Panasonic

No. SX-DSV03077

TECHNICAL REFERENCE

– Functional Specification –

MODEL

Product Name: AC Servo Driver

Model No.: MINAS-A6N series (RTEX communication type)

Issued on
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Motor Business Unit, Electromechanical Control Business Division,
Automotive & Industrial Systems Company, Panasonic Corporation

Revisions

Date	Page	Rev.	Description	Signed
Feb. 29, 2016		1.0	NEWLY ISSUED	-
Feb. 12, 2016	All pages	1.1	・Changed the parameter names below in consideration of consistency with other models. Pr1.16、Pr1.18、Pr1.21、Pr1.23、Pr1.25、Pr1.27、 Pr2.22、Pr2.23、Pr2.25、Pr2.26、Pr5.33、Pr6.57、 Pr7.10、Pr7.11、Pr7.12、Pr7.15	
	All pages		• Addition Added the attributes left out of the parameter list.	
	P55,56,64～66, 72-74		• Correction Corrected the parameters that would be changed due to real-time auto-gain tuning.	
	P90		• Addition Added the note about the setting of damping frequency and damping filter at the time of control mode switching.	
	P137		• Correction Corrected the cause of Err14.0 and Err14.1 and steps to take to deal with them.	
	P140,143		• Addition Added the steps to take to deal with Err27.4 and Err84.0.	
May. 20, 2016	P1	2.0	Software upgrade CPU1 Ver1.04 -> Ver1.05 CPU2 Ver1.01 -> Ver1.02	
			1) Function addition "Extend the quadrant projection suppression function"	
	P.105,175		- Added the description of P6.97(bit0)	
			2) Function addition "Correction function for detection delay of latch position"	
	P176,178,181		- Added the description of Pr7.09, Pr7.24, Pr7.92	
	P1		• Addition Added The table of changes.	
	P1		• Addition Added cautions of default setting	
	P105		• Correction Corrected the description in attributes of Pr6.47	
	P78～80,108,110		• Addition Added the description in electronic gear	
Sep. 9,2016	P1, P2, P3	3.0	Software upgrade CPU1 Ver1.05 -> Ver1.20 CPU2 Ver1.02 -> Ver1.20 Added the functional comparison chart of A6N series.	
	P14,23,155-156,179,180, 203,204,209		1) Function addition "Deterioration diagnosis warning function"	
	P141-143,203,205		2) Function addition "Slow stop function"	
	P12,P19,P20,P136, P206		3) Function addition "Dynamic brake (DB) operation function by I/O."	
	P59		4) Function addition "Battery refresh function"	
	P130,131,202,209		5) Function addition "Extend the protection function of motor working range setting"	
	P6-P8,P149,P152, P153		6) Function addition "Support of electronic gear to single-turn absolute function/infinitely rotatable absolute function"	
	(No change in this document)		7) Function addition "Pause function of profile operation"	
	(No change in this document)		8) Function addition "Extend the RTEX alarm command function"	
	P10,P39,P169		9) Function addition "Extend the settable range of electronic gear"	
	P163,P178,179, P200,P206,P215		10) Function addition "Extend the RANATERM command function during the establishment of RTEX communication"	
	(No change in this document)		11) Function addition "Extend the data of RTEX monitor command"	
	P30		12) Function addition "Extend the data of front panel display"	

Note: The page nuer (Page) is the current page number at the time of revision.

Revisions

Date	Page	Rev.	Description	Signed
	(No change in this document)		13) Function addition "Extend the profile homing function"	
	P35, P36		14) Function addition "Extend the data of monitor signal output function"	
	P5,9,26,27,30,35,40,45, 46,53-56,60,93,103,107, 125-127,145,157,158, 162,163,165,166,168, 169,179,182,193-217etc		15) Function addition "Full-closed control"	
	P157,P163, P185-P193		16) Function addition "Safety function"	
	P26,P27,P46,P61, P211		17) Function addition "External scale position information monitor function under semi-closed control"	
	P117,P199		18) Function addition "Hybrid vibration suppression function"	
	P44		• Addition Added Pr5.20 to the related parameters.	
	P63		• Addition Added the precautions for real-time auto-gain tuning.	
	P72		• Addition Added the description of the functions of Pr2.11 and Pr2.12.	
	P118		• Addition Added a description to (4) How to use.	
	P120		• Addition Added a description to the explanation of two-degree-of-freedom control mode.	
	P140,		• Addition Added precautions.	
	P146,P201		• Change Changed the setting range of Pr4.56.	
	P158,P165,P166		• Addition Added Err50.2, Err70.0, Err72.0, Err80.3.	
	P203		• Correction Corrected the unit of Pr5.49.	
	P208,P209,P214		• Addition Added Pr5.58, Pr5.59, Pr6.98, and Pr7.100. (manufacturer use)	
	P211,P212,P215		• Addition Added Pr7.22 bit6, Pr7.24 bit7, Pr7.99 bit3.	
Apr. 14, 2017	P20, P24	3.1	•Addition Added the conditions for forced switching of control mode.	
	P73, P81		•Addition Added the precautions for real time auto-gain tuning.	
	P135, P136		•Addition Added DB switching input specifications sequence details when the main power is off.	
	P188, P189, P193		•Addition Added the specifications for when in STO state to Note*2.	
	Overall		• Corrected all incorrect entries.	
June 9, 2017	P4	4.0	Software upgrade CPU1 Ver1.20 -> Ver1.21 CPU2 Ver1.20 -> Ver1.21	
	(No change in this document)		1) Function addition "Extension of the range of absolute data"	
	P222		2) Function addition "Functional extension of RTEX communication setting"	
	(No change in this document)		3) Function addition "Addition of RTEX monitor data"	
	P221, P222, P224		• Addition Added Pr7.40, Pr7.43, P7.52, Pr7.109, Pr7.110, and parameter of class 9 (used by the manufacturer). Added Pr7.99 bit7.	
	P144		• Change Changed the control mode of the applicable range. Added note *1 and *2.	
	P57, P204		• Change Changed the setting range of Pr3.23 and Pr3.26.	
	P5		• Addition Added (4), (5), and (6) in <IMPORTANT>.	
	P6		• Addition Added note *3 for Communication USB.	

Note: The page number (Page) is the current page number at the time of revision.

Revisions

Date	Page	Rev.	Description	Signed
	P39, P49, P54		• Addition Added the description of position/speed/torque control mode in block diagram.	
	P102		• Addition Added a note on the gain switching flag.	
	P113		• Addition Added a note on torque feed forward.	
	P135		• Addition Added note *3) for Pr5.04 = 1.	
	P136, P137, P138 P144, P145		• Addition Added a note for emergency stop.	
	P144		• Addition Added a note on Pr6.10 bit10.	
	P158, P210		• Addition Added a note on Pr5.76.	
	P160		• Addition Added a description on whether a deterioration diagnosis warning has occurred or not in the example.	
	P219		• Addition Added a note on Pr7.24 bit7.	
	P5		• Correction Corrected the notes on references in "Related documentation."	
	P21, P25, P94, P95 P127		• Correction Corrected the condition in which the control mode is forcedly switched.	
	P93, P96, P125, P130		• Correction Corrected the block diagram for position/full-closed control. Added notes.	
	P131		• Correction Corrected note *1) of the applicable range.	
	P167, P168, P170, P173, P190		• Correction/addition Corrected and added the cause/countermeasure description for Err27.7, Err29.1, Err34.0, Err80.3, Err94.3 and Err96.4.	
	P186, P187		• Correction Corrected the description in "4) Setup of the excess positional deviation protection".	
	P189		• Correction Corrected the explanation on the protection function setting while returning to the origin by using the Z phase.	
	P191 to P198		• Correction Corrected the description of the safety function.	
	P226 to P231		• Correction Corrected the timing diagram. Added a note on the servo-on state output.	
	P7, P8, P9		• Deletion Deleted "RTEX communication established state", which was a condition for the infinitely rotatable absolute function.	
	Overall		• Corrected all incorrect entries.	
July 10, 2017	P4	5.0	Software upgrade CPU1 Ver1.21 -> Ver1.22 CPU2 Ver1.21 -> Ver1.22	
	(No change in this document)		1) Function change "Expansion in range of the manufacturing number indication function"	
	P1, P4, P7 to P10, P13, P161, P163, P173, P222		2) Function addition "Latch mode with stop function"	
	(No change in this document)		3) Function addition "Expansion of the range for actual position setting/command position setting"	
May 28,2018	P5	6.0	Software upgrade CPU1 Ver1.22 → Ver1.23 CPU2 Ver1.22 → Ver1.23	
	P1,P8,P11,P170, P171,P244		1) Function change “Function extension of latch mode with stop function”	

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Revisions

Date	Page	Rev.	Description	Signed
	P1,P12,P14,P21, P22,P25,P40,P50, P55,P147,P172-179, P181,P182,P190,P191, P236,P237,P240,P244, P245,P246		2) Function addition “Retreat operation function”	
	P8-10,P47,P48, P94,P133-138, P142,P157,P186, P192,P225,P244		3) Function addition “Virtual full-closed control mode function”	
	P55,P84,97,P192,P193		4) Function addition “Torque control under two-degrees-of-freedom control”	
	P147,P228		5) Function change “Extension of Pr5.09 (Main power supply off detection period) setup range”	
	P122,P233		6) Function change “Extension of Pr6.35 (Hybrid vibration suppression filter) setup range”	
	P186,P192		7) Function change “Alarm change at return to origin command cancellation”	
	Overall		• Corrected all incorrect entries.	

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Contents

1. Introduction

This document describes the functions of the servo driver MINAS-A6N series.

<MINAS-A6 series Functional comparison>

○:Usable ×:Not usable

Function \ Product		[A6NE] (Standard type) Product number ending with:E	[A6NF] (Multi-function type) Product number ending with:F
		CPU1:Ver1.23 CPU2:Ver1.23	CPU1:Ver1.23 CPU2:Ver1.23
Control mode	Position control(CP)	○	○
	Position control(PP)	○	○
	Velocity control(CV)	○	○
	Torque control(CT)	○	○
	Full-closed control(CP)	×	○
	Full-closed control(PP)	×	○
Function	Two-degree-of-freedom control (Position)	○	○
	Two-degree-of-freedom control (Velocity)	○	○
	Two-degree-of-freedom control (Full-closed)	×	○
	Safety function	×	○
	Vibration control	○	○
	Model type damping filter	○	○
	Feed forward function	○	○
	Load change suppression control	○	○
	Third gain switching function	○	○
	Friction torque compensation	○	○
	Hybrid vibration suppression function	×	○
	Quadrant projection suppressionfunction	○	○
	Torque limit switching function	○	○
	Motor movable range setting function	○	○
	Torque saturation protection function	○	○
	Single-turn absolute function	○	○
	Infinitely rotatable absolute function	○	○
	External scale position information monitor function under semi-closed control	×	○
	Latch mode with stop function	○	○
	Retreat operation function	○	○
	Virtual full-closed control mode function	×	○

- [A6NF] : All functions described in this reference can be used.
- [A6NE] : There are some functions that cannot be used.
  Where applicable, these items are indicated with “Cannot be used in [A6NE]” in the descriptions contained in this reference for your confirmation.

<Software version>

This technical reference applies to the servo drivers of the following software version:

*Please check the software version by setup support software PANATERM or RTEX communication command.

<table>
<tr><th>Software version</th><th>Contents of function change</th><th>Available PANATERM</th></tr>
<tr><td>CPU1 Ver1.04
CPU2 Ver1.01</td><td>First edition</td><td>6.0.0.6
or later</td></tr>
<tr><td>CPU1 Ver1.05
CPU2 Ver1.02</td><td>Function extended edition 1
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Extend the quadrant projection suppression function</td><td>This document
5-2-13, 8-1</td></tr><tr><td>2) Correction function for detection delay of latch position</td><td>SX-DSV03078
6-5-4-4</td></tr></table></td><td>6.0.0.8
or later</td></tr>
</table>

(To be continued)

<table>
<tr><th>Software version</th><th>Contents of function change</th><th>Available PANATERM</th></tr>
<tr><td>CPU1 Ver1.20
CPU2 Ver1.20</td><td>Function extended edition 2
<table>
<tr><th>Additional capability</th><th>Reference</th></tr>
<tr><td>1) Deterioration diagnosis warning function</td><td>This document
2-2, 2-4-2, 6-8, 7-3, 9-1
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6-9-2, 6-9-3</td></tr>
<tr><td>2) Slow stop function</td><td>This document
6-3-7, 9-1</td></tr>
<tr><td>3) Dynamic brake (DB) operation function by I/O.</td><td>This document
2-1, 2-4, 6-3-3, 9-1</td></tr>
<tr><td>4) Battery refresh function</td><td>This document
4-7-1-4</td></tr>
<tr><td>5) Extend the protection function of motor working range setting</td><td>This document
6-2, 9-1</td></tr>
<tr><td>6) Support of electronic gear to single-turn absolute function/ infinitely rotatable absolute function</td><td>This document
6-6, 6-7</td></tr>
<tr><td>7) Pause function of profile operation</td><td>SX-DSV03078
6-8-4</td></tr>
<tr><td>8) Extend the RTEX alarm command function</td><td>SX-DSV03078
6-6, 6-6-4, 6-6-5</td></tr>
<tr><td>9) Extend the settable range of electronic gear</td><td>This document
1-2, 4-2-2, 7-2</td></tr>
<tr><td>10) Extend the RANATERM command function during the establishment of RTEX communication</td><td>This document
7-3, 9-1
SX-DSV03078
4-2-3, 4-3-3, 6-9-3</td></tr>
<tr><td>11) Extend the data of RTEX monitor command</td><td>SX-DSV03078
6-9-1, 6-9-6</td></tr>
<tr><td>12) Extend the data of front panel display</td><td>This document
3-2</td></tr>
<tr><td>13) Extend the profile homing function</td><td>SX-DSV03078
7-5-11</td></tr>
<tr><td>14) Extend the data of monitor signal output function</td><td>This document
3-4</td></tr>
<tr><td>15) Full-closed control</td><td>This document
2-5, 3-2, 3-4, 4-2-2, 4-2-5, 4-5, 4-7-2, 5-2-4, 5-2-18,7-1, 7-2, 7-3, 9-1
SX-DSV03078
2-5-1, 2-5-2, 6-4-1, 6-5-1,6-6-1, 6-8-1, 6-9-1, 6-9-3,7-2-3-1</td></tr>
<tr><td>16) Safety function</td><td>This document
3-2, 7-1, 7-2, 8, 9-1
SX-DSV03078
6-9-5</td></tr>
<tr><td>17) External scale position information monitor function under semi-closed control</td><td>This document
2-5, 4-2-5, 4-8, 9-1
SX-DSV03078
2-5-2, 6-6-1</td></tr>
<tr><td>18) Hybrid vibration suppression function</td><td>This document
5-2-13, 9-1</td></tr>
</table></td><td>6.0.0.9
or later</td></tr>
</table>

(To be continued)

<table>
<tr><th>Software version</th><th>Contents of function change</th><th>Available PANATERM</th></tr>
<tr><td>CPU1 Ver1.21
CPU2 Ver1.21</td><td>Function extended edition 3
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Extension of the range of absolute data</td><td>SX-DSV03078
7-2-4</td></tr><tr><td>2) Functional extension of RTEX communication setting</td><td>This document
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SX-DSV03078
2-5-2</td></tr><tr><td>3) Addition of RTEX monitor data</td><td>SX-DSV03078
6-7-1, 6-9-1, 6-9-7</td></tr></table></td><td>6.0.1.5
or later</td></tr>
<tr><td>CPU1 Ver1.22
CPU2 Ver1.22</td><td>Function extended edition 4
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Expansion in range of the manufacturing number indication function</td><td>SX-DSV03078
6-4-1</td></tr><tr><td>2) Latch mode with stop function</td><td>This document
1, 1-1, 2-1, 6-9, 7-1, 7-2, 9-1
SX-DSV03078
1, 1-1, 4-3-3, 6-5, 6-5-1, 6-5-5, 6-10-2, 7-2-5, 8-1, 8-1-12</td></tr><tr><td>3) Expansion of the range for actual position setting/ command position setting</td><td>SX-DSV03078
6-5, 6-5-3</td></tr></table></td><td>6.0.1.6
or later</td></tr>
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(To be continued)

<table>
<tr><th>Software version</th><th>Contents of function change</th><th>Available PANATERM</th></tr>
<tr><td>CPU1 Ver1.23
CPU2 Ver1.23</td><td>Function extended edition 5
<table>
<tr><th>Additional capability</th><th>Reference</th></tr>
<tr><td>1) Function extension of latch mode with stop function</td><td>This document
1, 1-2, 1-5, 6-9, 9-1
SX-DSV03078
1-1, 6-5-5, 6-10-2,7- 2-5</td></tr>
<tr><td>2) Retreat operation function</td><td>This document
1, 1-6, 2-1, 2-4-1, 2-4-2, 4-2, 4-3, 4-4, 6-3-3,6-10, 7-1, 7-2, 9-1
SX-DSV03078
1, 1-1, 4-2, 4-2-3, 4-3, 4-3-3, 4-3-4, 6-9-5, 6-10-2, 7-5-1, 7-6-3</td></tr>
<tr><td>3) Virtual full-closed control mode function</td><td>This document
1-2, 1-3, 1-4, 1-5, 4-2-5, 5-2, 5-2-19, 6-2, 6-5, 7-2, 9-1
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1, 1-1, 4-2, 4-2-3, 4-3-3, 6-3-2, 6-5-1, 6-8-7, 6-9-1, 6-10-1, 6-10-2, 8-1-11</td></tr>
<tr><td>4) Torque control under two-degrees-of-freedom control</td><td>This document
4-4, 5-1-3, 5-2-3, 7-2
SX-DSV03078
5-1-3, 5-2-3, 7-2</td></tr>
<tr><td>5) Extension of Pr5.09 (Main power supply off detection period) setup range</td><td>This document
6-3-3,9-1
SX-DSV03078
1-1</td></tr>
<tr><td>6) Extension of Pr6.35 (Hybrid vibration suppression filter) setup range</td><td>This document
5-2-13, 9-1
SX-DSV03078
1-1</td></tr>
<tr><td>7) Alarm change at return to origin command cancellation</td><td>This document
7-2
SX-DSV03078
6-5-1, 7-2-1, 8-1-12</td></tr>
</table></td><td>6.0.1.10
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 the “Function extended edition 1” are the default settings with additional capability invalidated and compatible with the “First edition”.
When using the additional capability, set parameters according to the description of each function in this document.

<Related documentation>

SX-DSV03089: Reference specifications
(The specification about hardware, Safety Precautions,Warranty etc. is indicated.
Please be sure to read carefully, After understanding the contents, refer to this specification.)

SX-DSV03078: Technical reference –RTEX Communication Specification –

<IMPORTANT>

- Motor Business Unit, Panasonic Corp. reserves the right to make modifications and improvements to its products and/or documentation, including specifications and software, without prior notice.
- The MINAS-A6N series have changed the default setting from the previous series, such as to enable the two-degree-of-freedom control mode.
  When replacing the previous series to MINAS-A6N series, please note that it is necessary to re-adjust the parameters.
  Refer to the Reference specifications for the default settings of MINAS-A6N series.
- Since the shipment value has the two-degrees-of-freedom control mode valid, note that Err91.1 “RTEX command error protection” will occur when torque control mode is set without changing the shipment setting values in function extended version 4 and earlier versions.
- For differences from the MINAS-A5N series, see 1-1 “Major differences from MINAS-A5N series” of the technical document RTEX Communication Specification.
- Although the MINAS-A6N series is trying to operate compatible with the previous series(MINAS-A5N series etc), It may not be fully compatible operation.
  In the case of replacing the previous series to the MINAS-A6N seriess, be sure to evaluate.

