The action sequence after entering drive prohibition inputs (POT and NOT) is set.

(1) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	04	Drive prohibition input setting	0 to 2	-	To set entering action of drive prohibition inputs (POT and NOT) 0: Functions as POT→ Positive direction drive prohibition and NOT→ Negative direction drive prohibition. When POT is entered at the time of positive direction action, the motor stops in compliance with Pr5.05 “Sequence at drive prohibition” In the case of negative direction, the motor makes same action at the time of NOT input. 1: POT and NOT become invalid and do not exert any effect on actions. 2: Err38.0 “Drive prohibition input protection” occurs by entering either POT or NOT.
5	05	Sequence at drive prohibition	0 to 2	-	To set the state during deceleration and stop after drive prohibition inputs (POT and NOT) are entered when Pr5.04 “Drive prohibition input setting” is 0.
5	11	Immediate stop torque setting	0 to 500	%	To set the torque limit at the time of an immediate stop.

(2) Content

• Detail of Pr5.05 “Sequence at drive prohibition”

Pr5.04	Pr5.05	During deceleration*6	After stop	Position deviation/ External scale deviation
0	0	Dynamic brake action	Torque command = 0 in drive prohibition direction	Retention*2*7
	1	Torque command = 0 in drive prohibition direction	Torque command = 0 in drive prohibition direction	Retention*2*7
	2	Immediate stop*5	Torque command = 0 in drive prohibition direction*1	Clear before and after deceleration *3

*1 In the case of position control and full-closed control, position command = 0 state is indicated, in the case of velocity control, speed command = 0 state, and in the case of torque control, speed limit value =0 state.

*2 Continuing giving commands in the drive prohibition direction with drive prohibition input set to ON causes position deviation to accumulate and Err24.0 “Excess position deviation error.” When the drive prohibition input is turned ON, stop giving commands in the drive prohibition direction.

*3 Position deviation and external scale deviation are cleared twice, deceleration start instance and deceleration completion instance. In the event that the position is controlled in order to clear the position deviation and external scale deviation, home position return action must be conducted to return.

*4 Because in the event that the setting is 2 in Pr5.04 “Drive prohibition input setting,” Err38.0 “Drive prohibition input protection” occurs when either one of POT or NOT turns ON, the motor operates not in accordance with this setting but in accordance with Pr5.10 “Sequence at alarm.” When other error occurs, too, priority is given to Pr5.10 “Sequence at alarm” in the same manner.

*5 Immediate stop means to immediately stop with control applied while servo is turned ON.
The torque command value in such event is restricted by Pr5.11 “Immediate stop torque setting.”
Because an immediate stop abruptly decelerates the motor, in position control, the position deviation may instantaneously increase, and Err24.0 “Position deviation excess protection” or Err34.0 “Allowable motor operating range setting error protection” may occur.
In such event, set Pr0.14 “Position deviation excess setting” and Pr5.14 “Allowable motor operating range” to appropriate values.
To stop with the torque set by “Immediate stop torque setting,” continue to provide normal command for at least 4 ms from signal input.

*6 During deceleration means an interval in which the motor achieves the speed lower than 30 r/min from the condition in which the motor operates. When the motor speed becomes 30 r/min or lower once and then changes after stopping, the motor follows the state after stopping irrespective of the motor speed.

*7 When the Pr6.28 ”Special function selection” is not zero, it becomes “Clear before and after deceleration.” Please refer to (Modbus communication specifications / Block operation function) for details.

6-5-2 Sequence with Servo OFF

The operation sequence in Servo OFF condition is set.

(1) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	06	Sequence at Servo OFF.	0 to 9	-	To set the state during deceleration and after stop with Servo OFF.
5	11	Immediate stop torque setting	0 to 500	%	To set the torque limit at the time of immediate stop.

(2) Content

• Detail of Pr5.06 "Sequence at servo-off"

Pr5.06	During deceleration*4	After stop	Position deviation and External scale deviation
0	Dynamic brake (DB) action	Dynamic brake (DB) action	Cleared
1	Free run (DB OFF)	Dynamic brake (DB) action	Cleared
2	Dynamic brake (DB) action	Free (DB OFF)	Cleared
3	Free run (DB OFF)	Free (DB OFF)	Cleared
4	Dynamic brake (DB) action	Dynamic brake (DB) action	Held*2
5	Free run (DB OFF)	Dynamic brake (DB) action	Held*2
6	Dynamic brake (DB) action	Free (DB OFF)	Held*2
7	Free run (DB OFF)	Free (DB OFF)	Held*2
8	Immediate stop*1	Dynamic brake (DB) action	Cleared*5
9	Immediate stop*1	Free (DB OFF)	Cleared*5

*1 An immediate stop means to instantaneously stop with control applied with Servo ON.
The torque command value in such event is restricted by Pr5.11 "Immediate stop torque setting."

*2 Continuing to give the position command with Servo OFF, or continuing to operate the motor causes position deviation to accumulate, and Err24.0 "Excess position deviation error" may occur. In addition, turning servo ON under the condition of large position deviation and external scale deviation causes control to zero the deviation to take place, and the motor may suddenly operate. When the motor is used with position deviation and external scale deviation held, take utmost care to the above.

*3 When any error occurs with Servo OFF, the motor operates in accordance with Pr5.10 "Sequence at alarm." In addition, when the main power supply is turned OFF with Servo OFF, the motor follows Pr5.07 "Main power OFF sequence."

*4 During deceleration means an interval in which the motor achieves the speed lower than 30 r/min from the condition in which the motor operates. When the motor speed becomes 30 r/min or lower once and then changes after stopping, the motor follows the state after stopping irrespective of the motor speed.

*5 Position deviation and external scale deviation are cleared before and after deceleration and after shifting to servo-OFF, position deviation and external scale deviation are constantly zero-cleared.

6-5-3 Sequence with main power supply OFF

The action sequence with the main power supply OFF is set.

(1) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	07	Main power supply OFF sequence	0 to9	-	To set the state during deceleration and after stop with main power supply OFF.
5	11	Immediate stop torque setting	0 to 500	%	To set the torque limit at the time of immediate stop.

(2) Content

• Detail of Pr5.07 "Main power supply OFF sequence"

Pr5.07	During deceleration	After stop		Position deviation and External scale deviation
		Pr6.36 = 0	Pr6.36 = 1	
0	Dynamic brake (DB) action	Dynamic brake (DB) action	Dynamic brake operates in accordance with the status of dynamic brake switch input (DB-SEL). *6	Cleared
1	Free run (DB OFF)	Dynamic brake (DB) action		Cleared
2	Dynamic brake (DB action	Free (DB OFF)		Cleared
3	Free run (DB OFF)	Free (DB OFF)		Cleared
4	Dynamic brake (DB action	Dynamic brake (DB) action		Held *2
5	Free run (DB OFF)	Dynamic brake (DB) action		Held *2
6	Dynamic brake (DB action	Free (DB OFF)		Held *2
7	Free run (DB OFF)	Free (DB OFF)		Held *2
8	Immediate stop *1	Dynamic brake (DB) action		Cleared *5
9	Immediate stop *1	Free (DB OFF)		Cleared *5

*1 An immediate stop means to instantaneously stop with control applied with Servo ON.
The torque command value in such event is restricted by Pr5.11 "Immediate stop torque setting."

*2 Continuing to give the position command with the main power supply OFF, or continuing to operate the motor causes position deviation to accumulate, and Err24.0 "Excess position deviation error" may occur. In addition, turning servo ON under the condition of large position deviation and external scale deviation causes control to zero the deviation to take place, and the motor may suddenly operate. When the motor is used with position deviation and external scale deviation held, take utmost care to the above.

*3 When any error occurs with the main power supply OFF, the motor operates in accordance with Pr5.10 "Sequence at alarm." When the main power supply is turned OFF with Servo ON, and in the event that bit0 of Pr5.08 "LV trip selection with the main power OFF" is 1, Err13.1 "Main power supply short voltage error" occurs, and the motor operates in accordance with Pr5.10 "Sequence at alarm."

*4 During deceleration means an interval in which the motor achieves the speed lower than 30 r/min from the condition in which the motor operates. When the motor speed becomes 30 r/min or lower once and then changes after stopping, the motor follows the state after stopping irrespective of the motor speed.

*5 Position deviation and external scale deviation are cleared before and after deceleration and after shifting to main power supply OFF, position deviation and external scale deviation are constantly zero-cleared.

*6 When Dynamic brake operation input is enabled (Pr6.36 = 1), Dynamic brake switch input (DB-SEL) will be possible. In input and output signal assignment, if connected to the COM- by a contact setting, Dynamic brake that built in driver will release, in case of disconnected to COM- , Dynamic brake that built in driver will operate. When servo ON, during the trip or main power is turned on, this input is disabled and the motor operates in accordance with normal sequence setting.

6-5-4 Sequence at alarm

Action sequence in the alarm generated state is set.

(1) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	10	Sequence at alarm	0 to7	-	To set the state during deceleration and after a stop when an alarm is generated.

(2) Content

• Detail of Pr5.10 "Sequence at alarm"

Pr5.10	During deceleration*3	After stop	Position deviation/ External scale deviation
0	Dynamic brake (DB) action	Dynamic brake (DB) action	Cleared*1
1	Free run (DB OFF)	Dynamic brake (DB) action	Cleared*1
2	Dynamic brake (DB) action	Free (DB OFF)	Cleared*1
3	Free run (DB OFF)	Free (DB OFF)	Cleared*1
4	Action A: Immediate stop Action B: DB operation*2	Dynamic brake (DB) action	Cleared*1
5	Action A: Immediate stop Action B: DB OFF*2	Dynamic brake (DB) action	Cleared*1
6	Action A: Immediate stop Action B: DB operation*2	Free (DB OFF)	Cleared*1
7	Action A: Immediate stop Action B: DB OFF*2	Free (DB OFF)	Cleared*1

*1 Position deviation and external scale deviation when alarm is generated are held in the alarm generated state, and cleared when alarm is cleared.

*2 Action A and B indicates whether an immediate stop is carried out when any error is generated. When the alarm that must respond to an immediate stop is generated, and when this setting is 4 to 7, the motor follows action A and an immediate stop is conducted. When the alarm that does not respond to an immediate stop occurs, no immediate stop takes place and dynamic brake (DB) operation or free run designated in action B result (see 6-5-5).

For the time until the motor makes a deceleration stop, keep the main circuit power supply ON.

For the alarm that responds to an immediate stop, see 7-1 "Protection function list."

*3 During deceleration means an interval in which the motor achieves the speed lower than 30 r/min from the condition in which the motor operates. When the motor speed becomes 30 r/min or lower once and then changes after stopping, the motor follows the state after stopping irrespective of the motor speed.

6-5-5 An immediate stop action when alarm comes on.

The motor is controlled and immediately stopped when alarm that must respond to an immediate stop occurs.

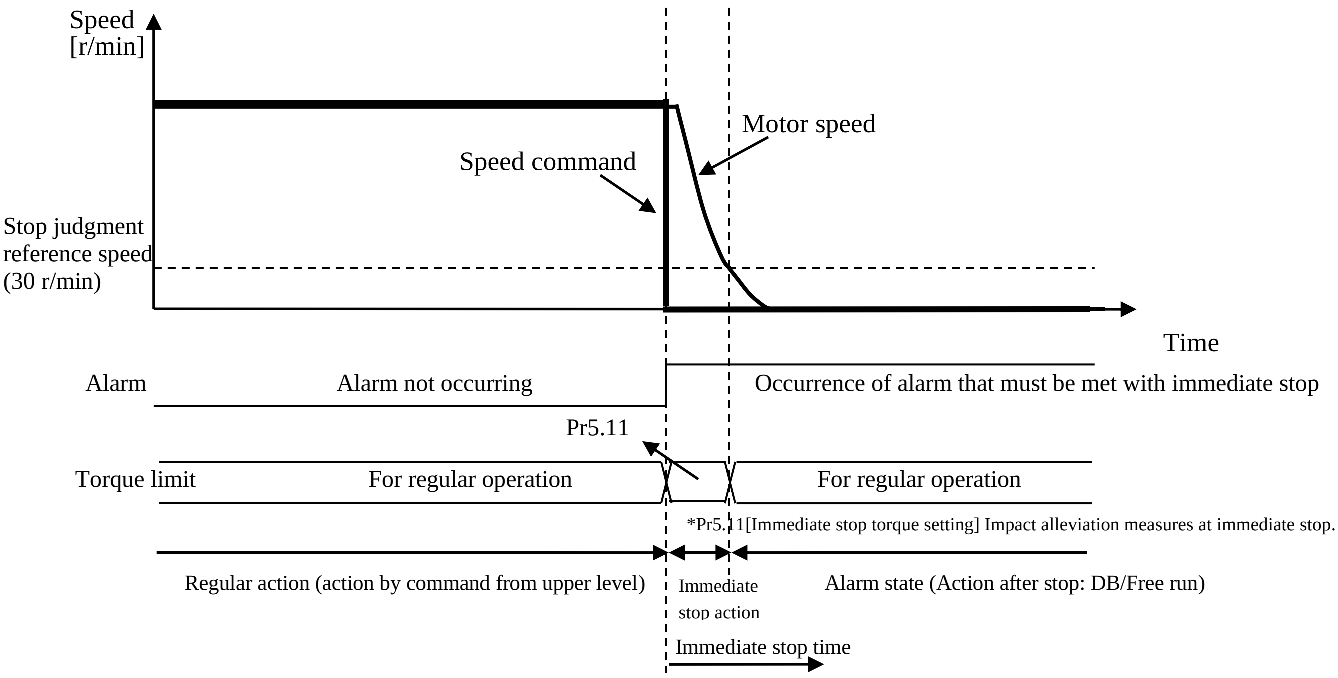
(1) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	10	Sequence at alarm	0 to 7	-	To set the state during deceleration and after stopping when alarm is generated. Setting to 4 through 7 enables an immediate stop.
5	11	Immediate stop torque setting	0 to 500	%	To set torque limit at an immediate stop.
5	13	Overspeed level setting	0 to 20000	r/min	To set detection level for Err 26.0 “Over speed protection”. Maximum motor revolution x 1.2 when value set to 0. Furthermore, internal value is limited to maximum motor revolution x 1.2. *1
6	14	Immediate stop time at the time of alarming	0 to 1000	ms	To set the allowable time to stop at an immediate stop when alarm is generated. When this setting is exceeded, the motor is forced to be in the alarm state. In the case of zero setting, no immediate stop takes place but the motor becomes in the immediate alarm state.
6	15	Second overspeed level setting	0 to 20000	r/min	When the motor speed exceeds this setting, Err26.1 “Second overspeed protection” occurs. In the case of zero setting, the overspeed level is the value of motor maximum rotating speed x 1.2 time. *1

*1 Except for some motors.

(2) Content

• Immediate stop action when alarm that must respond to an immediate stop occurs

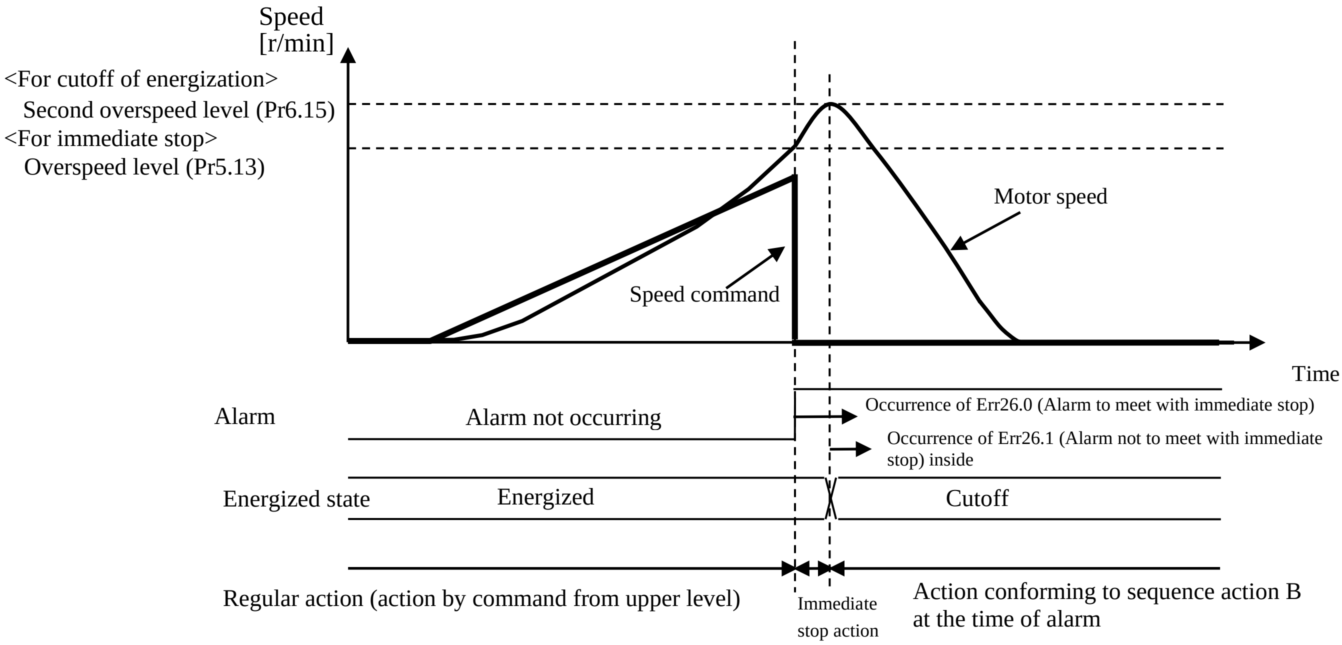


The immediate alarm state is generated when the actual speed is not 30 r/min or lower even after the time set in Pr6.14 “Immediate stop time at the time of alarming” passes after the alarm that must be met with an immediate stop comes on. In addition, if alarm not responding to an immediate stop occurs inside the driver in the middle of an immediate stop, the immediate alarm state is generated.

• Setting of Pr5.13 “Overspeed level setting” and Pr6.15 “Second overspeed level”

There are cases in which the motor does not normally stop even when the immediate stop function is used.
For example, as illustrated below, where are cases in which the motor speed rises because the motor is unable to be normally controlled even if the motor speed exceeds Pr5.13 “Overspeed level setting” and the motor enters the immediate stop action
For safety measures in such case, Err26.1 “Second overspeed protection” is provided.
Because Err26.1 is the alarm that does not respond to an immediate stop, motor energization is cut off to stop the motor in accordance with the sequence action B at the time of alarm. Set the allowable overspeed level to Pr6.15 “Second overspeed level setting.”

Furthermore, set Pr5.13 to a low value with sufficient margin to Pr6.15. In the case of small margin or the same setting, both Err26.0 and Err26.1 may be detected. In such event, Err26.0 is displayed but because Err26.1 is generated inside, the alarm that does not respond to an immediate stop is prioritized, and no immediate stop takes place.
Furthermore, in the event that Pr6.15 is set to be lower than Pr5.13, Err26.1 is generated before Err26.0, and no immediate stop takes place.



When the speed set in Pr6.15 “Second overspeed level setting” is exceeded, energization is cut off and actions conforming to sequence action B at the time of alarm is performed.

6-5-6 Drop prevention function when alarm comes on

Since the servo driver shuts down the motor energization upon occurrence of an alarm, a drop will occur on the vertical axis as of a robotic arm for the period from the moment of the brake release output (BRK-OFF) turning OFF to the actual functioning of the external brake.

This function can prevent any drop at the occurrence of an alarm by setting the on-alarm sequence to the immediate stop.

This function can't be used with an alarm that doesn't respond to an immediate stop.

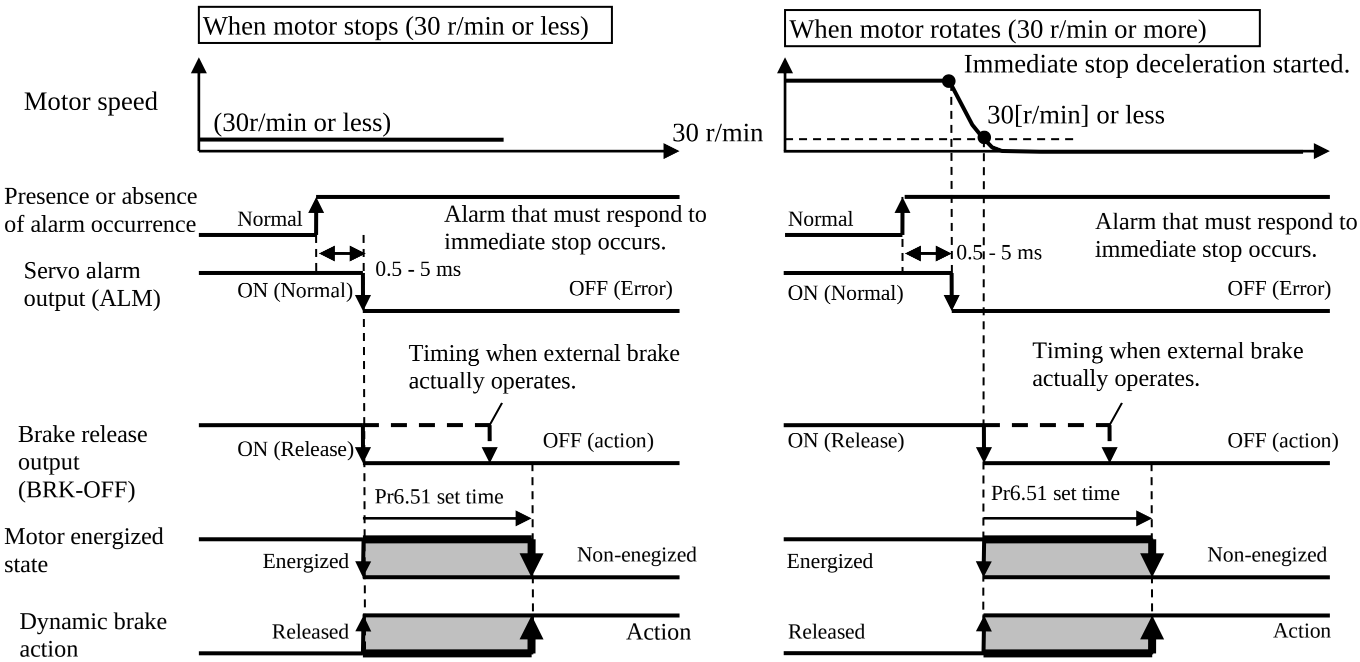
Please refer to 6-5-4 and 6-5-5 for "Sequence at alarm," and 7-1 for alarms that respond to an immediate stop.

(1) Related parameters

Class.	No.	Parameter name	Setting range	unit	Functions
5	10	Sequence at alarm	0 to7	-	To set the state during deceleration and after stopping when alarm is generated. Setting to 4 through 7 enables an immediate stop.
6	10	Function expansion setting	-32768 to 32767	-	To set the bit concerning drop prevention function. bit10: Drop prevention function at the time of alarm Position deviation processing 0: Invalid (retention) 1: Valid (clear) When the drop prevention function is made enabled, usually set to 1. Note: The least significant bit is designated as bit0.
6	51	Immediate stop completion wait time	0 to 10000	ms	When alarm that must respond to an immediate stop is generated, after turning OFF the brake release output (BRK-OFF), set the time to maintain the motor energization. In the case of zero setting, the drop prevention function is disabled.

(2) Content

• Drop prevention function action when alarm that must respond to an immediate stop



(Note) In the event that the drop prevention function is enabled when alarm is generated, set Pr5.10 "Sequence at alarm" to 4, Pr6.10 "Function expansion setting" bit 10 to "1," and a value longer than the time when brake release output (BRK-OFF) is turned OFF and external brake actually operates to Pr6.51 "Immediate stop end wait time."

6-5-7 Slow stop function

This allows the motor control to stop smoothly with the servo still remaining ON, when drive prohibited input, servo-OFF, main power OFF or immediate stop supporting alarm is detected under immediate stop setting.

(1) Scope of application

☐ This function cannot be applied unless the following conditions are satisfied.

	Condition for activation of slow stop function
Control mode	• Position control (Pr0.01=0)
Others	• Servo-ON state • Elements other than control parameters, such as torque limit, etc. have been appropriately set, without any problems in normal operations. • Block operation is set to “invalid.”

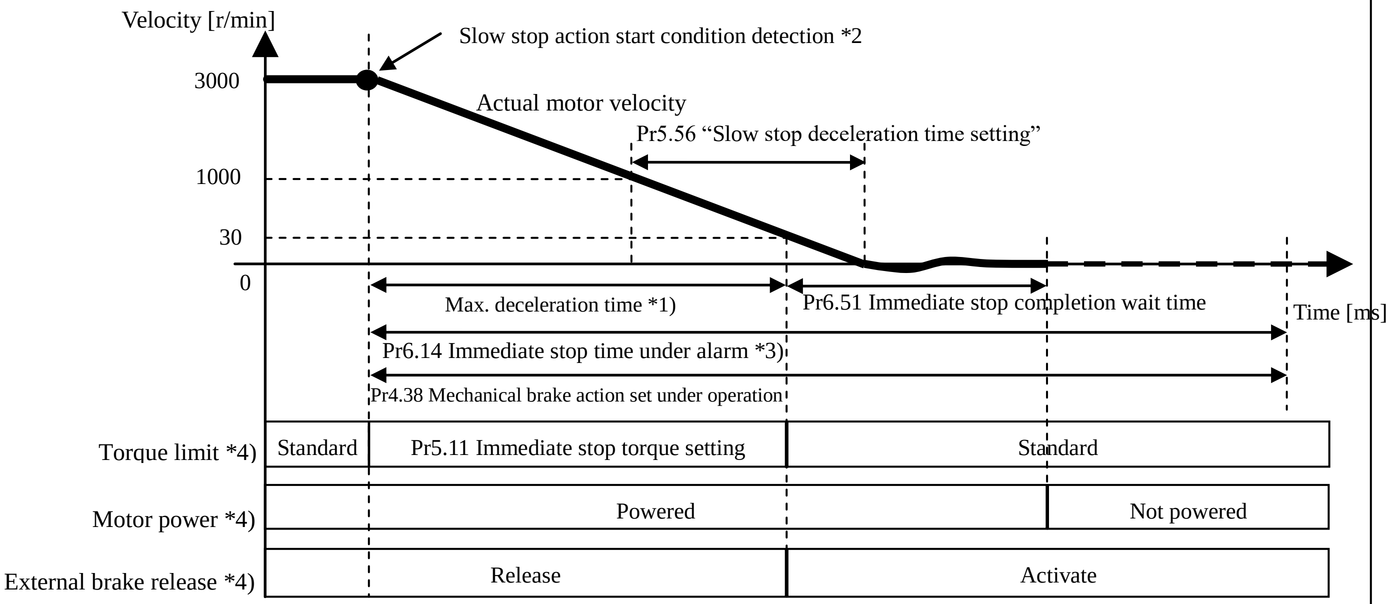
(2) Related parameters

Class	No.	Parameter name	Set range	Units	Functions
5	56	Slow stop deceleration time setting	0 to 10000	ms / (1000 r/min)	Sets the deceleration time under slow stop. This function will become effective when Pr6.10 “Function enhancement setting” bit 15 is set to 1.
5	57	Slow stop S-shape acceleration and deceleration setting	0 to 1000	ms	Sets the S-shape time for deceleration under slow stop. This function will become effective when Pr6.10 “Function enhancement setting” bit 15 is set to 1.
6	10	Function enhancement settings	-32768 to 32767	-	bit 10: Fall prevention function, position deviation processing under alarm 0 :Invalid (maintain), 1: Valid (clear) To enable the slow stop function, set to 1. bit 15: Slow stop function 0 :Invalid, 1: Valid *Only valid in case position control is set (Pr0.01 = 0) and block operation is invalid (Pr6.28 = 0)
6	14	Immediate stop time under alarm	0 to 1000	ms	Sets the allowable time for stopping when alarm is triggered for immediate stop. Exceeding this set value will trigger a forced alarm condition. In case the set value is 0 (zero), no immediate stop will be made, but an alarm condition will immediately occur. In case the slow stop function is to be used, set it to a length sufficiently longer than the maximum deceleration time, as the motor velocity will have a delay from the deceleration and stop command. * Please refer to (3) of this item for maximum deceleration time.

(3) Contents

• Slow stop operation

The figure below indicates the case of slow stop operation under alarm.



*1) The maximum deceleration time is approximately the value obtained by the following formula:
Maximum deceleration time [ms]

$$= \frac{\text{Maximum velocity under normal operation pattern [r/min]) x Pr5.56 [ms/(1000 r/min)]}}{1000} + \text{Pr5.57 [ms]}$$

*2) To be the detection of following conditions:
- Drive prohibited input with slow stop function valid setting.
- Servo-OFF with slow stop function valid setting.
- Main power OFF with slow stop function valid setting.
- Immediate stop response alarm triggered with slow stop function valid setting.

For immediate stop response alarm, refer to 7-1.

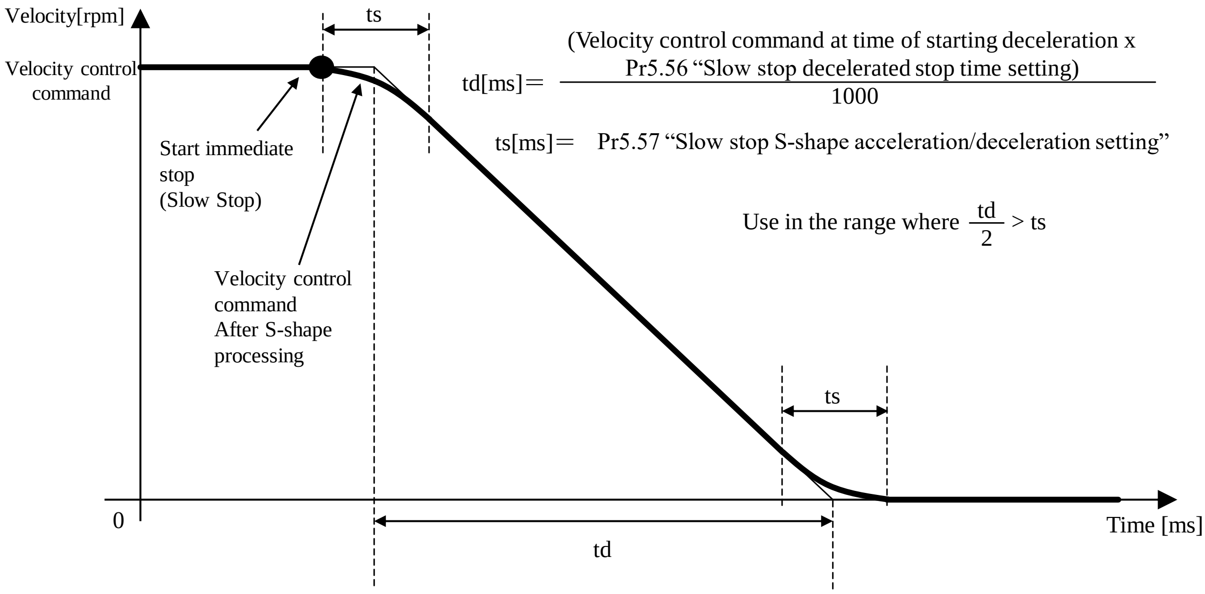
*3) Please set Pr6.14 "Immediate stop time under alarm" to a value that is sufficiently long in length than the completion of slow stop operation. The stop judgment under slow stop operation is based on actual velocity. Therefore, the time required for the actual deceleration may take longer than the maximum deceleration time. In the immediate stop operation from immediate stop response alarm, in case the immediate stop continuation duration exceeds Pr6.14 "Immediate stop time under alarm", an alarm state will be triggered regardless of the actual motor velocity.
Furthermore, immediate alarm condition will be triggered in case immediate stop non-response alarm is generated inside the driver during immediate stop.

*4) There will be a maximum variance of about 5 [ms] in the switching timing.

Note) Please maintain the main circuit power supply during the time of decelerated stop.

・ S shape processing of slow stop operation

S shape process at the time of slow stop operation can be made by setting Pr5.57. Refer to the following figure to set Pr5.57.



*) Velocity control command at the time of starting slow stop operation shall be calculated from the actual velocity.

・ Braking distance

When Pr 5.56 and Pr5.57 has been set, the braking distance under immediate stop will increase by approximately the following formula. Please confirm its influence on the actual machine operations, when using.

1) In case of linear deceleration (Pr5.57 =0)
   Linear decelerating time [s]

$$= \frac{\text{(Velocity control command at time of starting deceleration [r/min])} \times \text{Pr5.56 [ms/(1000r/min)]}}{1000 \times 1000}$$

   Linear deceleration brake distance [revolution]

$$= \frac{\text{(Velocity control command at time of starting deceleration [r/min])} \times \text{Linear decelerating time [s]}}{60 \times 2}$$

$$= \frac{\text{(Velocity control command at time of starting deceleration [r/min])}^2 \times \text{Pr5.56 [ms/(1000r/min)]}}{60 \times 2 \times 1000 \times 1000}$$

2) For S-shape deceleration (Pr5.57 ≠ 0)
   S-shape deceleration braking distance [revolution]

$$= \text{Linear deceleration brake distance [revolution]} + \frac{\text{(Velocity control command at time of starting deceleration [r/min])} \times \text{Pr5.57 [ms]}}{60 \times 1000 \times 2}$$

Note) The above formulae are braking distances for the velocity control command only and the actual motor control delay has to be taken into account. Furthermore, in case the torque command under deceleration is restricted by immediate stop torque stetting, the braking distance will not be as per the formulae indicated above.

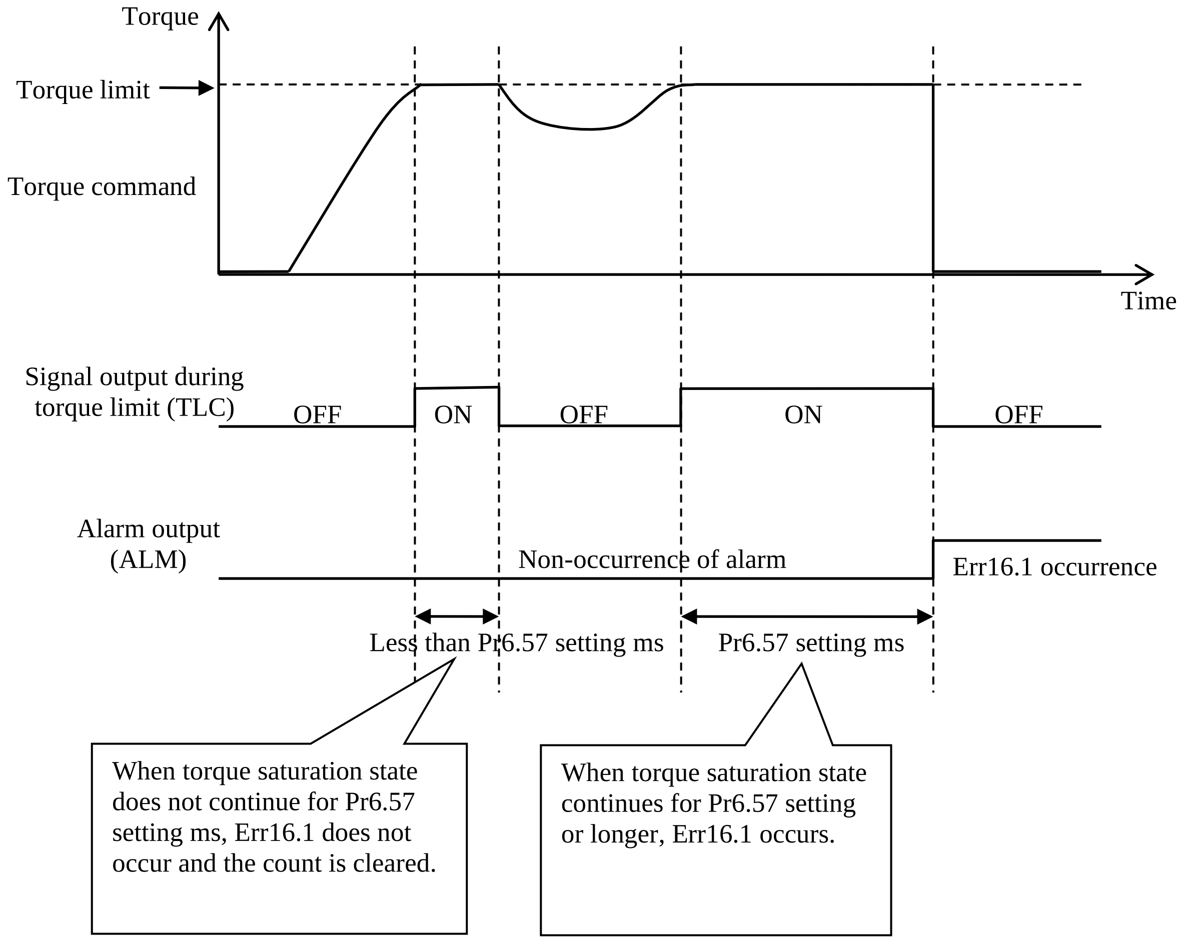
6-6 Torque saturation protection function

When the torque saturation state continues for a given period, alarm is able to be generated.

■ Related parameter

Class.	No.	Parameter name	Setting range	unit	Functions
6	57	Torque saturation error protection detection time	0 to 5000	ms	Set torque saturation error protection detection time. When torque saturation occurs for longer than the time setting, Err16.1 “Torque saturation error protection” occurs. In the event that the setting is 0, this function is invalidated and Err16.1 does not occur.

- For example, Err16.1 occurs when the torque saturation state continues for about 5 seconds when 5000 is set.
- When torque is controlled, this function is invalidated and Err16.1 does not occur.
- When an immediate stop alarm occurs, this function is invalidated and Err 16.1 does not occur.
- When torque is controlled, Torque in-limit signal output (TLC) is always ON.



6-7 Position compare output function

A pulse signal can be output from the generic output or the position compare output when the actual position has passed the position set in the parameter.

(1) Specification

Trigger output	I/F	[Generic output] 6 output (SO1 to 6) : Photocoupler (Open collector) [Position compare output] 1 output (OCMP4): Open collector 3 output (OCMP1 to 3): Line driver
	Logic	Parameter set (Polarity can be set for each output)
	Pulse width	Parameter set 0.1 to 3276.7 ms (in 0.1 ms units)
	Delay compensation	Available
Compare source	Encoder (comms)	Available
	External scale (comms)	Available
	External scale (A, B phase)	Available
Compare value	Set quantity	8 points
	Set range	32-bit with sign

(2) Applicable range

☐ This function is available only when the following conditions are satisfied:

	Conditions where position compare output function are valid
Control mode	• Either position control or full-closed control
Other	• Block operation set to valid (Pr6.28≠0) • Return to origin operation completed state if in incremental mode. (In case block operation return to origin invalid setting is set to invalid). • All parameters except for the control parameters are set appropriately and there are nothing to obstruct the normal rotation of the motor. • Other than Countinuous rotating absolute mode (Pr0.15=4).

(3) Precaution

Position compare output accuracy may deteriorate under the following condition:

- In case the number of external scale pulses per one motor revolution is extremely lower than 23 bits, under full-closed control.

(4) Related parameters

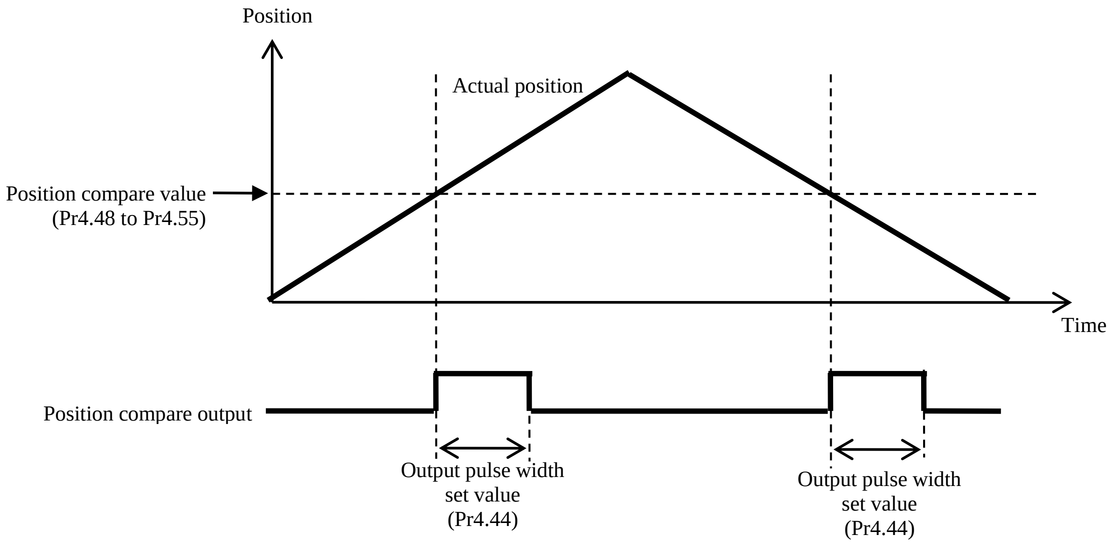
Class	No.	Parameter name	Set range	Units	Functions
4	44	Position compare output pulse width setting	0 to 32767	0.1 ms	Sets pulse width of position compare output No pulse output when 0 (zero)
4	45	Position compare output polarity select	0 to 63	-	Polarity of position compare output can be set by bit for each output terminal. ・ Set bits bit0 : SO1 or OCMP1 bit1 : SO2 or OCMP2 bit2 : SO3 or OCMP3 bit3 : SO4 or OCMP4 bit4 : SO5 bit5 : SO6 ・ Set value 0: Sets output photocoupler to ON for SO1 to 6, during pulse output and to L level for OCMP 1 to 4. 1: Sets output photocoupler to OFF for SO1 to 6, during pulse output and to H level for OCMP 1 to 4. Basically to be used set to 0.