1-1 Basic Specification

Item		Description
Control method		IGBT PWM method, sinusoidal drive
Control mode		1. Semi-closed control Position control: Profile position control [PP], Cyclic position control [CP] Velocity control: Cyclic velocity control [CV] Torque control: Cyclic torque control [CT] 2.Full-closed control Position control: Profile position control [PP], Cyclic position control [CP] - The two modes, [1] and [2] above are switched by parameters. - Switch PP/CP/CV/CT mode according to the RTEX communication command.
Encoder feedback		23-bit (resolution: 8,388,608) 7-serial absolute encoder
External scale feedback *1		A/B Phase, origin signal differential input Manufacturers supporting serial communication scale: *2 ・Mitutoyo Corporation ・Heidenhain K.K. ・Renishaw K.K. ・Magnescale Co., Ltd. ・Nidec Sankyo Corporation ・Fagor Automation S.Coop
Control signal	Input	Each 8 input can be assigned by the parameter.
	Output	Each 3 output can be assigned by the parameter.
Analogue signal	Output	2 outputs for analog monitors 1 and 2
Pulse signal	Output	Line driver output for encoder pulses (A/B phase signal) or external scale pulses.
Communi-cation	Realtime express (Abbr. RTEX)	Communication for transmission of a real-time operation command, the parameter setting, or the status monitoring.
	USB	USB interface to connect to computers (setup support software PANATERM) for parameter setting or status monitoring. USB cable and wireless LAN dongle connection is possible *3
Safety terminal		Terminal to support safety function.
Front panel		1. 7-segment LED (double digits) 2. Network status LED (LINK, COM) 3. Rotary switch for node address setting 4. Analog monitor output (Analog monitors 1 and 2)
Regeneration		Size A and B: Without built-in regenerative resistor (use external resistor) Size C–F: Built-in regenerative resistor (External regenerative resistor is also available)
Dynamic brake		For information on the built-in type, refer to the Reference specifications.

*1: It cannot be used in [A6NE].

*2: Please contact us for a corresponding part number.

*3: Do not use a wireless LAN dongle in a country that does not allow the use of it. Doing so will be a violation of the law. For details, see the website of Panasonic. For the list of countries that allow the use of a dongle, see the website of Panasonic.

1-2 Function (position control)

Item			Description
Position control	Control input		Positive direction drive inhibit, negative direction drive inhibit, latch signal, near home position, etc.
	Control output		Positioning completion etc.
	Position command input	Input mode	Command type by RTEX command
		Smoothing Filter	Either a primary delay filter or a FIR type filter can be selected against command input.
	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 change inhibit control		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Gain 3 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 glitch inhibit function		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Two-degree-of-freedom control mode		Available (standard/sync 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.
	Motor operatable setup function		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Torque saturation protection function		Available
	Single-turn absolute function		Available [Requirement] The absolute encoder is connected.
	Continuous rotating absolute encoder function		Available [Requirement] The 23-bit absolute encoder is connected. Encoder resolution (2^{23})/electronic gear ratio/reduction ratio is an integer less than or equal to (2^{31}-1).
	External scale position information monitor		Available
	Latch mode with stop function		Available [Requirement] Software version of function extended version 4 or later Servo-on. No hindrance for the motor's normal run. State in which communication cycle is set to 0.5 [ms] and command update cycle to 1.0 [ms]. State in which the electronic gear ratio is set to 1 or larger. * * Supported only by function extended version 4.
	Virtual full-closed control mode function		Not available

1-3 Function (velocity control)

Item			Description
Velocity control	Control input		Positive direction drive inhibit, negative direction drive inhibit, latch signal, etc.
	Control output		At speed etc.
	Velocity command input	Input mode	Command type by RTEX command
	Soft start/slowdown function		0 – 10 s / 1000 r/min Acceleration and deceleration can be set separately. S-curve acceleration/deceleration is also available.
	Damping control		Not available
	Model type damping filter		Not available
	Feed forward function		Available (torque)
	Load change inhibit control		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Gain 3 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 glitch inhibit function		Not available
	Two-degree-of-freedom control mode		Available (standard) [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.
	Motor operatable setup function		Not available
	Torque saturation protection function		Available
	Single-turn absolute function		Available [Requirement] The absolute encoder is connected.
	Continuous rotating absolute encoder function		Available [Requirement] The 23-bit absolute encoder is connected. Encoder resolution (2^{23})/electronic gear ratio/reduction ratio is an integer less than or equal to (2^{31}-1).
	External scale position information monitor		Available
	Latch mode with stop function		Not available
	Virtual full-closed control mode function		Not available

1-4 Function (torque control)

Item			Description
Torque control	Control input		Positive direction drive inhibit, negative direction drive inhibit, latch signal, etc.
	Control output		At speed etc.
	Torque command input	Input mode	Command type by RTEX command
	Speed limit function		Speed limit value cane be set by parameter. (Switched by RTEX command.)
	Damping control		Not available
	Model type damping filter		Not available
	Feed forward function		Not available
	Load change inhibit control		Not available
	Gain 3 switching function		Not available
	Friction torque compensation		Not available
	Hybrid vibration suppression function		Not available
	Quadrant glitch inhibit function		Not available
	Two-degree-of-freedom control mode		Not available
	Torque limit switching function		Not available
	Motor operatable setup function		Not available
	Torque saturation protection function		Not available
	Single-turn absolute function		Available [Requirement] The absolute encoder is connected.
	Continuous rotating absolute encoder function		Available [Requirement] The 23-bit absolute encoder is connected. Encoder resolution (2^{23})/electronic gear ratio/reduction ratio is an integer less than or equal to (2^{31}-1).
	External scale position information monitor		Available
	Latch mode with stop function		Not available
	Virtual full-closed control mode function		Not available

1-5 Function (full-closed control)

Item			Contents
*1 Full-closed to elated	Control input		Positive direction drive inhibit, negative direction drive inhibit, latch signal, near home position, etc.
	Control output		Positioning completion etc.
	Position command input	Input mode	Command type by RTEX command
		Smoothing Filter	Either a primary delay filter or a FIR type filter can be selected against command input.
	External scale division/ multiplication set to range		1/40 to 125200 times Although the ratio of encoder pulse (numerator) and external scale pulse (denominator) can be set anywhere between the range of 1 and 2^{23} for the numerator and 1 to 2^{23} for the denominator, please use within the range indicated above.
	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 change inhibit control		Available
	Gain 3 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 glitch inhibit function		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Two-degree-of-freedom control mode		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.
	Motor operatable setup function		Available [Requirement] Servo-on. No hindrance for the motor's normal run.
	Torque saturation protection function		Available
	Single-turn absolute function		Not available
	Continuous rotating absolute encoder function		Not available
	External scale position information monitor		Available
	Latch mode with stop function		Available [Requirement] Servo-on. No hindrance for the motor's normal run. State in which communication cycle is set to 0.5 [ms] and command update cycle to 1.0 [ms]. State in which the electronic gear ratio is set to 1 or larger. * * Supported only by function extended version 4.
	Virtual full-closed control mode function		[Requirement] Software version of function extended version 5 or later Servo-on state, state in which there is no hindrance to normal motor rotation Connected external scale is AB phase output type or serial incremental type

*1: It cannot be used in [A6NE].

1-6 Function (common)

Item		Description
Common	Electronic gear ratio	Applicable scaling ratio: 1/1000–8000 Although any value of 1 to 2^{30} (numerator) and any value of 1 to 2^{30} (denominator) can be used, resulting value should be within the range shown above.
	Auto-tuning	Identifies the load inertia real-time and automatically sets up the gain that meets the stiffness setting when the motor is running with upper and internal operation commands.
	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.
	Position comparison output function	Available [Requirement] RTEX communication is established. No hindrance for the motor's normal run. In the case of incremental encoder, home position return must be completed.
	Protective function	Overvoltage, undervoltage, overspeed, overload, overheat, overcurrent, encoder failure, positional overdeviaition, EEPROM failure, etc.
	Alarm data trace back	Tracing back of alarm data is available
	Deterioration diagnosis function	Available
	Retreat operation function	Available [Requirement] Software version of function extended version 5 or later Communication cycle is 0.25 ms or larger, servo-on state, state in which there is no hindrance to normal motor rotation State in which trial operation functions and frequency characteristic measurement function are not operating

2. Interface Specification

2-1 I/O connector input signal

Title of signal	Symbol	Conne-ctor pin No. *2)	Contents	Related control mode *1)				RTEX commu-nications monitor
				Position	Velocity	Torque	Full-closed	
Input signal source	I-COM	6	• Connect to the positive or negative terminal of the external DC source (12–24 V).					
Forced alarm input	E-STOP	*	• Generates Err 87.0 “Forced alarm input error”.	○				○
Positive direction over-travel inhibition input	POT	7 (SI2)	• Positive direction over-travel inhibit input and External signal input in a home position return. • The operation with this input turned ON is set up in Pr 5.04 “Setup of over-travel inhibit input”. • When using Positive direction over-travel inhibit input, set Pr 5.04 “Setup of over-travel inhibit input” to a value other than 1, and connect the signal so that the input is turned ON when the moving portion of the machine travels in positive direction exceeding a limit. • If used as a home position reference trigger in a home position return, the input can only be assigned to SI6 with Pr 5.04 set to 1 to disable the drive inhibit input. The signal width should be 1 ms or longer then at the time of closing, and should be 2 ms or longer then at the time of opening. Please keep in mind that it cannot guarantee this value.	○				○
Negative direction over-travel inhibition input	NOT	8 (SI3)	• Negative direction over-travel inhibit input and External signal input in a home position return. • The operation with this input turned ON is set up in Pr 5.04 “Setup of over-travel inhibit input”. • When using Positive direction over-travel inhibit input, set Pr 5.04 “Setup of over-travel inhibit input” to a value other than 1, and connect the signal so that the input is turned ON when the moving portion of the machine travels in negative direction exceeding a limit. • If used as a home position reference trigger in a home position return, the input can only be assigned to SI7 with Pr 5.04 set to 1 to disable the drive inhibit input. The signal width should be 1 ms or longer then at the time of closing, and should be 2 ms or longer then at the time of opening. Please keep in mind that it cannot guarantee this value.	○				○
Near home input	HOME	10 (SI5)	• When using the near home sensor during the return to home position operation, input the sensor signal, and External signal input in a home position return. • If used as a home position reference trigger in a home position return, the input can only be assigned to SI5, respectively. The signal width should be 1 ms or longer then at the time of closing, and should be 2 ms or longer then at the time of opening. Please keep in mind that it cannot guarantee this value.	○	△	△	○	○

Title of signal	Symbol	Conne-ctor pin No. *2)	Contents	Related control mode *1)				RTEX commu-nications monitor
				Position	Velocity	Torque	Full-closed	
Retreat operation stop input	STOP	*	• When STOP signal is input during retreat operation, it stops operation with Err85.2 or Err87.3 generated.	○				○
Retreat operation input	RET	*	• Retreat operation is executed when the condition is satisfied based on the settings on Pr6.85 "Retreat operation condition setting."	○				○
External latch input 1	EXT1	*	• An external input signal used as a trigger for position latch, Latch mode with stop function and home position return. • The signal width should be 1 ms or longer then at the time of closing, and should be 2 ms or longer then at the time of opening. Please keep in mind that it cannot guarantee this value. • When set a-contact and the rising edge or set b-contact and the falling edge, it latches to the timing which changes from opening (OFF) to closing (ON). • EXT1, EXT2, and EXT3 can only be assigned to S15, S16, and SI7, respectively.	○				○
External latch input 2	EXT2	11 (SI6)		○				○
External latch input 3	EXT3	12 (SI7)		○				○
General purpose monitor input 1	SI-MON1	9 (SI4)	• Used as the general purpose monitor input. • This input does not affect the operation, and can be used for monitoring through RTEX communications response.	△				○
General purpose monitor input 2	SI-MON2	*		△				○
General purpose monitor input 3	SI-MON3	*		△				○
General purpose monitor input 4	SI-MON4	13 (SI8)		△				○
General purpose monitor input 5	SI-MON5	5 (SI1)		△				○
External servo on input	EX-SON	*	• External servo on input. • When both this input and either of RTEX communication servo on command or the setup support servo on command are on, the servo on command for servo control process is turned on.	○				○
Dynamic brake (DB) switching input	DB-SEL	*	• Switches the dynamic brake (DB) ON and OFF after stop (when the main power is off). • Switching is only possible when main power supply Off is detected. • For details, refer to 6-3-3.	○				–

*1) The triangle in the table under [Control mode] indicates that the turning ON/OFF of the input signal does not affect system operation but monitoring is possible through response in RTEX communications.

2) Except for I-COM, input signal pin assignment can be changed. The pins in "Connector pin No." column in the table denote factory default settings. The signal with a pin that is marked with "" is not assigned by default. For more information, refer to "2-4-1 Input signal allocation".

*3) "-" mark in "RTEX communication monitor" in the table indicates that monitoring is impossible as there is not assignment in RTEX communication response (status flag).

2-2 I/O connector output signal

Title of signal	Symbol *2)	Conne-ctor pin No.	Contents	Related control mode *1)				RTEX commu-nications monitor *2)
				Position	Velocity	Torque	Full-closed	
Servo-Alarm output	ALM+ / ALM– (Alarm)	3 (S03+) / 4 (S03–)	• This signal shows that the driver is in alarm status. • Output transistor turns ON when the driver is at normal status, and turns OFF at alarm status.	○				○
Servo-Ready output	S-RDY (Servo_Ready)	*	• This signal shows that the driver is ready to be activated. • The servo becomes ready when all the following conditions are satisfied, and the output transistor is turned on. (1) Control/Main power is established. (2) Alarm does not occur. (3) RTEX communication is established, and synchronization between communication and servo is achieved.	○				○
External brake release signal	BRK-OFF+ / BRK-OFF–	1 (S01+) / 1 (S01–)	• Feeds out the timing signal which activates the electromagnetic brake of the motor. • Transistor is turned ON when electromagnetic brake is released. • This output needs to be assigned to every control mode.	○				—
Positioning complete	INP (In_Position)	*	• Outputs the positioning complete signal/positioning complete signal. • Turns on the output transistor when positioning is completed. • For details, refer to 4-2-4.	○	—	—	○	○
Speed arrival output	AT-SPEED	*	• Outputs the speed arrival signal. • Turns on the output transistor when a velocity is reached. • For details, refer to 4-3-1.	—	○	○	—	—
Torque in-limit signal output	TLC (Torque_Limited)	*	• Outputs the torque in-limit signal. • Turns on the output transistor when torque is limited.	○				○
Zero-speed detection output signal	ZSP	*	• Outputs the zero-speed detection signal. • Turns on the output transistor when zero velocity is detected.	○				—
Speed coincidence output	V-COIN	*	• Outputs the speed coincidence signal. • Turns on the output transistor when velocity matches. • For details, refer to 4-3-2.	—	○	○	—	—
Positioning complete 2	INP2	*	• Outputs the positioning complete signal/positioning complete signal 2. • Turns on the output transistor upon positioning completion 2. • For details, refer to 4-2-4.	○	—	—	○	—
Alarm output 1	WARN1 (Warning)	*	• Outputs the warning output signal set to Pr 4.40 “Selection of alarm output 1” • Turns on the output transistor when a selected alarm occurs.	○				△ *4)
Alarm output 2	WARN2 (Warning)	*	• Outputs the warning output signal set to Pr 4.41 “Selection of alarm output 2” • Turns on the output transistor when a selected alarm occurs.	○				△ *4)
Positional command ON/OFF output	P-CMD	*	• Turns on output transistor with positional command applied. • Turns on the output transistor when the positioning command (before filter) is other than 0 (with positioning command).	○	—	—	○	—

Title of signal	Symbol *2)	Conne-ctor pin No.	Contents	Related control mode *1)				RTEX commu-nications monitor *2)
				Position	Velocity	Torque	Full-closed	
Speed in-limit output	V-LIMIT	*	• Turns on output transistor when the speed is limited by torque controlling function. • Turns on the output transistor when velocity is limited.	—	—	○	—	—
Alarm clear attribute output	ALM-ATB	*	• The signal is output if an alarm has occurred and if it can be cleared. • Turns on the output transistor when an alarm occurs.	○				—
Velocity command ON/OFF output	V-CMD	*	• Turns on output transistor when the velocity command is applied while the velocity is controlled. • Turns on the output transistor if the velocity command (before filter) is not less than 30r/min (with velocity command).	—	○	—	—	—
RTEX operation output 1	EX-OUT1+	25 (S02+)	• Outputs signal according to the value of the control bit (EX-OUT1) of RTEX communication. • For the state of the output transistor, refer to Note *5.	○				—
	EX-OUT1–	26 (S02–)						
RTEX operation output 2	EX-OUT2	*	• Outputs signal according to the value of the control bit (EX-OUT2) of RTEX communication. • For the state of the output transistor, refer to Note *5.	○				—
Servo on status output	SRV-ST (Servo_Active)	*	• Turns on the output transistor during servo on. *6	○				○
Position comparison output	CMP-OUT	*	• The output transistor is turned ON or OFF when the actual position passes the position set by the parameter.	○				–
Deterioration diagnosis velocity output	V-DIAG	*	・Output transistor turned ON when motor speed is within the range of Pr4.35 “Speed coincidence range” of Pr5.75 “Deterioration diagnosis velocity setting”. ・There is a hysteresis of 10 r/min in the coincidence judgment of deterioration diagnosis velocity.	○				–

*1) For the signal with "-" sign in the "Related control mode" column, the output transistor is always turned off in that control mode.

*2) The sign [-] in [RTEX communication monitor] column in the table indicates that no allocation is made to the response (status flag) of RTEX communication and therefore monitor is impossible. The designation in ( ) in [Sign] column in the table shows the symbol used in RTEX communications. Notice that detection conditions of external output signal and RTEX communication signal are not the same. For details, refer to Technical Reference RTEX Communication Specification "Section 6-9-5".

3) Output pin assignment can be changed. The pins in "Connector pin No." column in the table denote factory default settings. The signal with a pin that is marked with "" is not assigned by default. For more information, refer to "2-4-2 Assignment of output signal".

*4) The sign [△] in [RTEX communication monitor] column in the table indicates that the status flag [Warning] of RTEX communication is turned ON whenever any warning is generated, regardless of setting value of Pr 4.40 or Pr 4.41.

*5) The following shows the output transistor state for the RTEX operation output 1/2 when RTEX is established, when RTEX communication after reset is not established, and when RTEX is shut down after established. Since operation by the control bit through RTEX communication is not allowed except when RTEX is established, configure the system avoiding problems with safety.

Title of signal	Symbol	Pr.7.24 RTEX function extended setup 3	RTEX control bit	Output transistor state		
				Communication established	Reset	Communication shut down
RTEX operation output 1	EX-OUT1	bit0 = 0 (Held)	EX-OUT1 = 0	OFF	OFF	Held
			EX-OUT1 = 1	ON		
		bit0 = 1 (Initialized)	EX-OUT1 = 0	OFF	OFF	OFF
			EX-OUT1 = 1	ON		
RTEX operation output 2	EX-OUT2	bit1 = 0 (Held)	EX-OUT2 = 0	OFF	OFF	Held
			EX-OUT2 = 1	ON		
		bit1 = 1 (Initialized)	EX-OUT2 = 0	OFF	OFF	OFF
			EX-OUT2 = 1	ON		

*6) Pr7.24 "RTEX function extended setup 3" bit4 = 1 (Turns on in command receivable state after servo ON.) is not supported.

＜Safety precautions＞

Please ensure safety on the equipment side.

2-3 I/O connector other signal

2-3-1 Encoder output signal / Position comparison output signal

Title of signal	Symbol	Conne-ctor pin No.	Contents	Control mode				RTEX commu-nications monitor
				Position	Velocity	Torque	Full-closed	
A-phase output / Position comparison output 1	OA+ / OCMP1+	17	• Outputs frequency-divided encoder signals or external scale singnals differentially (RS422 equivalent). • Ground for line driver of output circuit is connected to signal ground (GND) and is not insulated. • Max. output frequency is 4 Mpps (after quadrupled) • When Pr4.47 “Pulse output selection” is set to 1,can be used as position compare output.	○				—
	OA– / OCMP1-	18						
B-phase output / Position comparison output 2	OB+ / OCMP2+	20						
	OB– / OCMP2-	19						
Position comparison output 3	OCMP3+	21						
	OCMP3–	22						
Signal ground	GND	16	• Signal ground					

2-3-2 Others

Title of signal	Symbol	Conne-ctor pin No.	Contents	Control mode				RTEX commu-nications monitor
				Position	Velocity	Torque	Full-closed	
Frame ground	FG	shell	• This output is connected to the earth terminal inside of the driver.					
Absolute encoder battery input	BTP-I	14	• Connect the battery for absolute encoder (recommended: ER6V 3.6 V from Toshiba Battery), as follows. • Connect the power for multi-turn data storage to the absolute encoder through BTP-O (pin 3) and BTN-O (pin 4) of encoder connector X6. • Or, directly connect the encode connection cable to the battery.					
	BTN-I	15						
To be used by the manufacturer.	—	23, 24	• Keep these pins unconnected.					

2-4 I/O signal allocation function

Default I/O signal allocation can be changed.

2-4-1 Input signal allocation

Desired input signal can be allocated to any input pin of I/O connector. The logic can be changed.
Some allocation limit is applied to specific signals. Refer to "(2) Reallocation of input signal".

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

Note: Default settings of certain model will differ from those shown below. If the default settings shown in Reference specification are different from values shown below, the settings described in Reference specification are valid standard default values.

Pin name	Pin No.	Applicable parameter	Default setting ( ): decimal notation	Default setup					
				Position control/ Full-closed control		Velocity control		Torque control	
				Signal	Logic *1)	Signal	Logic *1)	Signal	Logic *1)
SI1	5	Pr 4.00	00323232h (3289650)	SI-MON5	a-contact	SI-MON5	a-contact	SI-MON5	a-contact
SI2	7	Pr 4.01	00818181h (8487297)	POT	b-contact	POT	b-contact	POT	b-contact
SI3	8	Pr 4.02	00828282h (8553090)	NOT	b-contact	NOT	b-contact	NOT	b-contact
SI4	9	Pr 4.03	002E2E2Eh (3026478)	SI-MON1	a-contact	SI-MON1	a-contact	SI-MON1	a-contact
SI5	10	Pr 4.04	00222222h (2236962)	HOME	a-contact	HOME	a-contact	HOME	a-contact
SI6	11	Pr 4.05	00212121h (2171169)	EXT2	a-contact	EXT2	a-contact	EXT2	a-contact
SI7	12	Pr 4.06	002B2B2Bh (2829099)	EXT3	a-contact	EXT3	a-contact	EXT3	a-contact
SI8	13	Pr 4.07	00313131h (3223857)	SI-MON4	a-contact	SI-MON4	a-contact	SI-MON4	a-contact

*1) Operation of a-contact and b-contact:

a-contact: The current in the input circuit is shut down and the photocoupler is turned OFF.
— function disabled (OFF state)
The current flows through the input circuit and the photocoupler is turned ON.
— function enabled (ON state)

b-contact: The current in the input circuit is shut down and the photocoupler is turned OFF.
— function enabled (ON state)
The current flows through the input circuit and the photocoupler is turned ON.
— function disabled (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.
And when the photocoupler is turned OFF, time to signal detection becomes long and Variation becomes large.

(2) Reallocation of input signal
To change the allocation of input signal, change the following parameters.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	00	C	SI1 input selection	0–00FFFFFFh	—	Assign functions to SI1 inputs. These parameters are presented in hexadecimals. Hexadecimal presentation is followed by a specific control mode designation. 0 0 – – – – * * h: position control/full-closed control 0 0 – – * * – – h: velocity control 0 0 * * – – – – h: torque control Replace * * with the function number. For the function number see the table below. Logical setup is also a function number. Example: To make this pin as SI-MON1_a-contact for position control/full-closed control, and as SI-MON2_b-contact for velocity control, and as disabled in torque control mode, set to 0000AF2Eh. Position ... 2Eh Velocity ... AFh Torque ... 00h
4	01	C	SI2 input selection	0–00FFFFFFh	—	Assign functions to SI2 inputs. Setup procedure is the same as described for Pr 4.00.
4	02	C	SI3 input selection	0–00FFFFFFh	—	Assign functions to SI3 inputs. Setup procedure is the same as described for Pr 4.00.
4	03	C	SI4 input selection	0–00FFFFFFh	—	Assign functions to SI4 inputs. Setup procedure is the same as described for Pr 4.00.
4	04	C	SI5 input selection	0–00FFFFFFh	—	Assign functions to SI5 inputs. Setup procedure is the same as described for Pr 4.00. * This pin has a latch correction function.
4	05	C	SI6 input selection	0–00FFFFFFh	—	Assign functions to SI6 inputs. Setup procedure is the same as described for Pr 4.00. * This pin has a latch correction function.
4	06	C	SI7 input selection	0–00FFFFFFh	—	Assign functions to SI7 inputs. Setup procedure is the same as described for Pr 4.00. * This pin has a latch correction function.
4	07	C	SI8 input selection	0–00FFFFFFh	—	Assign functions to SI8 inputs. Setup procedure is the same as described for Pr 4.00.

*1) For parameter attribute. refer to Section 9-1.

Function number table

Title	Symbol	Setup value	
		a-contact	b-contact
Invalid	—	00h	Do not setup.
Positive direction over-travel inhibition input	POT	01h	81h
Negative direction over-travel inhibition input	NOT	02h	82h
External servo ON input	EX-SON	03h	83h
Forced alarm input	E-STOP	14h	94h
Dynamic brake switching input	DB-SEL	16h	Do not setup.
External latch input 1	EXT1	20h	A0h
External latch input 2	EXT2	21h	A1h
Near home input	HOME	22h	A2h
Retreat operation stop input	STOP	23h	A3h
Retreat operation input	RET	27h	A7h
External latch input 3	EXT3	2Bh	ABh
General purpose monitor input 1	SI-MON1	2Eh	AEh
General purpose monitor input 2	SI-MON2	2Fh	AFh
General purpose monitor input 3	SI-MON3	30h	B0h
General purpose monitor input 4	SI-MON4	31h	B1h
General purpose monitor input 5	SI-MON5	32h	B2h

■ Precautions for input signal assignment

- Do not setup to a value other than that specified in the table.
- The same signal can't be assigned to multiple pins. Otherwise, duplicated assignment will cause Err 33.0 "Input multiple assignment error 1 protection" or Err 33.1 "Input multiple assignment error 2 protection".
- Disabled control input pin does not affect the operation and RTEX communication response.
- A signal used in multiple control modes should be assigned to the same pin and the logic should be matched. If not assigned to the same pin, the Err33.0 "Input duplicate assignment error 1 protection" or Err33.1 "Input duplicate assignment error 2 protection" occurs. In case that the logics do not match, Err33.2 "Input function number error 1 protection" or Err33.3 "Input function number error 2 protection" will occur.
- SI-MON1/EXT1, SI-MON2/EXT2/RET, SI-MON3/EXT3/STOP, SI-MON4/EX-SON, and SI-MON5/E-STOP have the same bit allocation in RTEX status. So, duplicate assignment is not allowed. Duplicate assignment causes the Err33.0 "Input duplicate assignment error 1 protection" or Err33.1 "Input duplicate assignment error 2 protection".
- The control mode is forced to switch inside the driver depending on its operating status irrespective of the command from the host device. This operation has an effect on input signal processing. Basically to one terminal assign the whole mode same function.

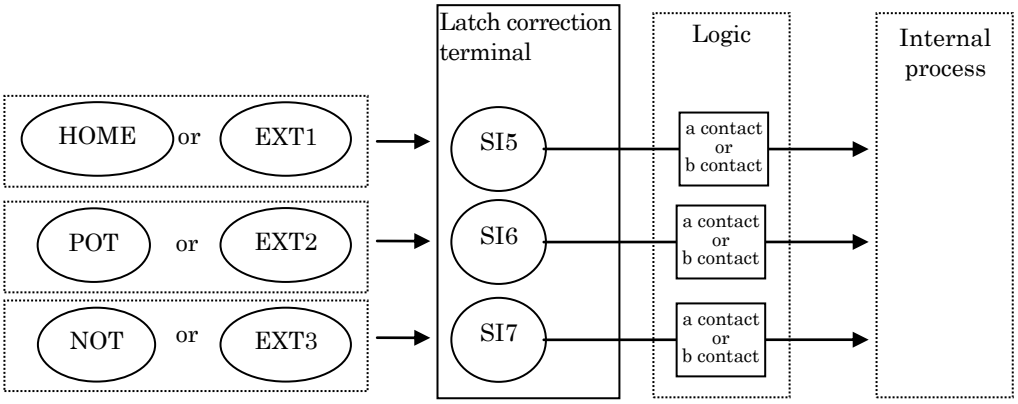
  [Conditions for the control mode to be forced to switch inside the driver]
  - ・When frequency characteristic is analyzed by Setup support software.
    (Position loop characteristics is position control, the speed closed loop characteristic and torque speed (vertical) are velocity control, torque speed (normal) is torque control.)
  - ・During test run operation of Setup support software PANATERM (The mode will be forced to switch to position control.)
  - ・There is the statement "Forcibly controls the position" in Operating setting of various sequence (Section 6-3).
  - ・During retreat operation (position control is enabled by force.)

- Setting is required for all control modes after setting Pr6.36 "Dynamic brake operation input setup" to 1, in case of using dynamic brake switching input (DB-SEL). In case only one or two control modes are set, either Err33.2 "Input function number error 1" or Err33.3 "Input function number error 2" will occur. Please refer to 6-3-3 for details.

<Precautions for latch correction pins (SI5/SI6/SI7)>

- EXT1 can be allocated only to SI5, EXT2 only to SI6 and EXT3 only to SI7. Wrong allocation will cause Err 33.8 “Latch input allocation error protection”.
- When using HOME/POT/NOT as the home reference trigger in the return to home position operation, HOME can be allocated only to SI5, POT only to SI6 and NOT only to SI7.
  The Err33.8 “Latch input allocation error protection” occurs if HOME is assigned to S16 and S17, POT is assigned to S15 and S17, and NOT is assigned to S15 and S16.
- When using POT/NOT as the home reference trigger in the return to home position operation, set Pr 5.04 to 1 and disable over-travel inhibit input. If Pr 5.04 is not 1, Err 38.2 “Drive inhibit input protection 3” will occur.
- When latch correction pins (SI5/SI6/SI7) are used, configuration is required for all the control modes. If configuration is made only for 1 or 2 modes, the Err33.8 “Latch input allocation error protection” occurs.

Connections to use edge of the sensor signal as home position.



<Safety precautions>

The over-travel inhibit input (POT, NOT) and forced alarm input (E-STOP) should normally be set to b-contact, which stops when wire is broken.
If a-contact is specified, be sure that there is no safety hazard.

2-4-2 Assignment of output signal

For the output signals, any functions can be assigned to the output pins of the I/O connector.
Some assignments may be restricted. Refer to (2) [Reallocation of output signal].

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

Note: Default settings of certain model will differ from those shown below. If the default settings shown in Reference specification are different from values shown below, the settings described in Reference specification become valid standard default values.

Pin name	Pin No.	Applicable parameter	Default setting ( ): decimal notation	Default Setup		
				Position control/ Full-closed control	Velocity control	Torque control
SO1	1 2	Pr 4.10	00030303h (197379)	BRK-OFF	BRK-OFF	BRK-OFF
SO2	25 26	Pr 4.11	00101010h (1052688)	EX-OUT1	EX-OUT1	EX-OUT1
SO3	3 4	Pr 4.12	00010101h (65793)	ALM	ALM	ALM

(2) [Reallocation of output signal].
To change the allocation of output signal, change the following parameters.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	10	C	SO1 output selection	0–00FFFFFFh	—	Assign functions to SO1 outputs. These parameters are presented in hexadecimals. Hexadecimal presentation is followed by a specific control mode designation. 0 0 – – – – * * h: position control/full-closed control 0 0 – – * * – – h: velocity control 0 0 * * – – – – h: torque control Replace * * with the function number. For the function number see the table below.
4	11	C	SO2 output selection	0–00FFFFFFh	—	Assign functions to SO2 outputs. Setup procedure is the same as described for Pr 4.10.
4	12	C	SO3 output selection	0–00FFFFFFh	—	Assign functions to SO3 outputs. Setup procedure is the same as described for Pr 4.10.

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

Function number table

Title of signal	Symbol		Setup value
	External output	RTEX status	
Invalid	—	—	00h
Alarm output	ALM	Alarm	01h
Servo-Ready output	S-RDY	Servo_Ready	02h
External brake release signal	BRK-OFF	—	03h
Positioning complete output	INP	In_Position	04h
At-velocity output	AT-SPEED	—	05h
Torque in-limit signal output	TLC	Torque_Limited	06h
Zero-speed detection output signal	ZSP	—	07h
Speed coincidence output	V-COIN	In_Position	08h
Alarm output1	WARN1	Warning *1)	09h
Alarm output2	WARN2	Warning *1)	0Ah
Positional command ON/OFF output	P-CMD	—	0Bh
Positioning complete 2	INP2	—	0Ch
Speed in-limit output	V-LIMIT	—	0Dh
Alarm clear attribute output	ALM-ATB	—	0Eh
Velocity command ON/OFF output	V-CMD	—	0Fh
RTEX operation output 1	EX-OUT1	—	10h
RTEX operation output 2	EX-OUT2	—	11h
Servo on status output	SRV-ST	Servo_Active	12h
Position comparison output	CMP-OUT	—	14h
Deterioration diagnosis velocity output	V-DIAG	—	15h

*1) The warning flag for RTEX status is set to 1 irrespective of Pr4.40 and Pr4.41 settings when an alarm occurs.

■ Precautions for output signal assignment

- For output signals, the same function can be assigned to multiple pins.
- For the output pins specified as disabled, output transistors are always turned off. However, RTEX communication response is not affected.
- Use only the values shown in the table above for setting.
- When using the external brake release signal (BRK-OFF) and the position comparison output (CMP-OUT), they need to be set on all control modes. If they are set on only one or two control modes, Err33.4 ”Output function number error 1 protection” or Err 33.5 “Output function number error 2 protection” will occur.
- The output transistor is turned off during a period from when the control power of a servo driver is turned on to when initialization is completed, while control power is turned off, during a reset, and while the display on the front face indicates as follows:

Design a system considering the above fact so that any problem does not occur.

- The control mode is forced to switch inside the driver depending on its operating status irrespective of the command from the host device. This operation has an effect on output signal processing. Basically to one terminal assign the whole mode same function.

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

- When frequency characteristic is analyzed by Setup support software.
  (Position loop characteristics is position control, the speed closed loop characteristic and torque speed (vertical) are velocity control, torque speed (normal) is torque control.)
- During test run operation of Setup support software PANATERM (The mode will be forced to switch to position control.)
- There is the statement ”Forcibly controls the position" in Operating setting of various sequence (Section 6-3).
- During retreat operation (position control is enabled by force.)

2-5 Basic network setting

This section describes the basic setting of network interfaces.
For information on the specification details and other settings, refer to the Technical Document RTEX Communication Specification“Section 2-5”.

1) Communication cycle/command update cycle

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Communication cycle</td><td>・Cycle to transfer the RTEX frame of a command and response.
・The servo driver processes commands and responses generally at this cycle except at a communication cycle of 0.0625 [ms].</td></tr>
<tr><td>Command update cycle</td><td>・Cycle to update a command from upper equipment.
・The table below lists the process in the servo driver:
<table>
<tr><td>Communication cycle 0.0625[ms]</td><td colspan="2">・The command and response are processed at 0.125 [ms] cycle.
・Set the command update cycle to 0.125 [ms].</td></tr>
<tr><td rowspan="2">Otherwise</td><td>CP</td><td>・Creates a Travel command by calculating the variation of command position (CPOS) between the command update cycles
・If the command update cycles do not match between the servo driver and upper equipment, a proper motion is impossible.
・The commands and responses other than the command position are processed at the communication cycle.</td></tr>
<tr><td>PP/CV/CT</td><td>・The commands and responses are processed at the communication cycle regardless of the command update cycle.</td></tr>
</table></td></tr>
</table>

2) Mode correspondence

The MINAS-A6N series support the communication cycle/command update cycle, control mode, and data size listed in the table below.

Responds only to position control (PP, CP) under full-closed control. Switching over to CV or CT is not possible.

Note:

- Communication cycle and command update cycle are different from the part MINAS-A5N series.
- In case of communication cycle 0.25 [ms] or less, the electronic gear ratio supports only 1/1.
- The accuracy of communication cycle of a host controller shall be designed within ±0.05%.
- Full-closed control cannot be used in [A6NE].
- In semi-closed control, external scale position information monitor function cannot be used in [A6NE].