(Continued)

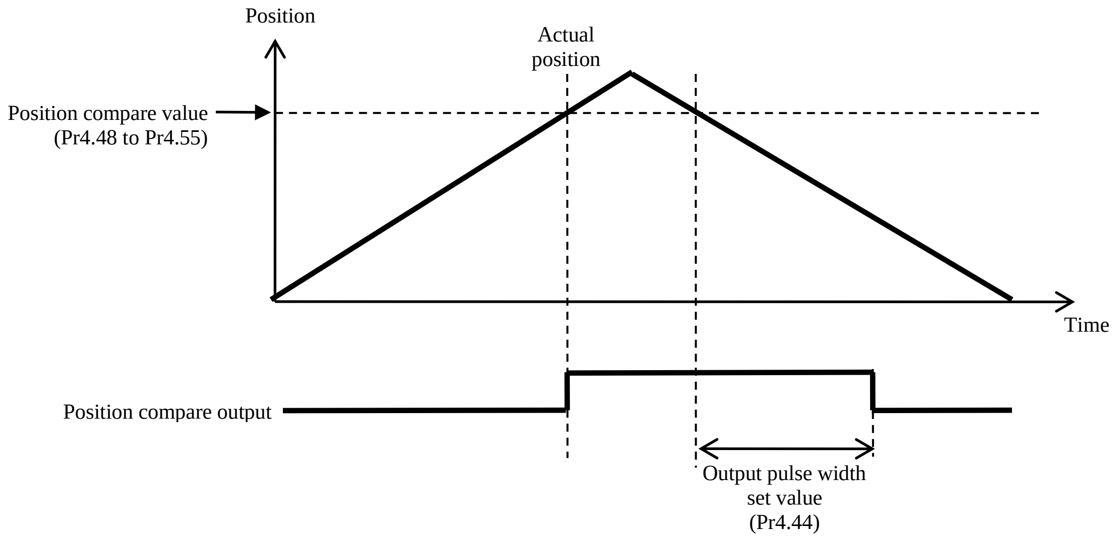
<table>
<tr><th>Class</th><th>No.</th><th>Parameter name</th><th>Set range</th><th>Units</th><th>Functions</th></tr>
<tr><td>4</td><td>47</td><td>Pulse output select</td><td>0 to7</td><td>-</td><td>Selects signal to be output from pulse output/position compare output terminal:
<table>
<tr><th>Set value</th><th>Connector pin No.21/22</th><th>Connector pin No.48/49</th><th>Connector pin No.23/24</th><th>Connector pin No.19</th></tr>
<tr><td>0</td><td>OA</td><td>OB</td><td>OZ</td><td>CZ</td></tr>
<tr><td>1</td><td>OCMP1</td><td>OCMP2</td><td>OZ</td><td>CZ</td></tr>
<tr><td>2</td><td>OA</td><td>OB</td><td>OCMP3</td><td>OCMP3</td></tr>
<tr><td>3</td><td>OCMP1</td><td>OCMP2</td><td>OCMP3</td><td>OCMP3</td></tr>
<tr><td>4</td><td>OA</td><td>OB</td><td>OZ</td><td>OCMP4</td></tr>
<tr><td>5</td><td>OCMP1</td><td>OCMP2</td><td>OZ</td><td>OCMP4</td></tr>
<tr><td>6</td><td>OA</td><td>OB</td><td>OCMP3</td><td>OCMP4</td></tr>
<tr><td>7</td><td>OCMP1</td><td>OCMP2</td><td>OCMP3</td><td>OCMP4</td></tr>
</table>
*OA, OB, OZ, and CZ are pulse output signals and OCMP1, OCMP2, OCMP3, and OCMP4 are position compare output signals.</td></tr>
<tr><td>4</td><td>48</td><td>Position compare value 1</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 1 comparison value</td></tr>
<tr><td>4</td><td>49</td><td>Position compare value 2</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 2 comparison value</td></tr>
<tr><td>4</td><td>50</td><td>Position compare value 3</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 3 comparison value</td></tr>
<tr><td>4</td><td>51</td><td>Position compare value 4</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 4 comparison value</td></tr>
<tr><td>4</td><td>52</td><td>Position compare value 5</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 5 comparison value</td></tr>
<tr><td>4</td><td>53</td><td>Position compare value 6</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 6 comparison value</td></tr>
<tr><td>4</td><td>54</td><td>Position compare value 7</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 7 comparison value</td></tr>
<tr><td>4</td><td>55</td><td>Position compare value 8</td><td>-2147483648 to 2147483647</td><td>Command unit</td><td>Sets position compare 8 comparison value</td></tr>
<tr><td>4</td><td>56</td><td>Position compare output delay compensation amount</td><td>-32768 to 32767</td><td>0.1μs</td><td>Compensates circuit delay of position compare output.</td></tr>
<tr><td>4</td><td>57</td><td>Position compare output assignment setting</td><td>-2147483648 to 2147483647</td><td>-</td><td>Sets output terminal corresponding to position compare 1 to 8 by bit. Multiple position compare values can be set to a single output terminal.
・ Set bits
bit0 to 3: Position compare 1
bit4 to 7: Position compare 2
bit8 to 11: Position compare 3
bit12 to 15: Position compare 4
bit16 to 19: Position compare 5
bit20 to 23: Position compare 6
bit24 to 27: Position compare 7
bit28 to 31: Position compare 8
・ Set value
0000: Output invalid
0001: Assigned to SO1 or OCMP1
0010: Assigned to SO2 or OCMP2
0011: Assigned to SO3 or OCMP3
0100: Assigned to SO4 or OCMP4
0101: Assigned to SO5
0110: Assigned to SO6
Other than above: For manufacturer use (please do not use)</td></tr>
<tr><td>5</td><td>94</td><td>Position compare output conditions setup</td><td>0 to 2</td><td>-</td><td>Select the operation direction in which the position compare output is enabled.
0: Enabled both in positive and negative directions
1: Enabled only when operated in positive direction
2: Enabled only when operated in negative direction</td></tr>
</table>

(5) Operation

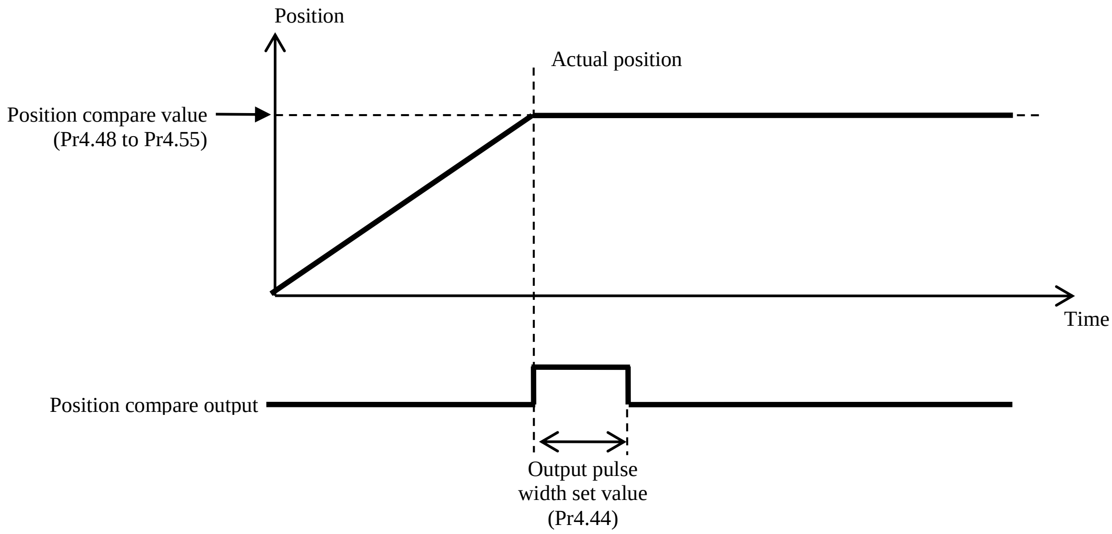
- A time width pulse set in Pr4.44 “Position compare output pulse width setting” will be output, when the actual position of the encoder passes over the position compare value (Pr4.48 to Pr4.55),



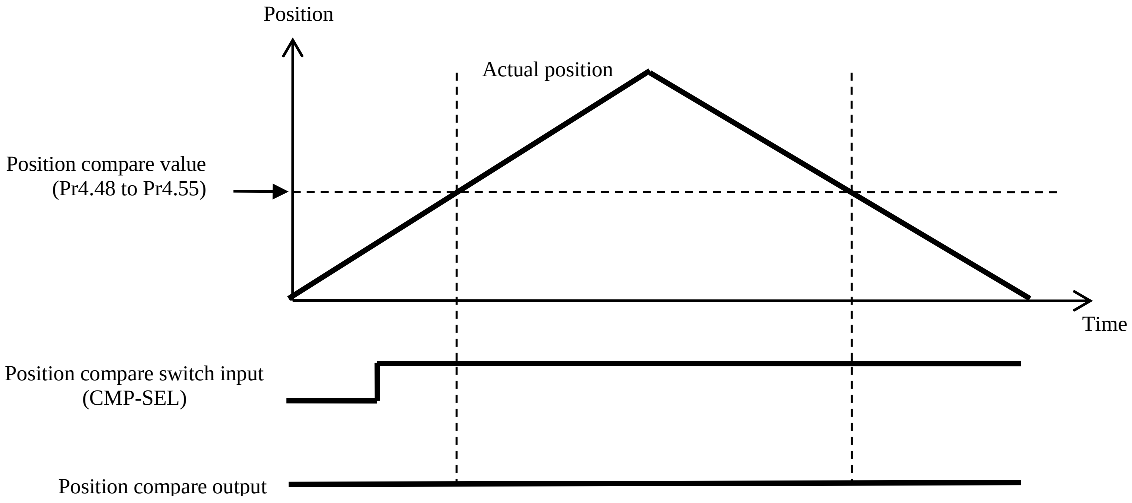
- Regardless of the direction of encoder position travel, a pulse will be output when the magnitude correlation changes as it passes over the position compare value.
- Multiple position compare value can be set to one position compare output.
- In the case that the operation direction has been reversed, or multiple position compare values have been set, when the encoder position or external scale position has passed the position compare value during pulse signal output, a state where pulse output is ON will continue from the time of the most recent passing until the output pulse width set value is reached.



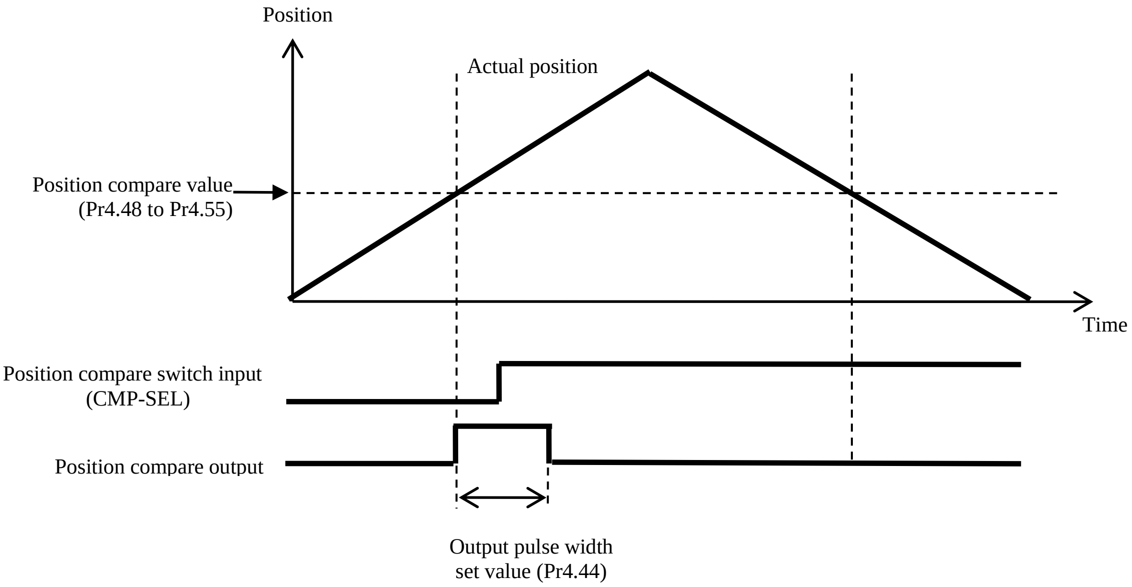
- When stopped at the same position as the position compare value, a single pulse will be output, similar to the case of passing over.



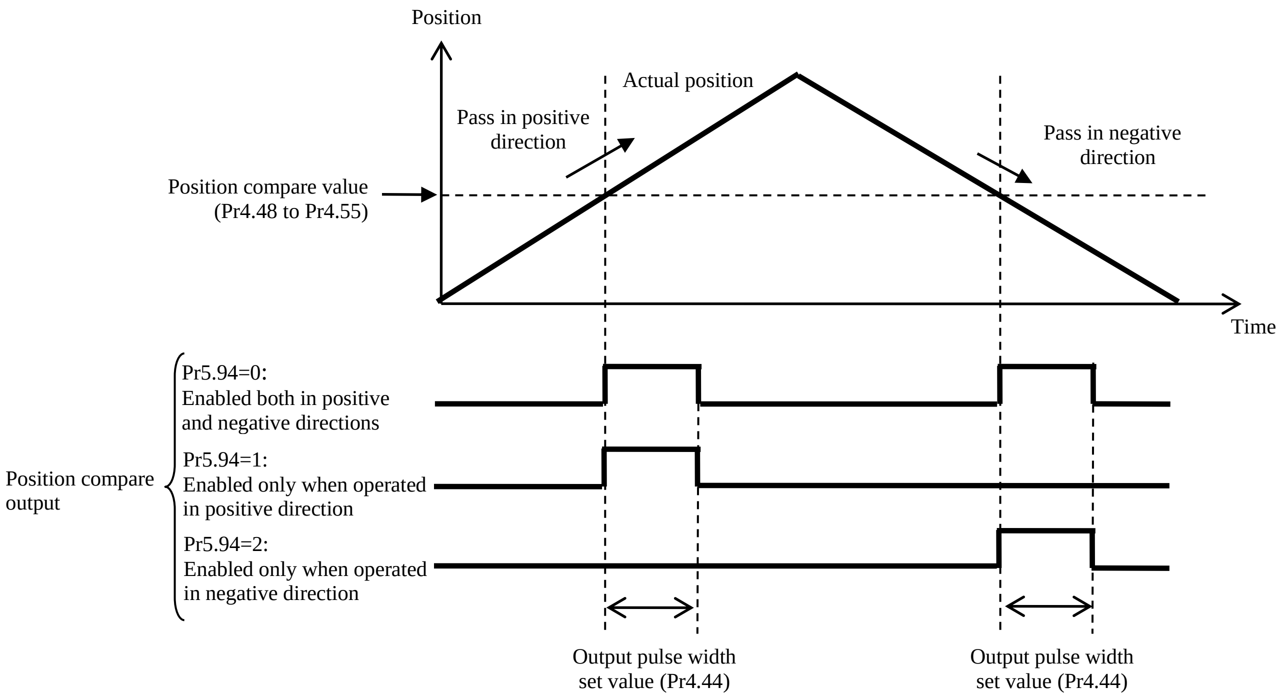
・Pulse output will be controlled depending on the input status of Position compare switch input (CMP-SEL).



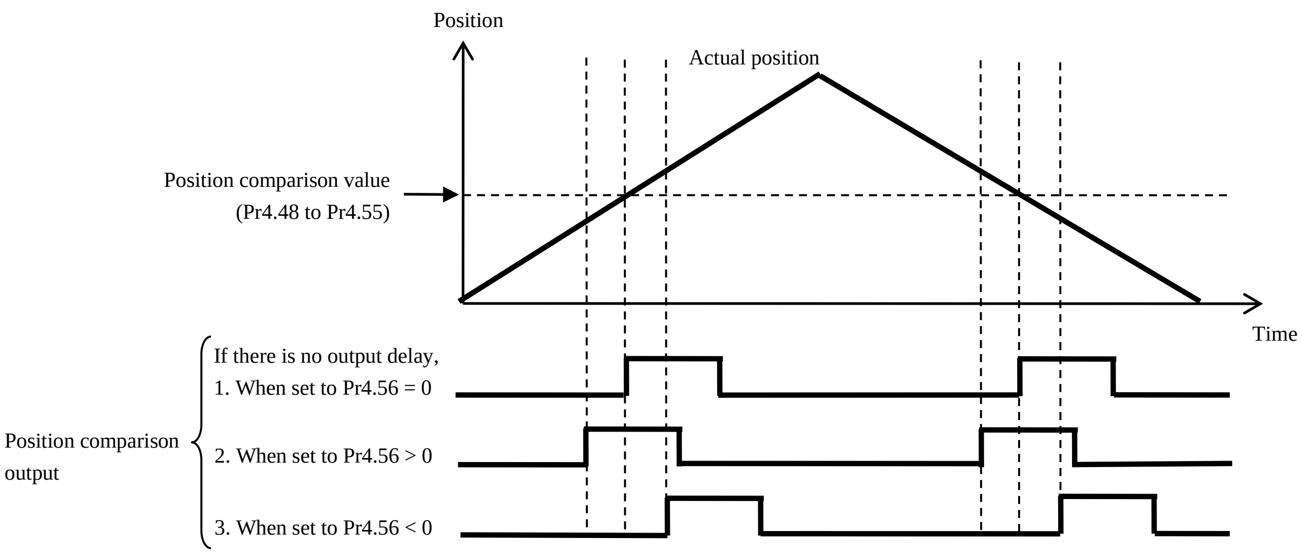
・When Position compare switch input (CMP-SEL) is enabled during pulse output, a state where pulse output is ON will continue from the time of the most recent passing until the output pulse width set value is reached.



・Pulses are output depending on the operation direction based on the setting of Pr5.94“Position compare output conditions setup”.



- The position comparison output function sends outputs while automatically compensating, based on the previous motor speed, the errors caused by the time of delay of encoder serial communication, etc. In addition, the amount of compensation can also be adjusted with the setup of the amount of position comparison output delay compensation (Pr4.56). For example, when using the position comparison output function as an operation trigger for the external device such as a camera, Pr4.56 can be set according to the delay time between the external device receiving the position comparison output signal and starting operation.



- When using generic outputs (SO1 to SO6) as position compare output (CMP-OUT), assign position compare output to Pr4.40 to 4.15 under all control mode.
- When generic outputs (SO1 to SO6) are assigned to position compare output (CMP-OUT), position compare output can not be monitored through PANATERM or Modbus communication.

6-8 Infinite rotation absolute function

Function to set the upper limit value of absolute encoder multi-rotation data to any arbitrary value.

(1) Related parameters

Class	No.	parameter name	Set range	Units	Functions
0	15	Absolute encoder setting	0 to 4	-	Sets the method of using the absolute encoder. 0: Use under absolute system (Absolute mode). 1: Use under incremental system (Incremental mode). 2: Use under absolute system (Absolute mode) but multi-rotation counter overflow is ignored 3: For manufacturer use (please do not set) 4: Used under absolute system (Absolute mode) but the upper limit value of the multi-rotation counter can be set to any value. Multi-rotation counter overflow is also ignored. (Infinite rotation absolute mode)
6	88	Absolute multi-rotation upper limit value	0 to 65534	-	Set the upper limit value for absolute multi-turn data when unlimited turn absolute mode (Pr0.15 to 4) is set. When the multi-turn data is more than the value set for this parameter, the multi-turn data changes to 0. When the multi-turn data falls below 0, multi-turn data will change to the set value. When absolute mode (Pr0.15 to 0 or 2) is set, the upper limit value for multi-turn data is set to 65535 regardless of the setting value. When incremental mode (Pr0.15 to 1) or one-turn absolute mode (Pr0.15 to 3) is set, this setting value will be invalid.

(2) Notes

- This setting will become effective when PR0.15 “Absolute encoder setting” is set to 4 and the control power supply is reclosed.
- In case of discrepancy in the encoder multi-rotation data upper limit value and the driver parameter multi-rotation data upper limit value when the control power supply is reclosed, Err92.3 “Multi-rotation data upper limit value mismatch error protection” will always be triggered, however this is not an abnormal condition.
  By reclosing the driver control power supply, the phenomenon will not reappear again.
- Please refer to 4-7-1-1 for Absolute system configuration.
- Please refer to section 6-1 Technical reference (Modbus communication and Block operation Specification) for details.

6-9 Deterioration diagnosis warning function

This is a function to check the changes in motor and connected equipment characteristics to output deterioration diagnosis warning.

(1) Applicable range

□ This function cannot be applied unless the following conditions are satisfied.

	Operating conditions for Deterioration diagnosis warning function
Control mode	• Available in all control modes
Other	• Pr6.97 “Function expansion setup 3” bit1 “Deterioration diagnosis warning function” is 1(valid).

(2) Related parameters

Class	No.	Parameter name	Set range	Units	Functions
5	66	Deterioration diagnosis convergence judgment time	0 to 10000	0.1s	Sets the time required to deem that real-time auto tuning load characteristics estimate has converged when deterioration diagnosis warning function is activated (Pr6.97 bit 1 = 1). When the set value is 0, it will be set automatically inside the driver in accordance with Pr6.31 (real-time auto tuning estimation speed). * When Pr6.31 (real-time auto tuning estimation speed) = 0, the deterioration diagnosis warning judgment for load characteristics estimate will be invalid.
5	67	Deterioration diagnosis inertia ratio upper limit value	0 to 10000	%	Sets the upper and lower limit values for inertia ratio estimate in deterioration diagnosis judgment when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and load characteristics estimate convergence has been completed. * The set resolution shall be in units of 0.2%.
5	68	Deterioration diagnosis inertia ratio lower limit value	0 to 10000	%	
5	69	Deterioration diagnosis unbalanced load upper limit value	-1000 to 1000	0.1%	Sets the upper and lower limit values for unbalanced load estimate in deterioration diagnosis judgment when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and load characteristics estimate convergence has been completed. * The set resolution shall be in units of 0.2%.
5	70	Deterioration diagnosis unbalanced load lower limit value	-1000 to 1000	0.1%	
5	71	Deterioration diagnosis dynamic friction upper limit value	-1000 to 1000	0.1%	Sets the upper and lower limit values for dynamic friction estimate in deterioration diagnosis judgment when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and load characteristics estimate convergence has been completed. * The set resolution shall be in units of 0.2%.
5	72	Deterioration diagnosis dynamic friction lower limit value	-1000 to 1000	0.1%	
5	73	Deterioration diagnosis viscous friction upper limit value	0 to 10000	0.1%/ (10000 r/min)	Sets the upper and lower limit values for viscous friction coefficient estimate in deterioration diagnosis judgment when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and load characteristics estimate convergence has been completed. * The set resolution shall be in units of 0.2%.
5	74	Deterioration diagnosis viscous friction lower limit value	0 to 10000	0.1%/ (10000 r/min)	
5	75	Deterioration diagnosis velocity setting	-20000 to 20000	r/min	Outputs deterioration diagnosis velocity output (V-DIAG) when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and the motor velocity is within the range of Pr5.75 ± Pr4.35 (velocity coinciding width). * Deterioration diagnosis velocity output has a 10 [r/min] hysteresis.
5	76	Deterioration diagnosis torque average time	0 to 10000	ms	Sets time required to calculate the torque command average value when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and diagnosis velocity output (V-DIAG) is ON. * Time from diagnosis velocity output (V-DIAG) ON to the start judgment for upper and lower value of torque command average value is also a part of the set time for this parameter. * If the setting value is 0, the torque command average value is not calculated.

(Continued)

Class	No.	Parameter name	Set range	Units	Functions
5	77	Deterioration diagnosis torque upper limit value	-1000 to 1000	0.1%	Sets the upper and lower limit values of torque command average value when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and deterioration diagnosis velocity output (V-DIAG) is ON.
5	78	Deterioration diagnosis torque lower limit value	-1000 to 1000	0.1%	
6	97	Function expansion setting 3	-2147483648 to 2147483647	-	Bit 1 to set the deterioration diagnosis warning function to valid or invalid 0: invalid, 1: valid Validity or invalidity of latch for deterioration diagnosis torque command average value is set with Bit5. 0: invalid, 1: valid

(3) Precautions

- When the upper limit value is set to the maximum value, the upper limit judgment will become invalid.
- When the lower limit value is set to the minimum value, the lower limit judgment will become invalid.
- In case upper limit value ≤ lower limit value, then both the upper limit and lower limit judgment will become invalid.

(4) Contents

- Deterioration diagnosis warning functions for the following five types of data can be used by setting bit 1 of Pr6.97 “Function expansion setup 3” to 1.
  - Inertia ratio (4-1-1)
  - Unbalanced load (4-1-2)
  - Dynamic friction (4-1-3)
  - Viscous friction (4-1-4)
  - torque command average value (4-2)

(4-1) Deterioration diagnosis warning for load characteristic estimates

- Deterioration diagnosis warning judgment for four load characteristics estimates (inertia ratio, unbalanced load, dynamic friction, and viscous friction coefficient) can be used in case real-time auto tuning load characteristics estimate is valid (refer to items 5-1-1, 5-1-3, 5-1-4).
- The abovementioned deterioration diagnosis warning judgment will become effective when the required operational conditions for load characteristics estimate has continued in total for Pr5.66 (deterioration diagnosis convergence judgment time) or more, and the load characteristics estimate has converged. Once it has become effective, it will remain in effect until Pr6.97 bit 1 is set to 0 (invalid) or the real-time auto tuning load characteristics estimate is invalidated.
- For each load characteristics estimate value, its upper and lower limit value can be set by the parameters as indicated in the following table. In case the load characteristic estimates has exceeded the upper or lower limit values for changes in load characteristics estimate, it generates deterioration diagnostic warning number AC.

	(4-1-1) Inertia ratio	(4-1-2) Unbalanced load	(4-1-3) Dynamic friction	(4-1-4) Viscous friction
Upper limit value	Pr5.67	Pr5.69	Pr5.71	Pr5.73
Lower limit value	Pr5.68	Pr5.70	Pr5.72	Pr5.74

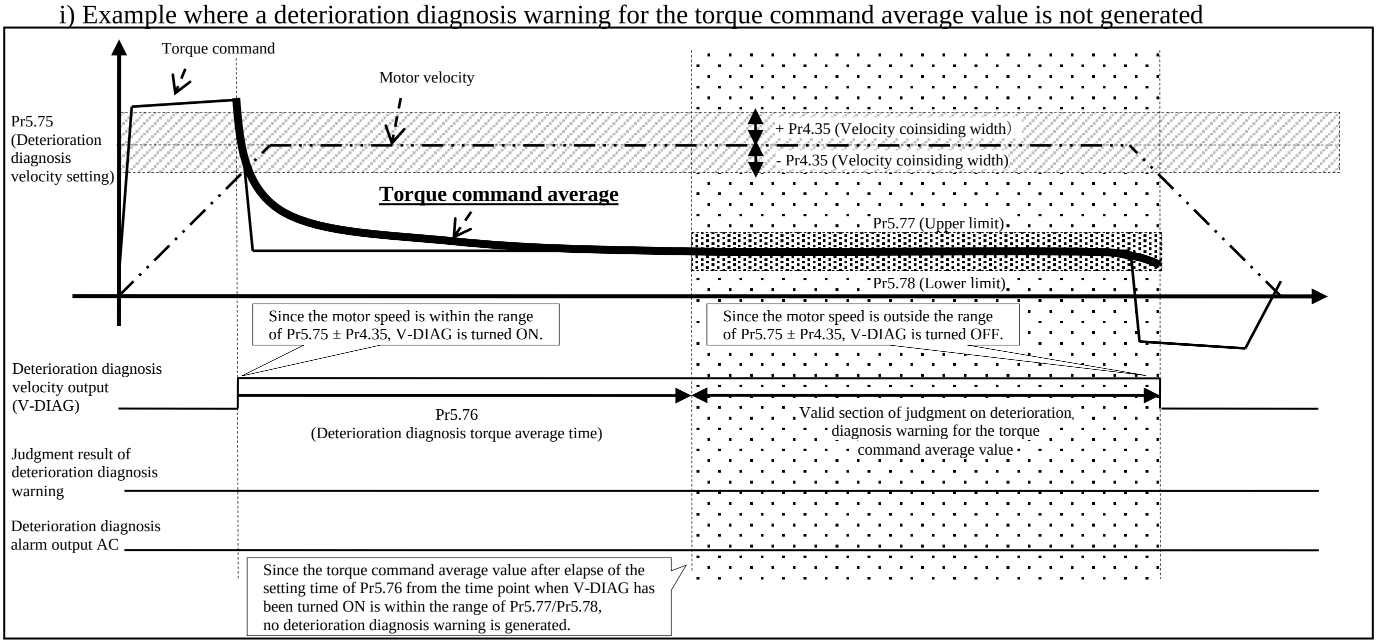
* Set resolution for the upper and lower limit of friction torque estimates (unbalanced load, dynamic friction, and viscous friction coefficient) shall be in units of 0.2%.

* In case Pr6.31 (real-time auto-tuning estimation speed) is set to 0 and is estimate stopped from the start or before the load characteristics estimate results has been confirmed, deterioration diagnosis warning judgment will become invalid even if real-time auto tuning load characteristics estimate is valid.

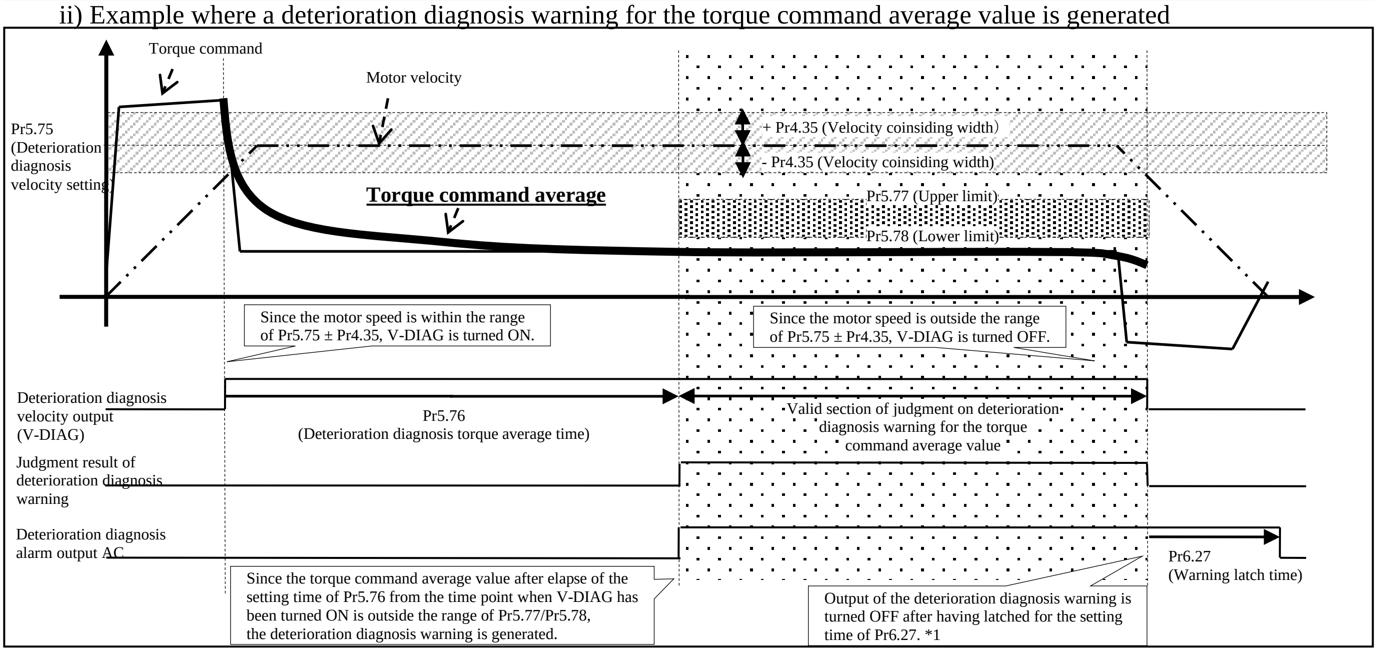
(4-2) Deterioration diagnosis warning for constant velocity torque command average value

This function is the deterioration diagnosis function, where torque command during motor operation at a constant speed is measured for a certain time, and an alarm is generated when the average value has exceeded the threshold value. The operation example of this function is shown in the following chart.

i) Example where a deterioration diagnosis warning for the torque command average value is not generated



ii) Example where a deterioration diagnosis warning for the torque command average value is generated



- Calculation of the torque command average value by Pr5.76 (deterioration diagnosis torque average time) is started from the time point when the deterioration diagnosis speed output (V-DIAG) is turned ON. When this torque command average value has exceeded the Pr5.77 (upper limit value of deterioration diagnosis torque) and Pr5.78 (lower limit value of deterioration diagnosis torque), deterioration diagnosis warning with the alarm No. AC is generated.
- V-DIAG (deterioration diagnosis speed output) is turned ON when motor speed is within the range of Pr5.75 (deterioration diagnosis speed setting) ± Pr4.35 (speed coincidence range), and turned OFF when it is outside the range. At the section where V-DIAG is turned OFF, the torque command average value becomes 0, and the deterioration diagnosis warning becomes OFF state.
- The valid section of judgment on deterioration diagnosis warning for the torque command average value becomes after elapse of the setting time of Pr5.76, from the time point when V-DIAG is turned OFF.

*1 The deterioration diagnosis warning output of the invalid section of judgment on deterioration diagnosis warning for the torque command average value differs depending on whether the latch for deterioration diagnosis torque command average value (Pr6.97 bit5) is valid or invalid.

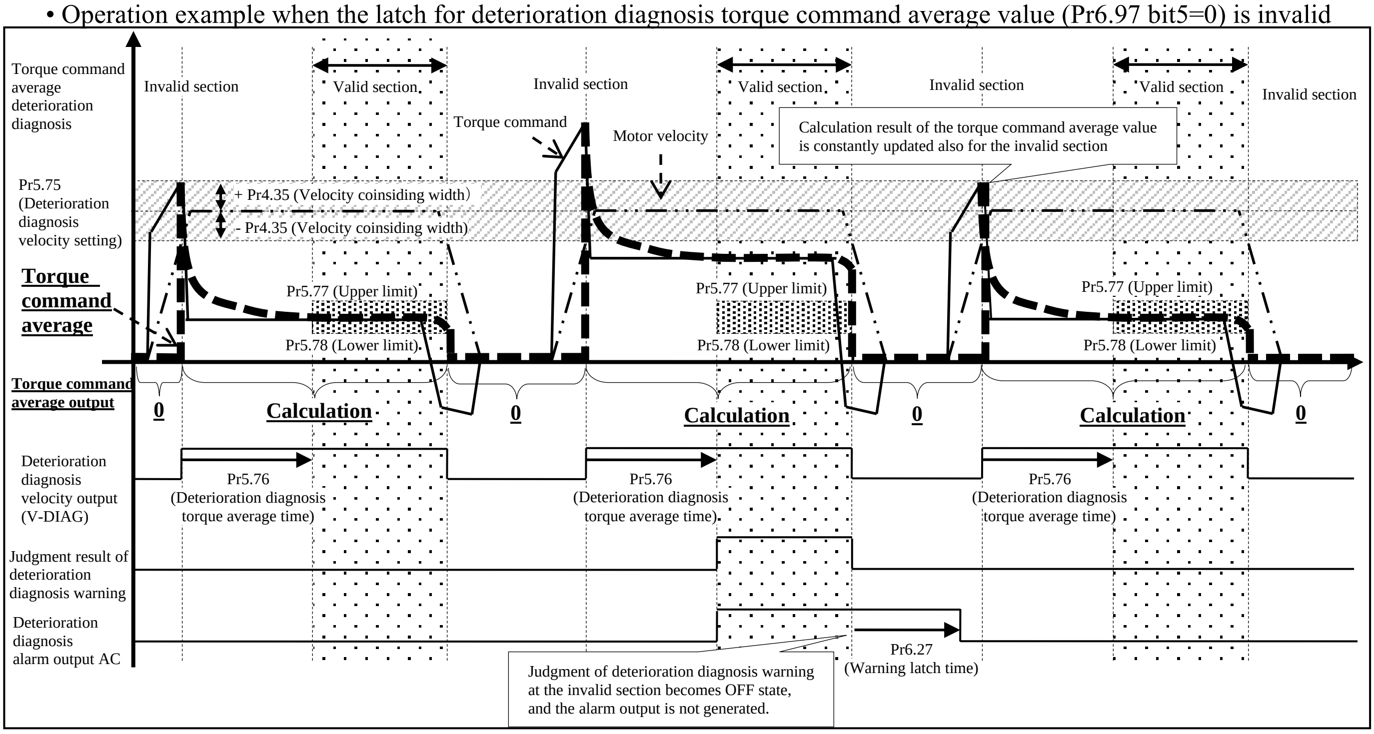
□ Latch for deterioration diagnosis torque command average value (Pr6.97 bit5)

When the latch for deterioration diagnosis torque command average value (Pr6.97 bit5=1) is valid, the torque command average value is updated only for the valid section of deterioration diagnosis, and the torque command average value is constantly updated, when it is invalid (Pr6.97 bit5=0).

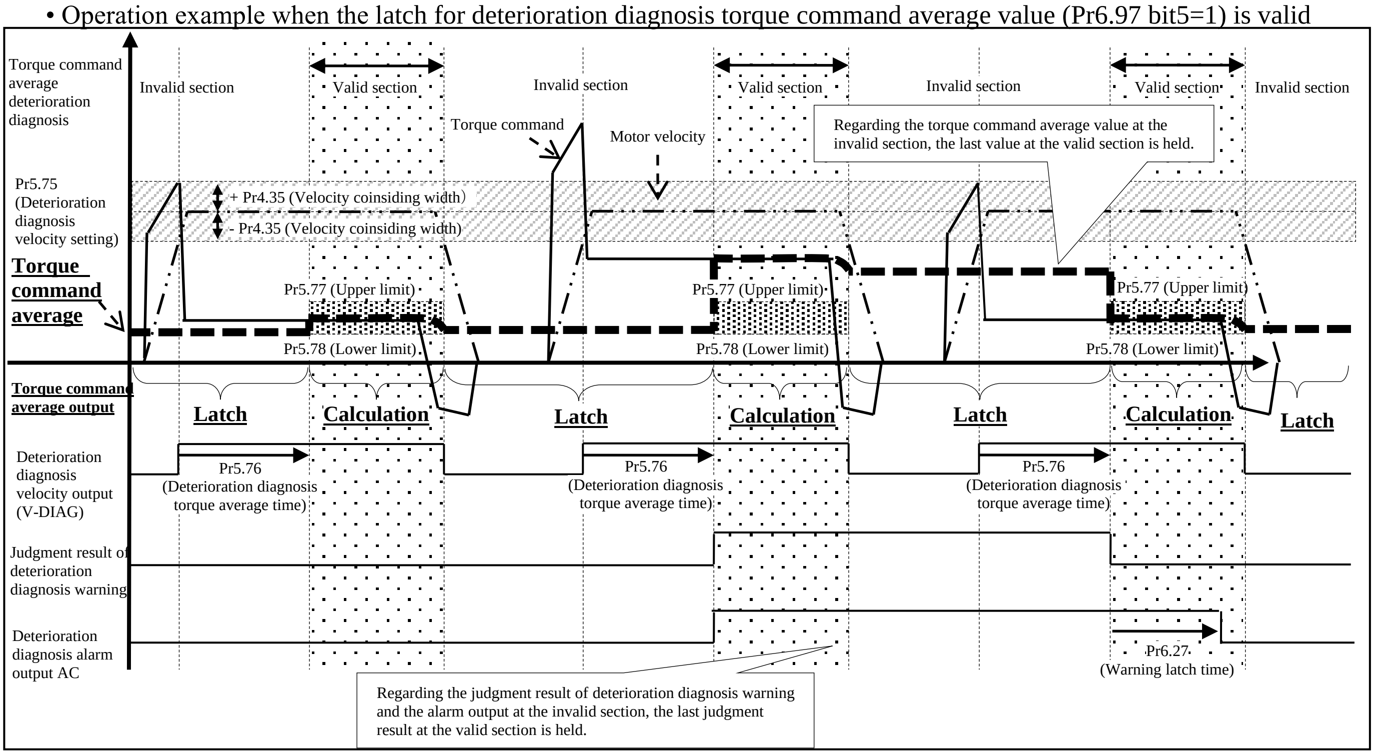
* Regarding the torque command average value acquired through the USB, it means acquisition of the delayed value compared with the present value inside the amplifier, due to communication delay of the USB. Thus, only the torque command average value at the invalid section of deterioration diagnosis is sometimes acquired. By making the latch for deterioration diagnosis torque command average value valid, it is possible to acquire only the torque command average value at the valid section of deterioration diagnosis.

Difference between operation examples of the cases when this function is valid and invalid is shown in the following chart.

• Operation example when the latch for deterioration diagnosis torque command average value (Pr6.97 bit5=0) is invalid



• Operation example when the latch for deterioration diagnosis torque command average value (Pr6.97 bit5=1) is valid

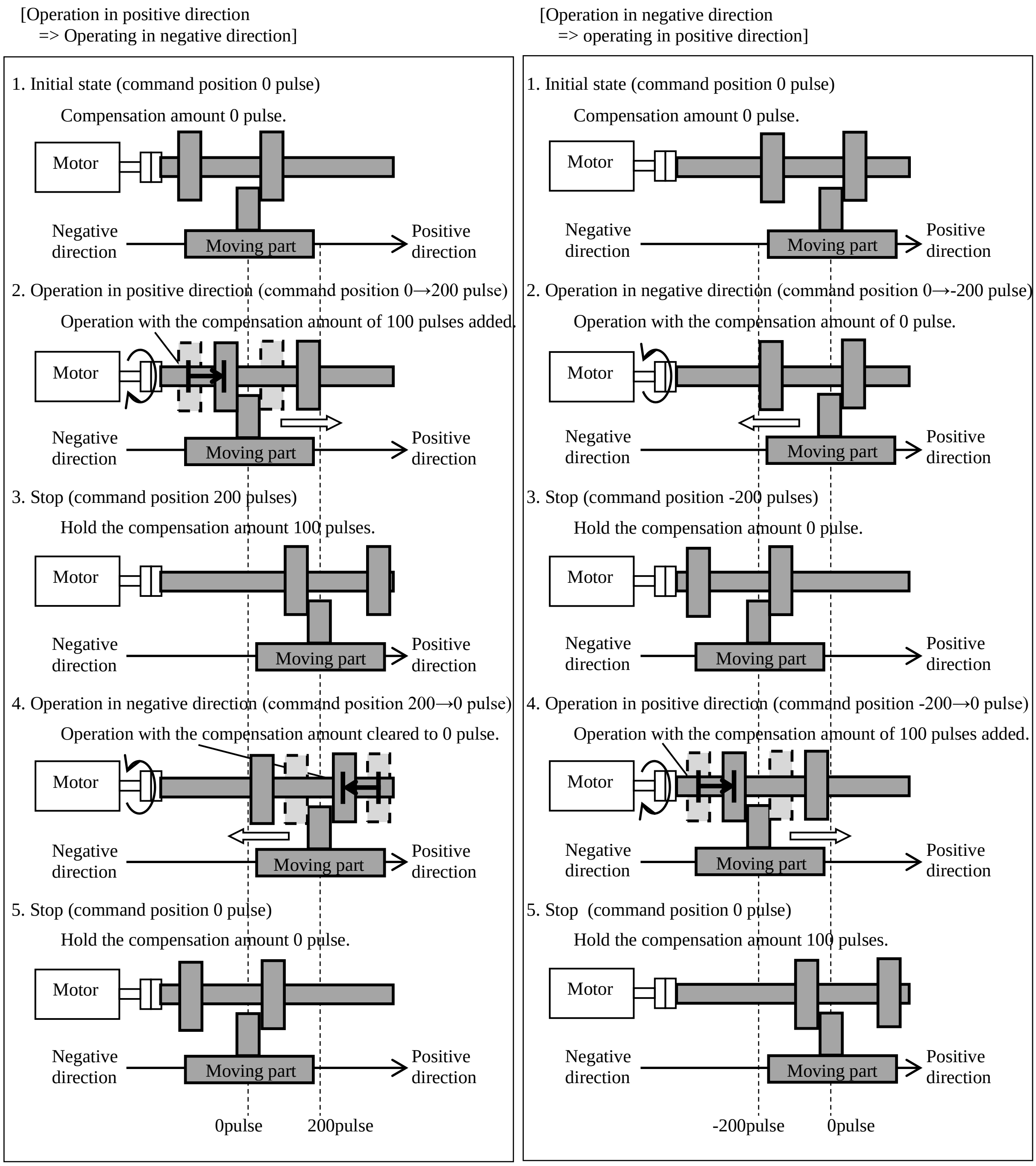


6-10 Backlash compensation function

It is possible to correct the backlash (mechanical gap in drive system) during position control (Excluding full-closed control).

(Example) Backlash compensation at the time of compensation in the positive direction when operating in the positive direction

Conditions) Pr7.04 "Backlash compensation selection" = 1
• bit1-0=01b (Corrected when operated in the positive direction)
Pr7.05 "Backlash compensation amount" = 100 pulses
Pr7.06 "Backlash compensation time constant" = Arbitrary
Electronic gear ratio 1:1



(Note) When the backlash compensation state is cleared to 0, such as when the power is turned on, make an arrangement so that the moving part of the equipment is in a state of butting against the backlash direction. (Initial state)
Otherwise, noise or oscillation may occur during motor operation, depending on the Pr7.06 "Backlash compensation time constant" setting.

(1) Applicable Range

□ This function cannot be applied unless the following conditions are satisfied:

	Conditions under which backlash compensation function operates
Control mode	・Position control
Other	・The software version must be function enhancement version 9 or later (Ver 1.14 or later).

(2) Caution

・It is prohibited to change Pr7.05 "Amount of backlash compensation", Pr7.06 "Backlash compensation time constant" and Pr7.04 "Backlash compensation selection" bit 2 during motor operation or command delivery.
The timing for reflection in case either is changed during motor operation or command delivery is undefined.
* Pr7.04 bit2 cannot be used in [A6BE/A6BF/A6BU]. Fix the value to 0.

・Changes in bits 1-0 of Pr7.04 "Backlash compensation selection" are reflected at the servo-on timing. .

・Backlash compensation state is maintained when position control is switched to velocity control or torque control. It will resume from the backlash compensation state in the previous position control when it is switched back to position control again.

・Registers 60A0h (Position demand internal value) [pulse], 600Dh (Position actual internal value) [pulse], and the internal encoder pulse sum of PANATERM monitor [pulse] display values that include the backlash compensation amount.
Register 600Fh (Position actual value) [command unit], 4DD8h (Position demand internal value (no backlash)) [pulse], 4DDAh (Position actual internal value (no backlash)) [pulse], the command pulse sum of PANATERM monitor [command unit], the encoder pulse sum [pulse], and the command pulse cumulative value of PANATERM waveform graphic [command unit] display values that do not include the backlash compensation amount.
The encoder pulse cumulative value of PANATERM waveform graphic [pulse] can switch the position information during the backlash compensation in Pr6.97 bit6.

・The position command is subjected to compensation when operation is executed for the first time in the set direction above after servo on. There will be no compensation if operation occurs in the opposite direction before that. Compensation is also executed in the opposite direction when operation occurs in the opposite direction for the first time after the first backlash compensation. Once backlash compensation is executed, there will be no more compensation as long as operation is repeated in the same direction for which backlash compensation was executed once.

・When Pr7.04 "Backlash compensation selection" bit2=0 and the servo is turned off with the backlash corrected, the backlash compensation amount is cleared by presetting the command position information inside the servo amplifier with the motor position information including the backlash compensation amount. (*1)
When servo on occurs again, the backlash compensation operation described above is executed.

・When Pr7.04 "Backlash compensation selection" bit2=1, the backlash compensation state can be maintained without clearing the backlash compensation amount even if the servo is turned off. If the servo is turned on again, the motor operation can be resumed from the backlash compensation state when the servo was turned on last time.
* Pr7.04 bit2 cannot be used in [A6BE/A6BF/A6BU]. Fix the value to 0.

(Note) Make sure that the positional relationship between the moving parts of the equipment and the motor is not broken while the server is off. If the positional relationship is broken, noise or oscillation may occur during motor operation after the servo is turned on next time depending on the setting of Pr7.06 "Backlash compensation time constant".

*1) The conditions for clearing the backlash compensation are shown below.