(1) 16 byte mode

⦿: Compatible with both semi- and full- closed control; ○: Compatible only with semi-closed control;
-: Not compatible

Communication period (ms)	Command update period (ms)																							
	0.125				0.250				0.5				1.0				2.0				4.0			
	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT
0.0625	-	○	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.125	-	○	○	○	-	○	○	○	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.250					-	○	○	○	-	○	○	○	-	-	-	-	-	-	-	-	-	-	-	-
0.5									⦿	⦿	○	○	⦿	⦿	○	○	-	-	-	-	-	-	-	-
1.0													⦿	⦿	○	○	⦿	⦿	○	○	-	-	-	-
2.0																	⦿	⦿	○	○	⦿	⦿	○	○

* In case bit 4 of Pr7.22 “External scale position information monitor function under semi-closed control” is set to valid, it will not respond to communication cycle of 0.250 [ms] or less. (Excluding NOP)

(2) 32 byte mode

⦿: Compatible with both semi- and full- closed control; ○: Compatible only with semi-closed control;
-: Not compatible

Communication period (ms)	Command update period (ms)																							
	0.125				0.250				0.5				1.0				2.0				4.0			
	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT
0.0625	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.125	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.250					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.5									⦿	⦿	○	○	⦿	⦿	○	○	-	-	-	-	-	-	-	-
1.0													⦿	⦿	○	○	⦿	⦿	○	○	-	-	-	-
2.0																	⦿	⦿	○	○	⦿	⦿	○	○

3) Relevant parameter

Class	No.	At-trib-ute	Title	Range	Unit	Description
0	01	R	Control mode setup	0-6	–	Select the control mode of the servo driver. 0: Semi-closed control Control can be switched between position (PP/CP), speed (CV) and torque (CT). 6:Full-closed control Position control (PP/CP) only Otherwise: To be used by the manufacturer but not by the user.
7	20	R	RTEX communication cycle	-1–12	–	Set the communication cycle of RTEX communication. -1: Enable the setup by Pr7.91 3: 0.5 [ms] 6: 1.0 [ms] Otherwise: Reserved for manufacturer's use (do not set this)
7	21	R	RTEX command updating cycle setup	1–2	–	Set the ratio between the communication cycle and command update cycle of the RTEX communication. Setting value = command update cycle / communication cycle 1: once 2: twice
7	22	R	RTEX function extended setup 1	-32768 –32767	–	[bit0]: Set the data size of the RTEX communication. 0: 16 byte mode 1: 32 byte mode [bit1]: Set the synchronous mode between multiple axes using TMG_CNT. If TMG_CNT is not used, set bit1 to zero. 0: Semi-synchronous mode between axes (partial asynchronous) 1: Full synchronous mode between axes (completely synchronous) ▪ For more information, refer to Section 4-2-1-1 in RTEX communication specification. [bit4] External scale position information monitoring function under semi-closed control setting: 0 : Invalid 1 : Valid ▪ Under full-closed control, external scale position information can be monitored regardless of the setting of this bit.
7	91	R	RTEX communication cycle expansion setting	0–2000000	ns	Set the RTEX communication cycle at the time of Pr7.20=-1. Only 62500, 125000, 250000, 500000, 1000000 or 2000000 can be set. If other value is set, Err93.5 (parameter setting error protection 4) occurs.

Note:
Make sure to set the same cycle as the upper equipment for the RTEX communication cycle (Pr7.20,Pr7.91) and RTEX command updating cycle (Pr7.21).
Also, make sure to set the same setting as the upper equipment for the extended RTEX function (Pr7.22).
Otherwise, the operation cannot be guaranteed.

4) Mode setting example

Communication cycle: 0.5 [ms], command update cycle: 1.0 [ms], 16 byte mode, semi-synchronous mode between axes:

- Pr0.01 = 0 (semi-closed control)
- Pr7.20 = 3 (communication cycle: 0.5 [ms])
- Pr7.21 = 2 (command updating cycle: 1.0 [ms] = 0.5 [ms] × 2)
- Pr7.22 = 0 (16 byte mode, semi-synchronous mode between axes)

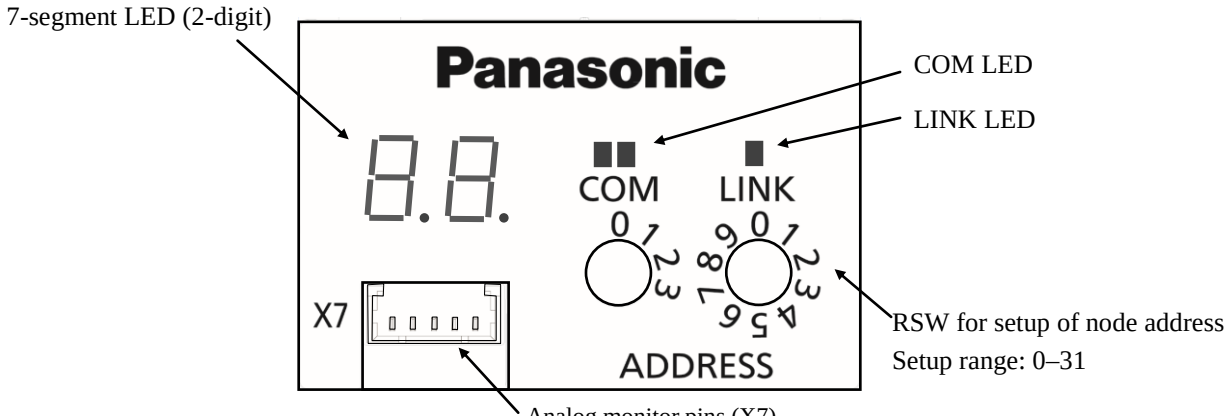
* When Pr7.20 is not "-1", Pr7.91 is not available.

According to the setting above, it is possible to change to the CP/CV/CT control mode. Change to the CP/CV/CT control mode by designating a command code.

Note:
If the combination of Pr7.20 “RTEX communication cycle setup”, Pr7.91 “RTEX communication cycle expansion setting”, Pr7.21 “RTEX command updating cycle setup” and electronic gear ratio is are not suitable, Err93.5 “Parameter setting error protection 4” is generated.

3. Front panel display specification

3-1 Appearance of front panel



Pin No.	Symbol	Description
1	AM1	Analog monitor 1
2	AM2	Analog monitor 2
3	GND	Signal ground
4, 5	-	Reserved (Do not use)

3-2 7-segment LED

Node address value set with RSW will be displayed at control power-UP, after that, the setting contents of Pr 7.00 "LED display" will be displayed.
Upon occurrence of an alarm, set of alarm codes (main and sub, alternately) is displayed. Upon occurrence of warning, the warning code will be displayed.

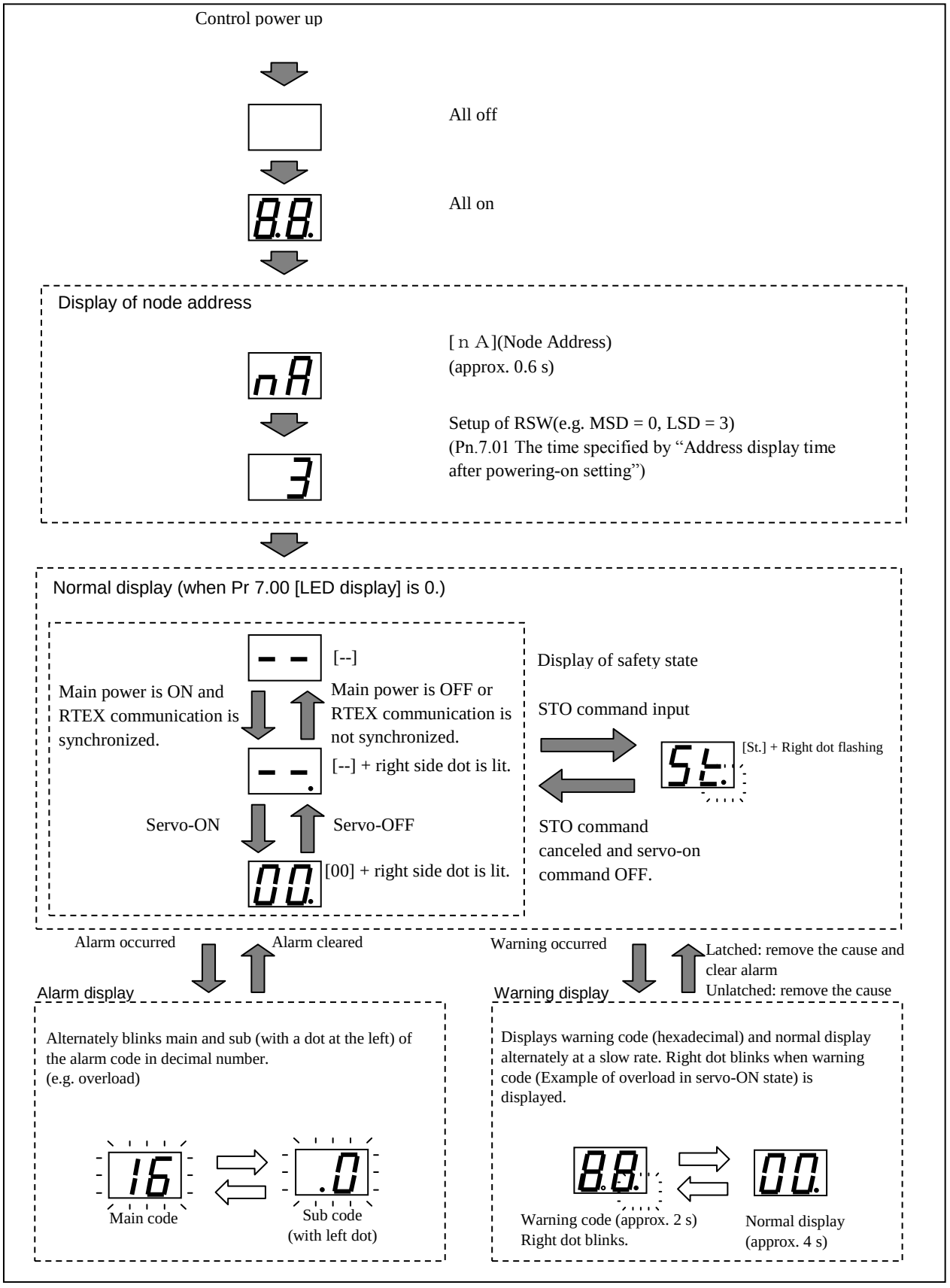
■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
7	00	A	Display on LED	0–32767	—	Selects the information displayed on 7-SEG LED display.
7	01	R	Display time setup upon power-up	-1–1000	100 ms	Sets node address display time upon turning ON of control power. When the setting value is 0 to 6, it is processed in 600ms. When the setting value is -1, a node address is shown from control power-on until the RTEX communication is established (communication and servo synchronization).

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

Pr 7.00	Information on display	Remarks
0	Normal display	[-]: servo OFF, [00]: servo ON
1	Mechanical angle	Range: 0 to FFF hex. 0: zero position of 1 revolution data of encoder. Data increments as motor turn CCW. When the displayed value exceeds [FF], the count is reset to [0] and restarted.
2	Electrical angle	Display range: 0 to FF hex. (Unit:[1.406 degree]) 0: the position where U phase induced voltage reaches the positive peak. Data increments as motor turn CCW. When the displayed value exceeds [FF], the count is reset to [0] and restarted.
3	RTEX Accumulated communication 1 error counts	Display range: 0 to FF hex. Max counts: FFFF hex. Only the least significant byte is displayed. When the displayed value exceeds [FF], the count is reset to [00] and restarted. * Will be cleared upon turning OFF of the control power source.
5	Encoder Accumulated communication error counts	
6	External scale Accumulated communication error counts	
4	Node address value	Displays the value set on rotary switch (node address) and read upon power-up, in decimal number. After power-up, the value cannot be changed from the rotary switch.
7	External scale Z phase counter	When incremental external scale is used under full-close control, the reading of external scale Z-phase counter value is indicated by 0 to F [hex]. * This will not to rely on the value of Pr3.26 "Reversal of direction of external scale" and will indicate the value read from the scale as it is. This function in valid only in the case of serial incremental external scale, and "nA" (not Available) will be displayed in A, B, and Z phase scale. It will also display "nA" when external scale position information monitor function under semi-closed control is used.
10	Overload load rate	Displayed by 0 to FF [hex]. Indicates the ratio [%] against rated load. Will indicate "nA" (not Available) in case the load ratio is larger than FF [hex].
Other	To be used by the manufacturer but not by the user.	—

The following figure shows the state flow of 7-segment LED.



3-3 Network status LED

Status indication and description of RTEX network status LED (COM/LINK).

■ COM LED

Display status	Description				
	RTEX communication status	Bit 4 of Pr 7.23 = 0		Bit 4 of Pr 7.23 = 1	
		RTEX communication IC status	State of synchronization between communication and servo	RTEX communication IC status	State of synchronization between communication and servo
Not lit	Not established	• INITIAL	Independent	• INITIAL	Not established
Blinking green	Established In process	• RING_CONFIG • READY		• RING_CONFIG • READY • RUNNING	Not established
Lit green	Established	• RUNNING		• RUNNING	Established
Blinking red	RTEX communication-related clearable alarm occurs.				
Lit red	RTEX communication-related unclearable alarm occurs.				

■ LINK LED

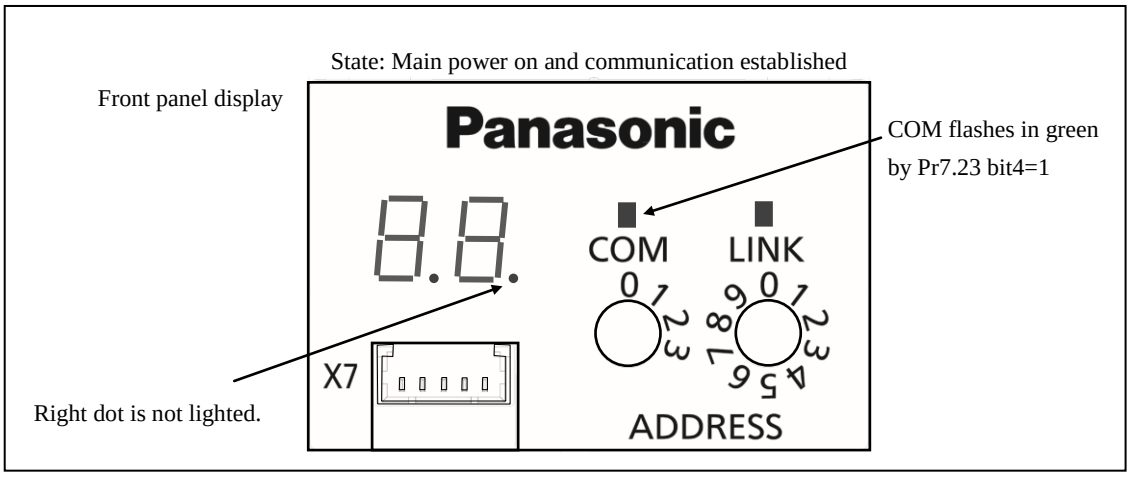
Display status	Description
Not lit	Not connected (Transmission node is not powered on, or cable is broken etc.)
Lit green	Connected normally (TX of transmission node and RX of local node are correctly connected electrically.)

- While an alarm (e.g. Err.16.0) other than RTEX communication-related occurs, if an alarm relating to RTEX communication occurs, the COM LED blinks red or lights up red according to the above.
  However, in this case, be aware that the 7-segment LED indicates the previous alarm, which is not relating to RTEX communication.
- The LINK LED lights up momentarily irrespective of cable connection when the power is turned on or a reset command is issued. This occurs due to internal initialization of a servo driver, not due to an error.
- The state of the bit 4 of Pr.7.23 “RTEX function enhancement setup 2” can change the condition for turning on COM LED.

The following phenomena occur in the software versions corresponding to function extended edition 1 or earlier.
(Not supporting Err80.3.)

<Phenomenon>

In the state that the main power is turned on and RTEX communication is established, Servo-Ready state is indicated.
The right dot of 7-segment LED is not lighted, and it cannot shift to Servo-ON.
In addition, when setting 1 to parameter Pr7.23 bit 4 in this state, COM LED changes from being lighted in green to flashing in green.



Note: Err83.1 “RTEX continuous communication error 2” rarely occurs.

If the above phenomena occur in the software versions corresponding to function extended edition 1 or earlier, take countermeasures in a similar fashion to Err80.3. (Refer to Section 7-2.)

3-4 Monitor signal output function

2 types of analog signals can be output for monitoring from the connectors (X7) of the analog monitor on the front panel. Types of monitor and scaling (output gain setting) can be set by the corresponding parameters.

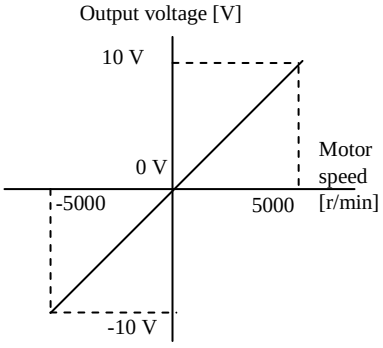
■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	16	A	Type of analog monitor 1	0–28	—	Select the type of monitor for analog monitor 1. * See the next page.
4	17	A	Analog monitor 1 output gain	0–214748364	[Monitor unit in Pr 4.16] / V	Set up the output gain of analog monitor 1. For Pr 4.16 = 0 Motor velocity, 1V is output at the motor velocity [r/min] = Pr 4.17 setup value.
4	18	A	Type of analog monitor 2	0–28	—	Select the type of monitor for analog monitor 2. *See the next page.
4	19	A	Analog monitor 2 output gain	0–214748364	[Monitor unit in Pr 4.18] / V	Set up the output gain of analog monitor 2. For Pr 4.18 = 4 Torque command, 1V is output at the torque command [%] = Pr 4.19 setup value.
4	21	A	Analog monitor output setup	0–2	—	Select output format of the analog monitor. 0: Signed data output –10 V to 10 V 1: Absolute value data output 0 V to 10 V 2: Data output with offset 0 V to 10 V (5 V at center)

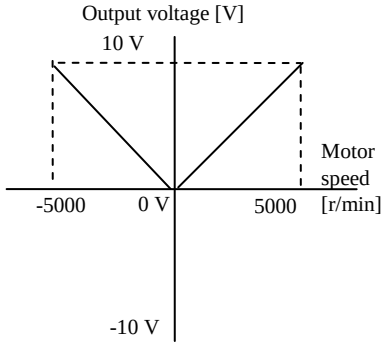
*1) For parameter attribute, refer to Section 9-1.

(1) Pr 4.21 Analog monitor output setup:
The figure below shows output specification when Pr 4.21 is 0, 1 or 2.

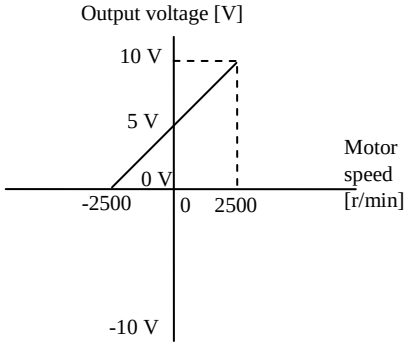
Pr 4.21 = 0, signed data output (output range –10 to 10 V)



Pr 4.21 = 1, absolute value data output (output range 0 to 10 V)



Pr 4.21 = 2, data output with offset (output range 0 to 10 V)



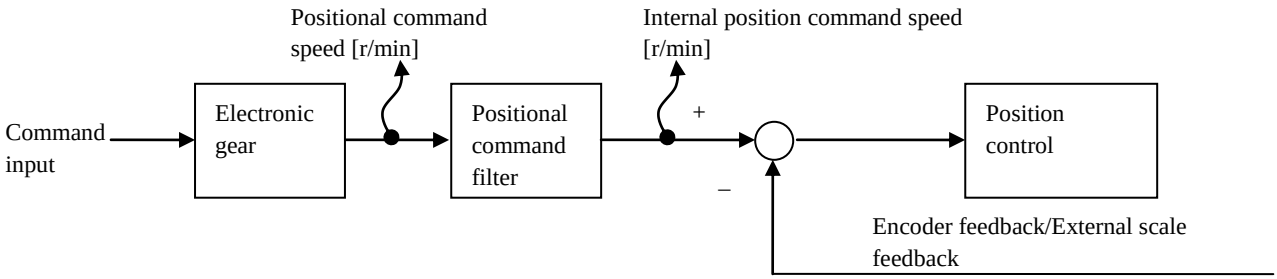
• When monitor type is motor speed, and conversion gain is 500 (1 V = 500 r/min).