	Conditions for clearing the compensation state
Pr7.04 bit2 = 0 (Amount of compensation set at 0 when the servo is OFF)	• When the servo is turned off • Alarm occurrence • When the position deviation is cleared • When the safe torque is off (STO) • When the servo (MINAS-A6) side decelerates and stops due to over-travel inhibition input • When CL signal is input with Pr6.28 = 0 (Block operations disabled (Pulse train enabled))
Pr7.04 bit2 = 1 (Amount of compensation held when the servo is OFF)	-

・Do not execute position information latch, position information initialization or control mode switching without backlash compensation output completely delivered (states other than “Backlash compensation output 0 or the state of the setting value in Pr7.05”). In addition, be sure to change the above objects related to backlash compensation during servo off.

・Set Pr7.05 "Amount of backlash compensation" and Pr7.06 "Backlash compensation time constant" so that Err27.2 does not occur.
If Err27.2 occurs, set Pr7.06 "Backlash compensation time constant" to a large value.

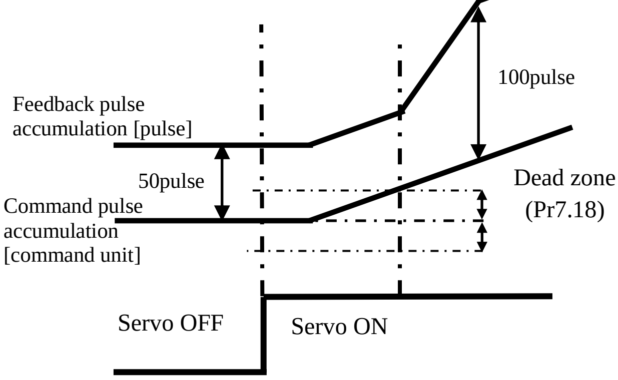
・If the moving part is moved by an external force while the servo is off, or if the servo is turned off while the backlash compensation amount is being discharged, the backlash compensation amount will shift. Perform return to origin again.

・Pr7.18 "Backlash compensation amount holding range" allows a position dead zone to be set for updating the backlash compensation status after the servo is turned on in order to prevent backlash compensation from working in an unintended direction due to a delay in the operation command from the host controller.

(Example) When the servo is off and the backlash compensation amount is held for 50 pulses in the positive direction

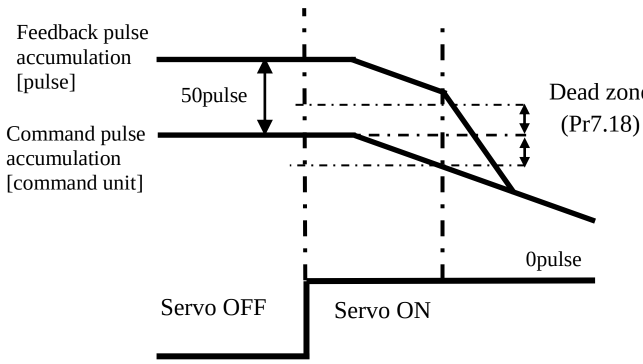
Conditions) Pr6.97 bit6 "Position information switching" = 0
Pr7.04 “Backlash compensation selection” = 5
• bit1-0=01b (Corrected when operated in the positive direction)
• Bit2=1 (compensation state is maintained when the servo is off)
Pr7.05 "Backlash compensation amount" = 100 pulses
Pr7.06 "Backlash compensation time constant" = Arbitrary
Electronic gear ratio 1:1

[During operation in positive direction]



If the relative position (*1) after the servo is turned on is within the dead zone, the backlash compensation amount of 50 pulses is held.
If the dead zone in the positive direction is exceeded, the compensation amount will be 100 pulses.

[During operation in negative direction]



If the relative position (*1) after the servo is turned on is within the dead zone, the backlash compensation amount of 50 pulses is held.
If the dead zone is exceeded in the negative direction, the compensation amount will be 0 pulse.

*1) Relative position after servo ON = Command pulse accumulation duringservo-ON - Command pulse accumulation immediately before servo-ON

・If the relative position after the servo is turned on (*1) is within the dead zone, when home position return with motor operation (Except for actual position set) is executed, home position return is performed with releasing the dead zone state
If home position return without motor operation (Actual position set) is executed, home position return will be performed without releasing the dead zone state.

・When the "Backlash compensation amount holding range" is set to the maximum value, the dead zone condition is not cleared. If the dead zone is not cleared, the backlash compensation amount continues to be held.

(3) Related parameters

Class	No.	Attribute *1)	Title	Range	Unit	Function
6	97	Always enabled	Function expansion setup 3	-2147483648 ～ 2147483647	—	bit6 : Switching during backlash compensation 0: The encoder pulse cumulative value of the waveform graphic includes the backlash compensation amount. 1: The encoder pulse cumulative value of the waveform graphic does not include the backlash compensation amount.
7	04	Always enabled	Backlash compensation selection	0～7	—	Select the backlash compensation for position control. bit1-0: Enable/disable backlash compensation and select operation direction during compensation. 00b: Disabled 01b: Correct the backlash at the first operation in the positive direction after the servo is turned on. 10b: Correct the backlash at the first operation in the negative direction after the servo is turned on. 11b: Manufacturer specification bit2: Extension of conditions for holding the backlash compensation state. 0: Amount of compensation set at 0 when the servo is OFF 1: Amount of compensation held when the servo is OFF
7	05	Always enabled	Amount of backlash compensation	-1073741824 ～ 1073741823	pulse	Set the amount of backlash (mechanical gap in drive system) compensation during position control.
7	06	Always enabled	Backlash compensation time constant	0～6400	0.01ms	Set the time constant for backlash (mechanical gap in drive system) compensation during position control.
7	18	Always enabled	Backlash compensation amount holding range	0～ 2147483647	Command unit	Set the dead zone for backlash compensation when the servo status changes from OFF to ON. If 0 is specified for this setting, the function will be disabled. This parameter does not depend on the Pr7.04 bit2 setting.

Pr7.04 bit1-0	Pr7.05 value is positive	Pr7.05 value is negative
01b	Corrects in the positive direction during operation in the positive direction	Corrects in the negative direction during operation in the positive direction
10b	Corrects in the positive direction during operation in the negative direction	Corrects in the negative direction during operation in the negative direction

7. Protection functions/alarm functions

7-1 Protection function list

This servo driver incorporates various protection functions. When these protection functions are activated, the servo driver turns OFF the alarm output signal (ALM) and enters the trip state, and Error Code No. is displayed on the 7-segment LEDs of the front panel unit.

Error No.		Alarm name	Attributes		
Main	Sub		History	Clearable	Immediate stop*6
11	0	Control power supply short voltage protection		○	
12	0	Overvoltage protection	○	○	
13	0	Main power supply short voltage protection (short voltage across P and N)		○	
	1	Main power supply short voltage protection (AC cutoff detection)		○	○
14	0	Overcurrent protection	○		
	1	IPM error protection	○		
15	0	Overheat protection	○		○
	1	Encoder overheat error protection	○		○
16	0	Overload protection	○	○*1	Switchable *7
	1	Torque saturation error protection	○	○	
18	0	Regeneration overload protection	○		○
	1	Regeneration Tr error protection	○		
21	0	Encoder communication disconnection error protection	○		
	1	Encoder communication error protection	○		
23	0	Encoder communication data error protection	○		
24	0	Position deviation excess protection	○	○	○
	1	Speed deviation excess protection	○	○	○
25	0	Hybrid deviation excess protection	○		○
26	0	Overspeed protection	○	○	○
	1	Second overspeed protection	○	○	
27	0	Command pulse input frequency error protection	○	○	○
	1	Absolute clear error protection	○		
	2	Command pulse multiplication error protection	○	○	○
28	0	Pulse regeneration limit protection	○	○	○
29	0	Deviation counter overflow error protection	○	○	
	1	Counter overflow protection 1	○		
	2	Counter overflow error protection 2	○		
31	0	Safety function error protection 1	○		
	2	Safety function error protection 2	○		
33	0	I/F input redundant allocation error 1 protection	○		
	1	I/F input redundant allocation error 2 protection	○		
	2	I/F input function No. error 1	○		
	3	I/F input function No. error 2	○		
	4	I/F output function No. error 1	○		
	5	I/F output function No. error 2	○		
	6	Counter clear allocation error	○		
	7	Command pulse prohibition input allocation error	○		
34	0	Range of motor movement setting error protection	○	○	
36	0-1	EEPROM parameter error			
37	0-2	EEPROM check code error			
38	0	Drive prohibition input protection		○	
39	0	Analog input 1 (Al1) excess protection	○	○	○
	1	Analog input 2 (Al2) excess protection	○	○	○
	2	Analog input 3 (Al3) excess protection	○	○	○
40	0	Absolute system down protection	○	○*2	
41	0	Absolute counter overflow protection	○		
42	0	Absolute overspeed error protection	○	○*2	
44	0	Single turn counter error protection	○		

(To be continued)

Error No.		Alarm name	Attributes		
Main	Sub		History	Clearable	Immediate stop*6
45	0	Multi-turn counter error protection	○		
47	0	Absolute status error protection	○		
50	0	External scale connection error protection	○		
	1	External scale communication error protection			
	2	External scale communication data error protection	○		
51	0	External scale ST error protection 0	○		
	1	External scale ST error protection 1	○		
	2	External scale ST error protection 2	○		
	3	External scale ST error protection 3	○		
	4	External scale ST error protection 4	○		
	5	External scale ST error protection 5	○		
55	0	Phase A connection error protection	○		
	1	Phase B connection error protection	○		
	2	Phase Z connection error protection	○		
70	0	Phase U current detector error protection	○		
	1	Phase W current detector error protection	○		
71	0	CCWTL error protection	○		
	1	CWTL error protection	○		
72	0	Thermal relay error protection	○		
80	0	Modbus communication timeout protection	○	○	○
87	0	Forced alarm input protection		○	○
92	0	Encoder data recovery error protection	○		
	1	External scale date recovery error protection	○		
	2	Multi-rotation upper limit value discordance error protection	○		
93	0	Parameter setup error protection 1	○		
	1	Block data setting error protection	○	○	
	2	Parameter set error protection 2	○		
	3	External scale connection error protection	○		
	8	Parameter setting error protection 6	○		
94	0	Block operation error protection	○	○	
	2	Return to origin error protection	○	○	
95	0-4	Motor auto recognition error			
96	2	Control unit error protection 1	○		
97	0	Control mode setting error protection			
98	5	Hardware self-diagnosis error protection 1			
Other numbers		Other errors	○		

*1: When Err16.0 “Overload Protection” or Err16.2 “Overload Protection 2” is activated, error can be cleared about 10 seconds after the occurrence.

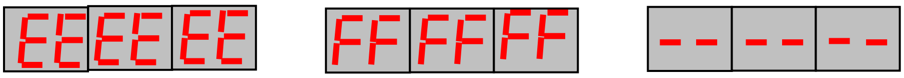
*2: When Err40.0 “Absolute System Down Error protection,” or Err42.0 “Absolute Overspeed Protection” occurs, the error is unable to be cleared unless Absolute Clear is performed.

*3: In the event that any alarm that is unable to be cleared occurs, first remove the error causes, and then, cut off the power supply once, and then, reset.

*4: In the event that any alarm that can be cleared occurs, the alarm is able to be cleared from Alarm Clear Input (A-CLR), front panel operation, or communication

Never fail to clear alarm while the motor is under suspension after removing error causes and securing safety.

*5: In the event that the control circuit inside the servo driver malfunctions due to excessively large noise, etc.,



the foregoing display may appear. In such event, immediately cut off the power supply.

*6: Immediate stop refers to alarms which result in an immediate stop when setting is made to 4 to 7 in Pr5.10 “Sequence at alarm” are shown. For the detail of an immediate stop, see 6-5-4 “Sequence at alarm.”

*7: Err 16.0 “Overload protection,” and Err 16.2 “Overload protection 2” can be switched to responsive/non-responsive by switching bit 11 of “Function expansion setting 2” of Pr 6.47. Set to non-responsive at time of shipment.

7-2 Description of protective functions

<table>
<tr><th colspan="2">Protective functions</th><th rowspan="2">Name</th><th rowspan="2">Causes</th><th rowspan="2">Actions taken</th></tr>
<tr><th>Main</th><th>Sub</th></tr>
<tr><td>11</td><td>0</td><td>Under voltage protection of control power supply</td><td>Voltage between P and N of converting unit of control power supply has fallen down and dropped below specified value.
1) Low power supply voltage. Occurrence of momentary power failure.
2) Power capacity shortage…Due to rush current at the main power-on, power supply voltage has fallen down.
3) Servo driver failure (circuit failure)</td><td>Measure L1C-L2C line voltage of connector and terminal block
1) Increase the capacity of power supply voltage. Change the power supply.
2) Increase the power capacity.
3) Replace with new servo driver.</td></tr>
<tr><td>12</td><td>0</td><td>Overvoltage protection</td><td>Power supply voltage has exceeded the allowable input voltage range→Voltage between P and N of converting unit has exceeded the specified value. Power supply voltage is high. A voltage jump due to phase-advancing capacitor and UPS (uninterruptible power supply).
1) Disconnection of regeneration resistor
2) External regeneration resistor is not appropriate and could not absorb the regenerative energy.
3) Servo driver failure (circuit failure)</td><td>Measure connector (L1, L2, and L3) line voltages. Enter correct voltage. Remove the phase-advancing capacitor.
1) Measure the resistance value of the external resistor between terminal P and terminal B of servo driver with tester, and if the value is ∞, disconnect them. Exchange the external resistor.
2) Change the specified regeneration resistance value to wattage.
3) Replace with new servo driver.</td></tr>
<tr><td rowspan="2">13</td><td>0</td><td>Main power supply under-voltage protection (PN)</td><td rowspan="2">In case of Pr5.08 ” LV trip selection with the main power off” bit0 = 1, the voltage between L1 and L3 has stopped instantaneously for more than the prescribed time in Pr5.09 “Main power off detection time,” or the voltage between P and N of converting unit of mains power has fallen down during servo-on and dropped below specified value.
1) Low power supply voltage. Occurrence of momentary power failure.
2) Occurrence of momentary power failure.
3) Power capacity shortage…Due to rush current at the main power-on, power supply voltage has fallen down.
4) Open-phase…3-phase input servo driver has been operated with single phase input.
5) Servo driver failure (circuit failure)</td><td rowspan="2">Measure connector (L1, L2, and L3) line voltages.
1) Increase the capacity of power supply voltage. Change the power supply. Remove the causes that the electromagnetic contactor of mains power was turned off, and turn on power again.
2) Check the setting of Pr5.09 (Main power off detection time).
Correctly set each phase of the power supply.
3) Increase the power capacity. For power capacity, refer to ” List of servo drivers and compatible peripheral equipment.”
4) Correctly connect each phase of the power supply (L1, L2, and L3). For single-phase 100 V and single-phase 200 V, use L1 and L3.
5) Replace with new servo driver.</td></tr>
<tr><td>1</td><td>Main power supply under-voltage protection (AC)</td></tr>
<tr><td rowspan="2">14</td><td>0</td><td>Over current protection</td><td rowspan="2">Current flowing to converting unit has exceeded the specified value.
1) Servo driver failure
(Failure of the circuit, IGBT or other component)
2) Short of the motor wire (U, V and W).
3) Earth fault of the motor wire.
4) Burnout of the motor.
5) Poor contact of the motor wire.
6) Adhesion of dynamic braking relay due to frequent servo ON/OFF operation.
7) The motor does not apply to servo driver.
8) Timing of pulse input is the same as or earlier than servo-on.</td><td rowspan="2">1) Remove the motor wire, perform servo-on operation, and in case of immediate occurrence, replace with new (running) servo driver.
2) Check that the motor wire (U, V and W) is not shorted, and the branched out wire out of the connector. Correctly connect the motor wire.
3) Measure the insulation resistance between motor wire, U, V and W and earth wire. In case of poor insulation, replace the motor.
4) Check the balance of resistance between each motor line, and if unbalance is found, replace the motor.
5) Check that the connector pin for the connection U, V, W of the motor does not come off, if it is loosen or come off, securely fix it.
6) Replace the servo driver. Do not use Servo-ON/Servo-OFF as a means of staring/stopping the operation.
7) Check the product number (capacity) of the motor servo driver with nameplate, and change to a right motor for servo driver.
8) Input pulse after waiting for more than 100 ms after servo-on.</td></tr>
<tr><td>1</td><td>IPM error protection</td></tr>
</table>

(Continued)

Protective functions		Name	Causes	Actions taken
Main	Sub			
15	0	Over-heat protection	The temperature of radiator of servo driver and power device has exceeded the specified value. 1) The ambient temperature of servo driver has exceeded the specified value. 2) Overload	1) Improve the ambient temperature of servo driver and the cooling condition. 2) Increase the capacity of the motor and servo driver. Set up longer acceleration/deceleration time. Reduce the load.
	1	Encoders abnormal overheat protection	The temperature of encoder has exceeded an encoder overheat abnormal level. 1) The ambient temperature of servomotor is high. 2) Overload	1) Improve the ambient temperature of servomotor and the cooling condition. 2) Increase capacity of servo driver and motor. Set up longer acceleration/deceleration time. Reduce the load.
16	0	Overload protection	When a torque command value exceeded the overload protection time characteristics, it has resulted in overload protection. 1) With heavy load, the actual torque has exceeded the rated torque, and the operation has been continued for a long time. 2) Oscillation and hunting due to improper gain adjustment. Vibration and abnormal noise of motor. Pr0.04 “Inertia ratio” setting value error. 3) Miswiring, disconnection of motor. 4) The machine has hit the peripheral objects, and the load suddenly has become large. The machine state has gotten worse. 5) Electromagnetic brake keeps functioning. 6) While wiring multiple units, miswiring has occurred by connecting the motor cable to other axis. ■ At the end of this section, the overload protection time characteristics are described.	Check that torque (current) waveform does not oscillate, moving violently up and down, by analog output or communication. Check it through an overload warning display and a front panel or communication about the load factor 1) Increase the capacity of the motor and servo driver. Set up longer acceleration/deceleration time. Reduce the load. 2) Readjust the gain. 3) Connect the motor wire as described in the wiring diagram. Replace the cable. 4) Resolve the machine state which has gotten worse. Lower the load. 5) Measure the voltage at brake terminal. Release the brake. 6) Correctly wire the motor wire and encoder cable to be aligned with the axis.
	1	Torque saturation abnormality protection	Torque saturated state has continued between the setup value of Pr6.57 “Torque saturation abnormality protection detection time.”	• Check the operational state of driver. • Perform the action same as that of Err16.0.
18	0	Over-regeneration load protection	Regenerative energy has exceeded the capacity of regeneration resistor. 1) Due to the regenerative energy during deceleration caused by large load inertia, converter voltage has risen, and the voltage is raised further due to the lack of capacity of absorbing this energy by the regeneration resistor. 2) Because the motor rotational speed is high, regenerative energy cannot be absorbed in the given deceleration time. 3) The operating limit of the external resistor is limited to 10% duty. <Request>When Pr0.16 is set to 2, an external protective apparatus, such as thermal fuse must be provided without fail. The regeneration resistor will not be protected, and the regeneration resistor may abnormally produce heat and be burned.	Check the load factor of the regeneration resistor from the front panel or via communication. Do not use in the continuous regenerative braking application. 1) Check the operation pattern (velocity monitor). Check the load factor of the regeneration resistor and over-regeneration alarm display. Increase the capacity of the motor and servo driver, and slow the deceleration time. Use the external regeneration resistor. 2) Check the operation pattern (velocity monitor). Check the load factor of the regeneration resistor and over-regeneration alarm display. Increase the capacity of the motor and servo driver, and slow the deceleration time. Lower the motor rotational speed. Use the external regeneration resistor. 3) Turn the setting of Pr0.16 to 2.
	1	Regeneration Tr error protection	• Failure of regeneration driving Tr of servo driver.	• Replace the servo driver.

(Continued)

<table>
<tr><th colspan="2">Protective functions</th><th rowspan="2">Name</th><th rowspan="2">Causes</th><th rowspan="2">Actions taken</th></tr>
<tr><th>Main</th><th>Sub</th></tr>
<tr><td rowspan="2">21</td><td>0</td><td>Encoder communication disconnect error protection</td><td>Encoder and servo driver communication was cut off a fixed number of times, and a detection function of guidewire malfunction has become active.</td><td>Install the wiring for the connection of encoder cable according to the correct connection. Correct the miswiring of the connector pins.</td></tr>
<tr><td>1</td><td>Encoder communication error protection</td><td>Communication error has occurred in data from the encoder. Data error mainly due to noise. Encoder cables are connected, but communication data has some error.</td><td>• Secure power supply voltage of the encoder at DC5 V±5 % (4.75 to 5.25 V)…Be notified particularly in case of longer encoder cable.
• If motor wire and encoder cable are bound together, separate them.
• Connect the shield to FG.</td></tr>
<tr><td>23</td><td>0</td><td>Encoder communication data error protection</td><td>Data communication from the encoder is normal, but contents of data are not correct. Data error mainly due to noise. Encoder cables are connected, but communication data has some error.</td><td>• Secure power supply voltage of the encoder at DC5 V±5 % (4.75 to 5.25 V)…Be notified particularly in case of longer encoder cable.
• If motor wire and encoder cable are bound together, separate them.
• Connect the shield to FG.</td></tr>
<tr><td rowspan="2">24</td><td>0</td><td>Position deviation excess protection</td><td>Position deviation pulse has exceeded the setting of Pr0.14 “Position deviation excess setting.”
1) The motor movement has not followed the command.
2) Pr0.14 “Position deviation excess setting” value is low.</td><td>1) Check that the motor follows the position command pulses. Check that the output toque has not saturated on torque monitor. Make a gain adjustment. Maximize Pr0.13 “The 1st torque limit setup” and Pr5.22 “The 2nd torque limit setup.” Make a connection of the encoder as described in the wiring diagram. Prolong acceleration/deceleration time. Lower the load and speed.
2) Increase the setup value of Pr0.14.</td></tr>
<tr><td>1</td><td>Speed deviation excess protection</td><td>The difference between internal position command speed and actual speed (velocity deviation) has exceeded the setting of Pr6.02 “Speed deviation excess setup.”
NOTE) At the moment when internal position command speed forcibly became 0, for example immediate stop due to command pulse input inhibition (INH) and positive direction/negative direction drive prohibition input, velocity deviation has been large. Also, because velocity deviation has been large also at start-up of internal position command speed, set with sufficient margin.</td><td>• Increase the setup value of Pr6.02.
• Prolong the acceleration/deceleration time of internal position command speed, or improve the following capability by making a gain adjustment.
• Disable speed deviation excess detection. (Pr6.02=0)</td></tr>
<tr><td>25</td><td>0</td><td>Hybrid deviation excess error protection</td><td>During the full-closed control, a load position due to external scale and a motor position due to encoder were misaligned for the set pulse number or more at Pr3.28 “Hybrid deviation excess setting.”
During the full-closed control, numerator of electronic gear were changed or switched.</td><td>• Check the connection of the motor and the load.
• Check the connection in the external scale and servo driver.
• Check that changes in the motor position (encoder feedback value) have the same sign as those in the load position (external scale feedback value) when moving the load. Check that the numerator and denominator of the external scale division (Pr3.24, 3.25) and reversal of external scale direction (Pr3.26) are correctly set.
• Fix the numerator of electronic gear during the full-closed control.</td></tr>
<tr><td rowspan="2">26</td><td>0</td><td>Over-speed protection</td><td>The motor rotational speed has exceeded the setup value of Pr5.13 “Over-speed level setup.”</td><td rowspan="2">• Do not give an extravagant velocity command.
• Check the command pulse input frequency and division/multiplication ratio.
• When overshoot occurs due to improper gain adjustment, make a gain adjustment.
• Wire the encoder cable as described in the connection diagram.</td></tr>
<tr><td>1</td><td>2nd over-speed protection</td><td>The motor rotational speed has exceeded the setup value of Pr6.15 “The 2nd over-speed level setup.”</td></tr>
</table>

(Continued)

Protective functions Main	Protective functions Sub	Name	Causes	Actions taken
27	0	Command pulse input frequency error protection	The frequency of command pulse input is more than 1.2 times the setting in Pr5.32 “Command pulse input maximum setup/digital filter setup.”	• Check the command pulse input.
	1	Absolute clear abnormal protection	Absolute encode multi-rotation clear has been executed when a block operation was enabled (Pr 6.28 is non 0).	• Confirm whether absolute encode multi-rotation clear has when a block operation was enabled.(Note) This is a safety measure and is not an abnormality.
	2	Command pulse multiplier error protection	Division and multiplication ratio which are set up with the command pulse counts per single turn and the 1st and the 4th numerator/denominator of the electronic gear are not appropriate. Backlash compensation function enabled. When (Pr7.04 bit1-0 is not 0), the setting value of Pr7.05 “backlash compensation amount” is not appropriate.	• Check the setup value of command division/multiplication numerator of electronic gear. • Pr7.05 Check the backlash compensation amount.
28	0	Limit of pulse replay protection	The output frequency of pulse regeneration has exceeded the limit.	• Check the setup values of Pr0.11 “Output pulse counts per one motor revolution” and Pr5.03 “Denominator of pulse output division.” • When disabling the detection, set Pr5.33 “Pulse regenerative output limit enable” to 0.
29	0	Deviation counter overflow protection	Position deviation value of the encoder pulse standard has exceeded 2^{30}-1 (1073741823).	• Check that the motor follows the position command. • Check that the output toque has not saturated on torque monitor. • Make a gain adjustment. • Maximize Pr0.13 “The 1st torque limit setup” and Pr5.22 “The 2nd torque limit setup”. • Make a connection of the encoder as described in the wiring diagram.
	1	Counter overflow error protection 1	The value of absolute encoder (absolute external scale) position [pulse units] / electronic gear ratio has exceeded $\pm 2^{31}$(2147483648) or an overflow occurred during the calculation, in position information initialization process after closing control power supply under absolute mode when block operations is valid	• Confirm the operating range of absolute encoder (absolute external scale) position and review the electronic gear ratio.
	2	Counter overflow error protection 2	Position deviation in unit of pulse has reached ± (2^{30}-1) (1073741823) or more. Or, position deviation in unit of command has exceeded $\pm 2^{30}$ (1073741824).	• Confirm that motor rotates in accordance with the positioning command. • Confirm that output torque has not saturated by the torque monitor. • Adjust gain. • Set Pr.0.13 “1st torque limit” and Pr5.22 “2nd torque limit” to maximum. • Connect encoder connection wiring as per the wiring diagram.
31	0	Safety function error protection 1	Safety function has detected an error.	• In case of the repeated occurrence, because failure is possible, replace the servo driver. Return to a dealer for investigation (repair).
	2	Safety function error protection 2		
33	0	I/F overlap allocation error 1 protection	Input signals (SI1, SI2, SI3, SI4, and SI5) are assigned with two functions.	• Allocate correct function to each connector pin.
	1	I/F overlap allocation error 2 protection	Input signals (SI6, SI7, SI8, SI9, and SI10) are assigned with two functions.	• Allocate correct function to each connector pin.
	2	I/F input function number error 1	Input signals (SI1, SI2, SI3, SI4, and SI5) are assigned with undefined number.	• Allocate correct function to each connector pin.
	3	I/F input function number error 2	Input signals (SI6, SI7, SI8, SI9, and SI10) are assigned with undefined number.	• Allocate correct function to each connector pin.
	4	I/F output function number error 1	Output signals (SO1, SO2, and SO3) are assigned with undefined number.	• Allocate correct function to each connector pin.
	5	I/F output function number error 2	Output signals (SO4, SO5, and SO6) are assigned with undefined number.	• Allocate correct function to each connector pin.
	6	Counter clear allocation error	Counter clear function is assigned to a signal number other than SI7.	• Allocate correct function to each connector pin.
	7	Command pulse inhibition input allocation error	Command pulse inhibition input function is assigned to a signal number other than SI10.	• Allocate correct function to each connector pin.

(Continued)

Protective functions Main	Protective functions Sub	Name	Causes	Actions taken
34	0	Motor working range setup error protection	The motor has exceeded the motor working range set to Pr5.14 “Allowable motor operating range setting” against the position command input range. 1) Gain is not appropriate. 2) Pr5.14 setup value is low. 3) Conditions of compulsory Err34.0 occurring have met in the case of Pr6.97 “Function expansion setting 3” bit2=1.	1) Check gain (the balance of position loop gain and velocity loop gain) and inertia ratio. 2) Increase the setup value of Pr5.14. Or, set Pr5.14 to 0 and disable the protective function. 3) Check the setting and operation conditions. (See precaution of 6-3.)
36	0	EEPROM parameter error protection	Data in parameter storage area has been damaged when reading the data from EEPROM at power-on.	• Reset all parameters. • In case of the repeated occurrence, because failure is possible, replace the servo driver. Return to a dealer for investigation (repair).
	1			
37	0	EEPROM check cord error protection	EEPROM writing-check data has been damaged when reading the data from EEPROM at power-on.	Failure is possible. Replace the servo driver. Return to a dealer for investigation (repair).
	1			
	2			
38	0	Drive prohibition input protection	Both positive and negative direction drive prohibition inputs (POT and NOT) have been turned ON at Pr5.04 “Over-travel inhibition input setting” =0. Either positive direction drive prohibition input or negative direction drive prohibition input has been turned ON at Pr5.04=2.	• Check that there is no error in the switches, wires and power supply connected to the positive direction/negative direction drive prohibition input. Check particularly that start-up of the power supply for the control signal (DC12 to 24 V) is not slow.
39	0	Analog input 1 (AI1) excess protection	The voltage more than the value set in Pr4.24 “Analog input 1 (AI1) excess setup” has been applied to analog input 1.	• Correctly set Pr4.24 “Analog input 1 (AI1) excess setup.” Check the connection of I/F connector. • Set Pr4.24 to 0 and disable the protective function.
	1	Analog input 2 (AI2) excess protection	The voltage more than the value set in Pr4.27 “Analog input 2 (AI2) excess setup” has been applied to analog input 2.	• Correctly set Pr4.27 “Analog input 2 (AI2) excess setup.” Check the connection of I/F connector. • Set Pr4.27 to 0 and disable the protective function.
	2	Analog input 3 (AI3) excess protection	The voltage more than the value set in Pr4.30 “Analog input 3 (AI3) excess setup” has been applied to analog input 3.	• Correctly set Pr4.30 “Analog input 3 (AI3) excess setup.” Check the connection of I/F connector. • Set Pr4.30 to 0 and disable the protective function.
40	0	Absolute system down error protection	The power supplies and battery powers to absolute encoder were shut down, and the built-in capacitor voltage dropped below specified value. The absolute encoder has not been cleared even once by the batteryless absolute encoder.	After connecting the battery for absolute data, clear the absolute encoder with battery. Clear the batteryless absolute encoder. The alarm cannot be cleared until the absolute encoder is reset.
41	0	Absolute counter over error protection	Multi-turn counter of absolute encoder has exceeded the specified value.	• Set Pr0.15 (Absolute encoder setup) to appropriate value. • Make an amount transferred from the machine zero within 32767 rotations.
42	0	Absolute over-speeds error protection	When using absolute encoder 1) During a power failure, when only battery power is supplied, the motor rotational speed has exceeded the specified value. 2) During normal operation, for some reason, the power of encoder has been shut down, and the rotational speed has exceeded the specified value. Note: It does not occur in the batteryless absolute encoder.	1) Check the driving from outside in a power outage and the rotational speed at the time, and operate to make it below specified value. 2) Because the mode was switched to a power failure mode during normal activity • Check the encoder-side power supply voltage (5 V±5 %). • Check the connection of connector CN2. The alarm cannot be cleared until the absolute encoder is reset.
44	0	Single turn counter error protection	Single turn counter error was detected.	Replace the motor.

(Continued)

Protective functions Main	Protective functions Sub	Name	Causes	Actions taken
45	0	Multi-turn counter error protection	Multi turn counter error has been detected.	Replace the motor.
47	0	Absolute status error protection	When power is turned on, absolute encoder has been rotated at the specified value or above.	Arrange so as the motor does not run at power-on.
50	0	External scale connection error protection	Communication between the external scale and the servo driver was cut off a fixed number of times, and a detection function of guidewire malfunction has become active.	• Install the wiring for the connection in the external scale according to the correct connection. Correct the miswiring of the connector pins.
	1	External scale communication error protection	Communication error has occurred in data from the external scale. Data error mainly due to noise. External scale cables are connected, but communication data has some error.	• Secure power supply voltage DC5 V±5 % (4.75 to 5.25 V) of the external scale…Be notified particularly in case of longer external scale cable. • Separate if the motor wire and the external scale cable are bound together. • Connect the shield to FG…Refer to the connection diagram for the external scale.
	2	External scale communication data error protection	The data from the feedback scale became abnormal despite the absence of communication error. Data error mainly due to noise. Feedback scale cables are connected, but communication data has some error.	
51	0	External scale ST error protection 0	The external scale error code (ALMC) has become 1 from bit 0. Check the external scale specification.	Remove the causes of the error, and then clear the external scale error from the front panel. And then, shut off the power to reset.
	1	External scale ST error protection 1	The external scale error code (ALMC) has become 1 from Bit 1. Check the external scale specification.	
	2	External scale ST error protection 2	The external scale error code (ALMC) has become 1 from Bit 2. Check the external scale specification.	
	3	External scale ST error protection 3	The external scale error code (ALMC) has become 1 from Bit 3. Check the external scale specification.	
	4	External scale ST error protection 4	The external scale error code (ALMC) has become 1 from Bit 4. Check the external scale specification.	
	5	External scale ST error protection 5	The external scale error code (ALMC) has become 1 from Bit 5. Check the external scale specification.	
55	0	A-phase wiring error protection	A-phase wiring in the external scale is defective, e.g. disconnected.	Check A-phase wiring in the external scale.
	1	B-phase wiring error protection	B-phase wiring in the external scale is defective, e.g. disconnected.	Check B-phase wiring in the external scale.
	2	Z-phase wiring error protection	Z-phase wiring in the external scale is defective, e.g. disconnected.	Check Z-phase wiring in the external scale.
70	0	U-phase current detector error protection	U-phase current detection offset value has some error.	• Turn off power once, and turn on again. • Even so, if an error indication appears and an error occurs, failure is possible. Discontinue the use and replace the motor and servo driver. Return to a dealer for investigation (repair).
	1	W-phase current detector error protection	W-phase current detection offset value has some error.	

(Continued)

Protective functions Main	Protective functions Sub	Name	Causes	Actions taken
71	0	CCWTL error protection	Voltage of 11 V or more or -11 V or less was applied to analog input 2.	•Check the connection of I/F connector. •Turn off power once, and turn on again.
	1	CWTL error protection	Voltage of 11 V or more or -11 V or less was applied to analog input 3.	
72	0	Thermal error protection	Thermal has some error.	• Turn off power once, and turn on again. • Even so, if an error indication appears and an error occurs, failure is possible. Discontinue the use and replace the motor and servo driver. Return to a dealer for investigation (repair).
80	0	Modbus communications timeout protection	While ensuring Modbus execution right, Modbus communication against own axis has not been received for more than the set time.	• Set Pr5.40 ”Modbus communication timeout period” to 0 to be disabled or to appropriate time. • Check the connection of Modbus communication.
87	0	Forced alarm input protection	Forced alarm input (E-STOP) is applied.	Check the wiring of forced alarm input (E-STOP).

(Continued)

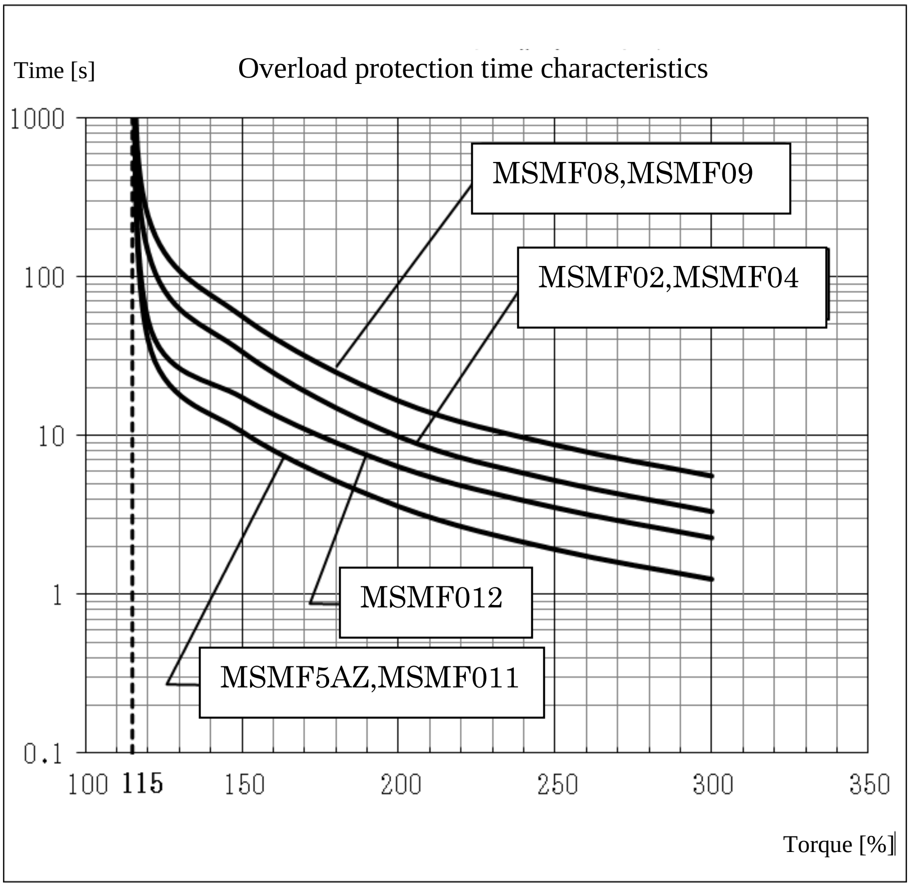
Protective functions Main	Protective functions Sub	Name	Causes	Actions taken
92	0	Encoder data recovery abnormal protection	Initialization process of internal position information has not conducted normally under absolute and semi-closed control mode.	• Secure encoder power supply voltage at DC5V±5% (4.75 to 5.25V). Care must be taken when the encoder lines are lengthy. • If motor wires and encoder wires are bundled together, separate them. • Connect shield to FG.
	1	External scale data recovery error protection	Internal position information initialization error under full-closed control and absolute mode with block operation enabled.	• Secure external scale power supply voltage of 5 VDC±5% (4.75 to 5.25 V). Please take extra care in case the cable connecting the external scale is long. • In case the motor line and the external scale connecting cable are bundled together, separate them. • Connect shield to FG. Refer to external scale connecting diagram
	3	Multi-rotation upper limit value inconsistency error protection	At continuous rotating absolute encoder function, there was a disagreement between the upper-limit value of encoder multi-turn data and the upper-limit value of driver parameter multi-turn data.	• Please confirm the set values of parameters. • Reclose the control power supply when this occurs immediately after closing the control power supply. (This is not an abnormality.)
93	0	Parameter setup error 1	1) Electronic gear ratio exceeds the allowable range. 2) When block operation by start on Modbus communication is valid (Pr6.28 = 1), Modbus connection was disabled (Pr 5.37 is 0). 3) When the backlash compensation function is enabled (Pr7.04 bit1-0 is other than 0) and the block operation is disabled (Pr6.28 = 0), the value of Pr7.18 "Backlash compensation amount holding range" converted to pulse units by the electronic gear ratio exceeds 2147483647.	• Check the setting value of the parameter. 1) When a block operation was enabled (Pr 6.28 is non 0), Electronic gear ratio must be in the range 1/1000 to 8000. 2) When a block operation was enabled (Pr 6.28 is non 0), Modbus connection was disabled (Pr 5.37 is 0). 3) Check the settings of the "Backlash compensation amount holding range" and the electronic gear ratio.
	1	Block data setting error protection	1) The speed, acceleration, and deceleration were set to 0, or the acceleration and deceleration were set to values exceeding 429496729 [command unit/s2], so a block operation was started. 2) A conditional branch command has not been supported for comparison purpose. 3) A designated block data command has been undefined. 4) A command other than the homing command was automatically started with Pr6.98 bit28 (Start of block operation when servo is turned on) = 1 (Valid). 5) Detection method 4 (Z phase (approximate)) for homing command was started when using with full-closed control (Pr0.01 = 6) or a motor other than MINAS-A6. 6) Also, block data setup has some error.	1) Check the values of speed, acceleration, and deceleration. 2) Check whether the conditional branch command or the comparison purpose does not have any problems. 3) Check whether the block data does not have any problems. Check whether the block number designated does not have any problems. 4) Check whether the block data setup does not have any problems. Alternatively, both Pr6.98 bit28 and bit29 are set to 1 (Valid). 5) Check whether the block data setup does not have any problems. 6) Check whether the block data setup does not have any problems.
	2	Parameter setting error protection 2	External scale ratio has exceeded the allowable range (1/160000 to 160000 times)	• Please confirm the set values of parameters. • Use external scale ratio in the range of 1/40 to 1280 times
	3	External scale connection error protection	Set value for Pr3.23 “External scale type selection” and the connected serial communication type external scale type do not match.	• Set Pr3.23 to match the type of the connected external scale
	8	Parameter setting error protection 6	• The continuous rotating absolute encoder function was set to enable with other than the 23-bit resolution absolute encoder. • Block operation origin offset (Pr60.49) has been set outside the range in absolute mode origin offset valid setting (Pr60.48 bit 1 =1) under infinite rotation absolute mode when block operation is valid (Pr6.28 ≠ 0).	• Please confirm the set values of parameters.

(Continued)

Protective functions Main	Protective functions Sub	Name	Causes	Actions taken
94	0	Block operation error protection	1) During the execution of movement system command (During the execution of position command creation process), a new movement system command has been executed. 2) During block operation, a new block number was designated to start. 3) Although it was servo-off, a block operation was started.	1) Check whether the block operation sequence does not have any problems. 2) Check whether the host sequence does not have any problems. 3) Check whether the host sequence does not have any problems.
94	2	Return to origin error protection	1) Abnormal condition has occurred during block operation return to origin 2) The drive inhibit input in the homing direction was turned on during the homing operation of the block operation, and the drive inhibit input in the direction opposite to the homing direction was turned on during the inverting operation. 3) Both drive prohibition inputs (POT and NOT) have been turned ON during the homing opretion of the block operation. 4) Relative positioning or absolute positioning was performed in the state of incomplete homing. 5) When setting 1 (HOME + Z phase) and 2 (HOME only) for the detection method of the return-to-origin command, HOME, POT, and NOT are not assigned to input signals. 6) When setting 2 (HOME only) for the detection method of the return-to-origin command, HOME is not assigned to SI4.	1) Check for abnormalities in various sensor installation status. 2) Check whether there is any problem in the positioning relation between the drive inhibit input and the origin (sensor input, Z phase). 3) Confirm there are no problems in the arrangement of the drive prohibited input. 4) Check whether the block data setup does not have any problems. 5) Allocate correct function to each connector pin. 6) Allocate correct function to each connector pin.
95	0 to 4	Motor automatic recognition error protection	The motor has not been matched by the servo driver.	Replace with a right motor for servo driver.
96	2	Control unit error protection 1	An error occurred in the servo driver control unit.	• Turn the power off and then on again. • Return the products to the dealer or manufacturer.
97	0	Control mode setting error prtection	1) Block operation is set to enabled, when other than Position control (Pr0.01 = 0) or full-closed control (Pr0.01 = 6) 2) When Pr6.28 "Special function setting" = 4 "Block operations by input signal enabled (Pulse train enabled)"was true, Pr0.15 "absolute encoder setup" = 1 "incremental mode" was not true. (The software of function enhancement version 9 or later does not detect alarms due to this cause.)	1) Check the setting of Pr 0.01 "control mode setting" and Pr 6.28 "Special function selection" 2) Check the settings of Pr6.28 "Special function setting " and Pr0.15 "absolute encoder setup.
98	5	Hardware self-diagnosis abnormality protection 1	The current detector has an abnormality.	Return to a dealer for investigation (repair).
Other number		Other error	Control circuit has malfunctioned due to excess noise or other causes. Self-diagnostic function of servo driver was performed, and some error has occurred within the servo driver.	• Turn off power once, and turn on again. • Even so, if an error indication appears and an error occurs, failure is possible. Discontinue the use and replace the motor and servo driver. Return to a dealer for investigation (repair).