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

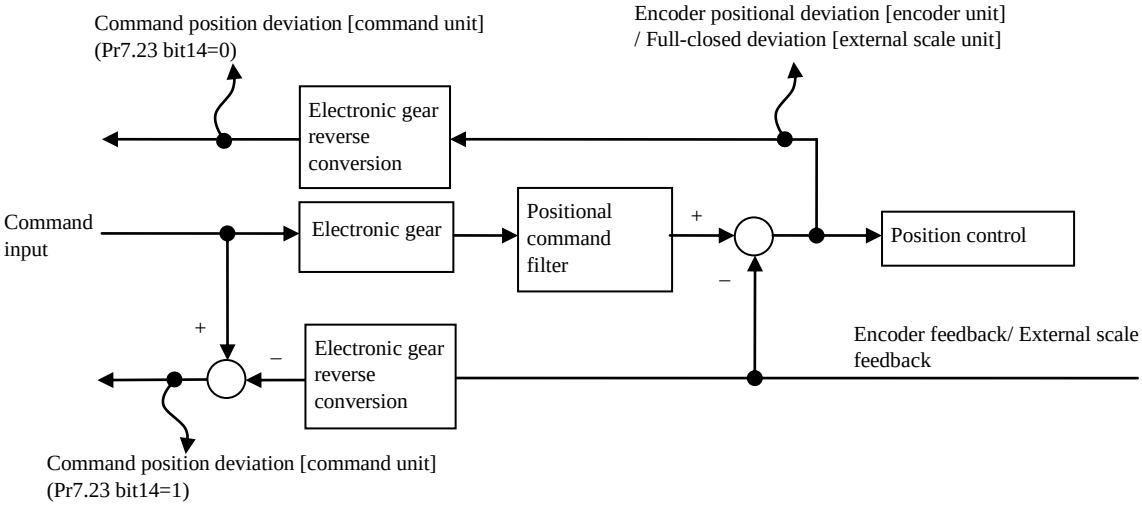
Pr 4.16/Pr 4.18	Type of monitor	Unit	Output gain for setting Pr 4.17/Pr 4.19 = 0
0	Motor velocity	r/min	500
1	Positional command velocity *2	r/min	500
2	Internal positional command velocity *2	r/min	500
3	Velocity control command	r/min	500
4	Torque command	%	33
5	Command positional deviation *3	pulse (Command unit)	3000
6	Encoder positional deviation *3	pulse (Encoder unit)	3000
7	Full closed deviation *3	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	Reserved	—	—
17	Reserved	—	—
18	Reserved	—	—
19	Encoder temperature	°C	10
20	Driver temperature	°C	10
21	Encoder single-turn data *1	pulse (Encoder unit)	110000
22	Reserved	—	—
23	Travel command status *4	—	—
24	Gain selection status *4	—	—
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	Amount of motor power consumption *5	Wh	100

*1 The direction of monitor data is basically as defined in Pr 0.00 “Rotational direction setup”, However, the direction of encoder rotational data is defined positive when it turns CCW.

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



*3 The RTEX communication type (MINAS-A6NE series) can set the calculation method (standard) for command position deviation.
Switchover is accomplished according to the setting for the command position deviation output switching (bit 14) of Pr7.23 “RTEX function extended setup 2”.
Pr7.23 bit14=0: Deviation with respect to command input after positional command filter
Pr7.23 bit14=1: Deviation with respect to command input before positional command filter
The figure below shows details.



*4 For monitor types No.23 and 24, digital signals are monitored using an analog monitor. Therefore, the output gain is as follows irrespective of the settings for Pr4.17 “Analog monitor 1 output gain” and Pr4.19 “Analog monitor 2 output gain”.

Pr4.16 /Pr4.18	Monitor type		Output voltage	
			0 [V]	+5 [V]
23	Travel command status	Profile position control (PP)	In process of profiling	Under suspension of profiling
		Cyclic position control (CP)	Command update interval Travel command ≠ 0	Command update interval Travel command = 0
		Cyclic velocity control (CV)	Velocity command ≠ 0	Velocity command = 0
		Cyclic torque control (CT)	Torque command ≠ 0	Torque command = 0
24	Gain selection status		2nd gain (Including 3rd gain)	1st gain

*5 The amount of motor power consumption per 30 minutes is output. The value is updated after the elapse of 30 minutes.

(Example) In the case of operation for 30 minutes with a motor power consumption of 10 W
10[W] * 0.5[h] = 5[Wh]

*6 Regardless of the setting for Pr4.17 and Pr4.19, output gain shall be 0 V at unit 0 and 5 V at unit 1.

4. Basic function

4-1 Rotational direction setup

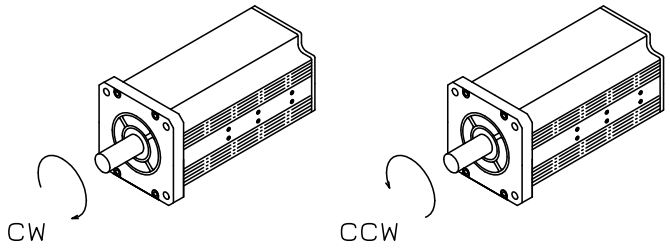
When the positional command, velocity command or torque command is applied, rotating direction of the motor can be changed.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	00	C	Rotational direction setup	0–1	—	Setup the relationship between the direction of command and direction of motor rotation. 0: Motor turns CW in response to positive direction command 1: Motor turns CCW in response to positive direction command

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

The direction of motor rotation, CW or CCW is defined as viewed from the load side shaft end.



For the purpose of this specification, positive direction refers to CW and negative direction CCW as defined above. The table below shows relationship between the positive direction drive inhibit input and negative direction drive inhibit input and resulting motor rotation direction.

Pr 0.00	Command direction	Motor rotational direction	Positive direction drive inhibit input	Negative direction drive inhibit input
0	Positive direction	CW	Valid	—
0	Negative direction	CCW	—	Valid
1	Positive direction	CCW	Valid	—
1	Negative direction	CW	—	Valid

When this parameter is changed, bit3 for Pr7.23 “RTEX function expansion setup 2” may need to be changed. Be sure to check the specifications of the host controller.

4-2 Position control

Control the position based on the positional command of RTEX communication command from the host controller. Below describes the basic settings necessary for position control.

The control mode is switched forcibly inside the driver depending on its operating status irrespective of the command from the host controller.

[Conditions that the control mode is switched forcibly inside the driver]

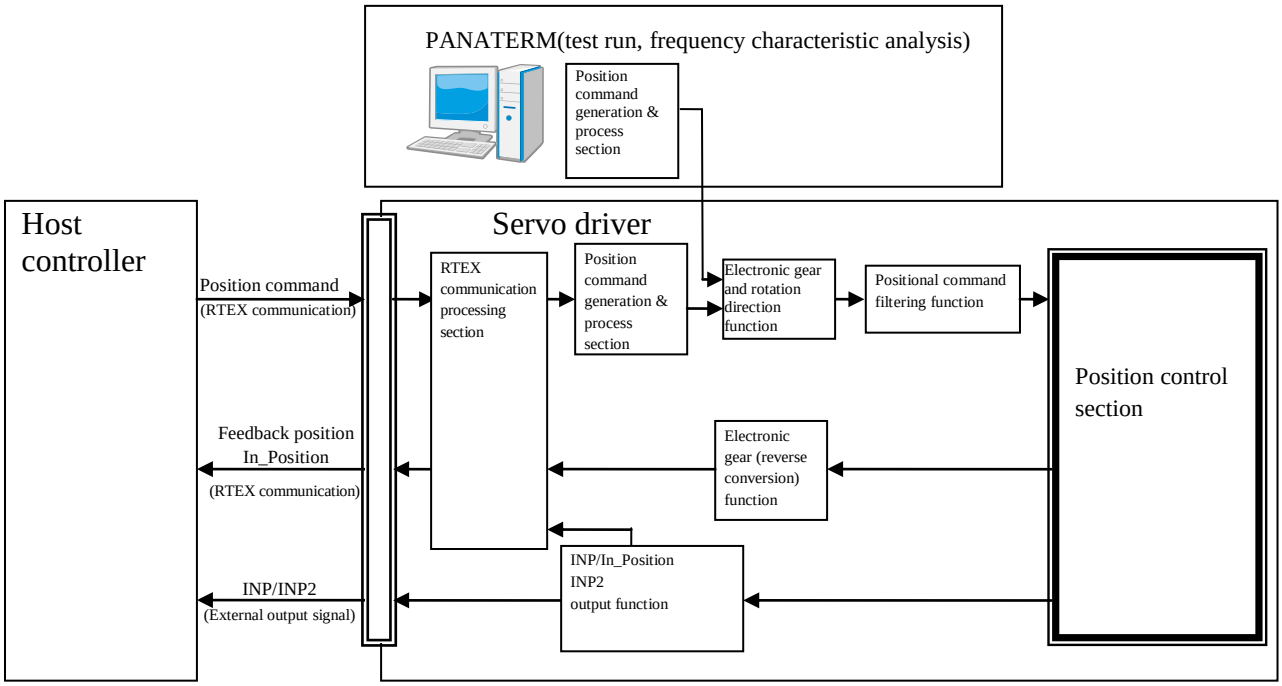
・When frequency characteristic is analized by Setup support software.

(Position loop characteristics is position control, the speed closed loop characteristic and torque speed (vertical) are velocity control, torque speed (normal) is torque control.)

・Test run of the setup support software (Forcibly position control mode).

・The states that are written "Forcibly controls the position" in "Deceleration stop sequence" (Section 6-3).

・During retreat operation (position control is enabled by force.)



4-2-1 Process of command pulse input

Positional command is input based on the command of RTEX communication.

As position control modes, profile position control (PP) and Cyclic position control (CP) are available. In the former, target position, a target velocity, and acceleration/deceleration are specified and a position command is generated in a servo driver; and in the latter, a position command is generated in an upper controller and a command position is updated at specified intervals. Those control modes are switched by a RTEX communication command.

For details, refer to Technical Reference RTEX Communication Specification “Section 5-3, 5-4”.

4-2-2 Electronic gear function

The electronic gear is a function to receive a position command from an upper controller, and multiplies it by an electronic gear ratio specified by a parameter to produce a position command to a position control section. By using this function, the number of revolutions and travel of the motor per command can be set to the desired value.
In addition, in case that communication cycle is 250us or less, please fix the value as 1/1.

■ Relevant parameters

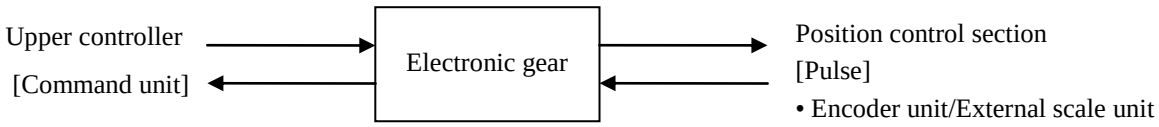
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	08	C	Command pulse counts per one motor revolution	0– 8388608	pulse	Specifies the number of command pulses equivalent to one revolution of a motor. If this value is 0, Pn0.09 “Numerator of electronic gear ratio” and Pn0.10 “Denominator of electronic gear ratio” are valid. This setting is invalid under full-closed.
0	09	C	Numerator of electronic gear	0– 1073741824	—	Set the numerator of electronic gear ratio *2) Valid when Pn0.08 “Number of command pulses per revolution of motor” is 0. When the setup value is 0, the numerator is replaced by the encoder resolution. Electronic gear ratio shall be 1:1 when the set value is 0 under full-closed.
0	10	C	Denominator of electronic gear	1– 1073741824	—	Set the denominator of electronic gear ratio *2) Valid when Pn0.08 “Number of command pulses per revolution of motor” is 0.

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

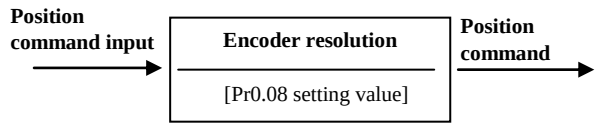
*2) In the range from 1/1000 to 8000: out of this range will cause Err. 93.0 “Parameter setting error protection”.

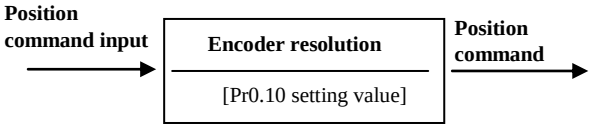
■ Command unit

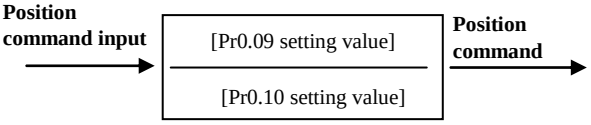
The command unit is the unit of the position command that is input to the electronic gear from an upper controller.



■ Relation among Pr0.08, Pr0.09, and Pr0.10 during position control

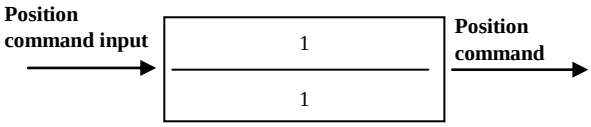
<table>
<tr><th>Pr0.08</th><th>Pr0.09</th><th>Pr0.10</th><th>Electronic gear process</th></tr>
<tr><td>1–8388608</td><td>—
(No effect)</td><td>—
(No effect)</td><td> 

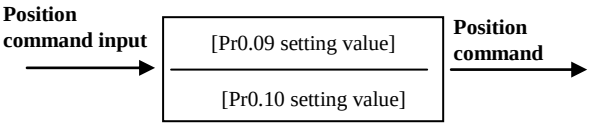
• The process in the above figure is performed according to Pr0.08 setting irrespective of Pr0.09 and 0.10 setting values.</td></tr>
<tr><td rowspan="2">0</td><td>0</td><td>1–1073741824</td><td> 

• If Pr0.08 and 0.09 are 0, the process in the above figure is performed according to the setting value of Pr0.10.</td></tr>
<tr><td>1–1073741824</td><td>1–1073741824</td><td> 

• If Pr0.08 is 0 and Pr0.09 is not 0, the process in the above figure is performed according to the Pr0.09 and 0.10 setting values.</td></tr>
</table>

■ Relation among Pr0.08, Pr0.09, and Pr0.10 during full-closed control

<table>
<tr><th>Pr0.08</th><th>Pr0.09</th><th>Pr0.10</th><th>Electronic gear process</th></tr>
<tr><td rowspan="2">—
(No effect)</td><td>0</td><td>—
(No effect)</td><td> 

• If Pr0.09 is not 0, the processing indicated in the above diagram will be carried out with both the numerator and denominator as 1.</td></tr>
<tr><td>1–1073741824</td><td>1–1073741824</td><td> 

• If Pr0.09 is not 0, the processing indicated in the above diagram will be carried out based on the set values of Pr0.09 and Pr0.10.</td></tr>
</table>

4-2-3 Positional command filtering function

To make the positional command divided or multiplied by the electronic gear smooth, set the command filter.
For details of, such as restrictions, refer to Technical Reference RTEX Communication Specification “Section 7-6-2”.

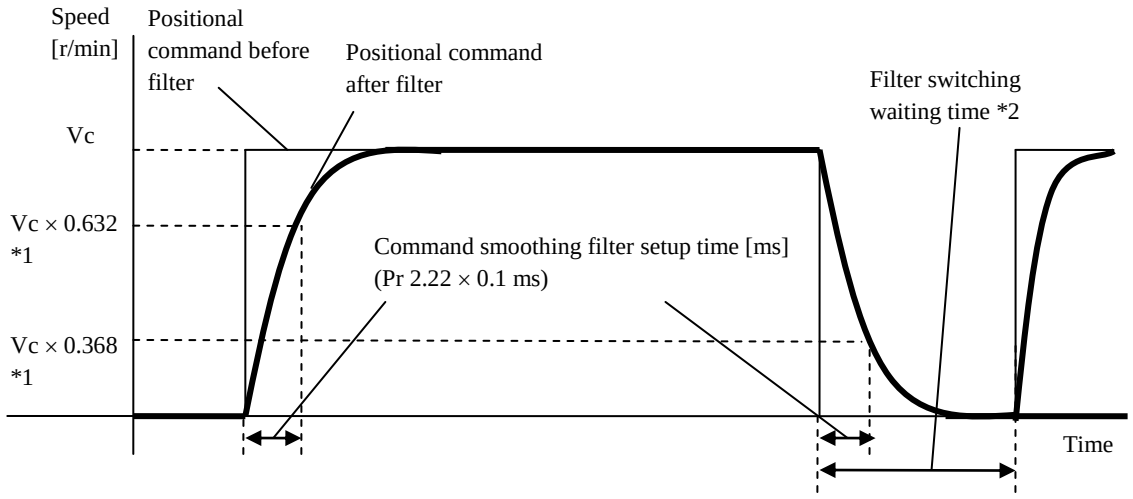
■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	22	B	Command smoothing filter	0–10000	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 5-2-16 "Two-degree-of-freedom control mode (With position control)", 5-2-17 "Two-degree-of-freedom control mode (With velocity control)" and 5-2-18 "Two-degree-of-freedom control mode (With full-closed control)".
2	23	B	Command FIR filter	0–10000	0.1 ms	Sets the time constant of FIR filter for the position command.

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

• Pr 2.22 Command smoothing filter

When a square wave command for the target speed Vc is applied, set up the time constant of the 1st delay filter as shown in the figure below.
Set the time constant for the command filter during 2 degrees of freedom control. For details, refer to Sections 5-2-16, 5-2-17 and 5-2-18.

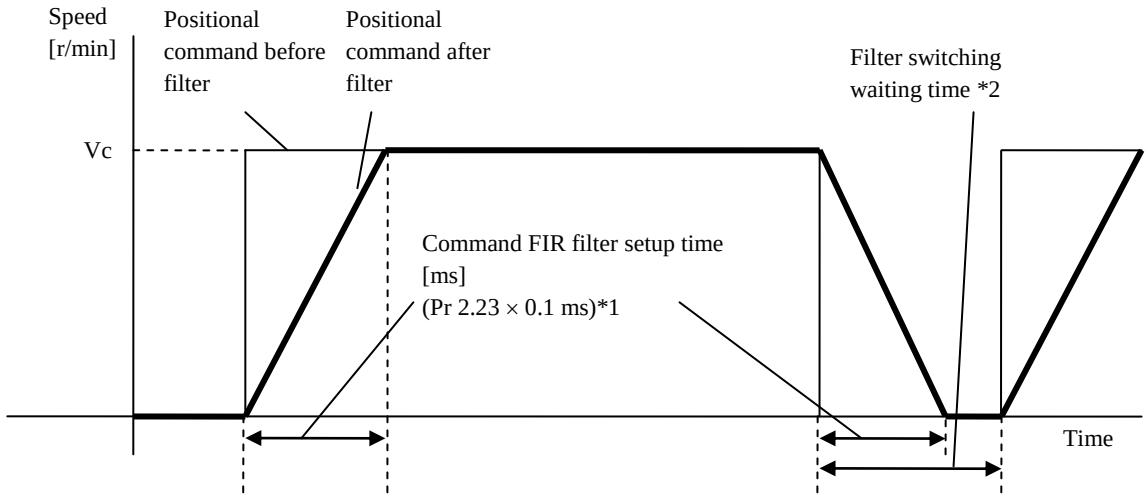


*1 Actual filter time constant (setup value × 0.1 ms) has the maximum absolute error of 0.4 ms for a time constant below 100 ms and the maximum relative error of 0.2% for a time constant 20 ms or more.