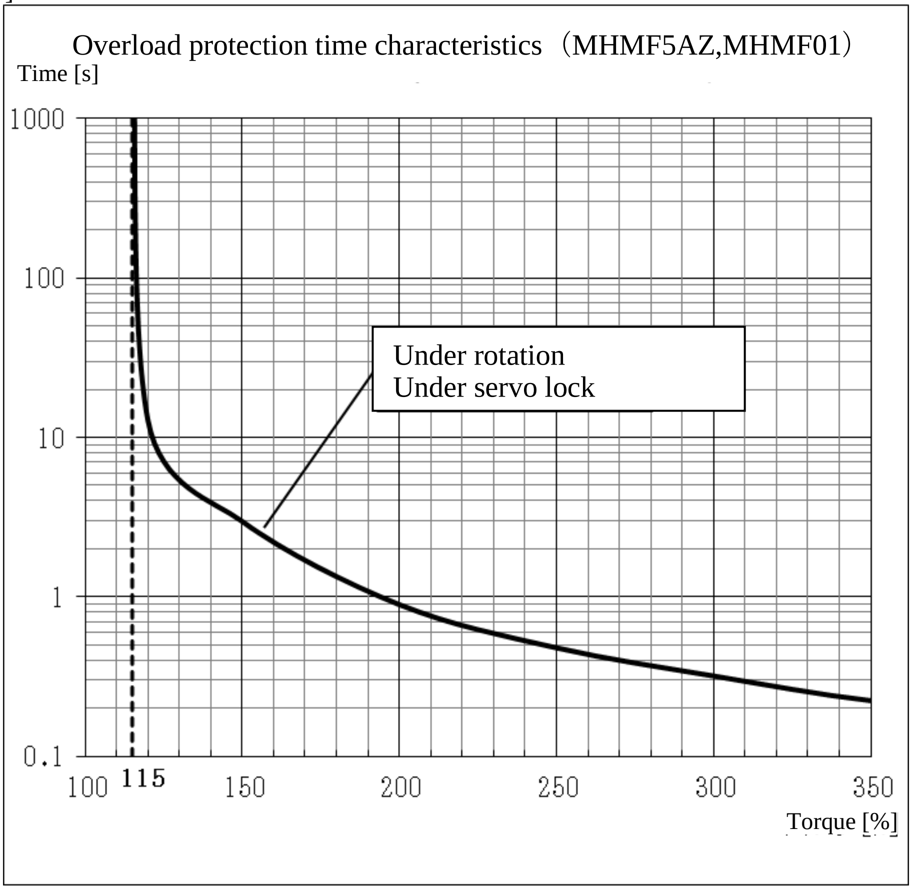
Overload protection time characteristics

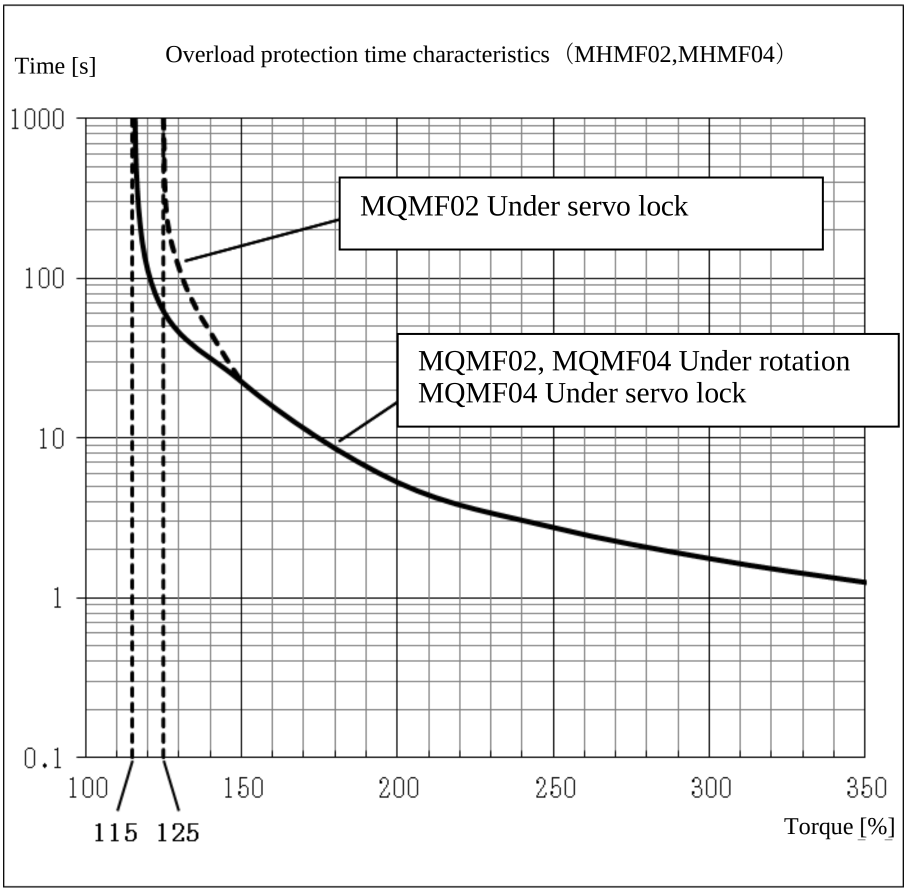
[Small type MSMF]



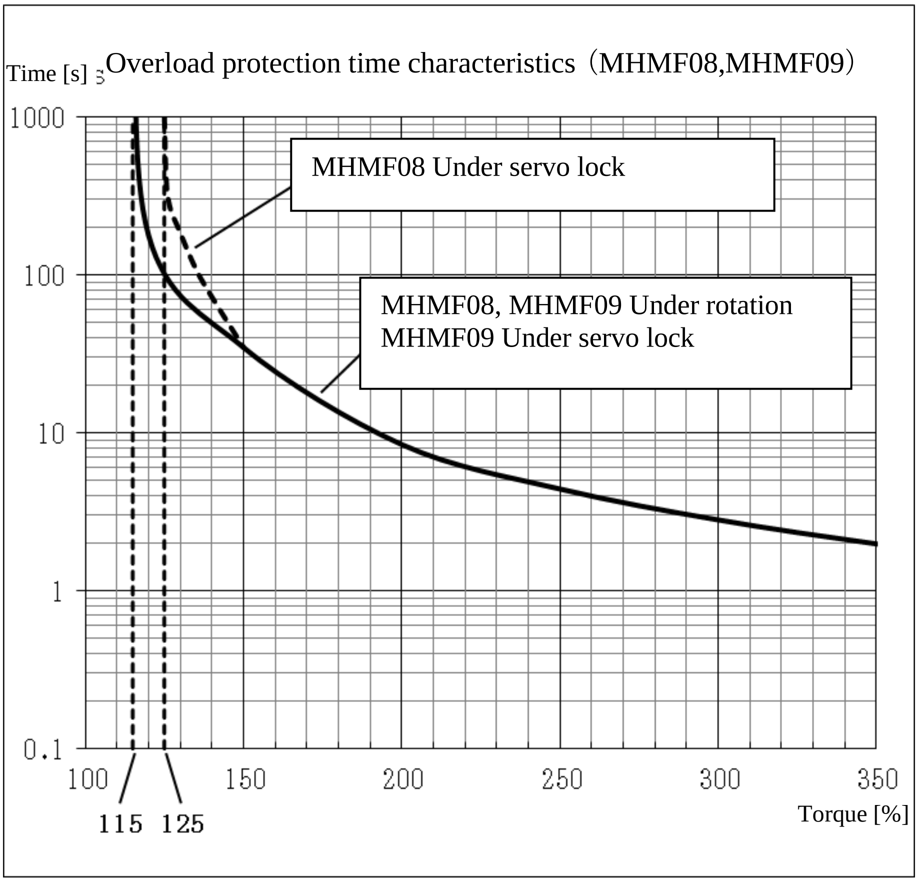
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor. Check the motor specification for “S-T characteristic.”

[Small type MHMF]



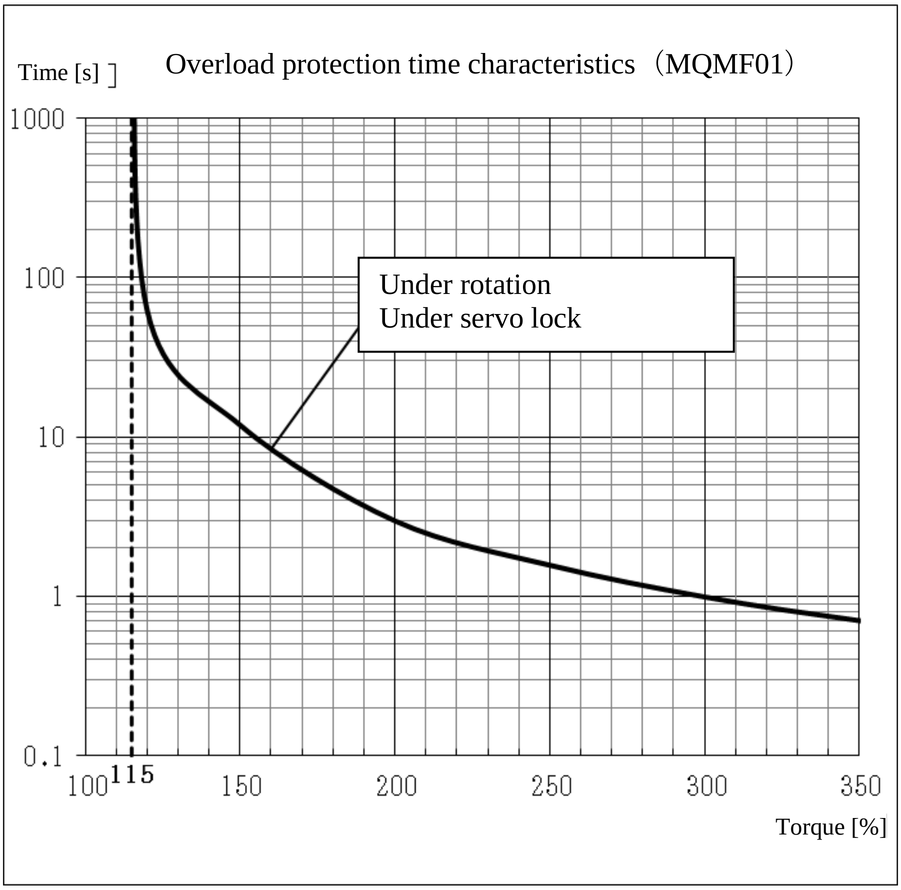


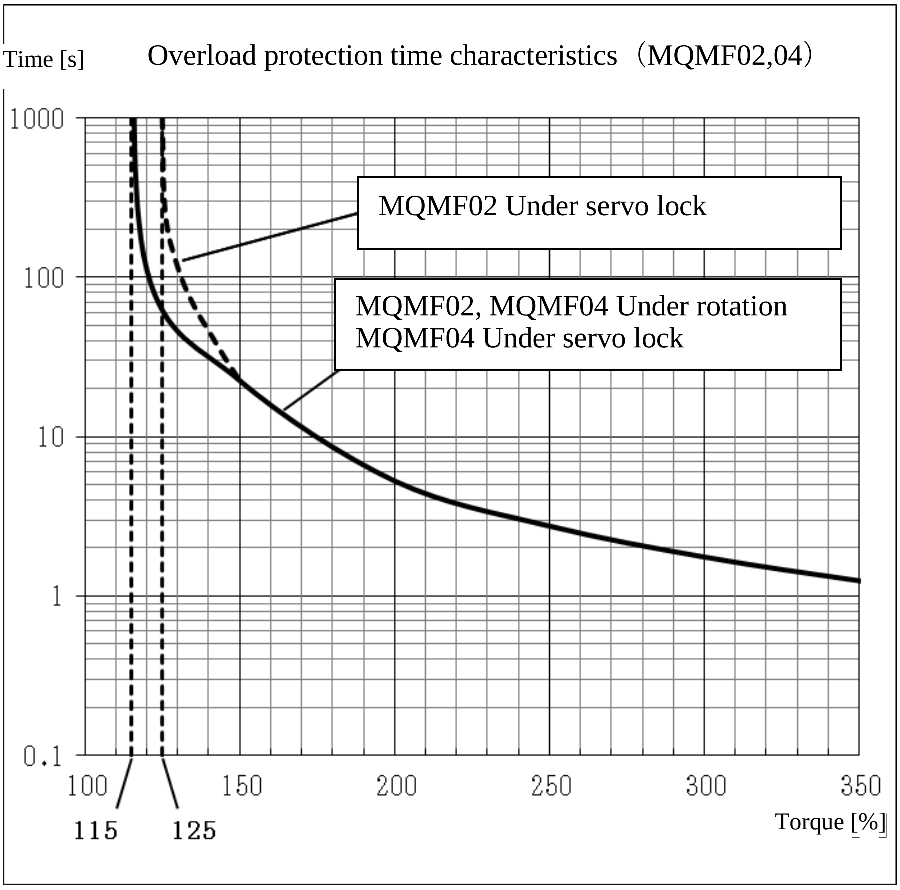
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”



NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

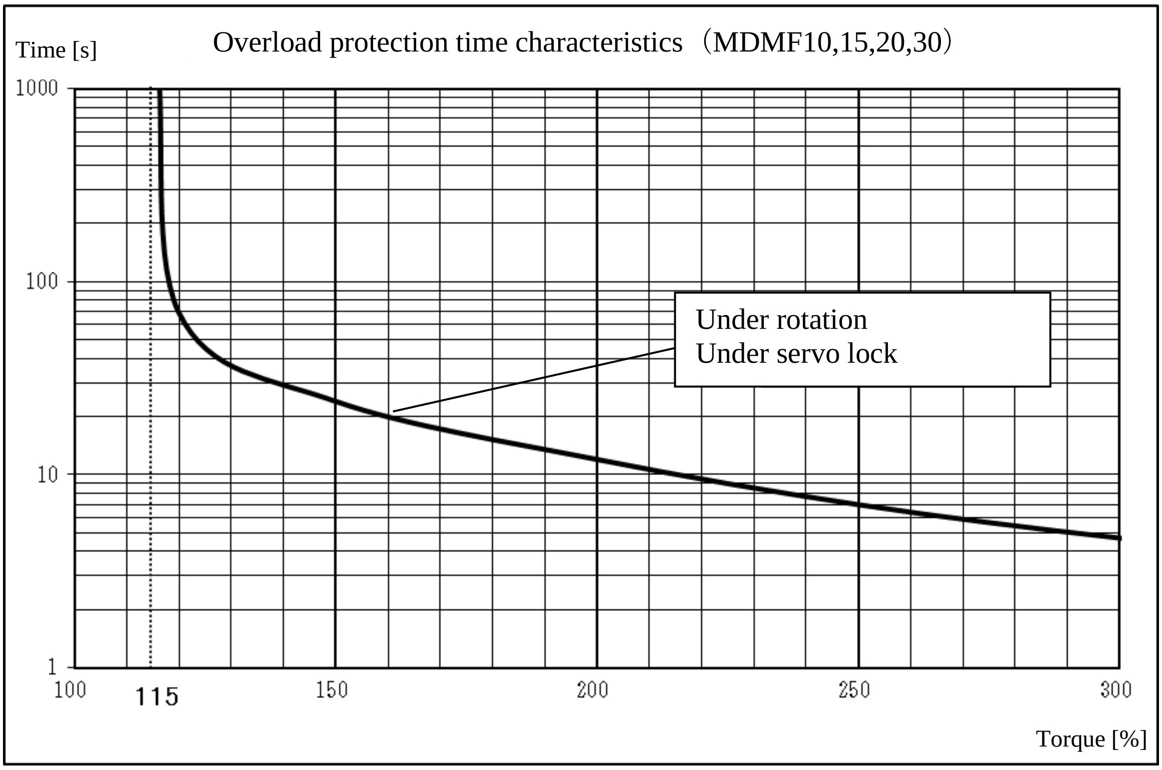
[Small type MQMF]

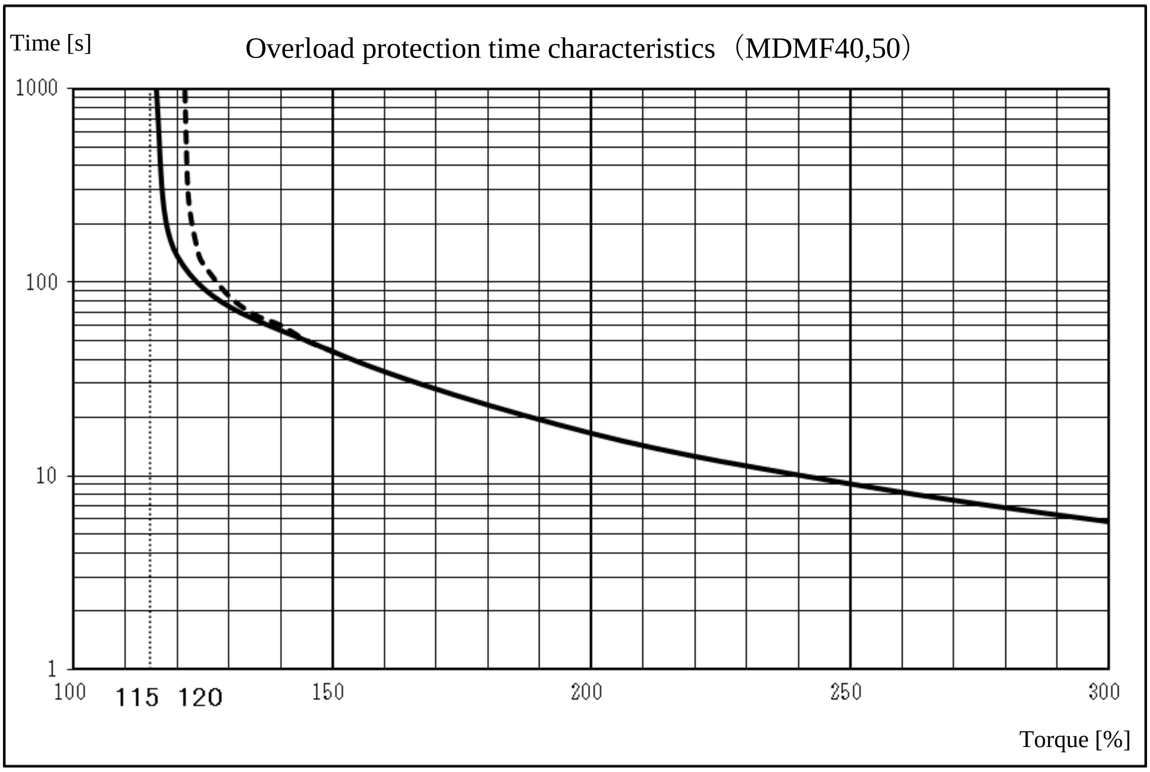




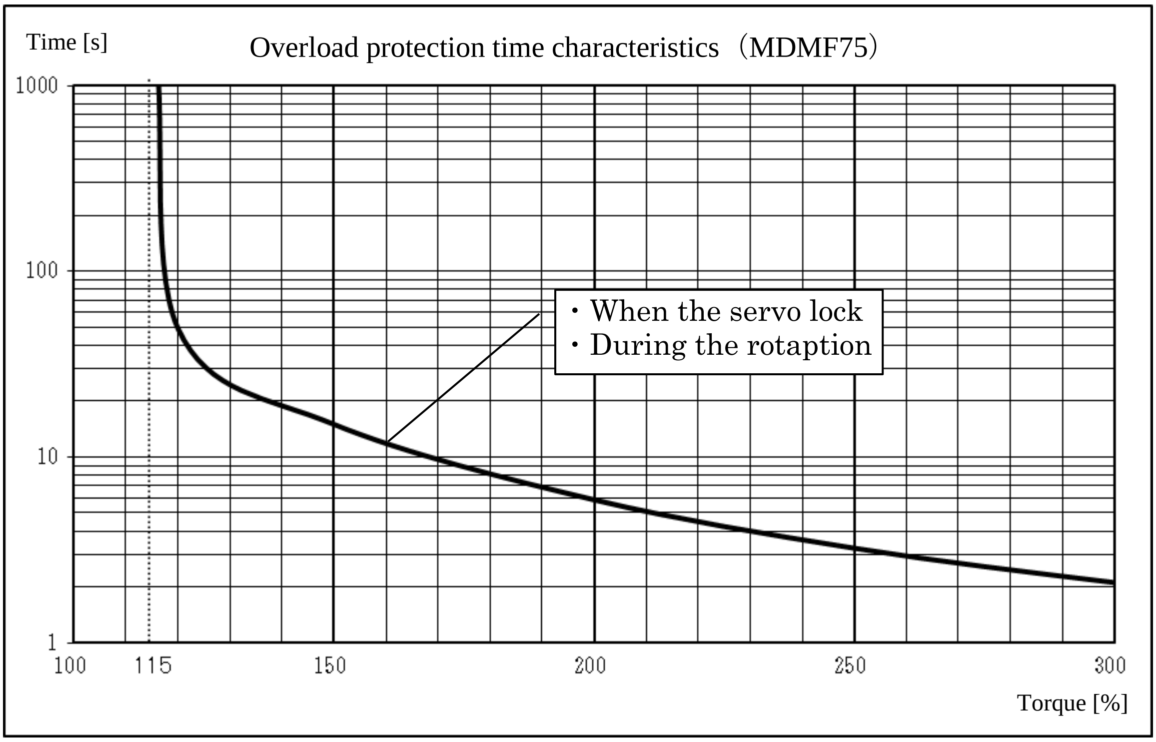
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor. Check the motor specification for "S-T characteristic."

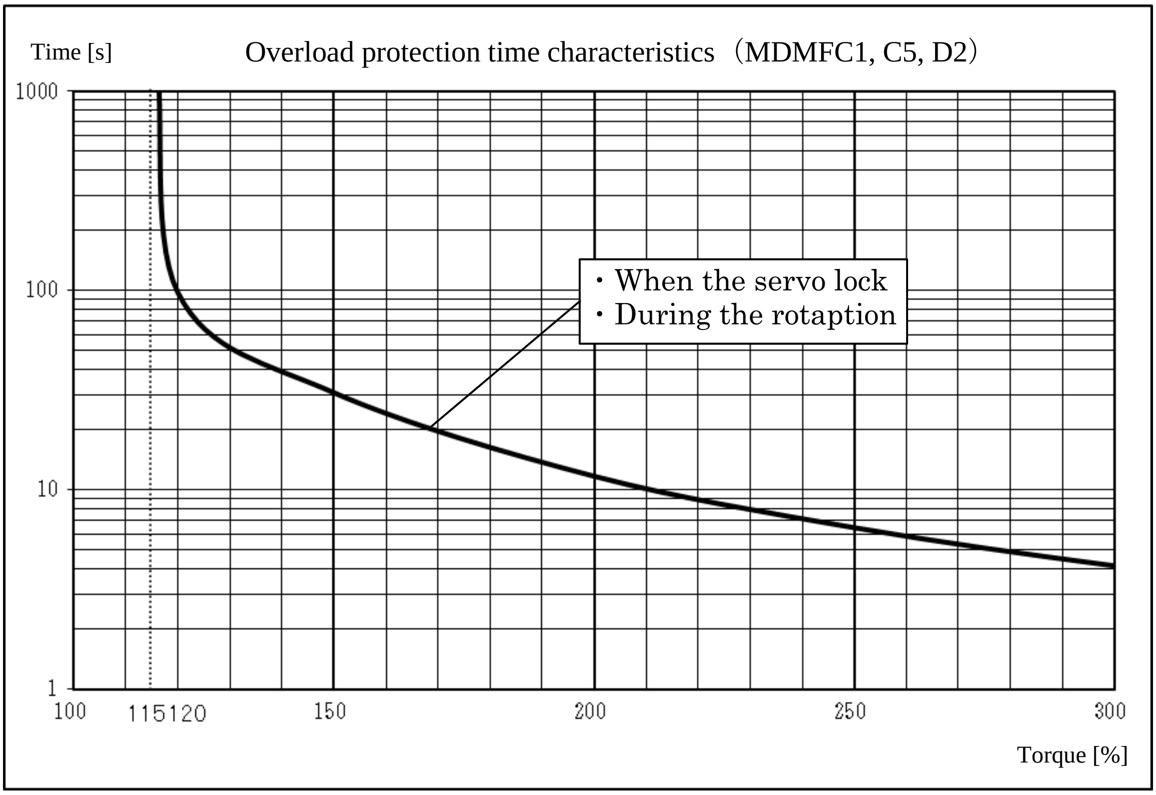
[Large type MDMF]





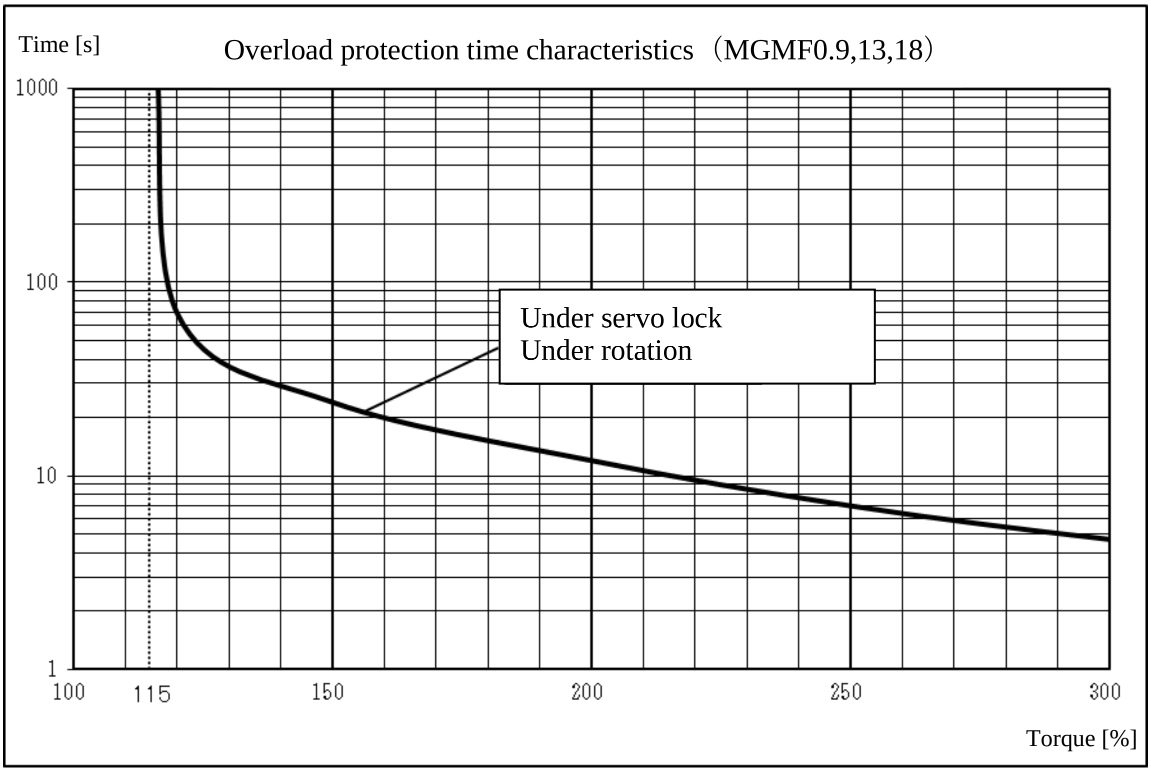
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for "S-T characteristic."

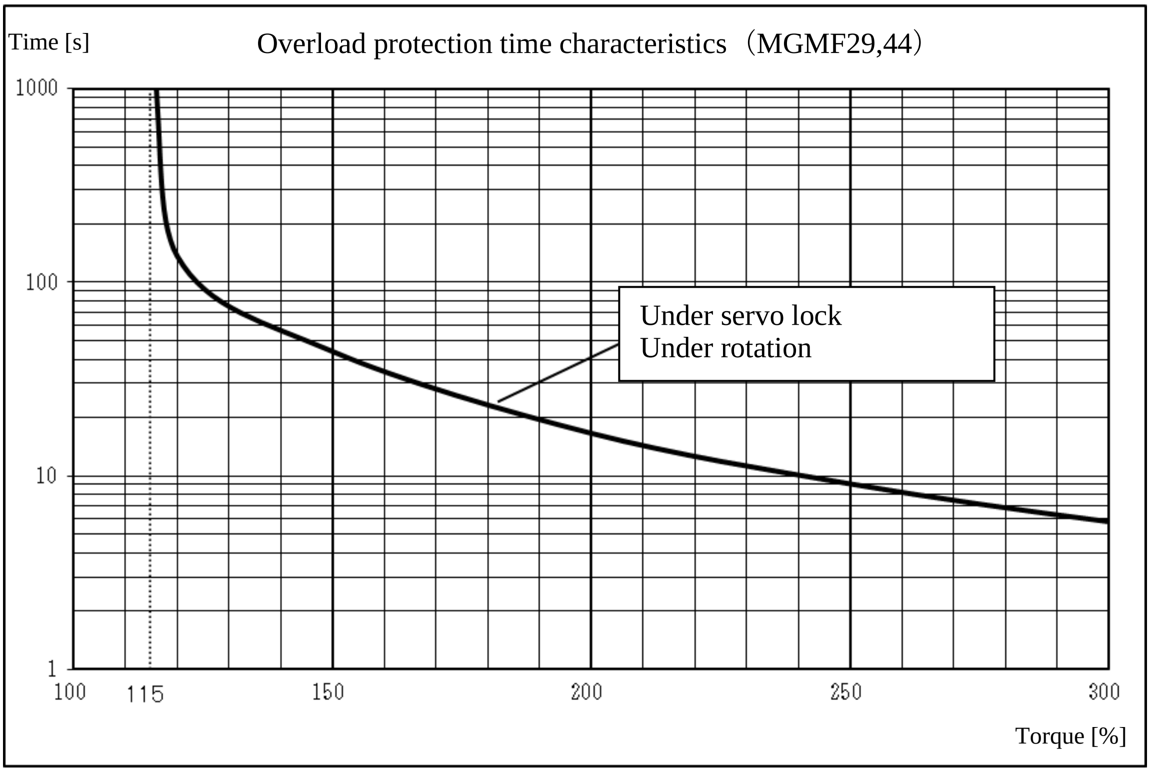




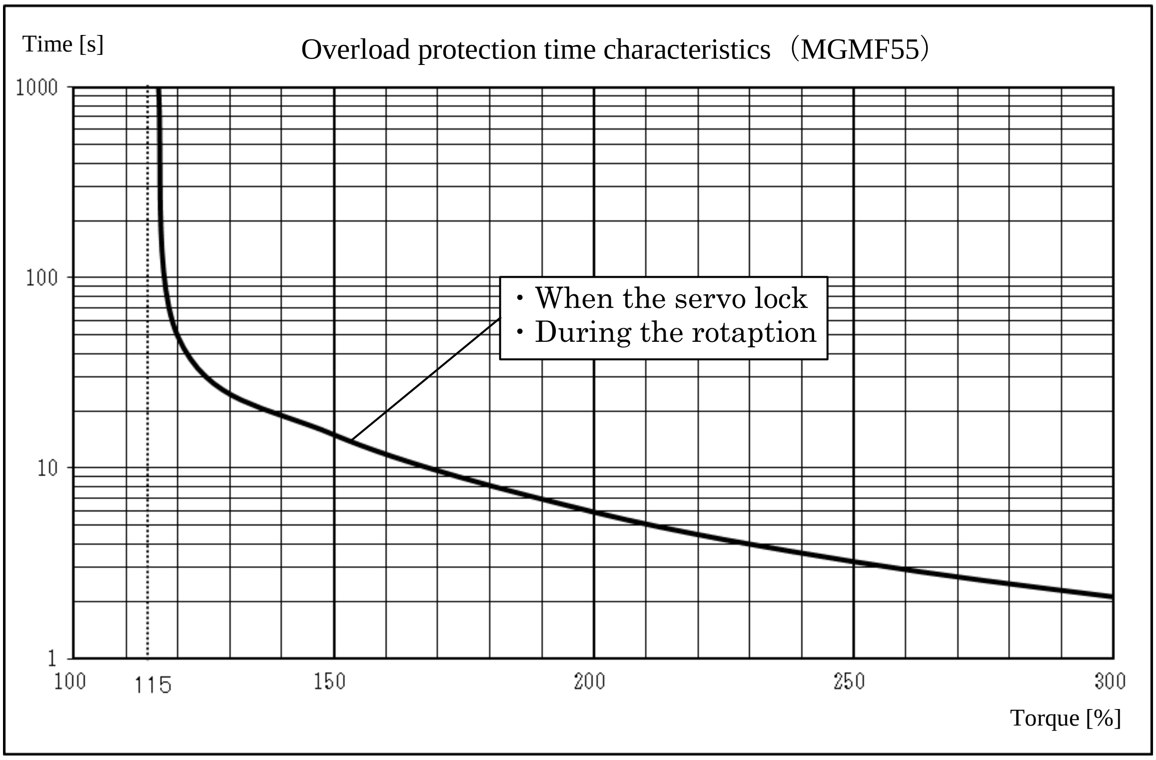
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

[Large type MGMF]



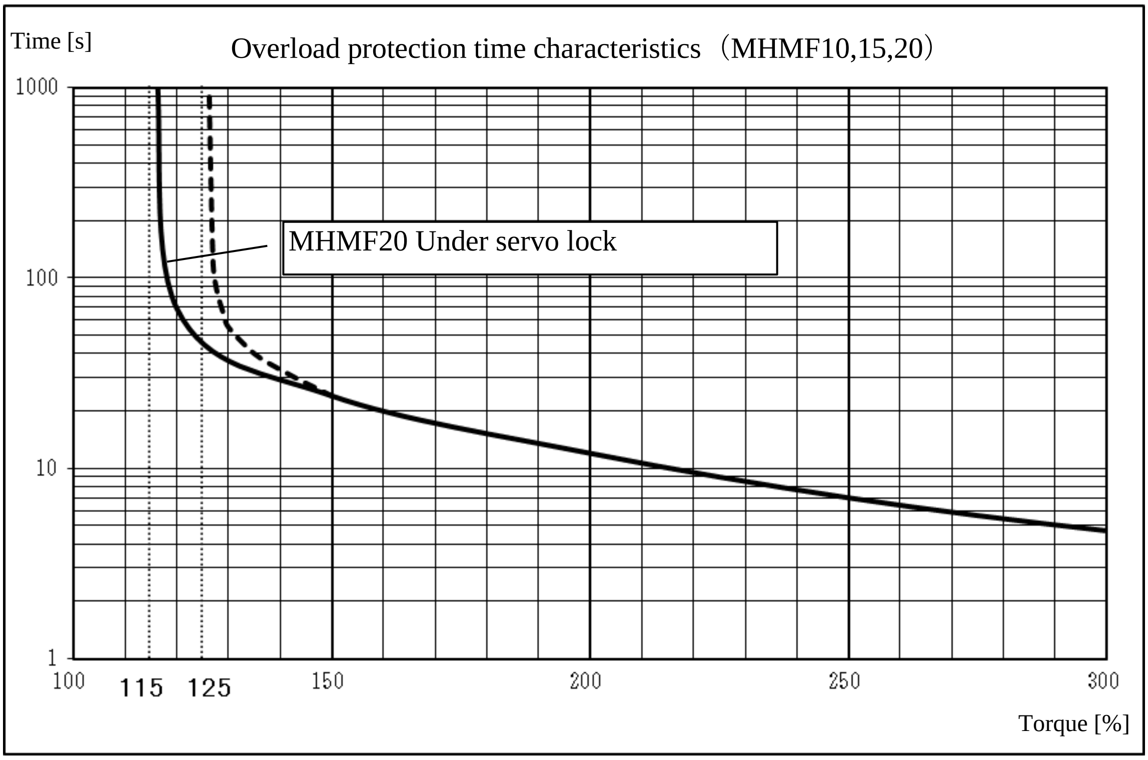


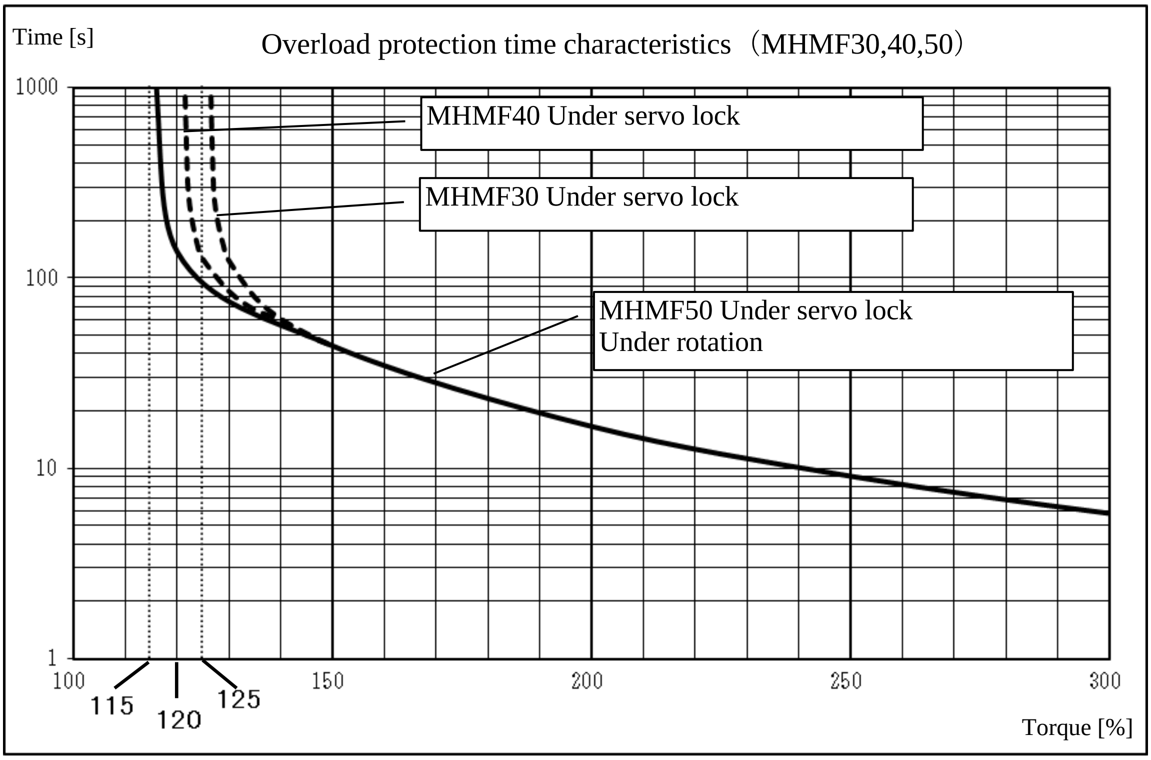
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”



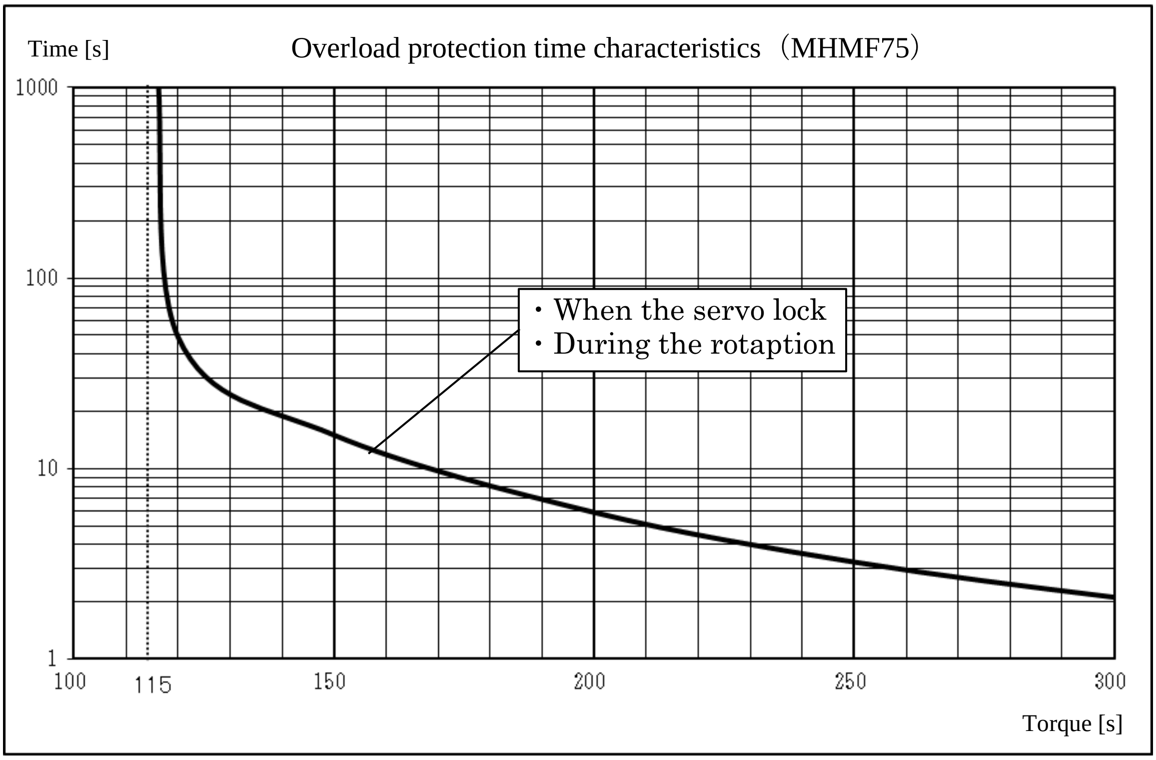
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

[Large type MHMF]



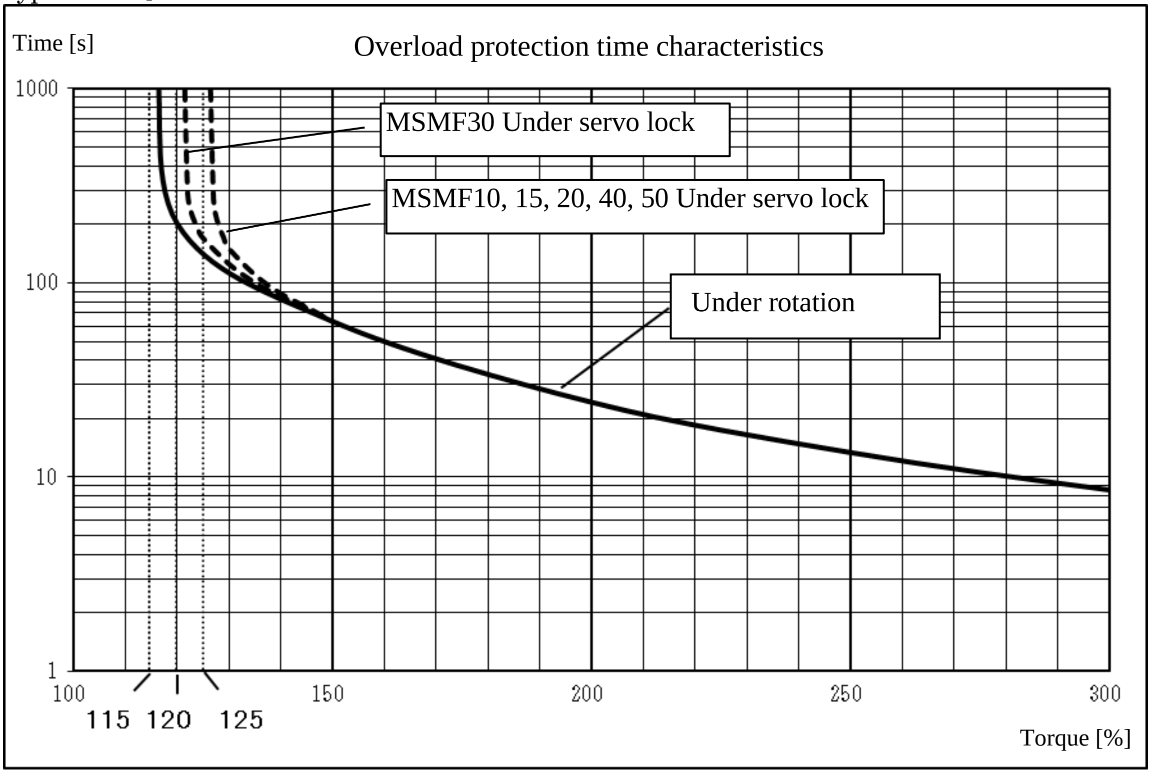


NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for "S-T characteristic."



NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

[Large type MSMF]



NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

7-3 Warning functions

Before the protective functions become active, the warning can be generated, and conditions such as overloading can be checked beforehand.

The warning will be automatically cleared as the cause of the error is removed. However, certain warning will remain latched for predetermined period as shown in the table below. To clear the warning before the warning under the latched condition is latched for predetermined period, implement the same procedure as that for clearing normal warning.

(1)Related parameter

Class	No.	Parameter name	Set range	Unit	Functions
4	40	Warning output 1	0 to 40	-	Select the warning issued as the warning output 1 (WARN1). Setting value 0: OR output of all warnings From 1: Use the following for a reference.
4	41	Warning output 2	0 to 40	-	Select the warning issued as the warning output 2 (WARN2). Setting value 0: OR output of all warnings From 1: Use the following for a reference.