*2 Switching of Pr 2.22 “Command smoothing filter” is performed on the rising edge of the command with the number of command pulses/0.125 ms is changed from 0 to a value other than 0 while the positioning complete is being output. Even if the control mode is changed to position control after Pr2.22 “Command smoothing filter” setting is changed during velocity control or torque control, the setting is not changed.
If the filter time constant is decreased and positioning complete range is increased, and a many number of pulses are accumulated in the filter (the area equivalent of “value of positional command before filter–value of positional command after filter” integrated over the time), at the time of switching, these pulses are discharged at a higher rate, causing the motor to return to the previous position—the motor runs at a speed higher than the command speed for a short time.

*3 Even if setting of Pr2.22 “Command smoothing filter” is changed, it is not immediately applied to the internal calculation. If the switching as described in *2 occurs during this delay time, the change of Pr2.22 will be suspended.

• Pr2.23 Command FIR filter
When a square wave command of the target speed Vc is applied, set up the Vc arrival time as shown in the figure below.

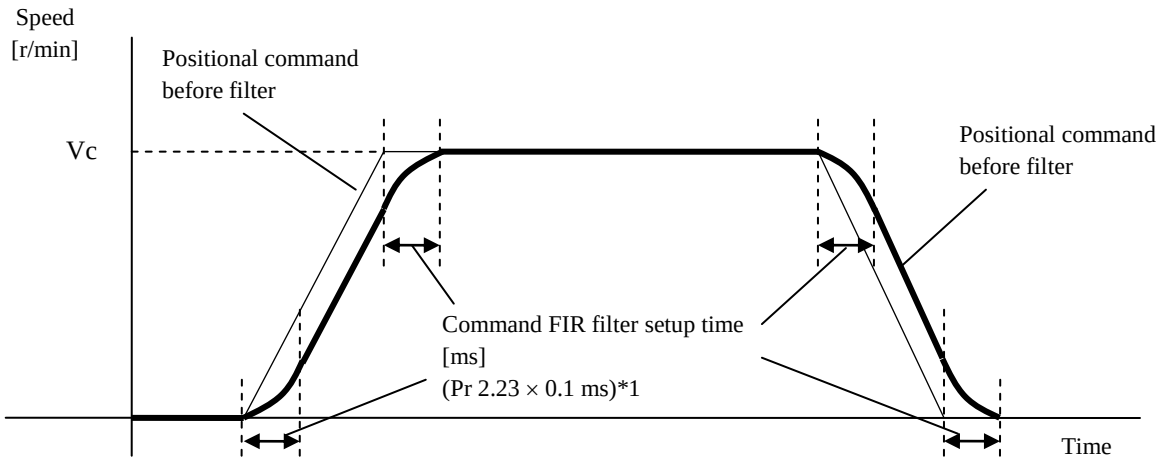


*1 The actual average travel time (setup value × 0.1 ms) has the maximum absolute error of 0.2 ms for a time constant below 10 ms and the maximum relative error of 1.6% for a time constant 10 ms or more.

*2 When changing the setting of Pr2.23 “Command FIR filter”, stop the command pulse and wait until the filter switching wait time has elapsed. The filter switching wait time is the setup value × 0.1 ms + 0.25 ms when the setup time is 10 ms, and setup value × 0.1 ms × 1.05 when the setup time is 10 ms or more. If Pr 2.23 is changed while the command pulse is being input, the change is not reflected until the command pulse-less state has continued for the filter switching wait time.

*3 Even if setting of Pr2.23 “Command FIR filter” is changed, it is not immediately applied to the internal calculation. If the switching as described in *2 occurs during this delay time, the change of Pr2.23 will be suspended.

When the positional command is trapezoidal wave, its waveform will be shaped to S at the output of the filter.



4-2-4 Positioning complete output (INP/INP2) function

The completion of positioning can be verified by the positioning complete output (INP) or the positioning complete output 2 (INP2).
When the absolute value of the positional deviation counter at the position control is equal to or below the positioning complete range by the parameter, the output is ON. Presence and absence of positional command can be specified as one of judgment conditions.
Positioning completion status can be checked also in positioning completion (In_Position) of RTEX communication status. For details, refer to Technical Reference RTEX Communication Specification “Section 4-3-3”.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	31	A	Positioning complete (In-position) range	0 –2097152	Command unit	Set the threshold of positional deviation with respect to the output of positioning complete (INP) signal. The command unit is used as the default unit but can be replaced by the encoder unit or external unit by using Pr 5.20. “Position setup unit select”. Note that when the encoder unit is used, unit of Pr 0.14 “Position deviation excess setup” is also changed. The value of the position deviation is possible to switch the command, before and after of the position command filter in the setting of Pr7.23 bit14. Note: This setting value is also used as the detection threshold of positioning complete of RTEX communication status (In_Position). However, when Pr7.24 “RTEX function extended setup 3” bit3 set to 1, it is always in command unit regardless of the value of Pr 5.20.
4	32	A	Positioning complete (In-position) output setup	0–10	—	Select the condition to output the positioning complete signal (INP1). Whether or not positional commands are set is judged by the command after the positional command filter in the case of settings 1 to 5, and the command before the positional command filter in the case of 6 to 10. The value of the position deviation is possible to switch the command, before and after of the position command filter in the setting of Pr7.23 bit14. 0: The signal will turn on when the positional deviation is smaller than Pr 4.31 “Positioning complete range” 1,6: The signal will turn on when there is no position command and the positional deviation is smaller than Pr 4.31 “Positioning complete range”. 2,7: The signal will turn on when there is no position command, the zero-speed detection signal is ON and the positional deviation is smaller than Pr 4.31 “Positioning complete range”. 3,8: The signal will turn on when there is no position command and the positional deviations smaller than Pr 4.31 “Positioning complete range”. Subsequently, ON state is maintained until Pr 4.33 “INP hold time” has elapsed. After the hold time, INP output will be turned ON/OFF according to the coming positional command or condition of the positional deviation. 4,9: Positioning completion decision starts in a delay time specified by Pr4.33 “INP hold time” after a change from “With command” to “Without command”. The signal turns on if position command is not received and position deviation is not larger than Pr4.31 “Positioning complete range”. 5,10 : After "With position command" changes to "Without position command" and then the positional deviation enters the positioning complete range, positioning completion decision is started upon the elapse of the positioning determination delay time specified for Pr4.33 “INP hold time”. The signal turns on when there is no position command and the positional deviation is equal to or smaller than Pr 4.31 "Positioning complete range". Note: This setting value is also used in the condition for detecting positioning completion (In_Position) of RTEX communication status.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	33	A	INP hold time	0–30000	ms	Set up the hold time when Pr 4.32 “Positioning complete output setup” = 3,8. 0: The hold time is maintained definitely, keeping ON state until the next positional command is received. 1 to 30000: ON state is maintained for setup time (ms) but switched to OFF state as the positional command is received during hold time. *) Becomes positioning detection delay time if Pr4.32 “Positioning complete output setup” is 4,5,9,10. 0: Positioning detection delay time becomes 0, and positioning completion decision is started immediately upon a change from “With position command” to “Without position command”. 1 to 30000: Positioning decision start time is delayed by a setting value [ms]. If a position command is received during the delay time, the delay time is reset. When the position command becomes 0, the delay time starts to be measured starting from 0. Note: This setting value is also used in the condition for detecting positioning completion (In_Position) of RTEX communication status.
4	42	A	2nd Positioning complete (In-position) range	0 –2097152	Command unit	Set the threshold of positional deviation with respect to the output of positioning complete (INP) signal. The INP2 turns ON whenever the positional deviation is lower than the value set up in this parameter, without being affected by Pr 4.32 “Positioning complete output setup”. (Presence/ absence of positional command is not related to this judgment.) The command unit is used as the default unit but can be replaced by the encoder unit by using Pr 5.20. “Position setup unit select”. Note that when the encoder unit or external scale unit is used, unit of Pr 0.14 “Position deviation excess setup” is also changed. The value of the position deviation is possible to switch the command, before and after of the position command filter in the setting of Pr7.23 bit14.
5	20	C	Position setup unit select	0–1	—	Specify the unit to determine the range of positioning complete and excessive positional deviation. 0: Command unit, 1: Encoder unit (external scale unit) Note: Positioning complete detection threshold of RTEX communication status is always in terms of command unit regardless of the setting of this parameter.
7	23	B	RTEX function extended setup 2	-32768 –32767	—	bit14: Position deviation [command unit] output setting 0: Internal command position (after filtering) [command unit] – Actual positon [command unit] 1: Internal command position (before filtering) [command unit] – Actual position [command unit]
7	24	C	RTEX function extended setup 3	-32768 –32767	-	bit 3: Setting condition for In_Position(positioning complete signal) of RTEX communication 0: Unit is set up by Pr5.20. 1: Command unit

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

4-2-5 Pulse regeneration function

The information on the amount of movement can be sent to the host controller in the form of A- and B-phase pulses from the servo driver. The resolution of information, B phase logic and output source (encoder and external scale) can be set up by using parameters.
Z phase signal is not compatible with pulse regeneration.
Please do not use this function during virtual full-closed control mode operation.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Parameter	Range	Unit	Function
0	11	R	Output pulse counts per one motor revolution	1–2097152	pulse/r	Set the resolution of pulse output by the number of output pulses per revolution of OA and OB, respectively. When the host counts pulses after multiplying by 4, resulting count is as follows: Pulse output resolution per revolution = Pr. 0.11 setting value × 4.
0	12	R	Reversal of pulse output logic/output source selection	0–3	—	Set the B-phase logic and the output source of the pulse output. By inverting the B-phase pulse by this parameter, it is possible to reverse the phase relationship between the B-phase pulses to the A-phase pulse. Either encoder or external scale can be selected for output source when external scale position information monitor function is valid under full-closed control or semi-closed control. Encoder is selected in case other than full-closed control and where external scale position information monitor function is invalid under semi-closed control.
4	47	R	Pulse output selection	0–1	—	Select the signal to be output from the pulse output terminal or position comparison output terminal. 0: Encoder output signal 1: Position comparison output signal
5	3	R	Denominator of pulse output division	0–8388608	—	For application where the number of output pulses is not an integer, this parameter can be set to a value other than 0 and the dividing ratio can be set by using Pr. 0.11 as numerator and Pr. 5.03 as denominator. When the host counts pulses after multiplying by 4, resulting count is as follows: Pulse output resolution per revolution = (Pr. 0.11 setting value/Pr.5.03 setting value) × encoder resolution
5	33	C	Pulse regenerative output limit setup	0–1	—	Enable/disable detection of Err28.0 “Pulse regenerative limit protection”. 0: Invalid 1: Valid
6	22	R	A, B phase external scale pulse output method selection	0–1	—	Selects pulse regenerated output of ABZ parallel external scale. 0: Outputs AB phase signal from ABZ parallel external scale as is. 1: Regenerates and outputs AB phase signal from ABZ parallel external scale.

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

The table below shows combination of Pr0.11 “Output pulse counts per one motor revolution” and Pr5.03 “Denominator of pulse output division”.

<table>
<tr><th>Pr 0.11</th><th>Pr 5.03</th><th>Command division/multiplication operation</th></tr>
<tr><td>1–2097152</td><td>0</td><td>[When the output source is encoder]
Encoder feedback pulse [pulse] → [Pr.0.11 setting value] × 4 / Encoder resolution → Output pulse [pulse]
• When Pr 5.03 = 0, the above process is made according to Pr 0.11 setup value. The number of pulses of reproduced pulse output OA and OB are the number of pulses set in Pr 0.11. The resolution of pulse output per one revolution is equal to or less the encoder resolution.
[When the output source is external scale]
External scale pulse [pulse] → 1 / 1 → Output pulse [pulse]
• When Pr.5.03 = 0, division ratio is 1:1.</td></tr>
<tr><td>1–2097152</td><td>1–8388608</td><td>Encoder feedback pulse or External scale pulse [pulse] → [Pr.0.11 setting value] / [Pr.5.03 setting value] → Output pulse [pulse]
• If Pr 5.03 is not equal to 0, then the above process is performed based on setup value of Pr 0.11 and Pr 5.03. This process enables the system to be compatible with application where the number of pulses per motor revolution of reproduced pulse output OA and OB are not an integral. However, the resolution of output pulse is equal to the resolution of encoder pulse at the best.</td></tr>
</table>

Table below shows details of Pr. 0.12 “Reversal of pulse output logic/output source selection”.

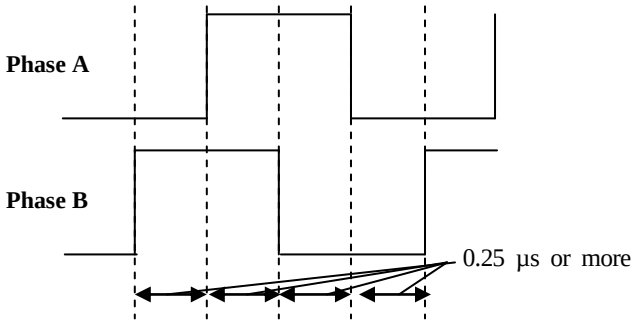
<table>
<tr><th>Pr 0.12</th><th>B-phase logic</th><th>Output source</th><th>CCW direction rotation</th><th>CW direction rotation</th></tr>
<tr><td>0</td><td rowspan="2">Nonreversal</td><td>Encoder</td><td rowspan="2">A-phase
B-phase</td><td rowspan="2">A-phase
B-phase</td></tr>
<tr><td>2</td><td>External scale</td></tr>
<tr><td>1</td><td rowspan="2">Reversal</td><td>Encoder</td><td rowspan="2">A-phase
B-phase</td><td rowspan="2">A-phase
B-phase</td></tr>
<tr><td>3</td><td>External scale</td></tr>
</table>

* 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(except during the virtual full-closed control mode state)
- In semi-closed control and when external scale position information monitor function is effective

.

■ Command on pulse regeneration function

• Maximum frequency of regenerated pulse output is 4 Mpps (after multiplied by 4), If the movement speed exceeds this frequency, the regeneration will not function correctly. That is, correct pulse is not returned to the host controller, causing positional deviation.



By enabling Pr5.33 “Pulse regenerative output limit setup”, Err28.0 “Pulse regenerative limit protection” can be generated upon reaching the pulse regeneration limit. Because this error is generated when the output limit of the pulse regeneration is detected, it is not generated at the maximum frequency. However, detection error may occur if the frequency instantaneously jumps up due to motor velocity change (irregular rotation).

4-3 Velocity Control

This function controls the velocity according to the velocity command RTEX communication command sent from the host controller. Below describes the basic set up of the velocity controls.
Available velocity control mode is the cyclic velocity control mode (CV control mode) which updates the command velocity through RTEX communication command.
For details, refer to Technical Reference RTEX Communication Specification “Section 5-5”.

The control mode is switched forcibly inside the driver depending on its operating status irrespective of the command from the host device. This operation has an effect on input signal processing.

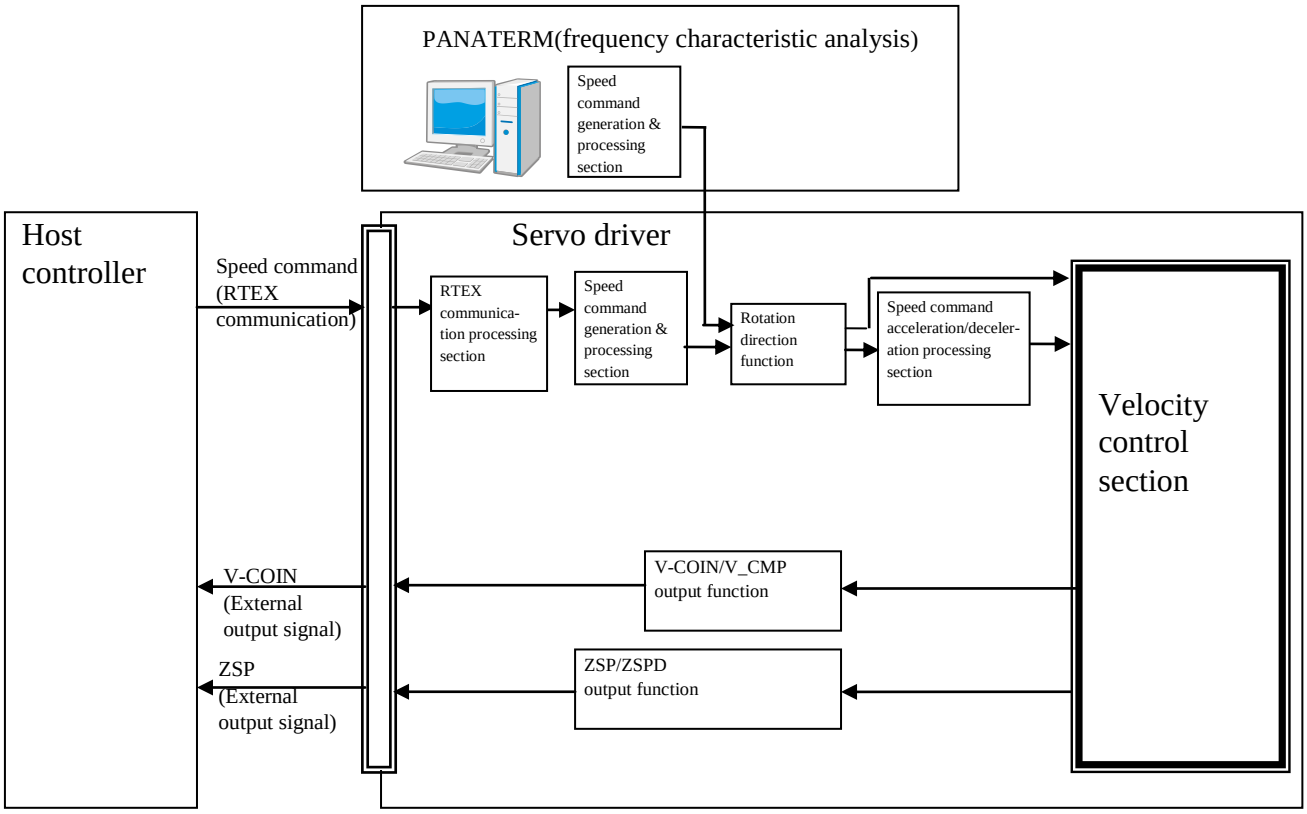
[Conditions that the control mode is switched forcibly inside the driver]

・When frequency characteristic is analized by Setup support software.
(Position loop characteristics is position control, the speed closed loop characteristic and torque speed (vertical) are velocity control, torque speed (normal) is torque control.)

・Test run of the setup support software (Forcibly position control mode).

・The states that are written "Forcibly controls the position" in "Deceleration stop sequence" (Section 6-3).

・During retreat operation (position control is enabled by force.)



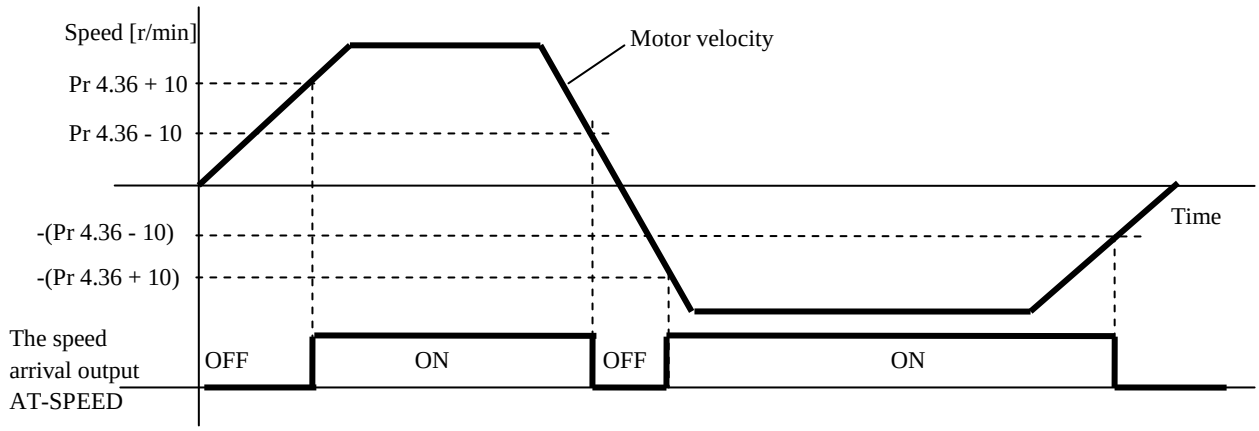
4-3-1 Attained speed output (AT-SPEED)

The AT-SPEED signal is output as the motor reaches the speed set to Pr 4.36 “Attained speed”.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	36	A	At-speed (Speed arrival)	10–20000	r/min	Set the detection timing of the speed arrival output (AT-SPEED). When the motor speed exceeds this setup value, the speed arrival output (AT-SPEED) is output. Detection is associated with 10 r/min hysteresis.

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



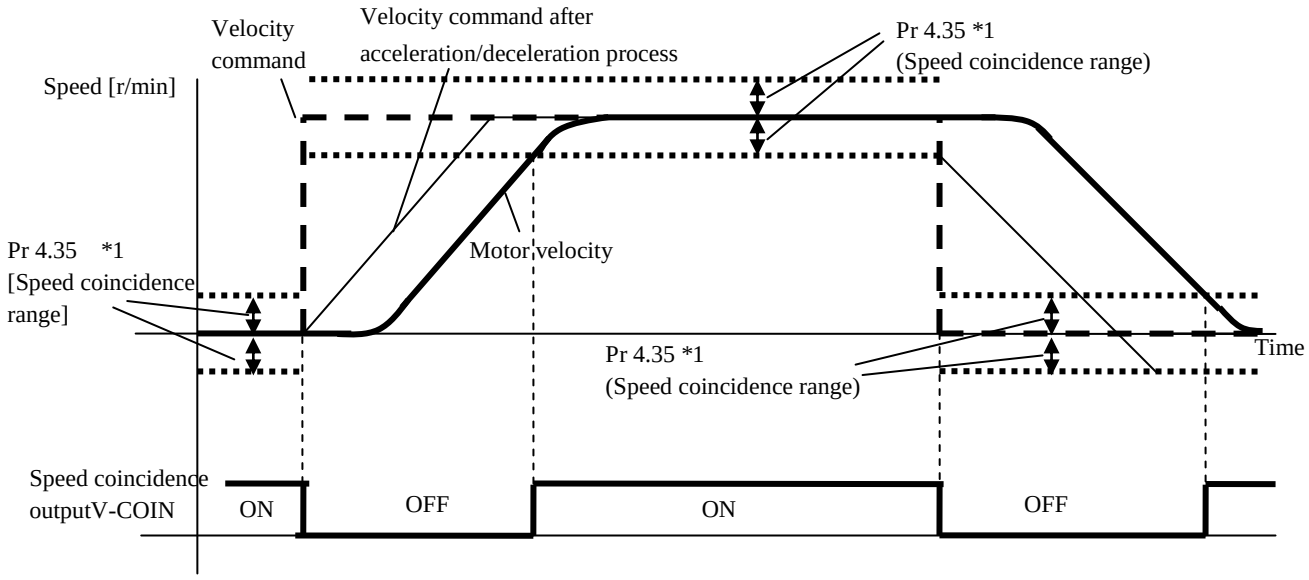
4-3-2 Speed coincidence output (V-COIN)

This signal is output when the motor speed is equal to the velocity specified by the velocity command. The motor speed is judged to be coincident with the specified speed when the difference from the velocity command before/after acceleration/deceleration is within the range specified by Pr 4.35 “Speed coincident range”

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	35	A	Speed coincidence range	10–20000	r/min	Set the speed coincidence (V-COIN) output detection timing. Output the speed coincidence (V-COIN) when the difference between the speed command and the motor speed is equal to or smaller than the speed specified by this parameter. The detection response has 10 r/min hysteresis.

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



*1 Because the speed coincidence detection is associated with 10 r/min hysteresis, actual detection range is as shown below.

Speed coincidence output OFF ON timing (Pr 4.35 – 10) r/min
Speed coincidence output ON OFF timing (Pr 4.35 + 10) r/min

4-3-3 Velocity command acceleration/deceleration setting function

This function controls the velocity by adding acceleration or deceleration command in the driver to the input velocity command.
Using this function, it is possible to can use the soft start when inputting stepwise velocity command or when using internal velocity setup. Also, it is possible to use S shaped acceleration/deceleration function to minimize shock due to change in velocity.

■ Relevant parameters

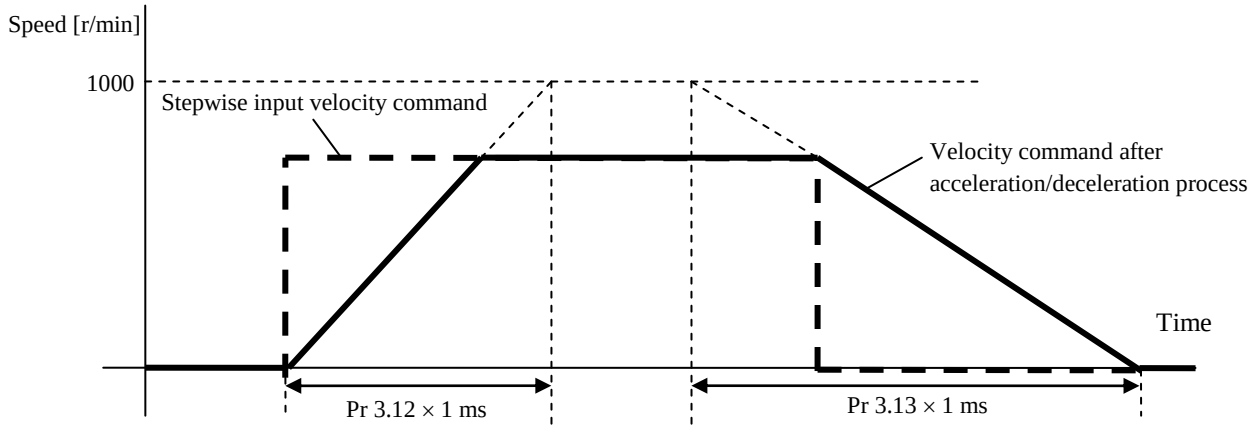
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	12	B	Acceleration time setup	0–10000	ms/ (1000 r/min)	Set up acceleration processing time in response to the velocity command input.
3	13	B	Deceleration time setup	0–10000	ms/ (1000 r/min)	Set up deceleration processing time in response to the velocity command input.
3	14	B	Sigmoid acceleration/ deceleration time setup	0–1000	ms	Set S-curve time for acceleration/deceleration process when the velocity command is applied.

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

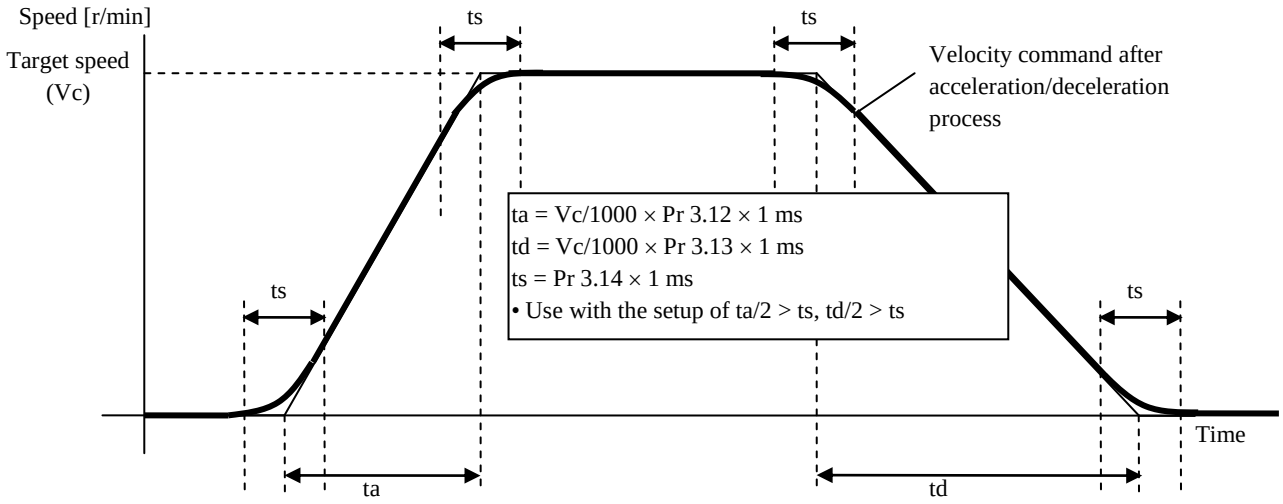
Note: When the position loop is external to the driver, do not use the acceleration/deceleration time setting. Set these values to 0.

• Pr 3.12 “Acceleration time setup”, Pr 3.13 “Deceleration time setup”
Set the time, elapsing before the velocity command (stepwise input) reaches 1000 r/min after a stepwise velocity command is input, to Pr 3.12 “Acceleration time setup”. Also set the time, elapsing before the velocity command reaches 0 r/min from 1000 r/min, to Pr 3.13 “Deceleration time setup”. Assuming that the target value of the velocity command is Vc (r/min), the time required for acceleration/deceleration can be computed from the formula shown below.

Acceleration time (ms) = Vc/1000 × Pr 3.12 × 1 ms
Deceleration time (ms) = Vc/1000 × Pr 3.13 × 1 ms



• Pr 3.14 “Sigmoid acceleration/deceleration time setup”
According to Pr 3.12 “Acceleration time setup” and Pr 3.13 “Deceleration time setup”, set up sigmoid time with time width centering the inflection point of acceleration/deceleration.



4-4 Torque control

This function performs torque control based on torque command of RTEX communication command sent from the host controller. Below describes basic setting of torque control to be used. In addition to the torque command, the speed limit command is required to maintain the motor at a speed below the limited value.
Available torque control mode is the cyclic torque control mode (CT control mode) which updates the command torque during communication period. The mode is selected by RTEX communication command. For details, refer to Technical Reference RTEX Communication Specification “Section 5-6”.
The control mode is switched forcibly inside the driver depending on its operating status irrespective of the command from the host device. This operation has an effect on input signal processing.

[Conditions that the control mode is switched forcibly inside the driver]

・When frequency characteristic is analized by Setup support software.
(Position loop characteristics is position control, the speed closed loop characteristic and torque speed (vertical) are velocity control, torque speed (normal) is torque control.)

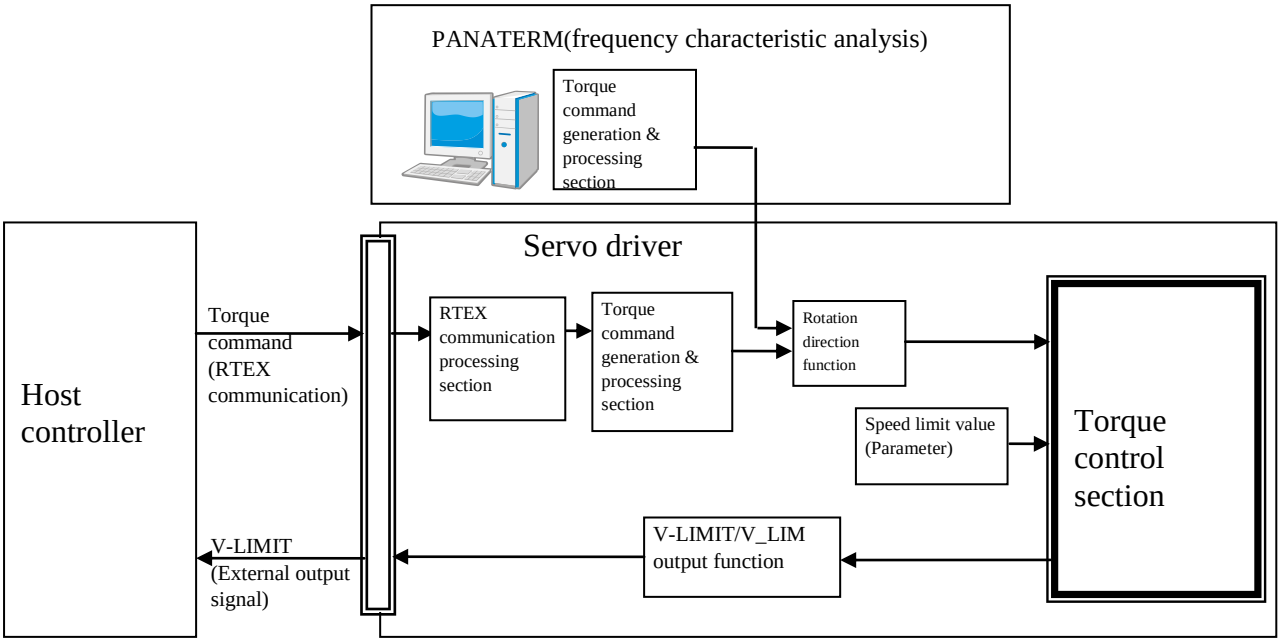
・Test run of the setup support software (Forcibly position control mode).

・The states that are written "Forcibly controls the position" in "Deceleration stop sequence" (Section 6-3).

・During retreat operation (position control is enabled by force.)

Note) Since the shipment value has the two-degrees-of-freedom control mode valid, set the two-degrees-of-freedom control mode to invalid (Pr6.47 bit0=0) when using the torque control mode with a version earlier than extended functions version 4.

Note) Since the shipment value has speed limit value 0, set up the speed limit value (Pr3.21/Pr3.22) to a proper level when using the torque control mode.
For details, please refer to Section 4-4-1.



4-4-1 Speed limit function

The speed limit is one of protective functions used during torque control.
This function regulates the motor speed so that it does not exceed the speed limit while the torque is controlled.
Switching by speed limit switching command (SL_SW) of RTEX communication is also possible.

Note: While the speed limit is used to control the motor, the torque command applied to the motor is not directly proportional to the analog torque command. Torque command should have the following result.: the motor speed is equal to the speed limit.

Note: The speed limit is disabled when the motor operates in the reverse direction to the torque command given by the host controller due to gravity and other disturbances.
If this behavior is a problem, by setting the rate at which the motor is stopped to Pr5.13“Over-speed level setup” or Pr6.15“2nd over-speed level setup”, to stop the motor by generating Err26.0“Over-speed protection” or Err26.1“2nd over-speed protection”.
For more information about the over-speed protection, please refer to Section 6-3-5.

■ Relevant parameters

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>3</td><td>17</td><td>B</td><td>Selection of speed limit</td><td>0–1</td><td>—</td><td>Set up the selection method of the speed limit used for torque controlling.
<table>
<tr><th>Setting value</th><th>SL_SW = 0</th><th>SL_SW = 1</th></tr>
<tr><td>0</td><td colspan="2">Pr 3.21</td></tr>
<tr><td>1</td><td>Pr 3.21</td><td>Pr 3.22</td></tr>
</table></td></tr>
<tr><td>3</td><td>21</td><td>B</td><td>Speed limit value 1</td><td>0–20000</td><td>r/min</td><td>Set up the speed limit used for torque controlling.
During the torque controlling, the speed set by the speed limit value cannot be exceeded.
Internal value is limited to the setting speed of Pr5.13 “Over-speed level setup”, Pr6.15 “2nd over-speed level setup”, and internal value of the over-speed protection level, whichever smaller.</td></tr>
<tr><td>3</td><td>22</td><td>B</td><td>Speed limit value 2</td><td>0–20000</td><td>r/min</td><td>When Pr 3.17 “Selection of speed limit” is set to 1, the speed limit selected with SL_SW 1 is set.
Internal value is limited to the setting speed of Pr5.13 “Over-speed level setup”, Pr6.15 “2nd over-speed level setup”, and internal value of the over-speed protection level, whichever smaller.</td></tr>
</table>

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

4-5 Full-closed control

Full-closed control is where the position of the unit being controlled is controlled by direct feedback of the detected position using an externally located scale (external scale). This allows, for example, control that is not affected by ball screw errors or position variation from temperature.
Configuring a full-closed control system will enable the achievement of high-precision positioning of sub-micrometer order.
Switching to cyclic velocity control mode (CV control mode) or cyclic torque control mode (CT control mode) is not possible under full-closed control.

This section describes the setting of external scale ratio and the setting of excessive hybrid deviation in the initial setting for full-closed control.

There is the profile position control (PP), where the target position, target velocity, acceleration, and deceleration are specified and position command is generated inside the servo amplifier, and the cyclic position control (CP), where the position command is generated by a host device and the position command is renewed by command renewal cycle, in full-closed position control mode, and these are switched by RTEX communication command. Please refer to Technical Reference RTEX Communication Specification “Sections 5-3 and 5-4” for details.

Precautions

(1) One command pulse(one command unit) 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 setup" and Pr3.29 "Hybrid deviation clear setup" 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 $1/40 \leq$ External scale ratio ≤ 125200 is recommended.
When the external scale rate is set at the value smaller than 50/position loop gain (Hz), control by the unit of 1 pulse in external scale may not become possible.
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.

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

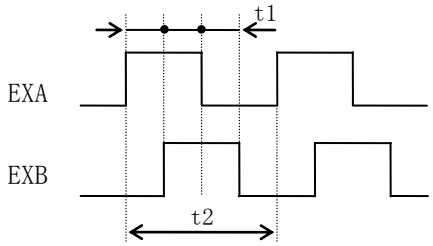
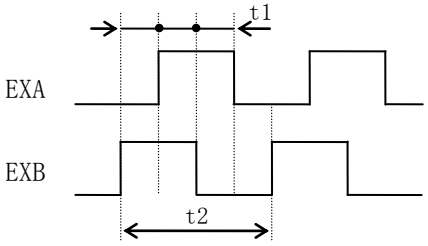
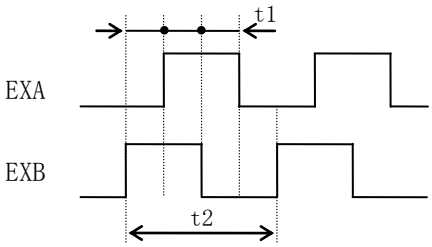
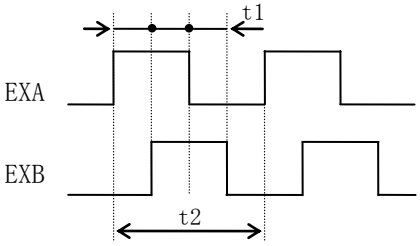
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	23	R	External scale selection	0–6	—	Selects the type of external scale. 0: A, B phase output type 1: Serial communication type (Incremental specification) 2: Serial communication type (Absolute specification) 3: For manufacturer's use *2) 4: For manufacturer's use *2) 5: For manufacturer's use *2) 6: For manufacturer's use *2) 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. If the scale of serial communication type of the absolute specification is set at 1 when connected, or the scale of serial communication type of the incremental specification is set at 2 when connected, Err.93.3 "External scale connection fault protection" is generated.
3	26	B	Reversal of direction of external scale	0–3	—	Sets the direction inversion of the external scale feedback counter. 0: Non-inversion 1: Inversion 2: For manufacturer's use *2) 3: For manufacturer's use *2)

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

*2) It is not supported in versions corresponding to function extended edition 2 or earlier.