(2) Type of warning

Warning number	Warning name	Content	Pr6.27 *1	Pr4.40/ Pr4.41 *2	Pr6.38/Pr6.39 corresponding bit *3
A0	Overload warning	Load factor is 85% or more the protection level.	○	1	Pr6.38 bit 7
A1	Over-regeneration warning	Regenerative load factor has exceeded 85% of the level.	○	2	Pr6.38 bit 5
A2	Battery warning *8	Battery voltage is 3.2 V or lower.	Fixed at no time limit.	3	Pr6.38 bit 0
A3	Fan warning	Fan has stopped for 1 sec.	○	4	Pr6.38 bit 6
A4	Encoder communication warning	The number of successive encoder communication errors has exceeded the specified value.	○	5	Pr6.38 bit 4
A5	Encoder overheat warning *4	Encoder temperature has exceeded the specified value. *7	○	6	Pr6.38 bit 3
A6	Oscillation detection warning	Oscillation or vibration has been detected.	○	7	Pr6.38 bit 9
A7	Lifetime detection warning	The life expectancy of capacity or fan has dropped below specified value	Fixed at no time limit.	8	Pr6.38 bit 2
A8	External scale error warning	The external scale has detected the warning.	○	9	Pr6.38 bit 8
A9	External scale communication warning	The number of successive external scale communication errors has exceeded the specified value.	○	10	Pr6.38 bit 10
AC	Deterioration diagnosis warning *6	Load characteristic estimates and torque command under constant speed has exceeded the set range.	○	22	Pr6.39 bit7
C3	Main power off warning	In case that Pr7.14 (Detection time of main power off warning) is 10 to 1999, the mains power between L1 and L3 has stopped instantaneously for more than the time prescribed in Pr7.14.	○	14	Pr6.38 bit 12

*1 The part "○" indicates Pr6.27 "Latched time of warning" and can set the time interval 1 to 10s or no time limit. Note that the battery warning and the end of life warning have "no time limit."
*2 Through Pr4.40 "Warning output select 1" and Pr4.41 "Warning output select 2," select the warning issued as the warning output signal 1 (WARN1) and signal 2 (WARN2). In case of setting value 0, OR output of all warnings will be obtained. In addition, do not use the setup values other than those listed in the above table.
*3 Each warning detection can be disabled by Pr6.38 "Warning mask setup" and Pr6.39 "Warning mask setting 2." The corresponding bits are indicated in the table. The warning detection will be disabled by bit=1.
*4 Encoder thermal warning is effective only when 23 bit absolute encoder, 20 bit absolute encoder and 20 bit incremental serial encoder are used. If other encoders are used, it will be disabled.
*5 Warnings can be cleared by using the alarm clear. While the alarm clear input (A-CLR) is kept ON, the all existing warnings are always cleared.
*6 Invalidated when Pr6.97 "Function expansion setting 3" bit1 = 0.
*7 Take measures such as lowering the ambient temperature and reducing the load, or re-examining the heat dissipation.
*8 In the case of Pr0.15 = 1 (incremental mode), when using the battery-powered absolute encoder, or when using the battery-less absolute encoder, no battery warning is detected.

7-4 Setup of gain pre-adjustment protection

Before starting gain adjustment, set the following parameters based on the conditions of use, to assure safe operation.

1) Drive prohibition input setup

By inputting the limit sensor signal to the driver, the bumping against mechanical end can be prevented. Refer to interface specification, positive/negative direction drive prohibition input (POT/NOT). In addition, set the following parameters which are related to drive prohibition input.

Pr5.04 “Drive prohibition input setup”
Pr5.05 “Sequence at drive prohibition”

2) Torque limit setup

By limiting motor maximum torque, damage caused by failure or disturbance such as bite of the machine and collision will be minimized. To apply standardized limit through parameters, set Pr0.13 “The 1st torque limit.”

If the torque limit setup is lower than the value required for the actual application, the following two protective features will be triggered: over-speed protection when overshoot occurs, and position deviation excess protection when delay in response to the command occurs.

By allocating the torque in-limit output of interface specification to the output signal, torque limit condition can be detected externally.

3) Over-speed protection setup

Generate Err26.0 “Over-speed protection” when the motor speed is excessively high.

Default setting is the applicable motor maximum speed [r/min] × 1.2.

If your application operates below the motor maximum speed, set Pr5.13 “Over-speed level setup” by using the formula below.

Pr5.13 “Over-speed level setup” = Vmax × (1.2 to 1.5) Vmax: Motor maximum speed in operating condition [r/min] Factor in ( ) is margin to prevent frequent activation of over-speed protection.

When running the motor at a low speed during initial adjustment stage, set the overspeed protection by multiplying the adjusting speed by a certain margin to protect the motor against possible oscillation.

4) Position deviation excess protection setup

During the position control or full-closed control, this function detects potential excessive difference between the position command and motor position and issues Err24.0 ”Position deviation excess protection”.

Excess position deviation level can be set by Pr0.14 “Position deviation excess setting.” The detection position can be selected from command position deviation [pulse (command unit)] and encoder position deviation [pulse (encoder unit)] or full-closed deviation [pulse (external scale unit)] in Pr5.20 “Position setting unit selection”. (See the control block diagram)

Default is set to 100000 [pulse (command unit)].

Because the position deviation during normal operation depends on the operating speed and gain setting, fill the values obtained from the equation below based on your operating condition and input the resulting value to Pr0.14.

4-1) In case two degree-of-freedom is set to valid (Pr6.47 bit 0 = 1)

■ For Pr5.20 = 0 (Detection by command position deviation)

> Pr0.14 “Excessive position deviation setting” = (P1 + P2 + P3 + P4) x (1.2 to 2.0)
>
> Coefficients in parenthesis are allowances to prevent frequent triggering of excessive position deviation protection

Position command smoothing accumulator pulse count: P1 = V_c × (set value for Pr2.22 / 10000) x 2

Position command FIR filter accumulator pulse count: P2 = V_c × (set value for Pr2.23 / 10000) / 2

Adjustment filter accumulator pulse count: P3 = V_c × (Set value for Pr6.48 / 10000)

Damping filter accumulator pulse count: P4 = Vc / (π × damping frequency [Hz])

Vc: Maximum frequency of positional command pulse [pulse (command unit)/s]

* Damping frequency is 1/10 of the set values for Pr2.14 (first), Pr2.16 (second), Pr2.18 (third) and Pr2.20 (fourth) and is calculated only when the set values are effective. In case multiple damping controls are valid, P4 shall be calculated for each damping filter and P4 shall be the total of the calculated values.

■ For Pr5.20 = 1 (Detection by encoder position deviation or full-closed position deviation)

> * In this case, the position deviation cannot be obtained through calculation formula. Set the value including allowance, by estimating the maximum value of encoder position deviation or full-closed position deviation (Pmax) from the actual operation waveform that could be used.
>
> Pr0.14 “Excessive position deviation setting” = Pmax × (1.2 to 2.0)

Note 1) Measure with the smallest value when switching position loop gain Kp.

Note 2) Setting of command filter and damping control will not have any effect in case Pr 5.20 = 1.

4-2) In case two degree-of-freedom control is invalid (Pr6.47 bit 0 = 0)

- For Pr5.20 = 0 (detection through command position deviation),

Pr0.14 “Position deviation excess setting” = Vc/Kp × (1.2 to 2.0) Vc: Maximum frequency of positional command pulse [pulse (command unit)/s] Kp: Position loop gain [1/s] Factor in ( ) is margin to prevent frequent activation of position deviation excess protection.

Note 1) When switching position loop gain Kp, select the smallest value for calculation.

Note 2) When using the positional command filter and damping control, add the following values.

Positional command smoothing filter: Vc × Filter time constant [s]

Positional command FIR filter: Vc × Filter time constant [s]/2

Damping control: Vc/(π × Damping frequency [Hz])

- For Pr5.20 = 1 (Detection through encoder position deviation and full-closed position deviation)

Pr0.14 “Position deviation excess setting” = Ve/Kp × (1.2 to 2.0) Ve: Maximum operation frequency [pulse/s] in encoder unit or full-closed unit Kp: Position loop gain [1/s]

Note 3) When switching position loop gain Kp, select the smallest value for calculation.

Note 4) When Pr5.20 = 1, setups of positional command filter and damping control have no effect.

5) Allowable motor operating range setting

During the position control or full-closed control, this function detects the motor position which exceeds the revolutions set to Pr5.14 Allowable motor operating range setting, and issues Err34.0 Motor working range limit protection.

For details, see 6-3 Allowable motor operating range setting function.

6) Hybrid deviation excess error protection setup

At the initial operation with full-closed control, operation failure may occur due to reverse connection of external scale or wrong external scale division ratio.

To indicate this type of defect, Err25.0 “Hybrid deviation excess error protection” is issued when the deviation of motor position (encoder unit) and load position (external scale unit) exceed Pr3.28 “Hybrid deviation excess setting.”

For details, see 4-5-3 Setting of hybrid deviation excess.

8. Safety function

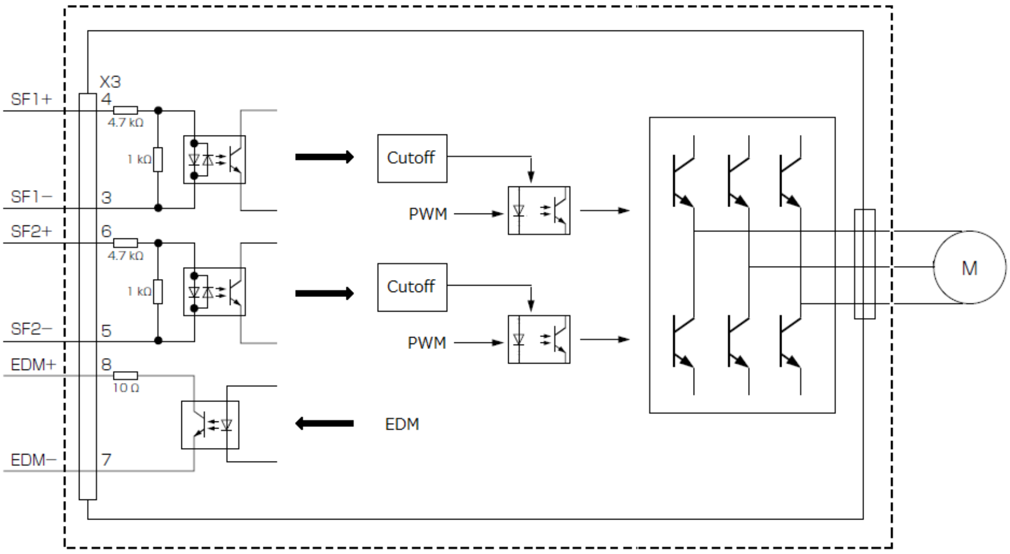
This servo driver has safety function built in. [A6SE], [A6SG] This function is not available.

≪Change point from MINAS-A5 series≫

	MINAS-A5	MINAS-A6 ([A6SF])	
STO operation	Alarm generation Err30.0	No alarm 7-segment LED is "st"	
Method of releasing the STO state	Release of the factors and Alarm clear	After the STO state status When the alarm is not generated	After the STO state status When the alarm is generated
		Release of the factors of STO and servo off command	Release of the factors of STO/alarm and Alarm clear

8-1 Outline of safe torque off (STO) function

The safe torque off (STO) function is a safety function that shuts the motor current and turns off motor output torque by forcibly turning off the driving signal of the servo driver internal power transistor. For this purpose, the STO uses safety input signal and hardware (circuit).



When STO is activated, the servo driver turns off the servo-ready output signal (S-RDY) and goes into a STO state, with the indication in the front panel turning to "St". When STO input is released and servo-on input is Off, it will automatically transition itself to Servo ready state.
In the STO state, the position deviation is 0 clear state.

8-2 Input/output signal specification

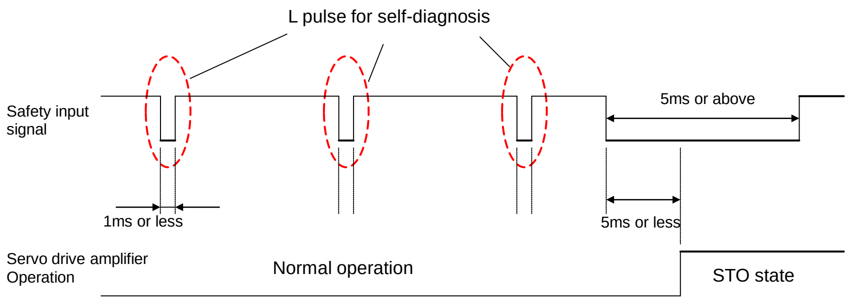
8-2-1 Safety input signal

• Two safety input circuit channels that trigger STO function are provided.

Class	Signal name	Signal	Connector pin number	Content	Control mode		
					Position	Velocity	Torque
Input	Safety input 1	SF1 +	X3-4	● It is input 1 that triggers STO function. This input turns off the upper arm drive signal of power transistor. ● When using the function, connect this pin in a way so that the photocoupler of this input circuit turns off to activate STO function.	○		
		SF1-	X3-3				
	Safety input 2	SF2 +	X3-6	● It is input 2 that triggers STO function. This input turns off the lower arm drive signal of power transistor. ● When using the function, connect this pin in a way so that the photocoupler of this input circuit turns off to activate STO function.	○		
		SF2-	X3-5				

- Safety input 1 or 2 enables STO to operate within 5 ms after input, and then the motor output torque will be turned off.
- Input the same signal to Safety input 1 or 2.

NOTE) Safety equipment self-diagnosis L pulse
The safety output signal from the safety equipment such as safety controller and safety sensor may include L pulse for self-diagnosis. To prevent the L pulse from mis-triggering STO function, the safety input circuit has built-in filter that removes the self-diagnosis L pulse.
Therefore, if the off period of safety input signal less than 1 ms, the safety input circuit does not detect this off event.
To validate this off period, turn off the safety input signal for more than 5 ms.



8-2-2 External device monitor (EDM) output signal

• The monitor output signal is used by the external device to monitor the state of the safety input signal. Be sure to connect the monitor output to the external device monitor terminal of the safety equipment such as safety controller and safety sensor.

Class	Signal name	Signal	Connector pin number	Content	Control mode		
					Position	Velocity	Torque
Output	EDM output	EDM +	X3-8	• Output monitor signal that is used to check the safety function. *This output signal is not a safety output.	○		
		EDM-	X3-7				

• Logical relationship between safety input signal and EDM output signal is as follows.
When both safety input 1 and 2 are off, i.e. when STO function of 2 safety input channels are active, the photocoupler in EDM output circuit turns on.

Signal name	Signal	Photocoupler logic			
Safety input	SF1	ON	ON	OFF	OFF
	SF2	ON	OFF	ON	OFF
EDM output	EDM	OFF	OFF	OFF	ON

By monitoring the logics (all 4 states) of photocoupler shown in the table above, the external device can determine the status (normal or abnormal) of safety input circuit and EDM output circuit. That is to say, in the case of an anomaly, although both safety input 1 and 2 are off, the photocoupler in EDM output circuit does not turn on. Or, although either safety input 1 or 2 or both safety input 1 and 2 turned on, the state in which the photocoupler in EDM output circuit turned on has been detected.

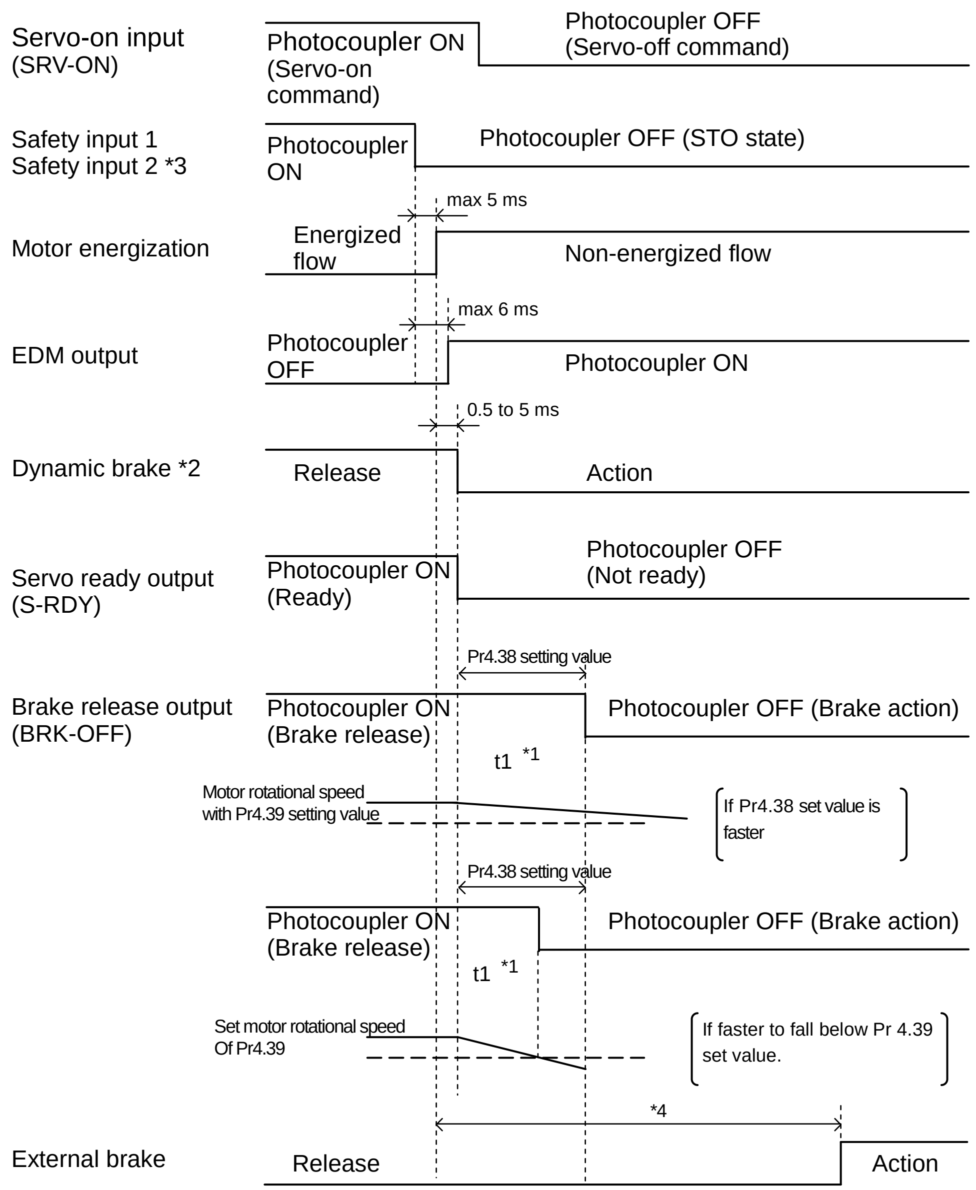
• Maximum delay time from input of safety 1 and 2 signals to output of EDM signal is 6 ms.

In order to satisfy all the standards, it is necessary to monitor the EDM signal with the host device.

• Be sure to monitor the EDM signal at the time of starting up the amplifier, every 3 months, and at the time of safety input.

8-3 Description of functions

8-3-1 Activation to STO state, timing diagram



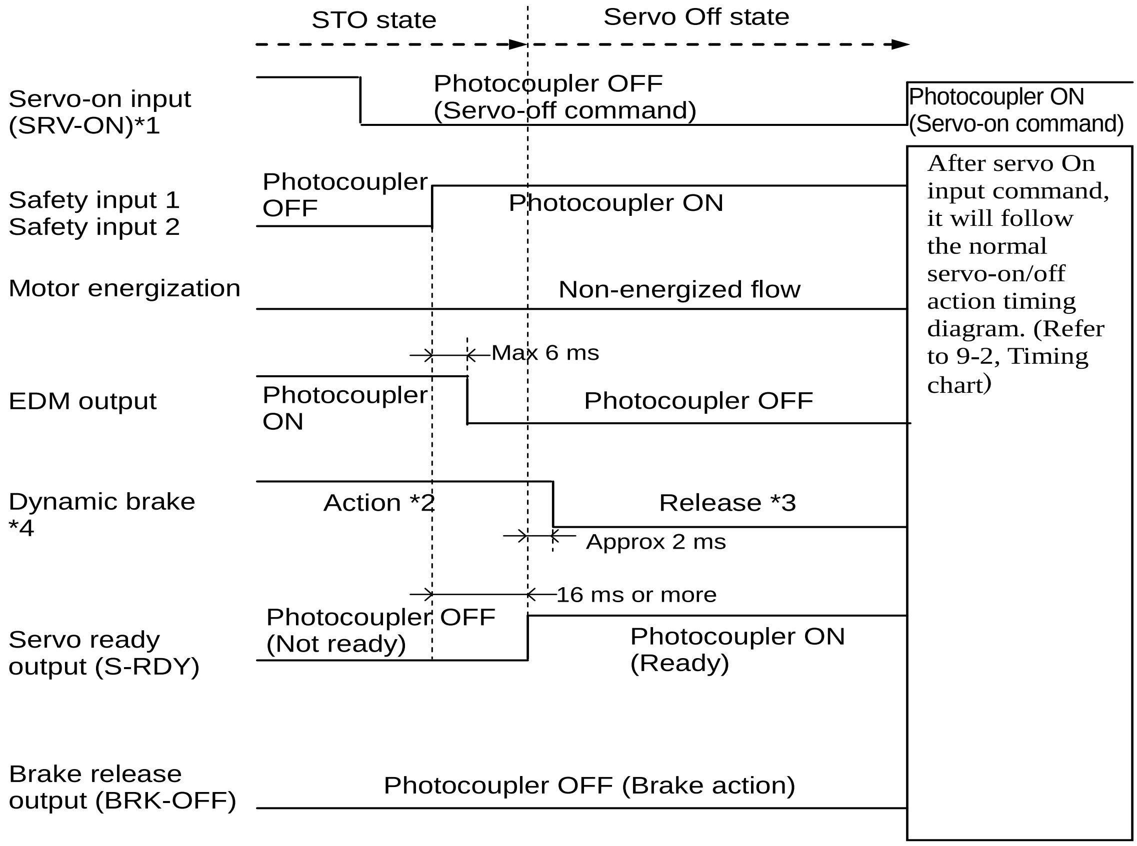
*1. t1 will be a shorter time of either the setup value of Pr4.38 “Mechanical braking setting during operation” or elapsing time for the motor speed to fall below Pr4.39 “Brake release speed setup.”

*2. Dynamic brake operates to the setting of Pr5.10 “Sequence at alarm.”
(During STO state, “sequence at alarm” will be applied even though no alarm is generated.)

*3. To activate STO function, turn safety input 1 and 2 OFF at the same time.

*4. Since servo-lock cannot be performed in the interval after motor energization is cut off until the external brake operates, the work may fall by gravity from the vertical axis. Take an appropriate measure to prevent this.

8-3-2 Return timing diagram from STO state



*1. Photocouplers for safety input 1 and 2 should be turned on again with servo-on input turned off.
Returning photocouplers for safety inputs 1 and 2 to ON will automatically reset it to Servo ready mode. There is no need to conduct alarm-clear.

*2. This is an STO state and the dynamic brake operates according to Pr5.10 “Sequence at alarm.”
(During STO state, “sequence at alarm” will be applied even though no alarm is generated.)

*3. This is normal servo-off condition and the dynamic brake operates according to Pr5.06 “Sequence at servo-off.”

8-4 Connection example

≪Attention point when connecting≫

・Depending on the safety device to be connected, it is necessary to turn on the power supply of the amplifier first.
At this time, the state of the amplifier becomes an alarm in the A5 series, the A6 series becomes the STO.

The method of returning from the alarm state or STO state is as follows.

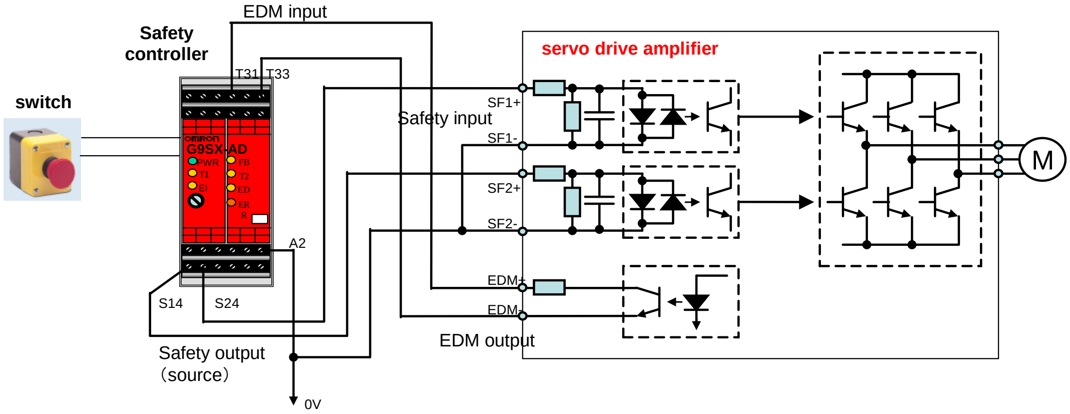
≪MINAS-A5 series≫

① Turn off servo ON input
② Return the photo couplers for safety input 1 and 2 to ON.
③ Release the alarm.

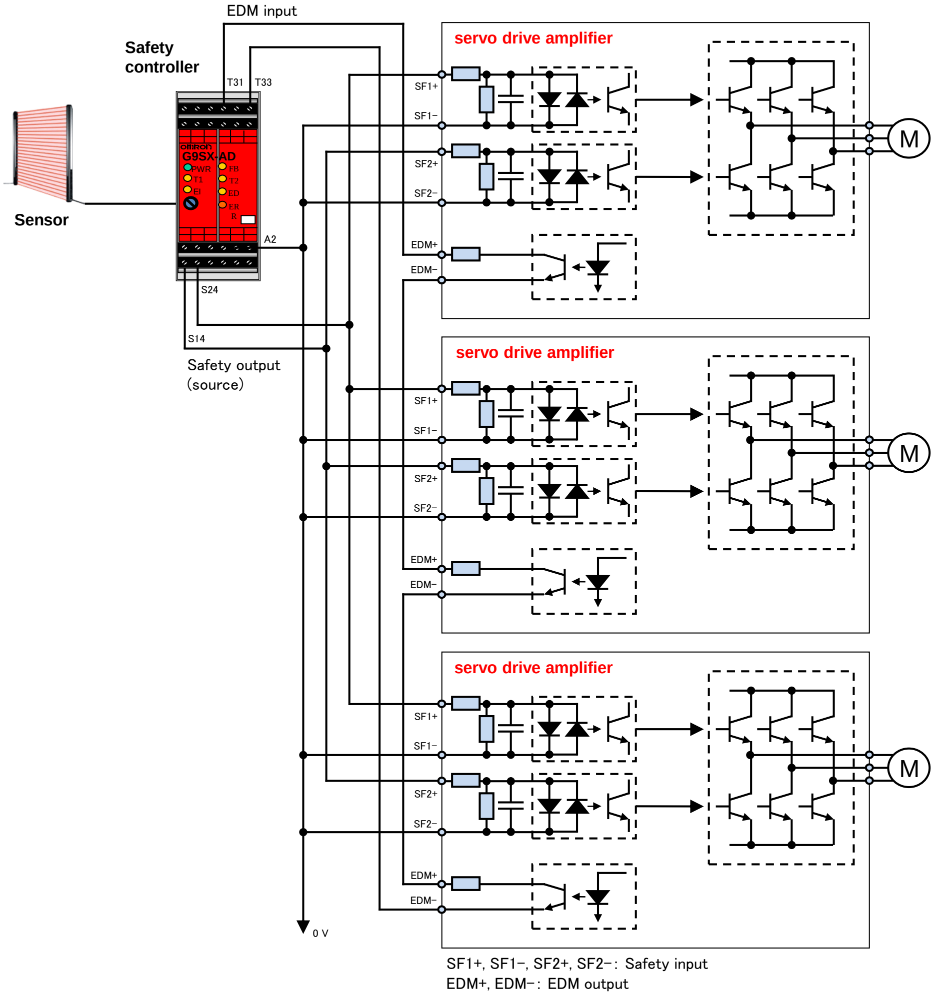
≪MINAS-A6 series≫

① Turn off servo ON input
② Return the photo couplers for safety input 1 and 2 to ON.
* Automatically return to the servo ready state.

8-4-1 Example of connection to safety contoller



8-4-2 Example of connection when using multiple axes



- Capacity requirement per safety output (source) channel: 5×No. of connected axes (mA)
- DC 24 V supply allowable voltage: 24 V±15 %
- Maximum No. of connectable axes: 8 axes *1

*1. The number is for reference only.
EDM output depends on external circuit because saturated voltage Vce (sat) of approx. 1.0 V in the built-in photocoupler varies with collector current.
Amount of current flowing to SF input is 5 mA per circuit.
When increasing the number of axes to be connected, make sure that required amount of current does not exceed the maximum output current of the safety controller.

8-5 Safety precautions

■ When using the STO function, be sure to perform equipment risk assessment to ensure that the system conforms to the safety requirements.
For use in a state not satisfying the safety requirement function, In some cases personal injury may result.

■ Even while the STO function is working, the following potential safety hazards exist. Check safety in risk assessment.
Incorrect use may cause personal injury in some cases.

- The motor may move when external force (e.g. gravity force on vertical axis) is exerted on it. Provide an external brake, etc., as necessary to secure the motor. Note that the purpose of servo motor with brake is holding and it cannot be used for braking application.
- When parameter Pr5.10 “Sequence at alarm” is set to free run (disable dynamic brake), the motor is free run state and requires longer stop distance even if no external force is applied. Make sure that this does not cause any problem.
  (During STO state, “sequence at alarm” will be applied even though no alarm is generated.)
- When power transistor, etc., becomes defective, the motor will move to the extent equivalent of 180 electrical angle (max.). Make sure that this does not cause any problem.
- The STO turns off the current to the motor but does not turn off power to the servo driver and does not isolate it. When starting maintenance service on the servo driver, turn off the driver by using a different disconnecting device.

■ EDM output signal is not a safety output. Do not use it for an application other than failure monitoring.
Incorrect use may cause personal injury in some cases.

■ Dynamic brake and external brake release signal output are not related to safety function. When designing the system, make sure that the failure of external brake release during STO state does not result in danger condition.
Incorrect use may cause personal injury in some cases.

■ When using the STO function, connect equipment conforming to the safety standards.
Use of equipment not compliant with safety standards, In some cases personal injury may result.

9. Other

9-1 List of parameters

9-1-1 Class 0: Basic setting

Class	No.	Parameter name	Unit	Set range	Functions/Contents	Attribute	Related control mode	Relevance
0	00	Rotational direction setting	-	0 to 1	Establishes the relationship between command direction and motor rotational direction. 0: Sets to CW direction, 1: Sets to CCW direction	Reapplying the power	All	4-1
	01	Control mode setting	-	0 to 6	Selects a control mode of servo driver. 0: Position control, 1: Velocity control, 2: Torque control, 3: Position (1st) / Velocity control (2nd), 4: Position (1st) / Torque control (2nd), 5: Velocity (1st) / Torque control (2nd), 6: Full-closed control *When the 3rd, 4th or 5th combined modes are set, either the 1st or 2nd mode can be selected by the control mode switching input (C-MODE). C-MODE OFF: Select 1st mode C-MODE ON: Select 2nd mode	Reapplying the power	All	-
	02	Real-time auto tuning setting	-	0 to 6	Sets an operation mode of real-time auto tuning.	Always enabled	All	5-1-1
	03	Real-time auto tuning stiffness set	-	0 to 31	Sets machine stiffness at the execution of real-time auto tuning.	Always enabled	All	5-1-1
	04	Inertia ratio	%	0 to 10000	Sets a load inertia ratio of the motor rotor inertia .	Always enabled	All	-
	05	Command pulse input selection	-	0 to 2	Selects a command pulse input. 0: Photo coupler input 1: Exclusive input for line driver 2: Photo coupler input [200 k[pulse/s] or below]	Reapplying the power	Position, full-closed	4-2-1
	06	Command pulse rotational direction setting	-	0 to 1	Sets a counting direction of command pulse.	Reapplying the power	Position, full-closed	4-2-1
	07	Command pulse input mode setting	-	0 to 3	Sets a command pulse input mode. 0,2: 90° phase difference 2-phase pulse 1: Positive direction pulse train + Negative direction pulse train 3: Pulse train + Code	Reapplying the power	Position, full-closed	4-2-1
	08	Command pulse number per one motor revolution	Pulse	0 to 2^{23}	Sets a command pulse number that causes single turn of the motor shaft.	Reapplying the power	Position	4-2-2
	09	First command division/multiplication numerator	-	0 to 2^{30}	When setting the command division/multiplication function as numerator/denominator, set up the numerator.	Always enabled	Position, full-closed	4-2-2
	10	Command division/multiplication denominator	-	1 to 2^{30}	When setting the command division/multiplication function as numerator/denominator, set up the denominator.	Always enabled	Position, full-closed	4-2-2
	11	Output pulse counts per one motor revolution	P/r	1 to 2097152	Sets the pulse output resolution with each of the output pulse count per one rotation of OA and OB. Consequently, the result of pulse count with host side ×4 multiplication processing becomes as follows. Pulse output resolution per one rotation = Pr0.11 set value × 4	Reapplying the power	All	4-2-4
	12	Pulse output logic inversion/output source selection	-	0 to 3	Selects the B-phase logic and the output source of the pulse regenerative output.	Reapplying the power	All	4-2-4
	13	1st torque limit	%	0 to 500	Sets the 1st limit value of motor output torque. Also, parameter values are limited at applicable motor maximum torque.	Always enabled	All	6-1 7-4
	14	Position deviation excess setting	Command unit	0 to 2^{30}	Sets a position deviation excess set range. Setting value 0 disables detection of Err24.0 "Position deviation excess protection." Unit is expressed in accordance with Pr5.20 "Position setting unit selection."	Always enabled	Position, full-closed	7-4
	15	Absolute encoder setting	-	0 to 4	Selects the using method of absolute encoder.	Reapplying the power	All	4-7-1
	16	External regeneration resistor setting	-	0 to 3	Sets for regeneration resistor-related.	Reapplying the power	All	4-6
	17	External regeneration resistor selection	-	0 to 4	Selects a type of load factor calculation for external regeneration resistor.	Reapplying the power	All	4-6
	18	For manufacturer's use	-	-	Fix to 0.	-	-	-

9-1-2 Class 1: Gain adjustment

Class	No.	Parameter name	Unit	Set range	Functions/Contents	Attribute	Related control mode	Relevance
1	00	1st position loop gain	0.1/s	0 to 30000	Sets the 1st position loop gain.	Always enabled	Position, full-closed	5-2
	01	1st velocity loop gain	0.1 Hz	1 to 32767	Sets the 1st velocity loop gain.	Always enabled	All	5-2
	02	1st velocity integration time constant	0.1 ms	1 to 10000	Sets the 1st time constant of velocity loop integration. Holds integral at setting value 9999. Disables at setting value 10000.	Always enabled	All	5-2
	03	1st velocity detection filter	-	0 to 5	Sets the 1st velocity detection filter in 6 stages.	Always enabled	All	5-2
	04	1st torque filter	0.01 ms	0 to 2500	Sets the time constant of 1st torque filter.	Always enabled	All	5-2
	05	2nd position loop gain	0.1/s	0 to 30000	Sets the 2nd position loop gain.	Always enabled	Position, full-closed	5-2
	06	2nd velocity loop gain	0.1 Hz	1 to 32767	Sets the 2nd velocity loop gain.	Always enabled	All	5-2
	07	2nd velocity integration time constant	0.1 ms	1 to 10000	Sets the 2nd time constant of velocity loop integration. Holds integral at setting value 9999. Disables at setting value 10000.	Always enabled	All	5-2
	08	2nd velocity detection filter	-	0 to 5	Sets the 2nd velocity detection filter in 6 stages.	Always enabled	All	5-2
	09	2nd torque filter	0.01 ms	0 to 2500	Sets the time constant of 2nd torque filter.	Always enabled	All	5-2
	10	Velocity feed-forward gain	0.1 %	0 to 4000	Sets velocity feed-forward gain.	Always enabled	Position, full-closed	5-2-8
	11	Velocity feed-forward filter	0.01 ms	0 to 6400	Sets the time constant of velocity feed-forward filter *it is disabled when.the two degree of freedom control mode	Always enabled	Position, full-closed	5-2-8
	12	Torque feed-forward gain	0.1 %	0 to 2000	Sets torque feed-forward gain.	Always enabled	All	5-2-8
	13	Torque feed-forward filter	0.01 ms	0 to 6400	Sets torque feed-forward filter.	Always enabled	All	5-2-8
	14	2nd gain setting	-	0 to 1	Sets when performing optimal tuning using gain switching function.	Always enabled	All	5-2-5
	15	Position control switching mode	-	0 to 10	Selects gain switching condition of position control.	Always enabled	Position, full-closed	5-2-5
	16	Position control switching delay time	0.1 ms	0 to 10000	Sets delay time when switching from 2nd gain to 1st gain.	Always enabled	Position, full-closed	5-2-5
	17	Position control switching level	-	0 to 20000	Sets gain switching level.	Always enabled	Position, full-closed	5-2-5
	18	Position control switching hysteresis	-	0 to 20000	Sets hysteresis at gain switching.	Always enabled	Position, full-closed	5-2-5
	19	Position gain switching time	0.1 ms	0 to 10000	Sets gain switching time at gain switching position.	Always enabled	Position, full-closed	5-2-5
	20	Velocity control switching mode	-	0 to 5	Selects gain switching condition of velocity control.	Always enabled	Velocity	5-2-5
	21	Velocity control switching delay time	0.1 ms	0 to 10000	Sets delay time when switching from 2nd gain to 1st gain.	Always enabled	Velocity	5-2-5
	22	Velocity control switching level	-	0 to 20000	Sets gain switching level.	Always enabled	Velocity	5-2-5
	23	Velocity control switching hysteresis	-	0 to 20000	Sets hysteresis at gain switching.	Always enabled	Velocity	5-2-5
	24	Torque control switching mode *1	-	0 to 3	Selects gain switching condition of torque control.	Always enabled	Torque	5-2-5
	25	Torque control switching delay time *1	0.1 ms	0 to 10000	Sets delay time when switching from 2nd gain to 1st gain.	Always enabled	Torque	5-2-5
	26	Torque control switching level *1	-	0 to 20000	Sets gain switching level.	Always enabled	Torque	5-2-5
	27	Torque control switching hysteresis *1	-	0 to 20000	Sets hysteresis at gain switching.	Always enabled	Torque	5-2-5

(Continued) *1 Not available with [A6SE], [A6SG].

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
1	28	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	29	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	30	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	31	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	32	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	33	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	34	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	35	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	36	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	37	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	38	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	39	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	40	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	41	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	42	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	43	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	44	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	45	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	46	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	47	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	48	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	49	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	50	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	51	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	52	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	53	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	54	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	55	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	56	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	57	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	58	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	59	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	60	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	61	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	62	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	63	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	64	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	65	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	66	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	67	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	68	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	69	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	70	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	71	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	72	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	73	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	74	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	75	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	76	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	77	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	78	Manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-

9-1-3 Class 2: Damping control

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
2	00	Adaptation filter mode	-	0 to 6	Sets adaptation filter action	Always enabled	Position, velocity, full-closed	5-1-2
	01	1st notch frequency	Hz	50 to 5000	Sets notch frequency of 1st resonance suppression notch filter. To be used matching the resonance frequency of the machine	Always enabled	All	5-2-6
	02	1st notch width	-	0 to 20	Sets notch width of 1st resonance suppression notch filter.	Always enabled	All	5-2-6
	03	1st notch depth	-	0 to 99	Sets notch depth of 1st resonance suppression notch filter.	Always enabled	All	5-2-6
	04	2nd notch frequency	Hz	50 to 5000	Sets notch frequency of 2nd resonance suppression notch filter. To be used matching the resonance frequency of the machine	Always enabled	All	5-2-6
	05	2nd notch width	-	0 to 20	Sets notch width of 2nd resonance suppression notch filter.	Always enabled	All	5-2-6
	06	2nd notch depth	-	0 to 99	Sets notch depth of 2nd resonance suppression notch filter.	Always enabled	All	5-2-6
	07	3rd notch frequency	Hz	50 to 5000	Sets notch frequency of 3rd resonance suppression notch filter. To be used matching the resonance frequency of the machine. Automatically set when adaptation notch is effective.	Always enabled	All	5-2-6 5-1-2
	08	3rd notch width	-	0 to 20	Sets notch width of 3rd resonance suppression notch filter. Automatically set when adaptation notch is effective.	Always enabled	All	5-2-6 5-1-2
	09	3rd notch depth	-	0 to 99	Sets notch depth of 3rd resonance suppression notch filter. Automatically set when adaptation notch is effective.	Always enabled	All	5-2-6 5-1-2
	10	4th notch frequency	Hz	50 to 5000	Sets notch frequency of 4th resonance suppression notch filter. To be used matching the resonance frequency of the machine. Automatically set when adaptation notch is effective.	Always enabled	All	5-2-6 5-1-2
	11	4th notch width	-	0 to 20	Sets notch width of 4th resonance suppression notch filter. Automatically set when adaptation notch is effective.	Always enabled	All	5-2-6 5-1-2
	12	4th notch depth	-	0 to 99	Sets notch depth of 4th resonance suppression notch filter. Automatically set when adaptation notch is effective.	Always enabled	All	5-2-6 5-1-2
	13	Damping filter switching selection	-	0 to 6	To select the switchover method when damping filter is to be switched.	Always enabled	Position, full-close	5-2-7-1
	14	1st damping frequency	0.1 Hz	0 to 3000	Sets 1st damping frequency to suppress vibration at the load tip for vibration suppression control. Set value becomes effective from 5 (= 0.5 Hz) and above.	Always enabled	Position, full-closed	5-2-7-1
	15	1st damping filter setting	0.1 Hz	0 to 1500	For fine tuning of 1st damping control function. Value to be set smaller in case of torque saturation of torque and larger for higher response.	Always enabled	Position, full-close	5-2-7-1
	16	2nd damping frequency	0.1 Hz	0 to 3000	Sets 2nd damping frequency to suppress vibration at the load tip for vibration suppression control. Set value becomes effective from 5 (= 0.5 Hz) and above.	Always enabled	Position, full-closed	5-2-7-1
	17	2nd damping filter setting	0.1 Hz	0 to 1500	For fine tuning of 2nd damping control function. Value to be set smaller in case of torque saturation of torque and larger for higher response.	Always enabled	Position, full-closed	5-2-7-1
	18	3rd damping frequency	0.1 Hz	0 to 3000	Sets 3rd damping frequency to suppress vibration at the load tip for vibration suppression control. Set value becomes effective from 5 (= 0.5 Hz) and above.	Always enabled	Position, full-closed	5-2-7-1
	19	3rd damping filter setting	0.1 Hz	0 to 1500	For fine tuning of 3rd damping control function. Value to be set smaller in case of torque saturation of torque and larger for higher response.	Always enabled	Position, full-closed	5-2-7-1
	20	4th damping frequency	0.1 Hz	0 to 3000	Sets 4th damping frequency to suppress vibration at the load tip for vibration suppression control. Set value becomes effective from 5 (= 0.5 Hz) and above.	Always enabled	Position, full-closed	5-2-7-1
	21	4th damping filter setting	0.1 Hz	0 to 1500	For fine tuning of 4th damping control function. Value to be set smaller in case of torque saturation of torque and larger for higher response.	Always enabled	Position, full-closed	5-2-7-1

(Continued)

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
2	22	Command smoothing filter	0.1 ms	0 to 10000	[For position control,full close control] • For conventional control (Pr 6.47 bit 0 = 0) Will set primary delay filter time constant against position command. • Two degree-of-freedom control (Pr 6.47 bit 0 = 1) Will be set to time constant of command response filter. Maximum value is limited to 2,000 (=200.0 ms) *1 [For velocity control] • For conventional control (Pr 6.47 bit 0 = 0) This setting will be ignored. • Two degree-of-freedom control (Pr 6.47 bit 0 = 1) Will be set to time constant of command response filter. Maximum value is limited to 640 (= 64.0 ms) *1 *1: The value of the parameter itself will not be limited but the value to be applied will be limited within the driver. Attenuation term can be set at Pr 6.49 “Command response filter, adjustment filter damping term setting”.	Always enabled	Position, velocity, full-closed	4-2-3 5-2-15 5-2-16 5-2-17 5-2-18
	23	Command FIR filter	0.1 ms	0 to 10000	Set FIR filter time constant against command.	Always enabled	Position, full-closed	4-2-3
	24	5th notch frequency	Hz	50 to 5000	Sets notch frequency of 5th resonance suppression notch filter. To be used matching the resonance frequency of the machine.	Always enabled	All	5-2-6
	25	5th notch width	-	0 to 20	Sets notch width of 5th resonance suppression notch filter.	Always enabled	All	5-2-6
	26	5th notch depth	-	0 to 99	Sets notch depth of 5th resonance suppression notch filter.	Always enabled	All	5-2-6
	27	1st vibration control width setting	-	0 to 1000	To conduct fine tuning of 1st vibration suppression control function.	Always enabled	Position, full-closed	5-2-7-1
	28	2nd vibration control width setting	-	0 to 1000	To conduct fine tuning of 2nd vibration suppression control function.	Always enabled	Position, full-closed	5-2-7-1
	29	3rd vibration control width setting	-	0 to 1000	To conduct fine tuning of 3rd vibration suppression control function.	Always enabled	Position, full-closed	5-2-7-1
	30	4th vibration control width setting	-	0 to 1000	To conduct fine tuning of 4th vibration suppression control function.	Always enabled	Position, full-closed	5-2-7-1
	31	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	32	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	33	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	34	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	35	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	36	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	37	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-

9-1-4 Class 3: Velocity/Torque/Full-closed control

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
3	00	Inside/outside speed setting switching	-	0 to 3	To select speed command for velocity control.	Always enabled	Velocity	4-3-1 4-3-2
	01	Speed command direction designation selection	-	0 to 1	To select designation method for speed command direction	Always enabled	Velocity	4-3-1 4-3-2
	02	Speed command input gain *1	(r/min)/V	10 to 2000	To set input gain of analog speed command input	Always enabled	Velocity, torque	4-3-1
	03	Speed command input inversion *1	-	0 to 1	To set polarity of analog speed command	Always enabled	Velocity	4-3-1
	04	Speed setting, 1st speed	r/min	-20000 to 20000	To set 1st. internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	05	Speed setting, 2nd speed	r/min		To set 2nd. internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	06	Speed setting, 3rd speed	r/min		To set 3rd. internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	07	Speed setting, 4th speed	r/min		To set 4th internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	08	Speed setting, 5th speed	r/min		To set 5th internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	09	Speed setting, 6th speed	r/min		To set 6th internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	10	Speed setting, 7th speed	r/min		To set 7th internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	11	Speed setting, 8th speed	r/min		To set 8th internal speed command value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Velocity	4-3-2
	12	Acceleration time setting	ms/(1000 r/min)	0 to 10000	To set acceleration time in acceleration processing for speed command	Always enabled	Velocity	4-3-6
	13	Deceleration time setting	ms/(1000 r/min)	0 to 10000	To set deceleration time in deceleration processing for speed command	Always enabled	Velocity	4-3-6
	14	S-shape acceleration/deceleration setting	ms	0 to 1000	To set S-shape time in acceleration/deceleration processing for speed command	Always enabled	Velocity	4-3-6
	15	Speed zero clamp function selection	-	0 to 3	To select zero speed clamp input (ZEROSPD) function	Always enabled	Velocity, torque	4-3-3
	16	Zero clamp level speed setting	r/min	10 to 20000	To set threshold for transfer to position lock	Always enabled	Velocity, torque	4-3-3
	17	Torque command selection *1	-	0 to 2	To select torque command and speed limit values	Always enabled	Torque	4-4
	18	Torque command direction designation selection *1	-	0 to 1	To select direction of torque command and commanding method	Always enabled	Torque	4-4
	19	Torque command input gain *1	0.1 V/100 %	10 to 100	To set input gain of analog torque command input	Always enabled	Torque	4-4
	20	Torque command input inversion *1	-	0 to 1	To set analog torque command input polarity	Always enabled	Torque	4-4

(Continued) *1 Not available with [A6SE], [A6SG]

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
3	21	Speed limit value 1 *1	r/min	0 to 20000	Sets speed limit value. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Torque	4-4-1-2
	22	Speed limit value 2 *1	r/min	0 to 20000	To be set in case of changing the speed limit value by direction. Furthermore, internal value shall be limited to the smaller of the set value of Pr 5.13 or the maximum motor revolution x 1.2.	Always enabled	Torque	4-4-1-2
	23	External scale type selection *1	-	0 to 6	Selects external scale type. 0: AB phase output type 1: Serial communication type (incremental spec.) 2: Serial communication type (absolute spec.) 3: For manufacturer use 4: For manufacturer use 5: For manufacturer use 6: For manufacturer use	Reapplying the power	All	4-5-1 4-8
	24	External scale division numerator *1	-	0 to 2^{23}	Sets external scale division numerator	Reapplying the power	Full-closed	4-5-2
	25	External scale division denominator *1	-	1 to 2^{23}	Sets external scale division denominator	Reapplying the power	Full-closed	4-5-2
	26	External scale direction inversion *1	-	0 to 3	Sets polarity of external scale feedback pulse	Reapplying the power	All	4-5-1 4-8
	27	Invalidate external scale Z-phase wire disconnection detection *1	-	0 to 1	Validate/invalidate Z-phase disconnection detection when using AB phase output type external scale. 0: Valid, 1: Invalid	Reapplying the power	All	4-8
	28	Hybrid deviation excess setting *1	command units	1 to 2^{27}	Sets threshold value for Err 25.0 “Hybrid deviation excess error protection”.	Reapplying the power	Full-closed	4-5-3 7-4
	29	Hybrid deviation clear setting *1	rotation	0 to 100	Clears hybrid deviation to zero at every set numbers of revolutions.	Reapplying the power	Full-closed	4-5-3

*1 Not available with [A6SE], [A6SG]

9-1-5 Class 4: I/F monitor setting

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
4	00	SI1 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI1	Reapplying the power	All	2-3-1
	01	SI2 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI2	Reapplying the power	All	2-3-1
	02	SI3 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI3	Reapplying the power	All	2-3-1
	03	SI4 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI4	Reapplying the power	All	2-3-1
	04	SI5 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI5	Reapplying the power	All	2-3-1
	05	SI6 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI6	Reapplying the power	All	2-3-1
	06	SI7 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI7	Reapplying the power	All	2-3-1
	07	SI8 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI8	Reapplying the power	All	2-3-1
	08	SI9 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI9	Reapplying the power	All	2-3-1
	09	SI10 Input selection	-	0 to 00FFFFFFh	Set function and logic for SI10	Reapplying the power	All	2-3-1
	10	SO1 Output selection	-	0 to 00FFFFFFh	Set function assignment for SO1	Reapplying the power	All	2-3-2
	11	SO2 Output selection	-	0 to 00FFFFFFh	Set function assignment for SO2	Reapplying the power	All	2-3-2
	12	SO3 Output selection	-	0 to 00FFFFFFh	Set function assignment for SO3	Reapplying the power	All	2-3-2
	13	SO4 Output selection	-	0 to 00FFFFFFh	Set function assignment for SO4	Reapplying the power	All	2-3-2
	14	SO5 Output selection	-	0 to 00FFFFFFh	Set function assignment for SO5	Reapplying the power	All	2-3-2
	15	SO6 Output selection	-	0 to 00FFFFFFh	Set function assignment for SO6	Reapplying the power	All	2-3-2
	16	Analog monitor 1 type	-	0 to 28	Select type for analog monitor 1	Always enabled	All	2-3-3
	17	Analog monitor 1 output gain	-	0 to 214748364	Select output gain for analog monitor 1	Always enabled	All	2-3-3
	18	Analog monitor 2 type	-	0 to 28	Select type for analog monitor 2	Always enabled	All	2-3-3
	19	Analog monitor 2 output gain	-	0 to 214748364	Select output gain for analog monitor 2	Always enabled	All	2-3-3
	20	For manufacturer use	-	-	Please set fixed to 0 (zero)..	-	-	-
	21	Analog monitor output setting	-	0 to 2	Select analog monitor output voltage type	Always enabled	All	2-3-3
	22	Analog input 1 (AI1) offset setting *1	0.359 mV	-27888 to 27888	Sets offset for analog input 1	Always enabled	All	4-3-1 4-4-1 4-4-2
	23	Analog input 1 (AI1) filter setting *1	0.01 ms	0 to 6400	Sets filter for analog input 1	Always enabled	All	4-3-1 4-4-1 4-4-2
	24	Analog input 1 (AI1) excessive setting *1	0.1 V	0 to 100	Sets excessive input voltage level for analog input 1 by voltage after offset.	Always enabled	All	-
	25	Analog input 2 (AI2) offset setting *1	5.86 mV	-1707 to 1707	Sets offset of analog input 2	Always enabled	All	4-4-2 6-2
	26	Analog input 2 (AI2) filter setting *1	0.01 ms	0 to 6400	Sets filter for analog input 2	Always enabled	All	4-4-2 6-2
	27	Analog input 2 (AI2) excessive setting *1	0.1 V	0 to 100	Sets excessive input voltage level for analog input 2 by voltage after offset.	Always enabled	All	-
	28	Analog input 3 (AI3) offset setting *1	5.86 mV	-1707 to 1707	Sets offset of analog input 3	Always enabled	All	6-2
	29	Analog input 3 (AI3) filter setting *1	0.01 ms	0 to 6400	Set filter for analog input 3	Always enabled	All	6-2

(Continued) *1 Not available with [A6SE], [A6SG]

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
4	30	Analog input 3 (AI3) excessive setting *1	0.1 V	0 to 100	Set excessive input voltage level for analog input 3 by voltage after offset.	Always enabled	All	-
	31	Positioning completion range	Command units	0 to 2097152	To set the allowable pulse numbers for positioning complete signal (INP). Unit shall be in accordance with Pr 5.20 “Position setting unit selection”.	Always enabled	Position, full-closed	4-2-6
	32	Positioning completion output setting	-	0 to 10	To set judgment condition for positioning complete output	Always enabled	Position, full-closed	4-2-6
	33	INP hold time	ms	0 to 30000	To set INP hold time or positioning complete judgment time delay	Always enabled	Position, full-closed	4-2-6
	34	Zero speed	r/min	10 to 20000	To set detection threshold for zero speed (ZSP)	Always enabled	All	2-3-2
	35	Speed coincidence width	r/min	10 to 20000	To set detection threshold of velocity coinciding output (V-COIN) by differential in speed command and actual speed.	Always enabled	Velocity, torque	4-3-5
	36	Attainment speed	r/min	10 to 20000	To set detection threshold of attained speed output (AT-SPEED)	Always enabled	Velocity, torque	4-3-4
	37	Mechanical braking setting during no operation	ms	0 to 10000	To set mechanical brake operation time at stopping	Always enabled	All	9-2-2
	38	Mechanical braking setting during operation	ms	0 to 32000	To set mechanical brake operation time during operation	Always enabled	All	9-2-2 9-2-3
	39	Brake release speed setting	r/min	30 to 3000	To set speed threshold mechanical brake output judgment during operation	Always enabled	All	9-2-2 9-2-3
	40	Warning output select 1	-	0 to 40	To select type of warning to be output by Warning output 1	Always enabled	All	7-3
	41	Warning output select 2	-	0 to 40	To select type of warning to be output by Warning output 2	Always enabled	All	7-3
	42	Positioning completion range 2	Command units	0 to 2097152	To set the allowable pulse numbers for positioning complete signal 2 (INP2). Unit shall be in accordance with Pr 5.20 “Position setting unit selection”.	Always enabled	Position, full-closed	4-2-6
	44	Position compare output pulse width setting	0.1ms	0 to 32767	Sets the signal width of position compare output. No signal will be output when 0.	Reapplying the power	Position full-closed	6-7
	45	Position compare output polarity select	-	0 to 63	Sets polarity of position compare output by bit for each output terminal. • Set bits bit 0: SO01 or OCMP1 bit 1: SO02 or OCMP2 bit 2: SO03 or OCMP3 bit 3: SO04 or OCMP4 bit 4: SO5 bit 5: SO6 • Set value 0: Output photocoupler for SO 1 to 6 will turn ON during pulse output and OCMP 1 to 4 will be L level respectively. 1: Output photocoupler for SO1 to 6 will turn OFF during pulse output and OCMP 1 to 4 will be H level respectively, Use 0 normally	Reapplying the power	Position full-closed	6-7
	47	Pulse output select	-	0 to 7	Selects signal to be output from pulse regeneration output / position compare output terminal	Reapplying the power	All	4-2-4 6-7

(Continued) *1 Not available with [A6SE], [A6SG]

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
4	48	Position compare value 1	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 1	Always enabled	Position full-closed	6-7
	49	Position compare value 2	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 2	Always enabled	Position full-closed	6-7
	50	Position compare value 3	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 3	Always enabled	Position full-closed	6-7
	51	Position compare value 4	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 4	Always enabled	Position full-closed	6-7
	52	Position compare value 5	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 5	Always enabled	Position full-closed	6-7
	53	Position compare value 6	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 6	Always enabled	Position full-closed	6-7
	54	Position compare value 7	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 7	Always enabled	Position full-closed	6-7
	55	Position compare value 8	Command unit	-2147483648 to 2147483647	Sets comparison value for position compare 8	Always enabled	Position full-closed	6-7
	56	Position compare output delay compensation amount	0.1 μs	-32768 to 32767	Compensates position compare output delay caused by the circuit	Reapplying the power	Position full-closed	6-7
	57	Position compare output assignment setting	-	-2147483648 to 2147483647	Sets output terminal corresponding to position compare 1 to 6 by bit. Multiple position compare can be set to a single output terminal. • Set bits bit 0 to 3: Position compare 1 bit 4 to 7: Position compare 2 bit 8 to 11: Position compare 3 bit 12 to 15: Position compare 4 bit 16 to 19: Position compare 5 bit 20 to 23 Position compare 6 bit 24 to 27 Position compare 7 bit 28 to 31 Position compare 8 • Set value 0000: Invalid output 0001: Assigned to SO1 or OCMP1 0010: Assigned to SO2 or OCMP2 0011: Assigned to SO3 or OCMP3 0100: Assigned to SO4 or OCMP4 0101: Assigned to SO5 0110: Assigned to SO6 Others: For manufacturer use (do not set)	Reapplying the power	Position full-closed	6-7

9-1-6 Class 5: Enhancing setting

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
5	00	2nd. command division/ multiplication numerator	-	0 to 2^{30}	To set 2nd. command segmentation numerator	Always enabled	Position, full-closed	6-4
	01	3rd. command division/ multiplication numerator	-	0 to 2^{30}	To set 3rd. command segmentation numerator	Always enabled	Position, full-closed	6-4
	02	4th command division/ multiplication numerator	-	0 to 2^{30}	To set 4th command segmentation numerator	Always enabled	Position, full-closed	6-4
	03	Pulse output division denominator	-	0 to 8388608	With uses that the output pulse count per one rotation does not become as an integer, the setting can be performed by setting this value to other than zero, Pr0.11 as division numerator, and Pr5.03 as division denominator. Consequently, the result of pulse count with host side ×4 multiplication processing becomes as follows. Pulse output resolution per one rotation= (Pr0.11 set value / Pr5.03 set value) × Encoder resolution	Reapplying the power	All	4-2-4
	04	Drive prohibition input setting	-	0 to 2	To set operation prohibiting positive or negative drive input	Reapplying the power	All	6-5-1 7-4
	05	Sequence at drive prohibition	-	0 to 2	To set the sequence for prohibited drive inputs	Reapplying the power	All	6-5-1 7-4
	06	Sequence at servo-off	-	0 to 9	TO set the sequence when servo is Off	Always enabled	All	6-5-2
	07	Main power supply AC Off sequence	-	0 to 9	To set the sequence when main power supply AC is Off	Always enabled	All	6-5-3
	08	LV trip selection with the main power AC OFF	-	0 to 3	To select whether to trip LV or Servo Off, in case of main power supply alarm. In addition, also sets conditions for detection of main power supply off warning, in case the main power supply cut-off condition persists more than the time set in Pr 7.14. Bit 0 0: Servo Off in accordance with setting of Pr 5.07 and resumes Servo On when power supply reclosed. 1: Detects Err 13.1 Main power supply low voltage protection. Bit 1 0: Main power supply Off warning detects only on Servo On conditions. 1: Main power supply off warning always detected.	Always enabled	All	-
	09	Main power supply AC Off detection time	ms	20 to 2000 *1	To set main power supply alarm detection time. When set to 2000, main power supply Off detection is invalidated.	Reapplying the power	All	-
	10	Sequence at alarm	-	0 to 7	To set the state during deceleration and after a stop when an alarm is generated.	Always enabled	All	6-5-4
	11	Immediate stop torque setting	%	0 to 500	To set torque limit for immediate stop. When set to 0, torque limit for normal operation shall be applied.	Always enabled	All	6-5-1 6-5-2 6-5-3 6-5-5
	12	Overload level setting	%	0 to 500	To set overload level. Set to be 115% when set value is 0. Furthermore, parameters are limited by the allowable values of the motor to be applied.	Always enabled	All	-
	13	Over-speed level setting	r/min	0 to 20000	To set detection level for Err 26.0 “Over speed protection”. Maximum motor revolution x 1.2 when value set to 0. Furthermore, internal value is limited to maximum motor revolution x 1.2.	Always enabled	All	6-5-5 7-4
	14	Allowable motor operating range setting	0.1 rotation	0 to 1000	Sets the allowable motor operating range corresponding to the position command input range. Err34.0 “Allowable motor operating range abnormal protection” will be triggered when the set value is exceeded. Protection function will be invalid in case the set value is 0. In addition, protection function will be invalid under the conditions indicated in Precaution of 6-3.	Always enabled	Position, full-closed	6-3 7-4
	15	Control input signal read setting	-	0 to 3	To select control input signal read cycle. 0:0.25 ms, 1:0.5 ms, 2:1 ms, 3:2 ms. However, to exclude deviation counter clear input (CL) and command pulse prohibited input (INH).	Reapplying the power	All	-

(Continued)

*1 In the case of using a smaller value than the shipment value, please check the matching under your power environment.

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
5	16	Alarm clear input setting (A-CLR)	-	0 to 1	To select acknowledgement time for alarm (A-CLR) input. 0: 120 ms 1: As per Pr 5.15 “Control input signal confirmation time selection”.	Reapplying the power	All	9-2-5
	17	Counter clear input setting (CL)	-	0 to 4	To select receiving conditions for counter clear input signal 0: Invalid 1: Clear at level (without read filter) 2: Clear at level (with read filter) 3: Clear at edge (without read filter) 4: Clear at edge (with read filter)	Always enabled	Position, full-closed	4-2-5
	18	Command pulse prohibition input (INH) disable	-	0 to 1	To set valid/invalid of command pulse prohibited input (INH) 0: Valid (When INH input is ON, the servo driver ignores the command pulse,disabling pulse counting function,and, at the same time, clears the accumulated pulses of the position command filter function and damping control as well as the remnant pulses of the command division/multiplication function.) 1: Invalid 2: Valid (When INH input is ON, the servo driver ignores the command pulse, disabling pulse counting function. In this setting, the servo driver keeps the accumulated pulses of the position command filter function and damping control as well as the remnant pulses of the command division/multiplication function.)	Always enabled	Position, full-closed	4-2-7
	19	Command pulse prohibition input (INH) read setting	-	0 to 5	To select signal read cycle of command pulse prohibited input (INH) 0: 3 consecutive matching of 0.250 ms cycle 1: 3 consecutive matching of 0.500 ms cycle 2: 3 consecutive matching of 1.0 ms cycle 3: 3 consecutive matching of 2.0 ms cycle 4: 1 matching of 0.250 ms cycle 5: 2 consecutive matching of 0.250 ms cycle	Reapplying the power	Position, full-closed	4-2-7
	20	Position setting unit selection	-	0 to 1	Select positioning complete range and set unit for excessive positioning deviation. 0: Command unit, 1: Encoder unit (external scale unit)	Reapplying the power	Position, full-closed	4-2-6 7-4
	21	Torque limit selection	-	0 to 6	To set the method for selecting forward and backward torque limit	Always enabled	Position, velocity, full-closed	6-1 6-2
	22	2nd torque limit	%	0 to 500	To set the 2nd. output torque limit of the motor. The parameter is limited by the maximum torque of the motor being applied on.	Always enabled	Position, velocity, full-closed	6-1
	23	Torque limit switching setting 1	ms /100 %	0 to 4000	To set the rate of change (incline) from 1st. to 2nd. torque limit upon switching.	Always enabled	Position, velocity, full-closed	6-1
	24	Torque limit switching setting 2	ms /100 %	0 to 4000	To set the rate of change (incline) from 2nd. to 1st. torque limit upon switching.	Always enabled	Position, velocity, full-closed	6-1
	25	Positive direction torque limit for external input	%	0 to 500	To set the forward torque limit upon input of TL-SEL when Pr 5.21 “Torque limit selection” is set to 6. The parameter shall be limited by the maximum torque of the motor to be applied.	Always enabled	Position, velocity, full-closed	6-1
	26	Backward direction torque limit for external input	%	0 to 500	To set the backward torque limit upon input of TL-SEL when Pr 5.21 “Torque limit selection” is set to 6. The parameter shall be limited by the maximum torque of the motor to be applied.	Always enabled	Position, velocity, full-closed	6-1
	27	Analog torque limit input gain *1, *2	0.1 V/ 100 %	10 to 100	To set the conversion gain for analog torque limit input	Always enabled	Position, velocity, full-closed	6-2
	28	LED initial state	-	0 to 42	To select the type of data to be indicated by the 7-segment led, in the initial state when the control power supply is turned on.	Reapplying the power	All	3-1-3 3-2-1

(Continued) *1 Not available with [A6SE]
*2 Not available with [A6SG]

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
5	29	RS232 communication baud rate setting *1	-	0 to 7	To set the baud rate for RS232 communications. 0:2400, 1:4800, 2:9600, 3:19200, 4:38400, 5:57600, 6:115200, 7:230400 bps Note) In case it is not a Modbus communication (Pr 5.37 = 0), when value is set to 7, it will be set to 9600 internally.	Reapplying the power	All	4-7-1-5
	30	RS485 communication baud rate setting *1	-	0 to 7	To set the baud rate for RS485 communications. 0:2400, 1:4800, 2:9600, 3:19200, 4:38400, 5:57600, 6:115200, 7:230400 bps Note) In case it is not a Modbus communication (Pr 5.37 = 0), when value is set to 7, it will be set to 9600 internally.	Reapplying the power	All	4-7-1-5
	31	Axis number	-	0 to 127	To set axis number for RS232/RS485 communications. In case of using MINAS standard protocol, use numbers in the range of 0 to 31. Use within the range of 1 to 127 for Modbus. 0 will invalidate Modbus communication.	Reapplying the power	All	-
	32	Command pulse input maximum setup/digital filter setup	Kpulse/s	250 to 8000	Please set the maximum number to be used for command pulse input. Specified pulse input frequency will generate Err 27.0 “Command pulse input frequency abnormal protection”. Note) Detection of abnormal command pulse input frequency is conducted on the number of pulses received by the driver. It may not be able to detect normally, in case of a pulse frequency input far larger than the set value.	Reapplying the power	Position, full-closed	4-2-1
	33	Pulse regeneration output limit enable	-	0 to 1	To activate/deactivate Err. 28.0 “Pulse regeneration limit protection”. 0: Inactivate 1: Activate	Reapplying the power	All	-
	34	For manufacturer use	-	-	Please set to 4 fixed.	-	-	-
	35	Front panel lock	-	0 to 1	To lock operations using the front panel 0: Front panel operations - Not restricted 1: Front panel operations - Locked	Reapplying the power	All	3-1-4
	36	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	37	Modbus connection setting *1	-	0 to 2	To set RS232/RS485 communications protocol 0: MINAS standard protocol 1: Modbus-RTU (RS232 communications, only for 1:1) 2: Modbus-RTU (RS485 communications, 1:N capable)	Reapplying the power	All	-
	38	Modbus communication setting *1	-	0 to 5	To set parity (even, odd, none) and stop bit length (1 bit, 2 bit) of Modbus communications. 0: Even/1 bit 1: Even/2 bit 2: Odd/1 bit 3: Odd/2 bit 4: None/1 bit 5: None/2 bit	Reapplying the power	All	-
	39	Modbus response waiting time *1	ms	0 to 10000	To set waiting time to be added from the receipt of Modbus communication request till the transmission of response data. Note) Delay time will be generated for the creation of response data, even if the value is set to 0 (zero).	Always enabled	All	-
	40	Modbus communication timeout time *1	ms	0 to 10000	To set the time required to detect Err. 80.0 “Modbus communication timeout protection” in case broadcast designated Modbus communications from own specified axis has not been received exceeding the set time, while maintaining the state where Modbus exercise right is secured. Err. 80.0 is not detected when set value is set to 0 (zero).	Always enabled	All	-
	41	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-

(Continued) *1 Not available with [A6SE]

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
5	42	Modbus broadcast setting *1	-	-32768 to 32767	To set response action and request processing when a request for broadcast mode is received in Modbus communication. Bit 0 response action: 0: Invalid (none), 1: Valid (yes) *1 Bit 1 request processing: 0: Valid (process), 1: Invalid (no processing) Bit 2 Strobe input operation automatic OFF 0: Invalid 1: Valid *2 Bit 3 Request operation specification switch *1 0: Use Pr5.40 , 1:Use Pr5.39 Bit 0 is set to be the least significant bit. *1 When bit 3 = 0, response returned after Pr 5.31 x Pr 5.40 [ms]. When bit 3 =1, response returned after Pr 5.31 × Pr 5.39[ms]. No response returned when bit 1 = 1 *2 Strobe input operation will be automatically switched OFF on the driver side after start of block operations. There is no need to write input OFF.	Always enabled	All	-
	45	Quadrant projection positive direction compensation value	0.1 %	-1000 to 1000	To set positive direction high-precision torque compensation value for quadrant projection.	Always enabled	Position, full-closed	5-2-15
	46	Quadrant projection negative direction compensation value	0.1 %	-1000 to 1000	To set negative direction high-precision torque compensation value for quadrant projection.	Always enabled	Position, full-closed	5-2-15
	47	Quadrant projection compensation delay time	ms	0 to 1000	To set compensation timing delay time for quadrant projection.	Always enabled	Position, full-closed	5-2-15
	48	Quadrant projection compensation filter setting L	0.01 ms	0 to 6400	To set compensation value LPF time constant for quadrant projection.	Always enabled	Position, full-closed	5-2-15
	49	Quadrant projection compensation filter setting H	0.1 ms	0 to 10000	To set compensation value HPF time constant for quadrant projection.	Always enabled	Position, full-closed	5-2-15
	50	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	51	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	52	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	53	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	54	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	55	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	56	Slow stop deceleration time setting	ms/ (1000 r/min)	0 to 10000	Sets deceleration time for immediate stop deceleration stop deceleration processing. This parameter will become valid when Pr6.10 “Function expansion setting” bit 15 = 1	Always enabled	Position	6-5-7
	57	Slow stop S-shape acceleration and deceleration setting	ms	0 to 1000	Sets the S-shape time for immediate stop deceleration stop deceleration processing. This parameter will become valid when Pr6.10 “Function expansion setting” bit 15 = 1	Always enabled	Position	6-5-7
	58	Modbus mirror register setting 1 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4418h “Mirror register 1.”	Reapplying the power	All	—
	59	Modbus mirror register setting 2 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4419h “Mirror register 2.”	Reapplying the power	All	—
	60	Modbus mirror register setting 3 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 441Ah “Mirror register 3.”	Reapplying the power	All	—
	61	Modbus mirror register setting 4 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 441Bh “Mirror register 4.”	Reapplying the power	All	—
	62	Modbus mirror register setting 5 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 441Ch “Mirror register 5.”	Reapplying the power	All	—
	63	Modbus mirror register setting 6 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 441Dh “Mirror register 6.”	Reapplying the power	All	—
	64	Modbus mirror register setting 7 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 441Eh “Mirror register 7.”	Reapplying the power	All	—
	65	Modbus mirror register setting 8 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 441Fh “Mirror register 8.”	Reapplying the power	All	—

(Continued) *1 Not available with [A6SE]

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
5	66	Deterioration diagnosis convergence judgment time	0.1 s	0 to 10000	Sets time for deemed convergence of real-time auto tuning load characteristics estimate when deterioration diagnosis warning function is valid (Pr6.97 bit 1 = 1) When the set value is 0, it will be set automatically inside the driver in accordance with Pr6.31 “Real time auto tuning estimation speed”. * When Pr6.31 “Real time auto tuning estimation speed” = 0, the deterioration diagnosis warning judgment for load characteristics estimate will be invalid.	Always enabled	All	6-9 7-3
	67	Deterioration diagnosis inertia ratio upper limit	%	0 to 10000	Sets the upper and lower limit values for inertia ratio estimate in deterioration diagnosis judgment of load characteristics estimate after completion of convergence, when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1). * When the upper limit value is set at 10000 (max. value), judgment of the upper limit becomes invalid. * When the lower limit value is set at 0 (min. value), judgment of the lower limit becomes invalid. * If Pr5.67 (upper limit) ≤ Pr5.68 (lower limit), judgment of both the upper limit and lower limit becomes invalid.	Always enabled	All	6-9 7-3
	68	Deterioration diagnosis inertia ratio lower limit	%	0 to 10000		Always enabled	All	6-9 7-3
	69	Deterioration diagnosis unbalanced load upper limit	0.1 %	-1000 to 1000	Sets the upper and lower limit values for unbalanced load estimate in deterioration diagnosis judgment of load characteristics estimate after completion of convergence, when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1). * When the upper limit value is set at 1000 (max. value), judgment of the upper limit becomes invalid. * When the lower limit value is set at -1000 (min. value), judgment of the lower limit becomes invalid. * If Pr5.69 (upper limit) ≤ Pr5.70 (lower limit), judgment of both the upper limit and lower limit becomes invalid. * The set resolution shall be in units of 0.2%.	Always enabled	All	6-9 7-3
	70	Deterioration diagnosis unbalanced load lower limit	0.1 %	-1000 to 1000		Always enabled	All	6-9 7-3
	71	Deterioration diagnosis dynamic friction upper limit	0.1 %	-1000 to 1000	Sets the upper and lower limit values for dynamic friction estimate in deterioration diagnosis judgment of load characteristics estimate after completion of convergence, when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1). * When the upper limit value is set at 1000 (max. value), judgment of the upper limit becomes invalid. * When the lower limit value is set at -1000 (min. value), judgment of the lower limit becomes invalid. * If Pr5.71 (upper limit) ≤ Pr5.72 (lower limit), judgment of both the upper limit and lower limit becomes invalid. * The set resolution shall be in units of 0.2%.	Always enabled	All	6-9 7-3
	72	Deterioration diagnosis dynamic friction lower limit	0.1 %	-1000 to 1000		Always enabled	All	6-9 7-3
	73	Deterioration diagnosis viscous friction upper limit	0.1%/ (10000 r/min)	0 to 10000	Sets the upper and lower limit values for viscous friction coefficient estimate in deterioration diagnosis judgment of load characteristics estimate after completion of convergence, when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1). * When the upper limit value is set at 1000 (max. value), judgment of the upper limit becomes invalid. * When the lower limit value is set at 0 (min. value), judgment of the lower limit becomes invalid. * If Pr5.73 (upper limit) ≤ Pr5.74 (lower limit), judgment of both the upper limit and lower limit becomes invalid. * The set resolution shall be in units of 0.2%.	Always enabled	All	6-9 7-3
	74	Deterioration diagnosis viscous friction lower limit	0.1%/ (10000 r/min)	0 to 10000		Always enabled	All	6-9 7-3

(Continued)

Class	No.	Parameter name	Unit	Set range	Functions, contents	Attribute	Related control mode	Relation
5	75	Deterioration diagnosis velocity setting	r/min	-20000 to 20000	Outputs deterioration diagnosis velocity output (V-DIAG) when the motor velocity is in the range of Pr5.75±Pr4.35 (velocity coinciding width), when deterioration diagnosis warning is valid (Pr6.97 bit 1 =1) * Deterioration diagnosis velocity output has a 10 [r/min] hysteresis.	Always enabled	All	6-9 7-3
	76	Deterioration diagnosis torque average time	ms	0 to 10000	Sets time required to compute the torque command average (weighted frequency) when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and diagnosis velocity output (V-DIAG) is ON. * Time from diagnosis velocity output (V-DIAG) ON to the start judgment for upper and lower value of torque command average value is also a part of the set time for this parameter. * If the setting value is 0, the torque command average value is not calculated.	Always enabled	All	6-9 7-3
	77	Deterioration diagnosis torque upper limit	0.1 %	-1000 to 1000	Sets the upper and lower limit values for torque command average value when deterioration diagnosis warning is valid (Pr6.97 bit 1 = 1) and deterioration diagnosis velocity output (V-DIAG) is ON. * When the upper limit value is set at 1000 (max. value), judgment of the upper limit becomes invalid. * When the lower limit value is set at -1000 (min. value), judgment of the lower limit becomes invalid. * If Pr5.77 (upper limit) ≤ Pr5.78 (lower limit), judgment of both the upper limit and lower limit becomes invalid.	Always enabled	All	6-9 7-3
	78	Deterioration diagnosis torque lower limit	0.1 %	-1000 to 1000		Always enabled	All	6-9 7-3
	79	Modbus mirror register setting 9 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4420h “Mirror register 9.”	Reapplying the power	All	-
	80	Modbus mirror register setting 10*1	-	-32768 to 32767	Sets register address linked to Modbus register address 4421h “Mirror register 10.”	Reapplying the power	All	-
	81	Modbus mirror register setting 11 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4422h “Mirror register 11.”	Reapplying the power	All	-
	82	Modbus mirror register setting 12 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4423h “Mirror register 12.”	Reapplying the power	All	-
	83	Modbus mirror register setting 13 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4424h “Mirror register 13.”	Reapplying the power	All	-
	84	Modbus mirror register setting 14 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4425h “Mirror register 14.”	Reapplying the power	All	-
	85	Modbus mirror register setting 15 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4426h “Mirror register 15.”	Reapplying the power	All	-
	86	Modbus mirror register setting 16 *1	-	-32768 to 32767	Sets register address linked to Modbus register address 4427h “Mirror register 16.”	Reapplying the power	All	-
	87	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	94	Position compare output conditions setup	-	0 to 2	Select the operation direction in which the position compare output is enabled. 0: Enabled both in positive and negative directions 1: Enabled only when operated in positive direction 2: Enabled only when operated in negative direction	Always enabled	Position, full-closed	6-7
	96	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	97	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	102	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	103	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	105	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-

*1 Not available with [A6SE]

9-1-7 Class 6: Special setting

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Relate d
6	00	Analog torque feed forward gain setting *1	0.1 V/ 100 %	0 to 100	Sets an input gain for analog torque FF. 0 to 9 are disabled.	Always enabled	Position, velocity, full-closed	-
	02	Speed deviation excess setting	r/min	0 to 20000	Sets the threshold value for Err24.1 "Speed deviation excess protection". When the set value is 0, the detection for speed deviation excess protection is disabled.	Always enabled	Position	-
	03	For manufacturer use	-	-	Please set fixed to 0 (zero).	-	-	-
	04	JOG trial run command speed	r/min	0 to 500	Sets the command speed for JOG trial run (velocity control).	Always enabled	All	3-2-4
	05	Position control third gain effective time	0.1 ms	0 to 10000	Sets the 3rd gain effective time of 3-level gain switching.	Always enabled	Position, full-closed	5-2-10
	06	Position control third gain scale factor	%	50 to 1000	Sets the 3rd gain at the multiplication of gain 1.	Always enabled	Position, full-closed	5-2-10
	07	Additional value to torque command	%	-100 to 100	Sets the offset torque to be added to the torque command.	Always enabled	Position, speed, full-closed	5-1-1
	08	Torque compensation value in positive direction	%	-100 to 100	Sets the value to be added to the torque command during positive-direction operation.	Always enabled	Position, full-closed	5-1-1
	09	Torque compensation value in negative direction	%	-100 to 100	Sets the value to be added to the torque command during negative-direction operation.	Always enabled	Position, full-closed	5-1-1
	10	Function expansion setting	-	-32768 to 32767	Sets various functions on a bit basis. bit0 Not used Fix at 0. bit1 Load fluctuation control function 0: Disabled 1: Enabled bit2 Load variation stabilization setting 0:Disabled 1:enabled. bit3 Inertia ratio switching 0: Disabled 1: Enabled bit4 Current response improvement 0: Disabled 1: Enabled bit5 Analog torque FF 0: Disabled 1: Enabled bit6-8 Not used Fix at 0. bit9 Manufacturer use Fix at 0. bit10 Fall prevention function during alarm, position deviation processing 0: Disabled (hold) 1: Enabled (clear) bit11 Encoder overheat abnormality protection detection 0: Disabled 1: Enabled *1 bit12 Not used Fix at 0. bit13 Manufacturer use Fix at 0 bit14 Load variation suppression function automatic adjustment setting 0: Disabled 1: Enabled bit15 Slow stop function. 0: Disabled 1: Enabled *2 *The least significant bit is considered as bit0. *1 When the encoder overheat alarm is generated, Err15.1 "Encoder overheat abnormality protection" is generated together. *2 Valid only when position control setting (Pr0.01 = 0) and block operation setting is invalid (Pr6.28 = 0).	Always enabled	All	5-2-9 5-2-12 6-5-6 6-5-7
	11	Current response setting	%	10 to 300	Adjust the current response with the level at shipment considered as 100%. Setting this setting value at a value larger than 100 can improve current responsiveness. (Note) The setting range is 10 to 100% for function enhancement version 4 or earlier.	Always enabled	All	5-2-22
	13	Second inertia ratio	%	0 to 10000	Sets the ratio of load inertia with respect to motor rotor inertia.	Always enabled	All	5-2-12
	14	Immediate stop time at the time of alarming	ms	0 to 1000	To set the allowable time to stop at an immediate stop when alarm is generated. When this setting is exceeded, the motor is forced to be in the alarm state. In the case of zero setting, no immediate stop takes place but the motor becomes in the immediate alarm state.	Always enabled	All	6-5-5
	15	Second overspeed level setting	r/min	0 to 20000	Err26.1 “Second overspeed protection” will be triggered when motor speed exceeds the set value. In case set value = 0, then the maximum motor r/min x 1.2	Always enabled	All	6-5-5

(Continued) *1 Not available with [A6SE], [A6SG].

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
6	16	Manufacturer use	-	-	Fix at 0.	-	-	-
	17	Front panel parameter writing selection	-	0 to 1	Selects an EEPROM write specification for the parameter change in the front panel. 0: Does not write to EEPROM concurrently 1: Writes to EEPROM concurrently	Reapplying the power	All	3-2-2
	18	Power turn-on wait time	0.1s	0 to 100	Sets the initialization time after power-on with the standard setting of approximately 1.5 s + α (set value × 0.1 s). E.g. when the set value is 10: 1.5 s + (10 × 0.1 s) = approximately 2.5 s	Reapplying the power	All	9-2-1
	19	Encoder Z-phase setting	pulse	0 to 32767	Makes fine adjustment of the encoder Z-phase width when the output pulse value per motor revolution after frequency division is not an integer.	Reapplying the power	All	4-2-4
	20	External scale Z-phase expansion setting *1	μs	0 to 400	Can extend the width of external scale Z-phase output.	Reapplying the power	All	4-2-4 4-8
	21	Serial absolute external scale Z-phase setting *1	pulse	0 to 2^{28}	Sets the Z-phase regeneration position to be applied when a serial absolute type external scale is used. 0: Z-phase output only when absolute external scale position = 0 1~2^{28}: Z-phase output at a set pulse period after a Z-phase output at absolute external scale position = 0; Z-phase output is not invoked before the passage of position 0.	Reapplying the power	All	4-2-4 4-8
	22	AB-phase output external scale AB phase regeneration method selection *1	-	0 to 1	Selects the OA/OB pulse output regeneration method to be applied when an AB-phase output type external scale is used. 0: Signal not regenerated 1: Signal regenerated *Z-phase output always takes a through output without signal regeneration. *When "signal regenerated", which regenerates OA and OB duties on the driver side, is selected, waveform disturbance can be reduced. However, note that a delay in Z phase occurs.	Reapplying the power	All	4-2-4 4-8
	23	Load fluctuation correction gain	%	-100 to 100	Sets a correction gain for load fluctuation.	Always enabled	Position, velocity, full-closed	5-2-9
	24	Load fluctuation correction filter	0.01 ms	10 to 2500	Sets the filter time constant for load fluctuation.	Always enabled	Position, velocity, full-closed	5-2-9
	25	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	26	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	27	Warning latch time	s	0 to 10	Sets the warning latch time. 0: Latch time infinite 1 to 10: Latch time set to 1 to 10 [s]	Reapplying the power	All	7-3
	28	Special function selection	-	0 to 4	Selects between enabling and disabling the block operation function. 0: Block operation disabled(Pulse train enabled) 1: Block operation by Modbus communication enabled. (Pulse train disabled) 2: Block operations by input signal enabled (Pulse train disabled) 3:Use by manufacturer 4:Block operations by input signal enabled (Pulse train enabled)	Reapplying the power	Position, full-closed	-
	30	Manufacturer use	-	-	Fix at 0.	-	-	-
	31	Real-time auto tuning estimation speed	-	0 to 3	Sets the load characteristic estimation speed to be applied when real-time auto tuning is enabled.	Always enabled	All	5-1-1
	32	Real-time auto tuning custom setting	-	-32768 to 32767	Sets details of the custom mode for real-time auto tuning. Set to 0 when two-degree-of-freedom control is used.	Always enabled	All	5-1-1 5-1-3 5-1-4
	33	Manufacturer use	-	-	Fix at 1000.	-	-	-
	34	Hybrid vibration suppression gain *1	0.1/s	0 to 30000	Sets the hybrid vibration suppression gain to be applied when full-closed control is used.	Always enabled	Full-closed	5-2-13
	35	Hybrid vibration suppression filter *1	0.01 ms	0 to 32000	Sets the time constant of the hybrid vibration suppression filer for full-closed control.	Always enabled	Full-closed	5-2-13

(To be continued) *1 Not available with [A6SE], [A6SG].

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
6	36	Dynamic brake operation input	-	0 to 1	Sets between enabling and disabling dynamic brake (DB) operation input by I/O. Note) This function is available only when the main power is turned off. 0: Disabled 1: Enabled	Reapplying the power	All	6−5−3
	37	Oscillation detection threshold value	0.1 %	0 to 1000	Sets the threshold value for oscillation detection. When a torque vibration equal to or greater than this setting is detected, an oscillation detection warning is caused. When 0 is set, oscillation detection warning is disabled.	Always enabled	All	7-3
	38	Warning mask setting	-	-32768 to 32767	Sets the mask setting for warning detection. When the corresponding bit is set to 1, the detection of the corresponding warning is disabled.	Reapplying the power	All	7-3
	39	Warning mask setting 2	-	-32768 to 32767				
	41	1st damping depth	-	0 to 1000	Sets the vibration suppression depth for the first vibration suppression function.	Always enabled	Position, full-closed	5-2-7-1
	42	Two-stage torque filter time constant	0.01 ms	0 to 2500	Sets the filter time constant for the torque command. When the set value is 0, the filter is disabled. This setting is always enabled irrespective of the gain selection status.	Always enabled	All	5-2-14
	43	Two-stage torque filter damping term	-	0 to 1000	Sets the damping term of the two-stage torque filter.	Always enabled	All	5-2-14
	47	Function expansion setting 2	-	-32768 to 32767	Sets various functions on a bit basis. bit0 Two-degree-of-freedom control mode 0: Disabled 1: Enabled bit1 Not used Fix at 0. bit2 Encoder/external scale communication abnormality judgment setting 0: Interchange as conventionally 1: Abnormality/warning judgment relaxation bit3 Two-degree-of-freedom control real-time auto tuning selection *1 0: Standard type 1: Sync type bit4 -7 Not used Fix at 0. bit8 Manufacturer use Fix at 0. bit9-10 Not used bit11 Immediate stop alarm extension 0: Disabled 1: Enabled bit12-13 Manufacturer use bit14 Quadrant projection suppression function 0: Disabled 1: Enabled bit15 For manufacturer use * The least significant bit is considered as bit0. *Regarding bit3 (two-degree-of-freedom control real-time auto tuning selection), the function is available only when bit0 is set to 1: Enabled. *1 For details on types, refer to 5-1-3 "Real-time auto tuning (two-degree-of-freedom control mode, standard type)" and 5-1-4 "Real-time auto tuning (two-degree-of-freedom control mode, sync type)".	Reapplying the power	All	5-2-15 5-2-16 5-2-18 5-2-20

(To be continued)

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
6	48	Adjustment filter	0.1 ms	0 to 2000	Sets the adjustment filter time constant for two-degree-of-freedom control (position control, velocity control, full close control).	Always enabled	Position, velocity, Full-closed	5-2-16 5-2-18 5-2-20
	49	Command response filter/adjustment filter damping term setting	-	0 to 99	Sets the damping terms of the command response filter and adjustment filter for two-degree-of-freedom control (position control, full close control)Using decimal notation, the first digit indicates the setting for command response filter, and the second digit, the setting for adjustment filter. Digit correspondence 0 to 4: No damping term (operation as the primary filter) 5 to 9: Secondary filter (the damping term ζ takes 1.0, 0.86, 0.71, 0.50, and 0.35 in this order) However, when Pr2.13 "Damping filter switching selection" is 4 (two model type vibration controls are enabled) and the secondary filter is selected, the damping ratio is fixed at 1.0. Example) To make the command response filter be ζ= 1.0, and adjustment filer 1 be ζ = 0.71, set the value to 75 (first digit = 5 (ζ = 1.0), second digit = 7 (ζ = 0.71)). Note that Pr2.22 "Command smoothing filter" is applied as the time constant for the command response filter.	Always enabled	Position, Full-closed	5-2-16
	50	Viscous friction compensation gain	0.1%/ (10000 r/min)	0 to 10000	With the command speed multiplied by this set value, the amount of compensation to be added to the torque command is determined. As the unit of measure, [rated torque 0.1%/ (10000 r/min)] is used.	Always enabled	Position, velocity, Full-closed	5-2-16
	51	Immediate stop completion wait time	ms	0 to 10000	Sets the time for which motor power-on is kept after brake release output (BRK-OFF) is turned off when an immediate stop alarm is generated.	Always enabled	All	6-5-6
	52	Manufacturer use	-	-	Fix at 0.	-	-	-
	53	Manufacturer use	-	-	Fix at 0.	-	-	-
	54	Manufacturer use	-	-	Fix at 0.	-	-	-
	57	Torque saturation error protection detection time	ms	0 to 5000	Sets the torque saturation abnormality protection detection time. When torque saturation continues for the set time duration or longer, Err16.1 "Torque saturation error protection" is invoked. When the set value is 0, this function is disabled and no alarm is generated.	Always enabled	Position, velocity, Full-closed	6-6
	58	Serial absolute external scale Z phase shift amount *1	pulse	-2147483648 to 2147483647	Sets the absolute position to output external scale Z-phase when serial absolute external scale is used.	Reapplying the power	All	4-2-4
	59	Manufacturer use	-	-	Fix at 0.	-	-	-

(Continued) *1 Not available with [A6SE], [A6SG].

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
6	60	2nd damping depth	-	0 to 1000	Sets the vibration control depth for the second vibration control function.	Always enabled	Position, full-closed	5-2-7-1
	61	1st resonance frequency	0.1 Hz	0 to 3000	Sets the resonance frequency for the load of model 1 type vibration control filter.	Always enabled	Position	5-2-7-2
	62	1st resonance damping ratio	-	0 to 1000	Sets the resonance damping ratio for the load of model 1 type vibration control filter.	Always enabled	Position	5-2-7-2
	63	1st anti-resonance frequency	0.1 Hz	0 to 3000	Sets the anti-resonance frequency for the load of model 1 type vibration control filter.	Always enabled	Position	5-2-7-2
	64	1st anti-resonance damping ratio	-	0 to 1000	Sets the anti-resonance damping ratio for the load of model 1 type vibration control filter.	Always enabled	Position	5-2-7-2
	65	1st response frequency	0.1 Hz	0 to 3000	Sets the response frequency for the load of model 1 type vibration control filter.	Always enabled	Position	5-2-7-2
	66	2nd resonance frequency	0.1 Hz	0 to 3000	Sets the resonance frequency for the load of model 2 type vibration control filter.	Always enabled	Position	5-2-7-2
	67	2nd resonance damping ratio	-	0 to 1000	Sets the resonance damping ratio for the load of model 2 type vibration control filter	Always enabled	Position	5-2-7-2
	68	2nd anti-resonance frequency	0.1 Hz	0 to 3000	Sets the anti-resonance frequency for the load of model 2 type vibration control filter.	Always enabled	Position	5-2-7-2
	69	2nd anti-resonance damping ratio	-	0 to 1000	Sets the anti-resonance damping ratio for the load of model 2 type vibration control filter.	Always enabled	Position	5-2-7-2
	70	2nd response frequency	0.1 Hz	0 to 3000	Sets the response frequency for the load of model 2 type vibration control filter.	Always enabled	Position	5-2-7-2
	71	3rd damping depth	-	0 to 1000	Sets the vibration control depth for the third vibration control function	Always enabled	Position, full-closed	5-2-7-1
	72	4th damping depth	-	0 to 1000	Sets the vibration control depth for the forth vibration control function.	Always enabled	Position, full-closed	5-2-7-1
	73	Load estimation filter	0.01 ms	0 to 2500	Sets the filter time constant for load estimation.	Always enabled	Position, velocity	5-2-9
	74	Torque compensation frequency 1	0.1 Hz	0 to 5000	Sets filter frequency 1 for velocity control output.	Always enabled	Position, velocity	5-2-9
	75	Torque compensation frequency 2	0.1 Hz	0 to 5000	Sets filter frequency 2 for velocity control output.	Always enabled	Position, velocity	5-2-9
	76	Load estimation count	—	0 to 8	Sets the number of times for load estimation.	Always enabled	Position, velocity	5-2-9
	78	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-
	79	For manufacturer use	-	-	Do not change from the shipping value setting.	-	-	-

(Continued) *1 Not available with [A6SE], [A6SG]

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
6	87	For manufacturer use	—	—	Set fixed to 0	—	—	—
	88	Absolute multi-rotation data upper limit	—	0 to 65534	Set the upper limit value for absolute multi-turn data when unlimited turn absolute mode (Pr0.15 to 4) is set. When the multi-turn data is more than the value set for this parameter, the multi-turn data changes to 0. When the multi-turn data falls below 0, m ulti-turn data will change to the set value. When absolute mode (Pr0.15 to 0 or 2) is set, the upper limit value for multi-turn data is set to 65535 regardless of the setting value. When incremental mode (Pr0.15 to 1) or one-turn absolute mode (Pr0.15 to 3) is set, this setting value will be invalid.	Reapplying the power	All	6-8
	97	Function expansion setting 3	—	-2147483648 to 2147483647	Sets various function in bit units: bit 0: Quadrant projection compensation function enhancement: 0: Invalid, 1: valid bit 1: Deterioration diagnosis warning function: 0: Invalid, 1: valid bit 2: Expansion of Allowable motor operating range abnormal protection: 0: Invalid, 1: valid bit 3 to 4: For manufacturer use. Please set fixed to 0. bit 5: Latch for deterioration diagnosis torque command average value 0: Invalid, 1: valid bit 6: Switching of position information when backlasha compensation 0: The encoder pulse cumulative value of the waveform graphic includes the backlash compensation amount., 1: The encoder pulse cumulative value of the waveform graphic does not include the backlash compensation amount. Bit7-14 For manufacturer's use, Fix at 0. bit15:Mode switching limit function release 0:Invalid 1:Valid bit16-31 For manufacturer's use, Fix at 0. *bit 0 is the least significant bit.	Always enabled	All	4-3-3 5-2-15 6-9 7-3 6-3 6-10
	98	Function expansion setting 4	—	-2147483648 to 2147483647	Sets various function in bit units: bit 0 to 21: For manufacture use. Please set fixed to 0 bit22: Effective bit switching in multi-turn data. 0:Invalid(-256～255 Turn) 1:Valid(-32768～32767 Turn) bit 23 to 27: For manufacture use. Please set fixed to 0 bit 28: Start of block operation when servo is turned on 0:Invalid 1:Valid bit 29: Extension of start of block operatio when servo is turned on 0:Invalid 1:Valid bit 30 to 31: For manufacture use. Please set fixed to 0 *bit 0 is the least significant bit.	Reapplying the power	All	-

9-1-8 Class 7: Special setting

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
7	00	For manufacturer use	-	-	Fix at 0.	-	-	-
	01	For manufacturer use	-	-	Fix at 0.	-	-	-
	03	For manufacturer use	-	-	Fix at 0.	-	-	-
	04	Backlash compensation selection	-	0 to 7	Enables/ disables backlash compensation and sets the operating direction during the compensation. bit 1-0: Enabling/ disabling backlash compensation and selecting the operating direction during the compensation. 00b: Disabled 01b: Corrects at the first positive operation after the servo is turned on. 10b: Corrects at the first negative operation after the servo is turned on. 11b: For manufacturer's use bit 2: Backlash compensation state holding condition extension. 0: Amount of compensation set at 0 when the servo is OFF 1: Amount of compensation held when the servo is OFF bit 3: For manufacturer's use	Always enabled	Position	6-10
	05	Backlash compensation amount	pulse	-1073741824 to 1073741823	Sets the backlash (mechanical clearance of the drivetrain) compensation amount during position control.	Always enabled	Position	6-10
	06	Backlash compensation time constant	0.01ms	0 to 6400	Sets the backlash (mechanical clearance of the drivetrain) time constant during position control.	Always enabled	Position	6-10
	07	For manufacturer use	-	-	Fix at 0.	-	-	-
	08	For manufacturer use	-	-	Fix at 0.	-	-	-
	09	For manufacturer use	-	-	Fix at 0.	-	-	-
	10	For manufacturer use	-	-	Fix at 0.	-	-	-
	11	For manufacturer use	-	-	Fix at 0.	-	-	-
	12	For manufacturer use	-	-	Fix at 0.	-	-	-
	13	For manufacturer use	-	-	Fix at 0.	-	-	-
	14	Main power turn-off warning detection time	ms	0 to 2000	Sets the time elapsed before the main power turn-off warning is detected when a main power turn-off state continues. 0 to 9, 2000: Warning detection disabled 10 to 1999: Warning detection enabled (unit shown in ms). Note) To cause the warning detection to occur earlier than turn-off detection, maintain the relationship "Pr7.14 < Pr5.09" when this parameter is set. In addition, when the time set for Pr7.14 is long and the P-N voltage at the main power converter area is reduced to the specified value or below before the warning is detected, Err13.0 "Main power insufficient voltage protection" is invoked earlier than the warning.	Reapplying the power	All	-
	15	For manufacturer use	-	-	Fix at 0.	-	-	-
	16	For manufacturer use	-	-	Fix at 0.	-	-	-
	18	Backlash compensation amount holding range	command unit	0 to 2147483647	Sets the dead zone for backlash compensation when the servo is OFF → ON. The function is disabled when this setup value is 0. This parameter does not depend on Pr7.04 bit2 setting.	Always enabled	Position	6-10

(To be continued)

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
7	20	For manufacturer use	-	-	Fix at 0.	-	-	-
	21	For manufacturer use	-	-	Fix at 0.	-	-	-
	22	Special function enhancement setting 1	-	-32768 to 32767	Sets various function in bit units: bit 0 to 3: Not used, fixed at 0 bit 4: external scale position information monitor function setting under semi-closed control. 0: Invalid, 1: valid bit 5 to 31: Unused. Fixed at 0. *bit 0 is the least significant bit. *For bit 4 (external scale position information monitor function setting under semi-closed control"), external scale position information can be monitored regardless of the setting of this bit, in case of full closed control.	Reclose power supply	All	4-8
	23	For manufacturer use	-	-	Fix at 0.	-	-	-
	24	For manufacturer use	-	-	Fix at 0.	-	-	-
	25	For manufacturer use	-	-	Fix at 0.	-	-	-
	26	For manufacturer use	-	-	Fix at 0.	-	-	-
	27	For manufacturer use	-	-	Fix at 0.	-	-	-
	28	For manufacturer use	-	-	Fix at 0.	-	-	-
	29	For manufacturer use	-	-	Fix at 0.	-	-	-
	30	For manufacturer use	-	-	Fix at 0.	-	-	-
	31	For manufacturer use	-	-	Fix at 0.	-	-	-
	32	For manufacturer use	-	-	Fix at 0.	-	-	-
	33	For manufacturer use	-	-	Fix at 0.	-	-	-
	34	For manufacturer use	-	-	Fix at 0.	-	-	-
	35	For manufacturer use	-	-	Fix at 0.	-	-	-
	36	For manufacturer use	-	-	Fix at 0.	-	-	-
	37	For manufacturer use	-	-	Fix at 0.	-	-	-
	38	For manufacturer use	-	-	Fix at 0.	-	-	-
	39	For manufacturer use	-	-	Fix at 0.	-	-	-
	41	For manufacturer use	-	-	Fix at 0.	-	-	-
	87	For manufacturer use	-	-	Fix at 0.	-	-	-
	91	For manufacturer use	-	-	Fix at 0.	-	-	-
	92	For manufacturer use	-	-	Fix at 0.	-	-	-
	93	For manufacturer use	-	-	Fix at 0.	-	-	-

9-1-9 Class 8: For manufacturer use

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
8	00	For manufacturer use	-	-	Fix at 0.	-	-	-
	01	For manufacturer use	-	-	Fix at 100.	-	-	-
	02	For manufacturer use	-	-	Fix at 0.	-	-	-
	03	For manufacturer use	-	-	Fix at 0.	-	-	-
	04	For manufacturer use	-	-	Fix at 100.	-	-	-
	05	For manufacturer use	-	-	Fix at 0.	-	-	-
	10	For manufacturer use	-	-	Fix at 0.	-	-	-
	12	For manufacturer use	-	-	Fix at 0.	-	-	-
	13	For manufacturer use	-	-	Fix at 0.	-	-	-
	14	For manufacturer use	-	-	Fix at 0.	-	-	-
	15	For manufacturer use	-	-	Fix at 0.	-	-	-
	19	For manufacturer use	-	-	Fix at 0.	-	-	-

9-1-10 Class 9: For manufacturer use

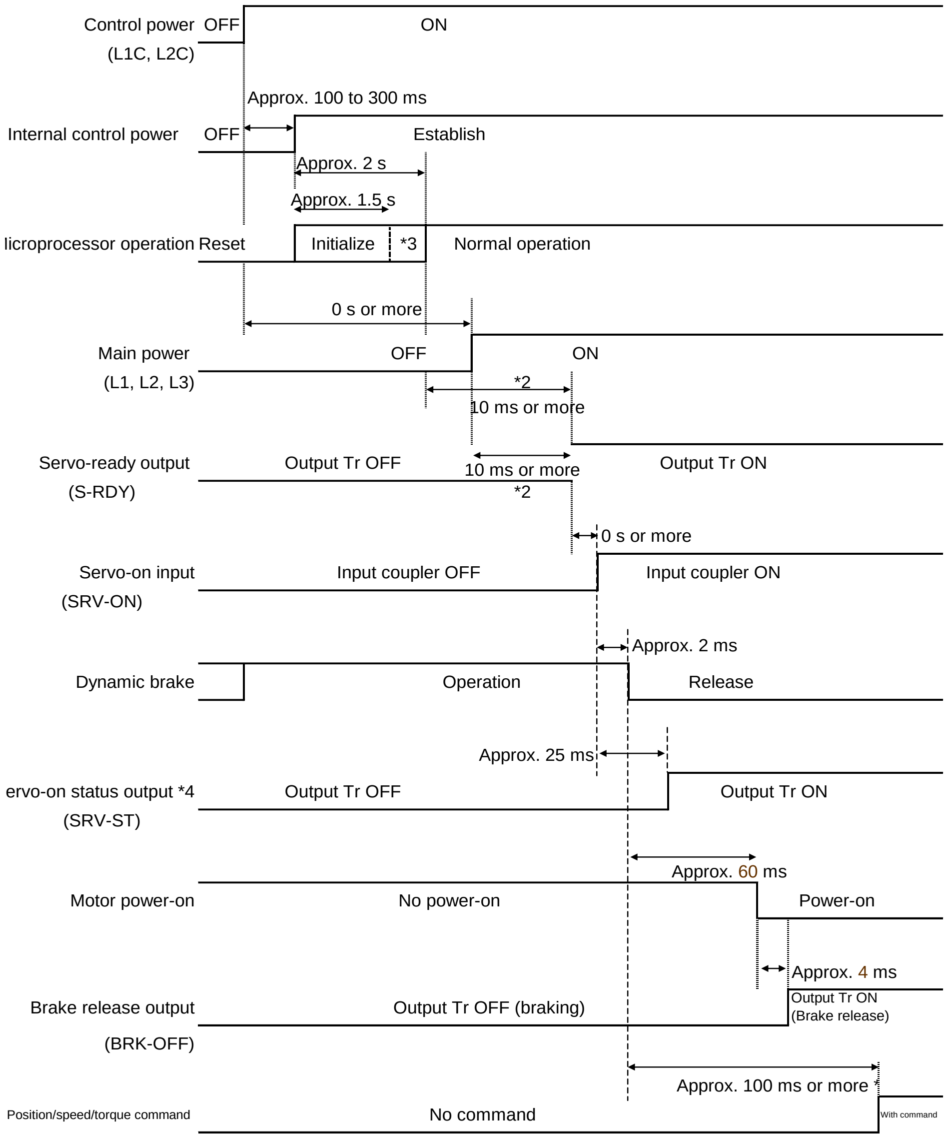
Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
9	00	For manufacturer use	–	–	Fixed to 1	–	–	–
	01	For manufacturer use	–	–	Fixed to 0	–	–	–
	02	For manufacturer use	–	–	Fixed to 0	–	–	–
	03	For manufacturer use	–	–	Fixed to 0	–	–	–
	04	For manufacturer use	–	–	Fixed to 0	–	–	–
	05	For manufacturer use	–	–	Fixed to 0	–	–	–
	06	For manufacturer use	–	–	Fixed to 0	–	–	–
	07	For manufacturer use	–	–	Fixed to 0	–	–	–
	08	For manufacturer use	–	–	Fixed to 0	–	–	–
	09	For manufacturer use	–	–	Fixed to 0	–	–	–
	10	For manufacturer use	–	–	Fixed to 0	–	–	–
	11	For manufacturer use	–	–	Fixed to 1	–	–	–
	12	For manufacturer use	–	–	Fixed to 80	–	–	–
	13	For manufacturer use	–	–	Fixed to 50	–	–	–
	14	For manufacturer use	–	–	Fixed to 10	–	–	–
	17	For manufacturer use	–	–	Fixed to 0	–	–	–
	18	For manufacturer use	–	–	Fixed to 0	–	–	–
	19	For manufacturer use	–	–	Fixed to 0	–	–	–
	20	For manufacturer use	–	–	Fixed to 0	–	–	–
	21	For manufacturer use	–	–	Fixed to 0	–	–	–
	22	For manufacturer use	–	–	Fixed to 200	–	–	–
	23	For manufacturer use	–	–	Fixed to 50	–	–	–
	24	For manufacturer use	–	–	Fixed to 100	–	–	–
	25	For manufacturer use	–	–	Fixed to 40	–	–	–
	26	For manufacturer use	–	–	Fixed to 40	–	–	–
	27	For manufacturer use	–	–	Fixed to 100	–	–	–
	28	For manufacturer use	–	–	Fixed to 100	–	–	–
	29	For manufacturer use	–	–	Fixed to 0	–	–	–
	30	For manufacturer use	–	–	Fixed to 0	–	–	–
	48	For manufacturer use	–	–	Fixed to 0	–	–	–
	49	For manufacturer use	–	–	Fixed to 0	–	–	–
	50	For manufacturer use	–	–	Fixed to 0	–	–	–

9-1-11 Class 15: For manufacturer use

Class	No.	Parameter name	Unit	Setting range	Function/description	Attribute	Related control mode	Related
15	00	For manufacturer use	-	-	Fix at 0.	-	-	-
	16	For manufacturer use	-	-	Fix at 2.	-	-	-
	17	For manufacturer use	-	-	Fix at 4.	-	-	-
	30	For manufacturer use	-	-	Fix at 0.	-	-	-
	31	For manufacturer use	-	-	Fix at 5.	-	-	-
	33	For manufacturer use	-	-	Fix at 0.	-	-	-
	34	For manufacturer use	-	-	Fix at 0.	-	-	-
	35	For manufacturer use	-	-	Fix at 0.	-	-	-

9-2 Timing charts

9-2-1 Timing chart of operation after power-on



- The above chart shows the timings from the turn-on of control power to the input of command.
- Input the servo-on signal, and the position, speed and torque commands in accordance with the timings shown in the above chart.

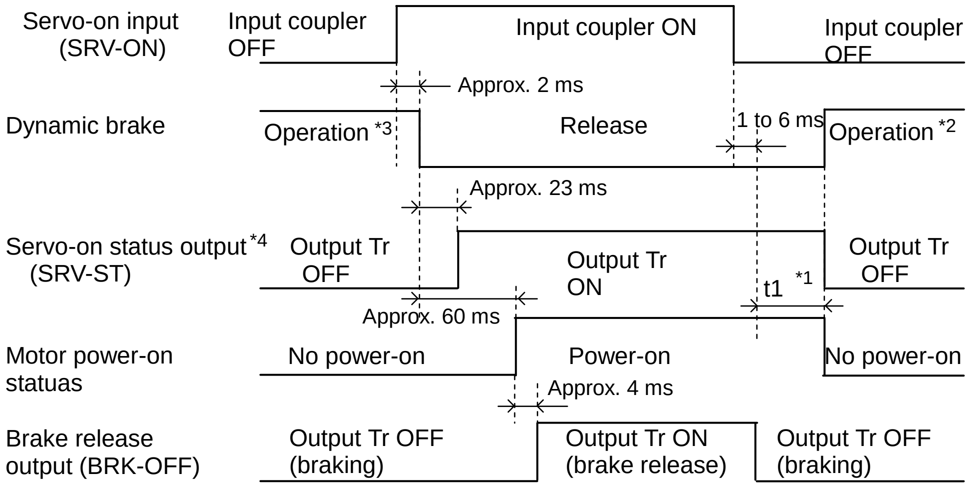
*1. This zone shows that the servo-on signal (SRV-ON), which is input from the hardware viewpoint, has not been received.

*2. The S-RDY output turns on when both conditions, which are the completion of microprocessor initialization and the establishment of the main power, have been met.

*3. Protection function starts operating approximately 1.5 s after the start of microprocessor initialization after the internal control power is established. When you design, allow all input/output signals connected to the driver (especially those which could be a trigger for protection function, such as positive-/negative-direction drive prohibition inputs and external scale inputs) to be established before protection function starts operating. For your information, this time duration can be extended with Pr6.18 "Power-on wait time".

*4. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

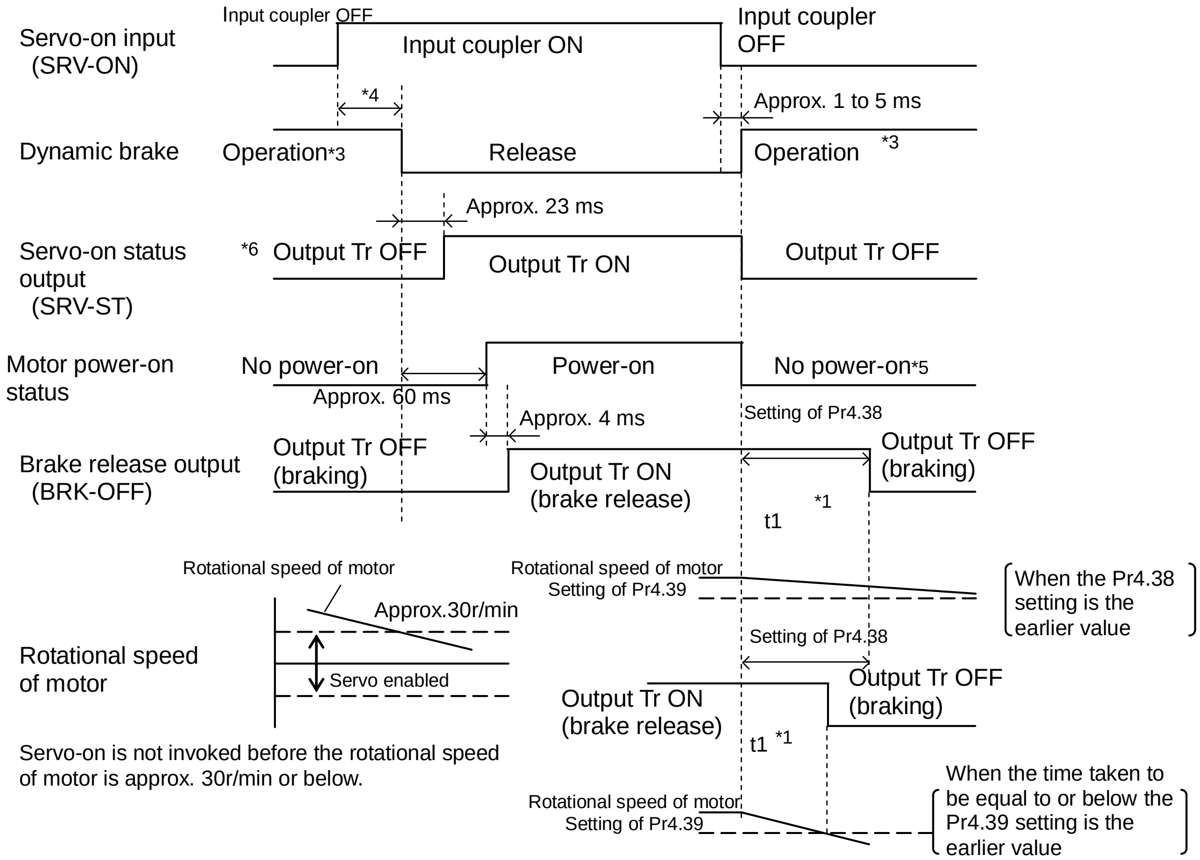
9-2-2 Timing chart of servo-on/-off operation with nonoperating motor (servo locked)
(During normal operation, stop the motor and perform servo-on/-off operation.)



*1. t1 depends on the setting specified for Pr4.37 "Mechanical braking setting during no operation".
*2. Dynamic brake operation during servo-off depends on the setting specified for Pr5.06 "Sequence at servo-off".
*3. Servo-on is not invoked before the rotational speed of motor is approximately 30 r/min or below.
*4. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-2-3 Timing chart of servo-on/-off operation with running motor

(This chart shows the timing for an emergency stop or trip. Repeated use is not possible.)



*1. t1 takes the earlier of: the value specified for Pr4.38 "Mechanical braking setting during operation", or the time taken before the rotational speed of motor becomes equal to or below the value set for Pr4.39 "Brake release speed setting"

*2. Even if the SRV-ON signal is turned on again when the motor is decelerating, the shift to servo-on is not invoked before the motor stops.

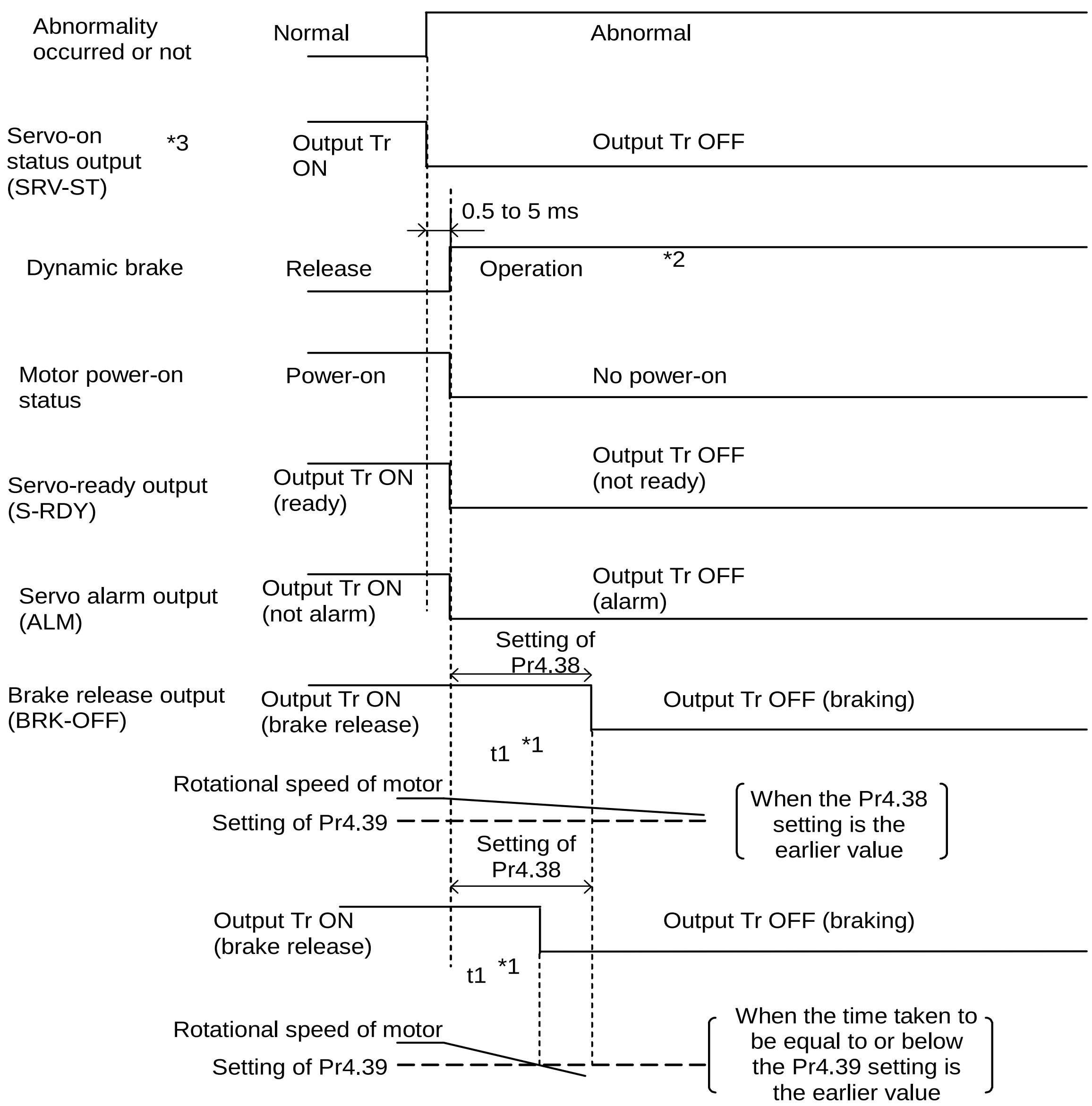
*3. The dynamic brake operation during servo-off depends on the setting specified for Pr5.06 "Sequence at servo-off".

*4. Servo-on is not invoked before the rotational speed of motor is approximately 30 r/min or below.

*5. The power-on status of the motor during deceleration at the time of servo-off depends on the setting specified for Pr5.06 "Sequence at servo-off".

*6. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-2-4 Timing chart of (servo-on command status) operation when abnormality (alarm) occurs (DB/Free run deceleration operation)



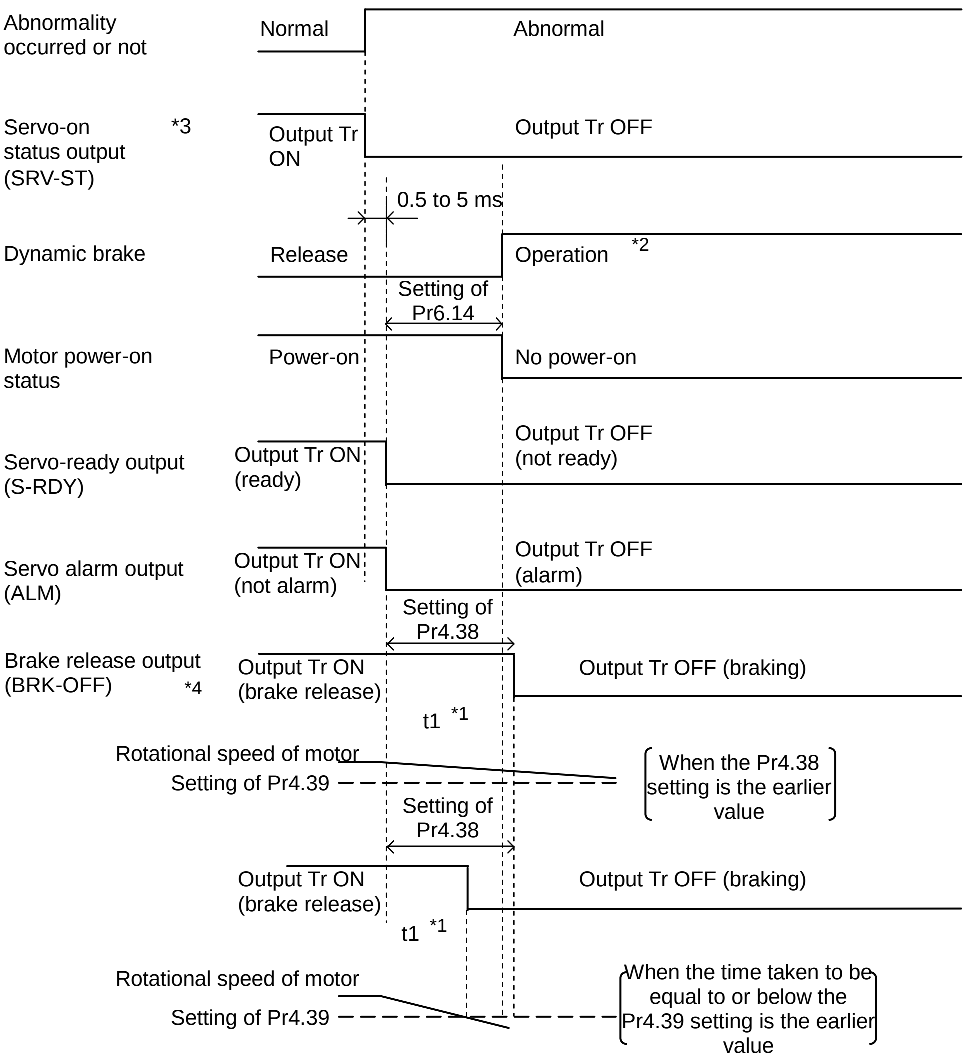
- The timing of the above figure will vary with the setting of various sequence operations.

*1. t1 takes the earlier of: the setting specified for Pr4.38 "Mechanical braking setting during operation", or the time taken before the rotational speed of motor becomes equal to or below the value set for Pr4.39 "Brake release speed setting".

*2. The dynamic brake operation when an alarm is generated depends on the setting specified for Pr5.10 "Sequence during an alarm".

*3. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-2-5 Timing chart of (servo-on command status) operation when abnormality (alarm) occurs (Immediate stop operation)



- The timing of the above figure will vary with the setting of various sequence operations.

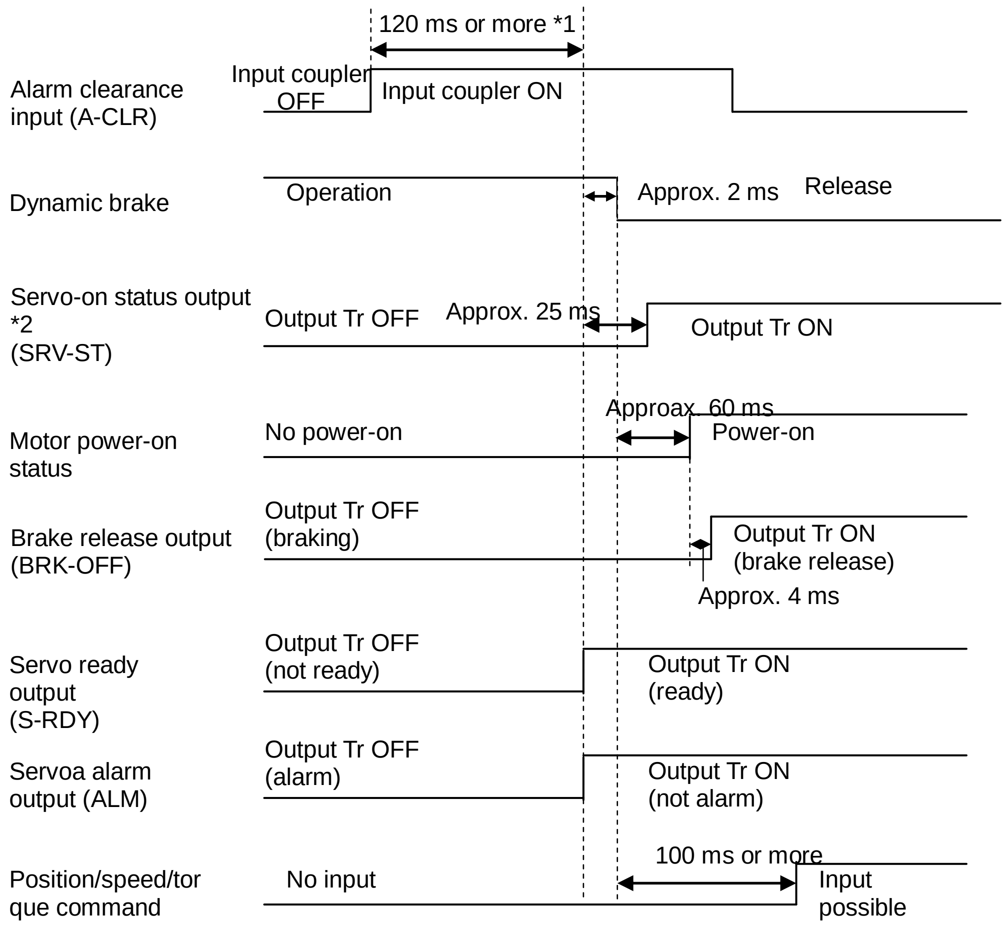
*1. t1 takes the earlier of: the setting specified for Pr4.38 “Mechanical braking setting during operation,” or the time taken before the rotational speed of motor becomes equal to or below the value set for Pr4.39 “Brake release speed setting.”

*2. The dynamic brake operation when an alarm is generated depends on the setting specified for Pr5.10 “Sequence during an alarm.”

*3. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

*4 The setting where Pr4.38 “Mechanical braking setting during operation” = Pr6.14 “Immediate stop time in case of alarm” is recommended.
When set to Pr4.38≤Pr6.14, the brake will be operated after lapse of Pr4.38 time.
When set to Pr4.38>Pr6.14, the brake will not operate even after lapse of Pr4.38 time, but will operate when transitioned to OFF state.

9-2-6 Timing chart of (servo-on command status) operation when an alarm is cleared



*1. The recognition time for alarm clearance input can be changed with Pr5.16 "Alarm clearance input setting" (the factory-configured setting is 120 ms).

*2. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-3 Communication functions (RS232/RS485 MINAS standard protocol)

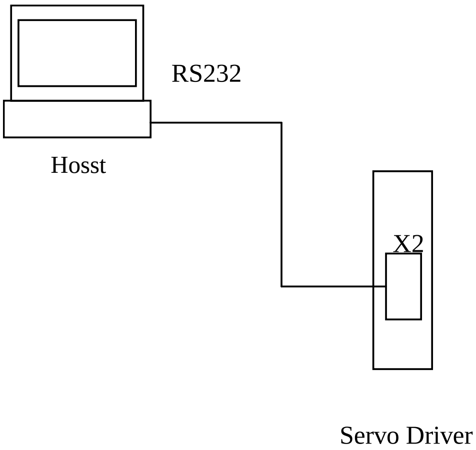
[A6SE] This function is not available.

MINAS-A6 series comes with two types of communication ports, RS232 and RS485, and allows connection to be made to the host in the following three configurations. Please refer to the Technical reference (Modbus communication and Block operation Specification) described in Chapter 1 “Introduction” for Modbus communication specifications.

9-3-1 Connection with communication lines

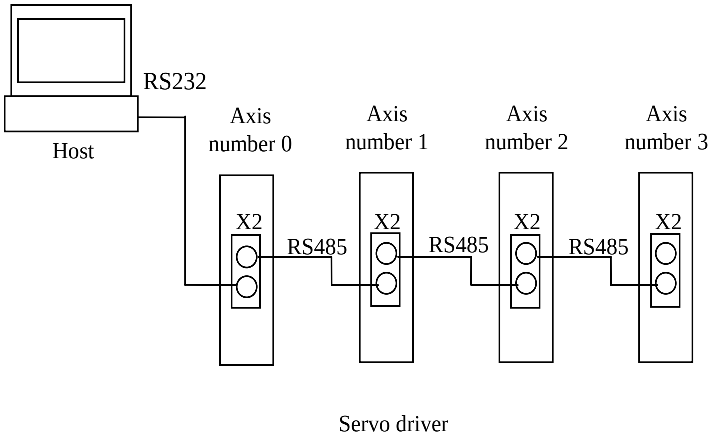
(1) For communications using RS232 only:

Make a 1 to 1 connection between the host and the driver using RS232 and communicate using RS232 transmission protocol.



(2) For communications using both RS232 and RS485:

When connecting multiple drivers to a single host, the first driver is connected to the host using RS232 and the remaining drivers may be connected to the first driver using RS485. The axis number of the driver connected to the host by RS232 shall be 0 (zero), while the remaining drivers will each be numbered 1 through 31 individually.

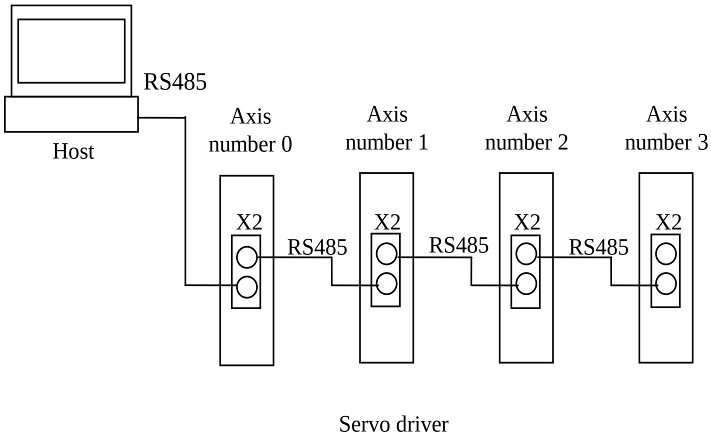


Communications to multiple drivers can be made by entering the axis number of the driver to be connected from the host in the axis of the command block, and sending commands in accordance with RS232 transmission protocol.

Note) The driver with axis number 0 (zero) will output command to drivers connected by RS485, and when no response is returned from drivers connected by RS485 (drivers with axis numbers starting from 1), (Break in RS485 wiring or power cut-off of driver, etc.), it will return a transmission data with a command bite number “1” with a data region of 90H (RS485 error) to the host. (Indicates RS485 time out detection.)
In case of transmitting continuous data, please ensure that the next command is output only when data transmission from the servo to the host has been confirmed.

(3) For communications using RS485 only:

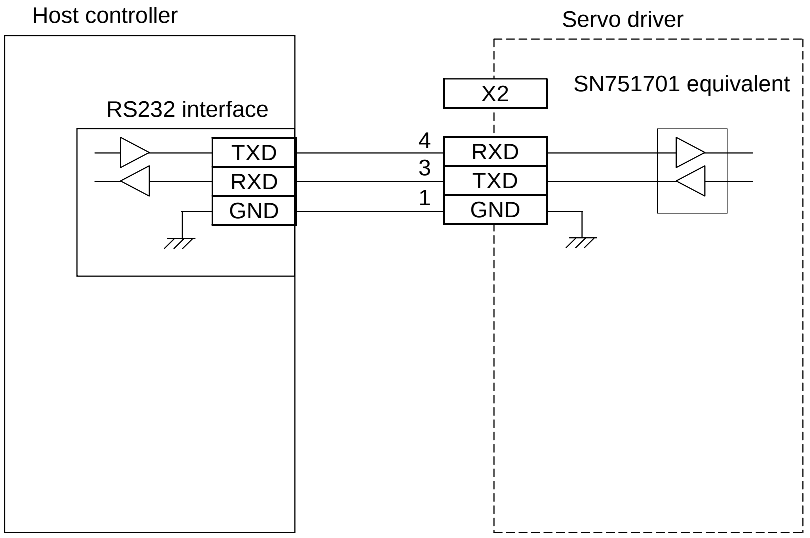
Multiple drivers can all be connected to a single host using RS485.
Drivers will be assigned with individual axis number from 1 through 31.



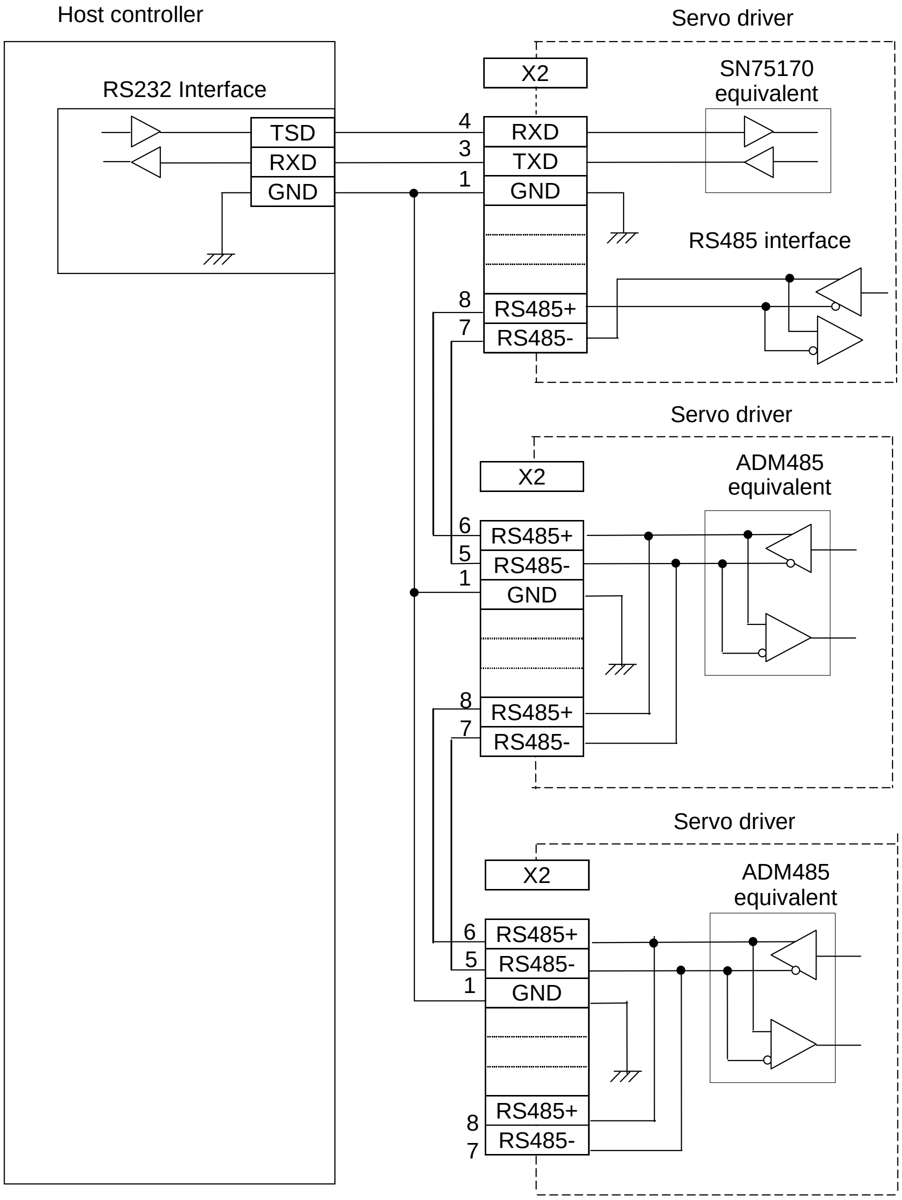
Command is transmitted to the module ID of the driver to be connected to the host using RS485 transmission protocol.
Module ID of the communicating partner shall also be set in the axis of the command block.

9-3-2 Connector wiring diagram

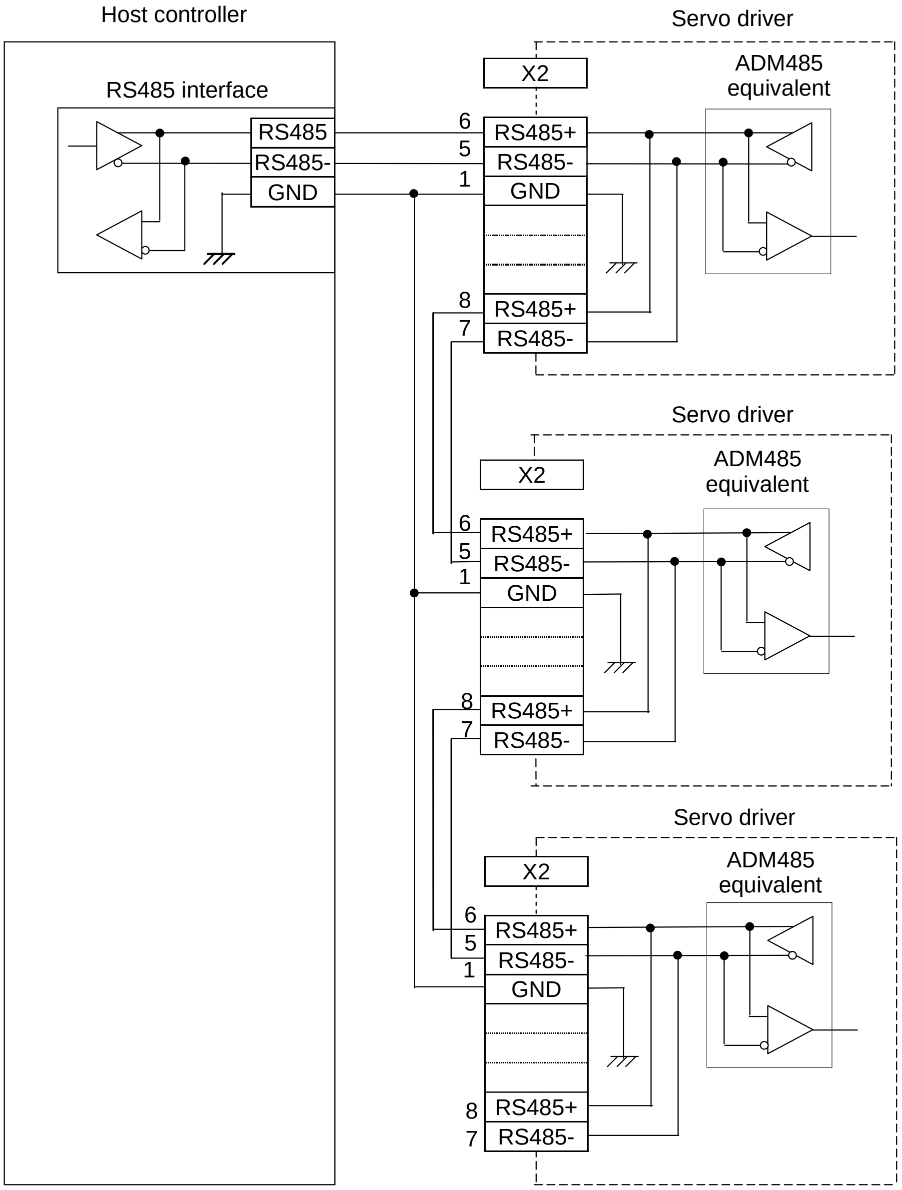
(1) In case of 1 to 1 communications using RS232:



(2) In case the servo driver connected to the host by RS232 communication is to conduct RS485 communications as a RS485 communication host:



(3) In case all servo drivers are connected to communicate with RS485 communications:



9-3-3 Communication specifications

RS232	Full duplex, start-stop system
Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 bps
Data	8 bit
Parity	None
Start bit	1 bit
Stop bit	1 bit

RS485	Semi duplex, start-stop system
Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 bps
Maximum axis number	31 axis
Data	8 bit
Parity	None
Start bit	1 bit
Stop bit	1 bit

Baud rate can be selected by:
Pr 5.29 Setting RS232 communication baud rate, or
Pr 5.30 Setting RS485 communication baud rate.
Changes to parameters will become effective when control power is switched on.

9-3-4 Transmission sequence

(1) Hand shake byte

Line control is conducted using the following codes:

Name	Code	Function
ENQ	(Receiving end module acknowledgment byte) 05h	Transmit request
EOT	(Receiving end module acknowledgment byte) 04h	Receive ready
ACK	06h	Acknowledge
NAK	15h	Negative acknowledge

Contents:

ENQ: Sent out when there are blocks to be transmitted.
EOT: Transmitted when able to receive blocks. Line will transmit out ENQ and when EOT is received, it will go into transmit mode, receives ENQ and goes into receiving mode when EOT is transmitted.
ACK: Transmitted when received blocks are judged to be without anomalies.
NAK: Transmitted when received blocks are abnormal. Judgment of normal, abnormal is done by checksum and time-out.

In case of RS485:

Module recognition byte:
The value of Pr 5.31 Axis number is taken as the module ID and its data with its bit 7 changed to 1 shall be the module recognition byte. ENQ and EOT shall be a 2 byte data with this recognition module byte attached.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
1	Module ID						

Module ID: 1 through 31
(However, connection on RS485 bus is limited to 16, including the host.) Module ID of the communicating host shall be 0 (zero).

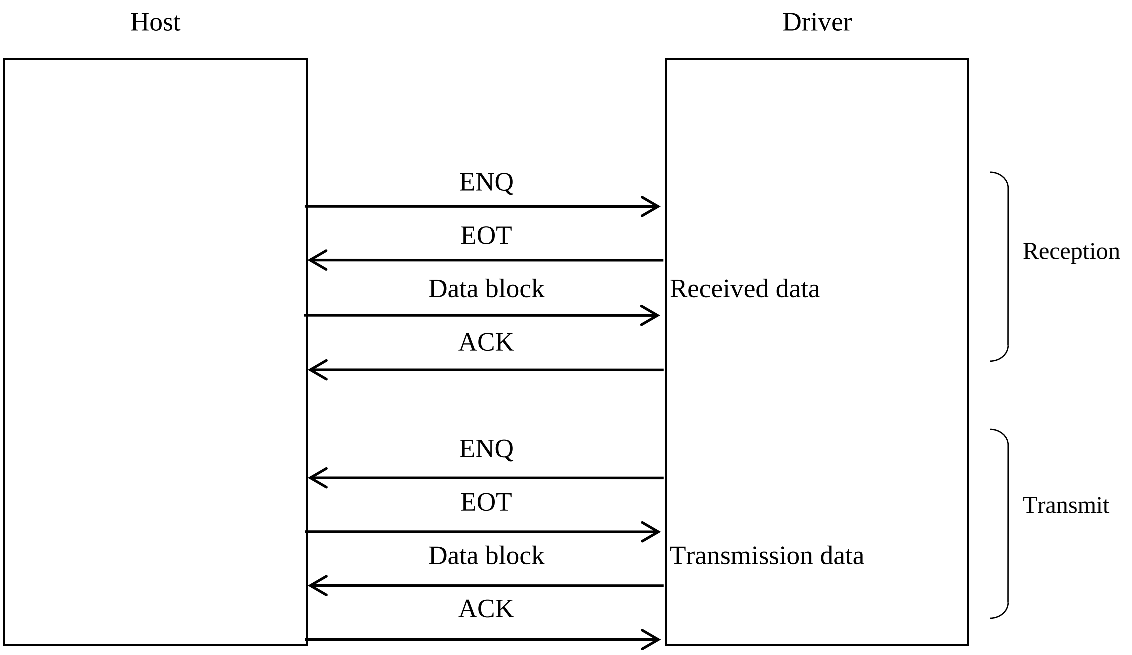
(2) Transmission protocol

⊙ Line control:
Solves transmission direction and clashes.
Receiving mode: From receipt of ENQ to transmission of EOT.
Transmission mode: From transmission of ENQ and receiving of EOT.
In case of slave mode:
During EOT receipt stand by after transmission of ENQ, when ENQ is received, ENQ will have priority and will enter into receiving mode.

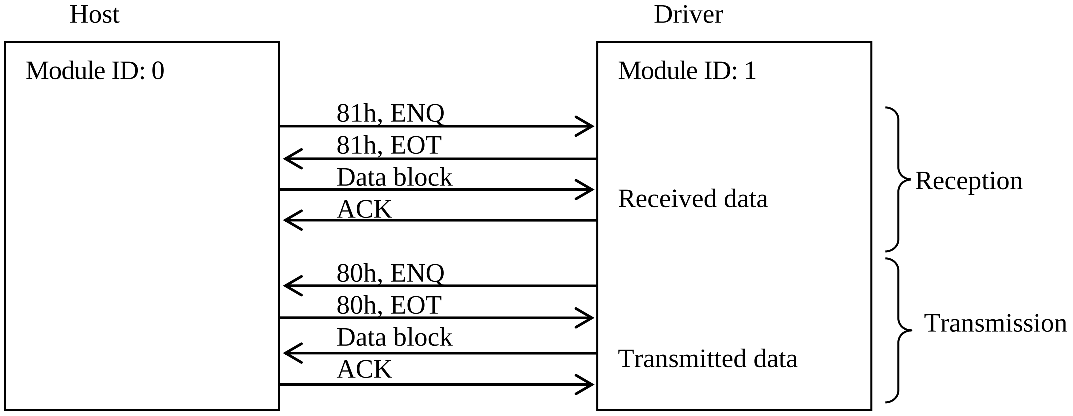
⊙ Transmission control:
In transmission mode, command block is transmitted continuously, then will go into ACK receiving stand by. Transmission is completed upon receipt of ACK. Re-try will be made in case of codes other than ACK. In case of error in command byte numbers, there are cases where ACK is not returned. In case ACK is not received within T2, a re-try will be performed.
Re-try will be repeated from ENQ.

⊙ Receiving control:
In receiving mode, transmission blocks are received continuously. Command byte is obtained from the first byte, and the number of bytes plus 3 bytes will be received. Transmission is deemed to be received normally when the total sum of received data reaches zero, and ACK is returned. In case of abnormal checksum or inter-character time outs, NAK will be returned.

In case of RS232



In case of RS485



(4) Protocol parameters:

There are the following parameters to control block transmissions:

These values may be set to arbitrary values using INIT command to be explained later.

Name	Function		Initial value	Set range	Unit
T1	Inter-character time out	RS232	5 (0.5 sec)	1 to 255	0.1 sec
		RS485	1 (0.1 sec)		
T2	Protocol time out	RS232	10 (10 sec)	1 to 255	1 sec.
		RS485	2 (2 sec)		
RTY	Retry time limit		1 (Once)	1 to 8	Once
M/S	Master/Slave		0 (slave)	0,1 (master)	

T1: This is the time allowed between the module recognition byte and ENQ/EOT or the time from the receipt of character code in the transmission and reception data block till the receipt of the next character code of this equipment. Time out error will occur when this time is exceeded, and NAK will be returned to the transmitting side.

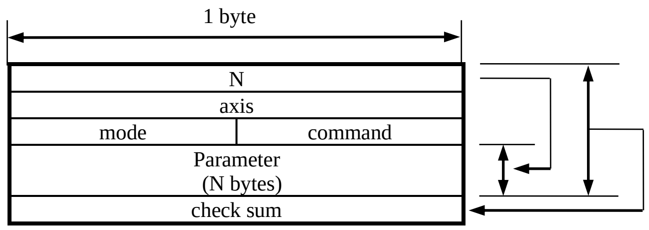
T2:
- Allowable time from the transmission of ENQ to the receipt of EOT by this equipment. When this time is exceeded, it indicates that the receiving side is not in a state to receive or was unable to receive the ENQ code for some reason. In this case, the next ENQ code will be resent to the receiving side. (Number of retries)
- Allowable time from transmission of EOT until the receipt of the first character. NAK will be returned when this time is exceeded and receiving mode is terminated.
- Allowable time from the transmission of checksum byte till the receipt of ACK. Similar to NAK receipt, ENQ code will be resent to the receiving side when this time is exceeded.

RTY: Maximum number of retries. Judged to be transmission error if this number is exceeded.

M/S: Switching of master/slave. In case clashing of ENQ should occur, decides which to have priority. (0 for slave mode, 1 for master mode) The one set as master will have priority.

(4) Block configuration

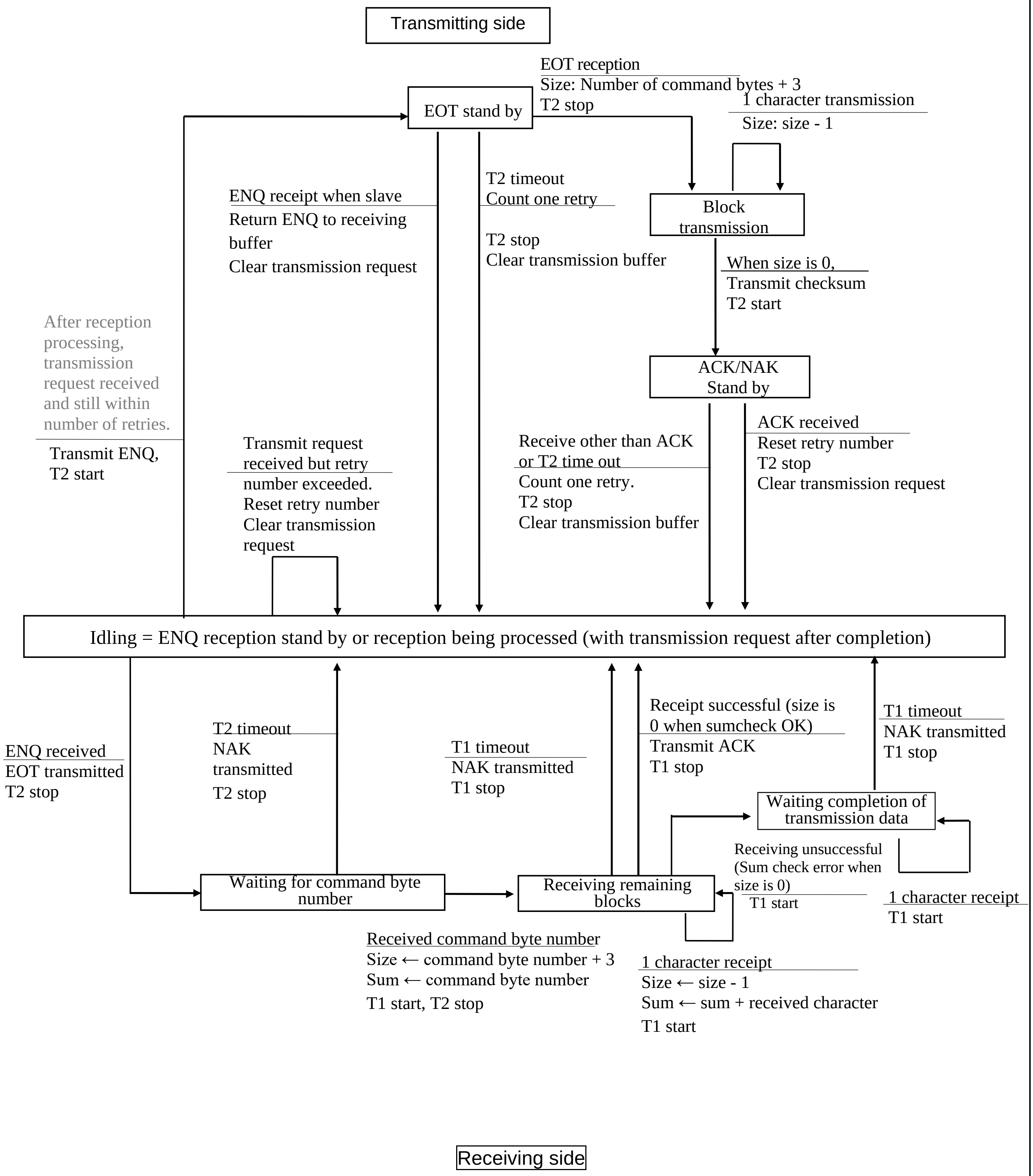
Configuration of blocks transmitted in physical phase are as indicated:



N:	Number of command bytes (0 to 240) Indicates the number of parameters required by the command
axis:	Sets the value for Pr 5.31 Axis number (0 to 15)
command:	Control command (0 to 15)
mode:	Indicates command execution mode (0 to 15) Contents vary with the command.
Checksum:	Complement of 2 of the sum of byte units from the top of the block to immediately before.

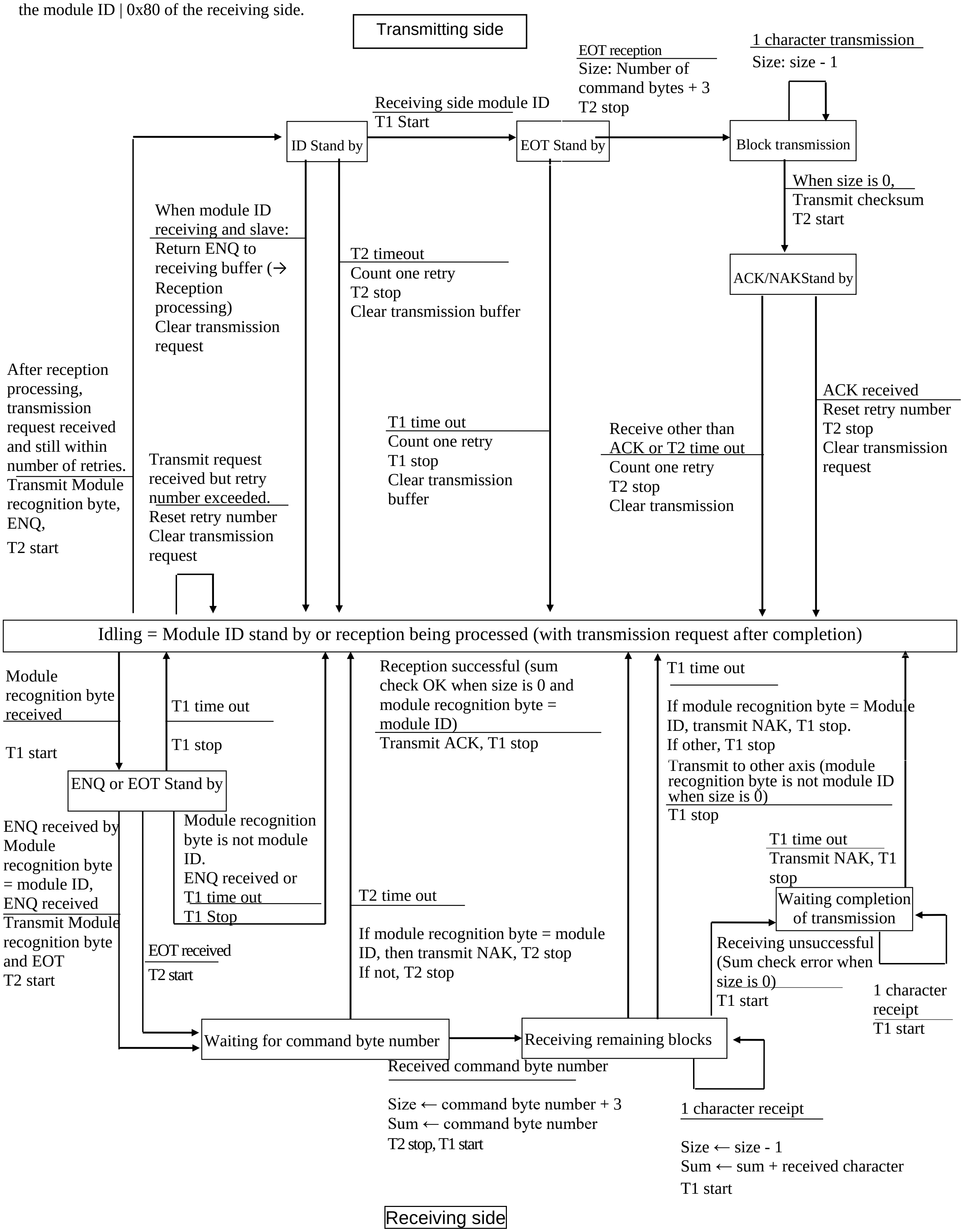
9-3-5 State transition diagram

(1) RS232

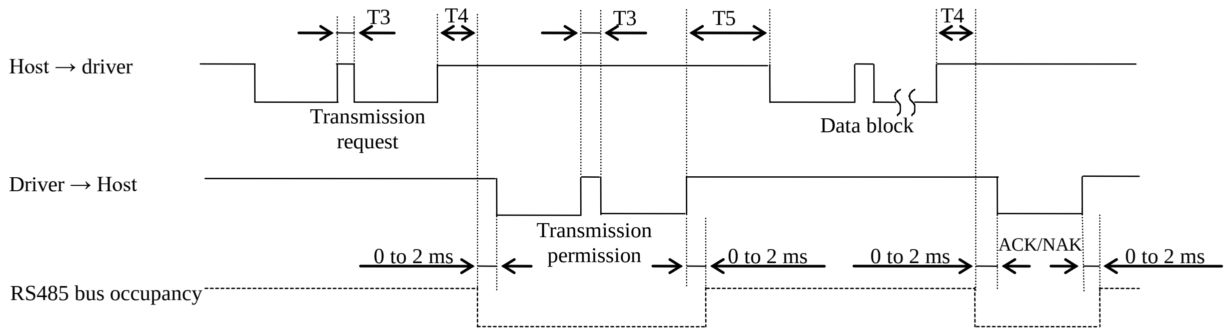


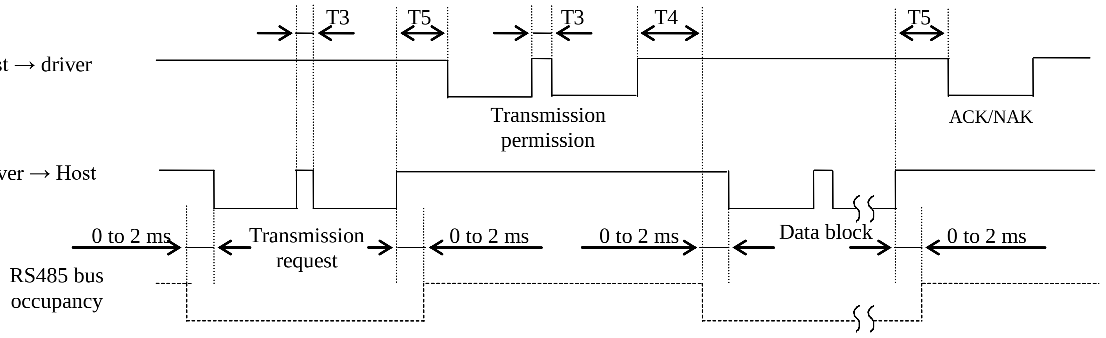
(2) RS485

Transmitting side module recognition byte is the module ID | 0x80 of the receiving side.



7. RS485 Timing (To apply accordingly for RS232)





Symbol	Name	Minimum	Maximum
T3	Continuous inter-character time	Stop bit length	Protocol parameter T1
T4	Driver response time	4 ms	Protocol parameter T2
T5	Host response time	2 ms	Protocol parameter T2

Note) Time is from the leading edge of stop bit.

9-3-6 Communication command list

Command	Mode	Contents	Remarks
0		NOP	
	1	Read software version information	
	5	Read driver model	
	6	Read motor model	
	A	Read driver serial number	
	B	Read motor serial number	
1		INIT	
	7	Obtain, release execution right	
	8	Set RS232 protocol parameter	
	9	Set RS485 protocol parameter	
2		POS, STATUS, I/O	
	0	Read status	
	1	Read command pulse counter	
	2	Read feedback pulse counter	
	4	Read current velocity	
	5	Read current torque output	
	6	Read current deviation counter	
	7	Read input signal	
	8	Read output signal	
	9	Read current velocity, torque and deviation counter	
	A	Read status, input signal, and output signal	
	B	Read overload load ratio	
	C	Read external scale	
	D	Read absolute encoder	
	E	Read external scale deviation and aggregate pulse	
7		PARAMETER	
	0	Read individual user parameters	
	1	Write individual user parameters	
	2	Write user parameters into EEPROM	
	6	Read individual user parameter attributes	
	7	Read multiple user parameter attributes	
	8	Write multiple user parameters	
9		ALARM	
	0	Read current alarm data	
	2	Read batched alarm history	
	3	Clear alarm history	
	4	Alarm clear	
	B	Absolute clear	

- Use only the abovementioned commands.
  Action of the driver cannot be guaranteed in case commands other than those listed above have been transmitted.
- In the event the number of received data with the abovementioned command is in error, regardless of the communication command, a single byte transmission communication data (error code only) will be transmitted.

9-3-7 Communication command details

[Read software version information]

Command	Mode
0	1

Received data

0	
axis	
1	0
checksum	

Transmitted data

3	
axis	
1	0
Version (higher)	
(lower)	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ Version information will be returned with V.0.00 being separated into higher data and lower data.
(Decimal point will be returned, expressed by 0 for the lower four (4) bits of the higher data.)
■ Version shall be indicated by numbers ranging from 0 to 9.
(Example: Ver 1.10 will be expressed as upper data: 10h and lower data: 10h.)

[Read driver model]

Command	Mode
0	5

Received data

0	
axis	
5	0
checksum	

Transmitted data

0Dh	
axis	
5	0
Driver model name (higher)	
:	
Driver model name (lower)	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ Model name of driver is transmitted in 12 ASCII code characters.
(Example) MADDT1105***"

[Read motor model]

Command	Mode
0	6

Received data

0	
axis	
6	0
checksum	

Transmitted data

0Dh	
axis	
6	0
Motor model name (Higher)	
Motor model name (Lower)	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ Model name of motor is transmitted in 12 ASCII code characters.
(Example) "MSMD012S1***"

[Read driver serial number]

command	mode
0	A

Received data

0	
axis	
A	0
checksum	

Transmitted data

5	
axis	
A	0
Production year	
Production month	
Serial in the month (Lower)	
Serial in the month (Higher)	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- ■ Read the driver production serial number.
- ■ Serial in the month (Lower/Higher) is binary data.
- ■ Range of serial number in the month (Higher/Lower) is 0-255.
  Serial number in the month (Decimal) is calculated by the following formula.
  Serial number in the month (Decimal) = Serial number in the month (Higher) × 256 + Serial number in the month (Lower)
- ■ Serial number in the month on the nameplate display may contain alphabetic characters, in which case the data converted to decimal is read out according to the following table.

Serial number in the month on the nameplate display (4 digit alphanumeric characters)	Read-out value of Serial number in the month (Decimal)
0001	1
9999	9999
A000	10000
A999	10999
B000	11000
H999	17999
J000 *1	18000
N999	22999
P000 *1	23000
Z999	33999

*1 The alphabetic characters “I” and “O” are not used.

[Read motor serial number]

command	mode
0	B

Received data

0	
axis	
B	0
checksum	

Transmitted data

5	
axis	
B	0
Production year	
Production month	
Serial in the month (Lower)	
Serial in the month (Higher)	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- ■ Read the motor production serial number.
- ■ Serial in the month (Lower/Higher) is binary data.
- ■ Range of serial number in the month (Higher/Lower) is 0-255.
  Serial number in the month (Decimal) is calculated by the following formula.
  Serial number in the month (Decimal) = Serial number in the month (Higher) × 256 + Serial number in the month (Lower)
- ■ Serial number in the month on the nameplate display may contain alphabetic characters, in which case the data converted to decimal is read out according to the following table.

Serial number in the month on the nameplate display (4 digit alphanumeric characters)	Read-out value of Serial number in the month (Decimal)
0001	1
9999	9999
A000	10000
A999	10999
B000	11000
H999	17999
J000 *1	18000
N999	22999
P000 *1	23000
Z999	33999

*1 The alphabetic characters “I” and “O” are not used.

[Obtain, release execution right]

Command	Mode
1	7

Received data

1	
axis	
7	1
mode	
checksum	

Transmitted data

1	
axis	
7	1
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error	mode error			In use

- ■ Acquisition of execution right is conducted to prevent conflict between operations by communications and operations from the front panel
- ■ Makes request to obtain execution right for writing parameters or writing EEPROMs, and releases the execution right when action is completed.
- ■ Mode = 1: Request to obtain execution right
  Mode = 0: Request to release execution right
- ■ When execution right has been acquired in the communication, no operation except for monitor mode can be made from the front panel.
- ■ In case of failure to obtain execution right, an error code "in use" will be transmitted.

[Set RS232 protocol parameter]

Command	Mode
1	8

Received data

4	
axis	
8	1
T1	
T2	
T6	
0	RTY
checksum	

Transmitted data

1	
axis	
8	1
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		T6 error	RS485 error	RTY error	T2 error	T1 error	

- Processing will continue with the protocol parameters set previously, until the completion of the execution of this command.
- RTY is 4 bits.
- Units used are 0.1 sec for T1, 0.1 sec for T2, and 1 ms for T6.

[Set RS485 protocol parameter]

Command	Mode
1	9

Received data

4	
axis	
9	1
T1	
T2	
T6	
0	RTY
checksum	

Transmitted data

1	
axis	
9	1
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		T6 error	RS485 error	RTY error	T2 error	T1 error	

- Processing will continue with the protocol parameters set previously, until the completion of the execution of this command.
- RTY is 4 bits.
- Units used are 0.1 sec for T1, 0.1 sec for T2, and 1 ms for T6.

[Read status]

Command	Mode
2	0

Received data

0	
axis	
0	2
checksum	

Transmitted data

3	
axis	
0	2
Control mode	
Status	
Error code	
checksum	

Status

bit7	6	5	4	3	2	1	0
				In rotation, Positive direction	In rotation, Negative direction	Under velocity permitted by DB	Torque under limitation

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ Control mode shall be as follows:

0	Position control mode
1	Velocity control mode
2	Torque control mode
3	Ful-close contrl mode

[Read command pulse counter]

Command	Mode
2	1

Received data

0	
axis	
1	2
checksum	

Transmitted data

5	
axis	
1	2
Value of counter L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Returns current position of command in absolute coordinates from the time of start-up. (cumulative sum of command pulse)
- The value of the counter is 32 bits.
- (-) for negative direction and (+) for positive direction shall be used in the value of the counter.

[Read feedback pulse counter]

Command	Mode
2	2

Received data

0	
axis	
2	2
checksum	

Transmitted data

5	
axis	
2	2
Value of counter L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Returns current position of feedback pulse counter in absolute coordinates from the time of start-up.
- (-) for negative direction and (+) for positive direction shall be used in the value of the counter.
- Feedback pulse counter indicates the total number of pulses detected by the position detector, and shows the real movement of the motor position.

[Read current velocity]

Command	Mode
2	4

Received data

0	
axis	
4	2
checksum	

Transmitted data

3	
axis	
4	2
Current velocity L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Reads the current velocity (units: [r/min])
- Output value is 16 bits.
- (-) for negative and (+) for positive direction when expressing velocity.

[Read current torque]

Command	Mode
2	5

Received data

0	
axis	
5	2
checksum	

Transmitted data

3	
axis	
5	2
Torque command L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Reads current torque command value (Units: Converted based on rated motor toque = 2000)
- Output value is 16 bits.
- (-) for negative direction and (+) for positive direction of torque command.

[Read current position command deviation]

Command	Mode
2	6

Received data

0	
axis	
6	2
Checksum	

Transmitted data

5	
axis	
6	2
Position command deviation L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Comman d error	RS485 error				

- Reads the current value of deviation counter. (Units: [command range])
- Output value is 32 bits.
- (+) is indicated when encoder position is in the negative position against the position command, and (-) for the positive position.

[Read input signal]

Command	Mode
2	7

Received data

0	
axis	
7	2
checksum	

Transmitted data

5	
axis	
7	2
Data L	
Data H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

Data

bit7	6	5	4	3	2	1	0
Manufacturer use	Command division multiplication switching 1	Zero velocity clamp	Control mode switching	Prohibit positive direction drive	Prohibit negative direction drive	Alarm clear	Servo ON

bit15	14	13	12	11	10	9	8
Manufacturer use	Manufacturer use	Internal velocity command select 2	Internal velocity command select 1	Manufacturer use	Counter clear	Gain switching	Command pulse input inhibition

bit23	22	21	20	19	18	17	16
Command division multiplication switching 2	Vibration damping control switching 2	Torque limit switching	Internal velocity command select 3	Vibration damping control switching 1	Manufacturer use	Manufacturer use	Manufacturer use

bit31	30	29	28	27	26	25	24
Manufacturer use	Manufacturer use	Manufacturer use	Safety input 2	Safety input 1	Manufacturer use	Designate torque sign	Designate torque sign

- Logic for each input signal shall follow the assignment setting of the parameter.
- Input signal from the connector X5 will not correspond 1:1, as these are internal logic data after input conversion.
- Prohibit positive direction drive, Prohibit negative direction drive will change in accordance with the input logic, even if prohibit drive input is disabled by parameter.

[Read output signal]

Command	Mode
2	8

Received data

0	
axis	
8	2
checksum	

Transmitted data

7	
axis	
8	2
Data L	
Data H	
Alarm data L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

Data

bit7	6	5	4	3	2	1	0
Manufacturer use	Velocity match	Torque being limited	Zero velocity detection	Mechanical brake release	Positioning completed	Servo alarm	Servo ready

bit15	14	13	12	11	10	9	8
Motor excitation	Power latch control	Dynamic brake action	Rush suppression relay control	Regenerative brake control	Manufacturer use	Achieved velocity	Manufacturer use

bit23	22	21	20	19	18	17	16
Safety EDM	Velocity command Yes/No output	Alarm attribute output	Velocity being limited output	2nd positioning complete	Position command Yes/No input	Alarm output 2	Alarm output 1

bit31	30	29	28	27	26	25	24
Manufacturer use	Manufacturer use	Manufacturer use	Manufacturer use	Manufacturer use	Manufacturer use	Manufacturer use	Manufacturer use

Alarm data

bit7	6	5	4	3	2	1	0
Overload alarm	Fan alarm	Over regeneration alarm	Encoder communication alarm	Encoder overheat alarm	Service life alarm	Manufacturer use	Battery alarm

bit15	14	13	12	11	10	9	8
Manufacturer use	Manufacturer use	Manufacturer use			External scale communication alarm	Transmission detection alarm	External scale abnormal alarm

■ The relationship between the signals and actions are as indicated in the following table:

Signal name	0	1
Servo ready	Not ready	Ready state
Servo alarm	Normal	Abnormal
Positioning complete	Positioning incomplete	Positioning complete
Mechanical brake release	Mechanical brake activated	Mechanical brake released
Zero velocity detection	Zero velocity undetected	Zero velocity detected
Torque being limited	Torque not limited	Torque limited
Achieved velocity	Velocity not achieved	Velocity achieved
Velocity match	Velocity not matched	Velocity matched
Regenerative brake control	Regeneration Tr OFF	Regeneration Tr ON
Rush suppression relay control	Rush suppression relay released	Rush suppression relay activated
Dynamic brake action	Dynamic brake released	Dynamic brake activated
Power latch control	Power latch released	Abnormal power latch
Motor excitation	Motor powered on	Servo free

■ Output signal to connector X5 will not correspond 1:1, as these are internal logic data before output conversion.

[Read current velocity, torque and position command deviation counter]

Command	Mode
2	9

Received data

0	
axis	
9	2
checksum	

Transmitted data

9	
axis	
9	2
Data L	
(Velocity) H	
Data L	
(Torque) H	
Data L	
(Position command deviation)	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Output values are 16 bits for velocity and torque and 32 bits for deviation.
- The units and sign convention for output data are the same as for command numbers 24, 25, and 26.

[Read status, input signal, and output signal]

Command	Mode
2	A

Received data

0
axis
A / 2
Checksum

Transmitted data

0Dh
axis
A / 2
Control mode
Status
Input signal L
Input signal H
Output signal L
Output signal H
Alarm data L
H
Error code
checksum

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ The legend for each bit of control mode, status, input signal, output signal, and alarm data are the same as those for command numbers 20 (command =2, mode =0), 27 (mode =7), and 28 (mode = 8).

[Read overload load ratio]

command	mode
2	B

Received data

0	
axis	
B	2
Checksum	

Transmitted data

9	
axis	
B	2
Manufacturer use L	
H	
Manufacturer use L	
H	
Overload load vaule L	
H	
Manufacturer use L	
H	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■Returs overload ratio in the overload load ratio=0.2% unit(500=100%).

[Read external scale]

Command	Mode
2	C

Received data

0	
axis	
C	2
checksum	

Transmitted data

0Bh	
axis	
C	2
External scale ID (L)	
(H)	
Status (L)	
(H)	
(L)	
Absolute position data	
(48 bits)	
(H)	
Error code	
checksum	

External scale ID

Please refer to external scale specifications for details of external scale ID.

Status

Please refer to the external scale specifications for details of external scale status.

Error code

bit7	6	5	4	3	2	1	0
0: normal 1: error		Command error	RS485 Error				

- Command error will occur, when external scale position information monitor function under semi-closed control is invalid, in control mode other than full closed control.
- Absolute position data = 48 bits (800000000000h to 7FFFFFFFFFFFh)

[Read absolute encoder]

Command	Mode
2	D

Received data

0	
axis	
D	2
checksum	

Transmitted data

0Bh	
axis	
D	2
Encoder ID (L)	
(H)	
Status (L)	
(H)	
(L)	
1 revolution data	
(H)	
Multi rev data (L)	
(H)	
0	
Error code	
checksum	

Encoder ID

	Encoder ID (L)	Encoder ID (H)
23bit Absolute	0Bh	A7h

In case of 17bit Absolute

Status (L)

bit7	6	5	4	3	2	1	0
Battery alarm	System down	Multi-rev. error	0	Counter overflow	Count error	Full absolute status	Overspeed

Status (H)

- bit4: System down
- bit5: Logical sum of battery alarm, multi-rev. error, counter overflow, count error, full absolute status, and overspeed.

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Command error generated for encoder other than absolute.
- 1 revolution data = 23 bit (000000h to 7FFFFFh)
- Multi revolution data = 16 bit (0000h to FFFFh)

[Read external scale deviation and aggregate pulse]

Command	Mode
2	E

Received data

0	
axis	
E	2
checksum	

Transmitted data

9	
axis	
E	2
(L)	
External scale	
FB aggregate pulse	
(H)	
(L)	
External scale deviation	
(H)	
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Current position of external scale counter will be returned by absolute coordinates from the point of start up, for external scale feedback aggregate pulse.
- For external scale feedback aggregate pulse, negative direction will be expressed with (-), and positive with (+) sign.
- External scale deviation will be expressed by (+) when the external scale position is to the negative direction against the position command, and with a (-), when it is in the positive direction.

[Read individual parameters]

Command	Mode
7	0

Received data

2
axis
0 / 7
Parameter classification
Parameter No.
checksum

Transmitted data

5
axis
0 / 7
(L)
Parameter value
(H)
Error code
checksum

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error	Number error			

- Returns number error in case parameter classification and parameter number are out of range.
- Parameter value will be returned in value code extended to 32 bits.

[Write individual parameters]

Command	Mode
7	1

Received data

6	
axis	
7	1
Parameter classification	
Parameter No.	
(L)	
Parameter value	
(H)	
checksum	

Transmitted data

1	
axis	
1	7
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error	Data error	Command error	RS485 error	Number error			

- Returns number error in case parameter classification and parameter number are out of range.
- This command is to temporarily change the parameter. In case of writing onto EEPROM, please execute the EEPROM write parameter (mode =2).
- Please make sure to set all unused parameters to 0 (zero). Failure to do this may result in data error. Data error will also occur when parameter values outside the set range is transmitted.
- Please transmit parameters code extended into 32 bits.

[Write parameters into EEPROM]

Command	Mode
7	2

Received data

0	
axis	
2	7
checksum	

Transmitted data

1	
axis	
2	7
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error	Number error			

- Write set parameters into EEPROM.
- Transmission data will be replied after completion of writing into EEPROM.
  It may take about 5 seconds maximum, to write onto the EEPROM. (when all parameters are changed)
- Data error will occur when writing fails.
- In case of control power supply LV, control LV error code will be returned and write will not be take place.

[Read individual user parameter and attributes]

Command	Mode
7	6

Received data

2	
axis	
6	7
Parameter classification	
Parameter No.	
checksum	

Transmitted data

17 (11h)	
axis	
6	7
Parameter classification	
Parameter No.	
(L)	
Parameter value	
(H)	
(L)	
MIN value	
(H)	
(L)	
MAX value	
(H)	
Attribute L	
H	
Error code	
checksum	

Attribute

bit7	6	5	4	3	2	1	0
Unused parameter	Display prohibited		Change at initialize				

Error code

Bit15	14	13	13	12	11	9	8
							Read only

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error	Number error			

- Returns number error in case parameter classification and parameter number are out of range.
- 32 bit code extended value will be returned for parameter MIN and MAX values.

[Read user parameter and attribute pages]

Command	Mode
7	7

Received data

10h (16)	
axis	
7	7
[1] Parameter classification	
[1] Parameter No.	
[2] Parameter classification	
[2] Parameter No.	
≈	
[8] Parameter classification	
[8] Parameter No.	
checksum	

Transmitted data

129 (81h)	
axis	
6	7
[1] Parameter classification	
[1] Parameter No.	
	(L)
[1] Parameter value	
	(H)
	(L)
[1] MIN value	
	(H)
	(L)
[1] MAX value	
	(H)
[1] Attribute (L)	
	(H)
≈	
[8] Parameter classification	
[8] Parameter No.	
⋮	
[8] Attribute (L)	
	(H)
Error code	
checksum	

Attribute

bit7	6	5	4	3	2	1	0
Unused parameter	Display prohibited		Change at initialize				

Error code

Bit15	14	13	13	12	11	9	8
							Read only

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error	Number error			

- Returns number error in case parameter classification and parameter number are out of range.
- 32 bit code extended value will be returned for parameter MIN and MAX values.

[Write multiple user parameters]

Command	Mode
7	8

Received data

30h(48)
axis
8 | 7
[1] Parameter classification
[1] Parameter No.
(L)
[1] Parameter value
(H)
≈ ≈
[8] Parameter classification
[8] Parameter No.
(L)
[8] Parameter value
(H)
checksum

Transmitted data

17(11h)
axis
8 | 7
[1] Parameter classification
[1] Parameter No.
[2] Parameter classification
[2] Parameter No.
≈ ≈
[8] Parameter classification
[8] Parameter No.
Error code
checksum

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error	Data error	Command error	RS485 error	Number error			

- Please make sure to set all unused parameters to 0 (zero). Failure to do this may result in data error. Data error will also occur when parameter values outside the set range is transmitted.
- Returns number error in case parameter classification and parameter number are out of range.

[Read current alarm data]

Command	Mode
9	0

Received data

0	
axis	
0	9
checksum	

Transmitted data

2	
axis	
0	9
Alarm No. (main)	
Alarm No. (sub)	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ Alarm No. is 0 (zero) when no alarm is generated.

[Read batch alarm history]

Command	Mode
9	2

Received data

0	
axis	
2	9
checksum	

Transmitted data

29 (1Dh)		
axis		
2	9	
Alarm No. (main)		Previous
Alarm No. (sub)		
Alarm No. (main)		Two times before
Alarm No. (sub)		
≈		
Alarm No. (main)		14 times before
Alarm No. (sub)		
Error code		
checksum		

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

■ Reads alarm going back 14 times in the past.

[Clear alarm history]

Command	Mode
9	3

Received data

0	
axis	
3	9
checksum	

Transmitted data

1	
axis	
3	9
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error	Data error	Command error	RS485 error			Control LV	

■ Clears alarm data history.
■ Data error in case of clear failure.
■ In case of control power supply LV, error code Control LV will be returned and write will not take place.

[Alarm clear]

Command	Mode
9	4

Received data

0	
axis	
4	9
checksum	

Transmitted data

1	
axis	
4	9
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Clears currently activated alarm (only in case of alarms that can be cleared).
- Also clears absolute battery alarm.

[Absolute clear]

Command	Mode
9	B

Received data

0	
axis	
B	9
checksum	

Transmitted data

1	
axis	
B	9
Error code	
checksum	

Error code

bit7	6	5	4	3	2	1	0
0: Normal 1: Error		Command error	RS485 error				

- Clears absolute encoder error and multiple rotation data.
- Returns encoder error when absolute encoder is not in use.