Pr3.23	External scale type	Supporting scale manufacturers	Supporting velocity *3
0	A, B phase output type *1 *2 *4	External scale of A, B phase output type	to 4M pulse/s (after 4 multiplications)
1	Serial communications type (increment specification) *2 *4	Magnescale Co., Ltd. Nidec Sankyo Corporation	to 4G pulse/s
2	Serial communications type (absolute specification) *2 *4	Mitutoyo Corporation Magnescale Co., Ltd. Heidenhain K.K. Renishaw K.K. Fagor Automation S.Coop	to 4G pulse/s
3-6	For manufacturer's use *5	—	—

*1. The counting direction of driver internal processing on the A, 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 "Reversal of direction of external scale".

The installation direction can be checked USB communication (PANATERM) 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 “Reversal of direction of external scale” (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. Others, please contact the Company for supporting external scales.

*5. It is not supported in versions corresponding to function extended edition 2 or earlier.

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

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	24	R	Numerator of external scale divison	$0 – 2^{23}$	—	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	R	Denominator of external Scale divison	$1 – 2^{23}$	—	Sets the denominator of external scale division setting.

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

- Check the encoder pulse count per one motor rotation and the external scale pulse count per one motor rotation, then set the numerator of external scale division (Pr3.24) and denominator of external scale division (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

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

- 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 setup”, 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.

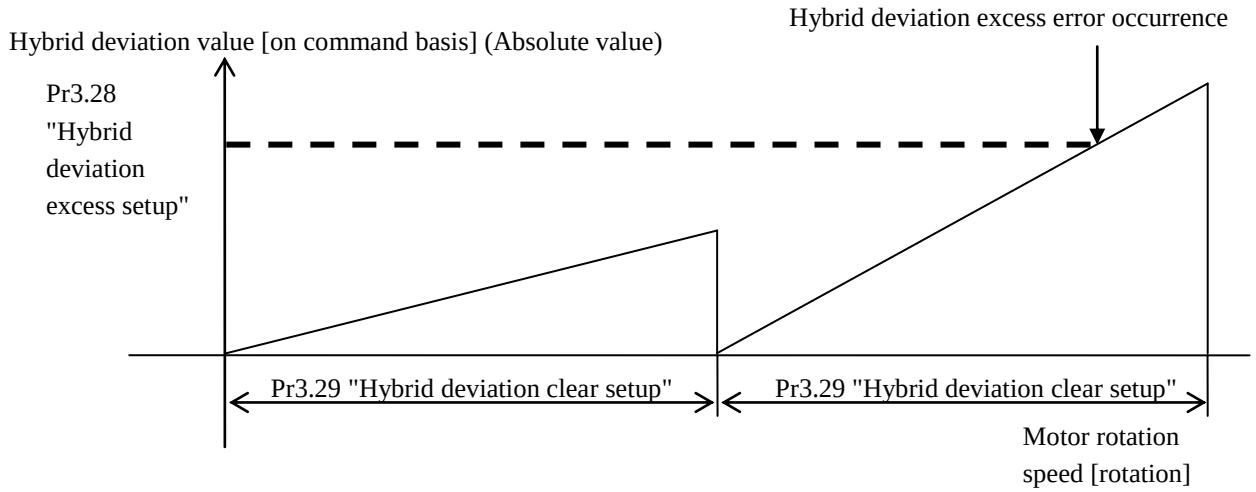
■Relevant parameters

Class	No.	At-tribute *1)	Title	Range	Unit	Function
3	28	C	Hybrid deviation excess setup	1–2^{27}	Command unit	Sets the allowance (hybrid deviation) between the motor (encoder) position and load (external scale) position on a command basis.
3	29	C	Hybrid deviation clear setup	0–100	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.

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

• Regarding hybrid deviation clear specification

Each time the motor rotates for the amount set with Pr3.29 “Hybrid deviation clear setup”, 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 setup” to an appropriate value. If set to a significantly smaller value compared with the set value of Pr3.28 “Hybrid deviation excess setup”, 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.

Other than the above, hybrid deviation is cleared when the following position information is initialized:

- When turning on the power of the absolute system
- When completing returning to home
- When completing the execution of reset command (attribute C parameter validation mode)
- When completing the execution of the functions below by the setup support software (PANATERM)

  Test run function, Z phase search function, frequency response analyzing function (FFT), fit gain function, pin assignment setting, multi-turn clearing of the absolute encoder

4-6 Setting regenerative resistor

The table describes setup of regenerative resistor.
For details of regenerative resistor specification, refer to Reference specifications.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	16	C	External regenerative resistor setup	0–3	—	It uses the regenerative resistance incorporated in the driver, or the disconnect the internal resistance, providing a regenerative resistor to the outside, set in this parameter. 0: Use the built-in resistor and activate regenerative over-load protection. 1: Use the external resistor and activate regenerative over-load protection. 2: Use the external resistor but do not activate regenerative over-load protection. 3: Do not use regenerative resistor. (Do not use over-load protection.)
0	17	C	Load factor of external regenerative resistor selection	0–4	—	When selecting the external regenerative resistor (Pr 0.16 = 1, 2), select the computing method of load factor of regenerative resistor. 0: Regenerative load factor is 100% when duty factor of external regenerative resistor is 10%. (Compatible with A4N series) 1–4: For manufacturer's use (do not setup)

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

4-7 Absolute setup

4-7-1 Absolute encoder

When using the motor with absolute encoder, which does not require to execute a homing operation at power-ON. For that, it is necessary to set Pr 0.15 “Absolute encoder setup” to except a “1” after connecting the battery for absolute encoder.
For details of the single-turn absolute function, refer to section 6-6. In this case, the connection of the battery is not required.
For details of the continuous rotating absolute encoder function, refer to section 6-7.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	15	C	Absolute encoder setup	0–4	—	Select the use method of the absolute encoder. *2) 0: Use as an absolute system (absolute mode). 1: Use as an incremental system (incremental mode). 2: Use as an absolute system (absolute mode), however ignore the multi-turn counter over. 3: Use as an absolute system, however not use the multi-turn counter (single-turn absolute mode). 4: Used as an absolute system (absolute mode), however any upper limit value can be set for the multi-turn counter, and ignore the multi-turn counter over. (continuous rotating absolute mode)

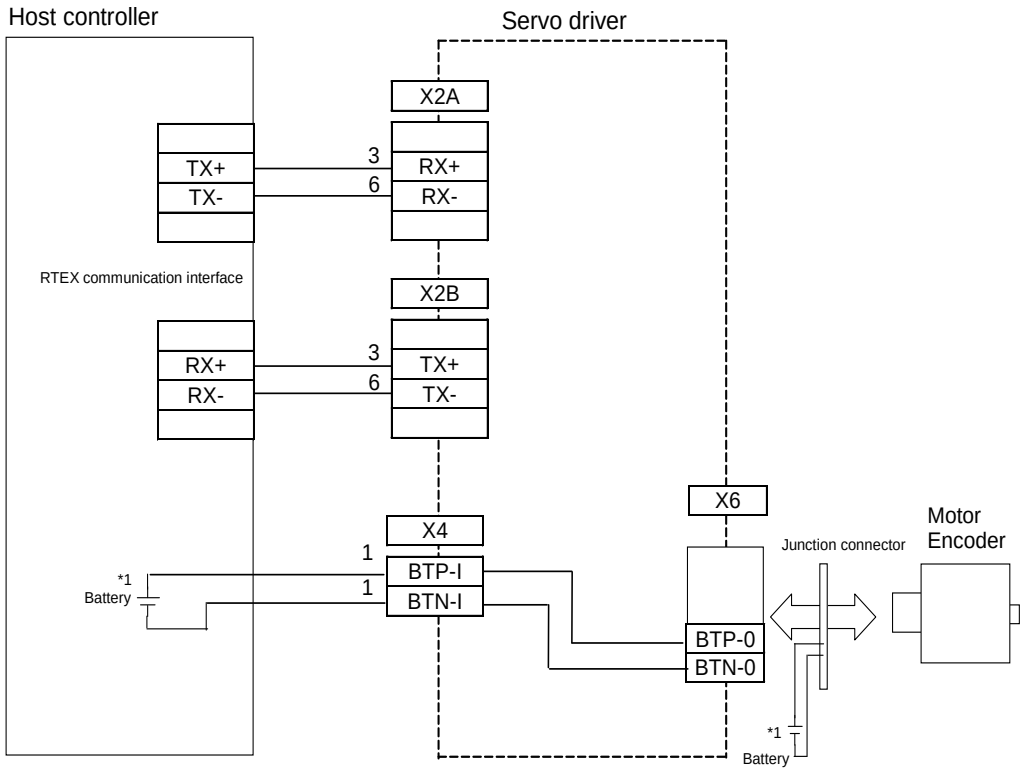
*1) For parameter attribute, refer to Section 9-1.

*2) Under full-closed control, absolute encoder will be handled in internal control as an incremental system (set value = 1).

4-7-1-1 Structure of absolute system

Absolute system configuration using RTEX communication interface (example: with servo driver single-axis connection)

In the RTEX communication response (driver → host controller), the absolute data is transferred to the host controller as the current position data.



*1. Connect to either X4 or the junction connector between X6 and the encoder, when you connect the battery. Do not connect to both.

Note: During replacing the battery, the control power input must be held ON. If not so, the absolute data will be lost.

4-7-1-2 Installing battery for absolute data

Refer to Reference specifications.

4-7-1-3 Clearing of absolute data

Multi-turn data of the absolute data is hold by the battery.
Therefore, when you start up the machine for the first time, it is required to make the multi-turn data to 0 by encoder clearing at the home position after installing the battery.

Clearing operation of absolute encoder is made through communications (USB (setup support software PANATERM) or RTEX).
After clearing the absolute data, turn off and on the power without fail.

4-7-1-4 Battery refreshment of the 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.

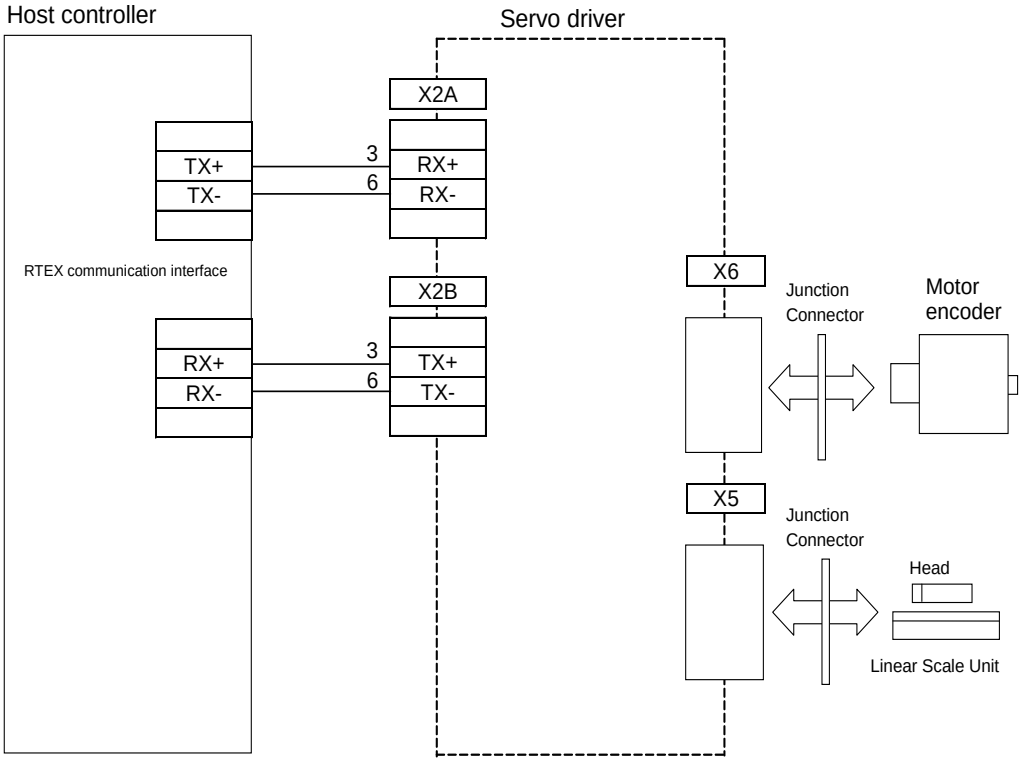
4-7-2 External scale

Under full-closed control, an absolute system that does not require return to origin action after power-up, can be configured

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

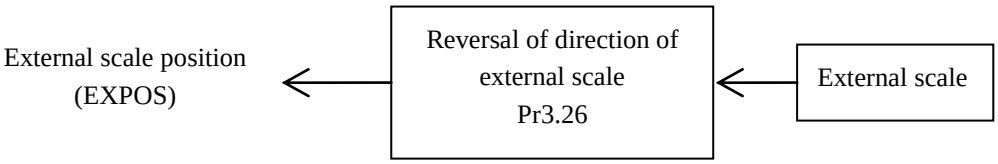
Absolute system configuration using RTEX communication interface (example: with servo driver single-axis connection)

In the RTEX communication response (driver → host controller), the absolute data is transferred to the host controller as the current position data.



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

External scale position information can also be monitored by RTEX communications under semi-closed control, and full-closed control can be conducted from the host controller.
The amplifier is under semi-closed control, allowing position (PP, CP), velocity (CV), and torque (CT) to be switched.



■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
7	22	R	RTEX function extended setup 1	-32768 –32767	–	[bit4] External scale position information monitoring function under semi-closed control setting: 0 : Invalid 1 : Valid ▪ Under full-closed control, external scale position information can be monitored regardless of the setting of this bit.

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

・When this function is effective the following function becomes effective by not only full-close control but semi-close control (PP, CP, CV, CT).
Since the alarm function of an external scale also becomes effective, be careful.
・It is a read-out function of an external scale position (EXPOS) with the monitor command of RTEX communication.
・It is a read-out function of external scale system ID (vendor ID, model ID) with the system ID command of RTEX communication.
・Alarm and warning detection function of disconnection of an external scale, the abnormalities in communication, and the abnormalities in status
(Err93.3 , Err50.0-2 , Err51.0-5 , Err55.0-2 , WngA8h , WngA9h)

・When this function is effective the following contents are not reflected in the external scale position (EXPOS) monitored by RTEX communication.
・Rotational direction setup (Pr0.00)
・Electronic gear (Pr0.08 , Pr0.09 , Pr0.10)
・Absolute home position offset (Pr7.13)
*Reversal of direction of external scale (Pr3.26) is reflected.

・It cannot be used in 0.250 ms, 0.125ms and 0.0625 ms of communication cycles.
When this function is enabled in 0.250 ms, 0.125 ms and 0.0625 ms of communicationcycles, Err91.1 "RTEX command unusual protection" occurs.

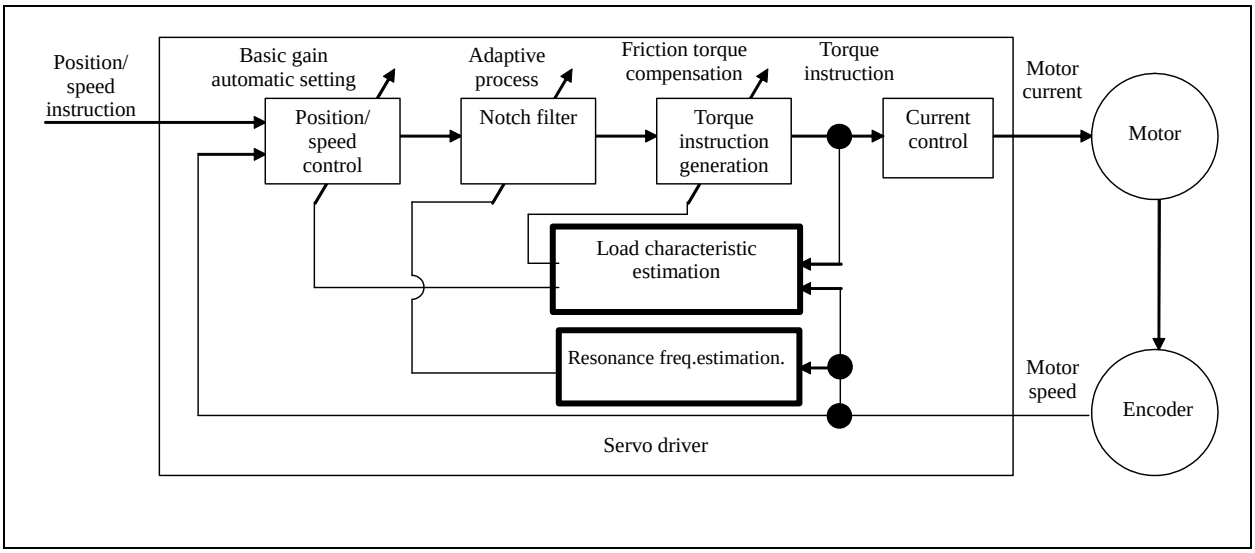
・Please set to a suitable value in accordance with the specification of the external scale which connects Pr3.23 “External scale selection.”
In the case which is not suitable, Err93.3 "external scale connection unusual protection" occurs.

・In the following cases, external scale position (EXPOS) initialization is performed.
・At the time of the control power supply ON
・At the time of reset command execution of RTEX communication (soft reset mode only)
*It does not initialize at the time of a zero return.

5. Gain tuning/vibration suppressing function

5-1 Automatic adjusting function

The figure below shows outline of automatic adjusting function of MINAS-A6N series.



1) Real-time auto tuning
Estimates the load characteristics based on the motor velocity and torque command, and automatically sets up the basic gain related to position and velocity control, based on estimated inertia. Also estimates the friction torque at the same time and adds the estimated value to the torque command to shorten positioning settling time.

2) Adaptive filter
Estimates the resonance frequency based on the motor velocity and removes the frequency components from torque command to prevent resonant oscillation.

5-1-1 Real-Time Auto Tuning

The system estimates the load characteristics in real time, and automatically performs basic gain setting and friction compensation by referring to stiffness parameter.
For the two-degree-of-freedom control mode, refer to section 5-1-3/5-1-4.

1) Applicable Range
This function operates under the following conditions.

	Real-time auto-tuning condition
Control Mode	Specific real-time auto-tuning mode is selected according to the currently active control mode. For details, refer to the description of Pr 0.02 “Real-time auto-gain tuning setup. ”
Others	• Should be in servo-on condition • Parameters except control parameters such as torque limit settings are correctly set, assuring that the motor can run smoothly.

2) Caution

- After the power is turned on, estimate value following may become quicker regardless of Pr6.31 “Real-time auto tuning estimation speed” until operation data effective for the estimation of load characteristics is sufficiently accumulated.

- When real-time auto-gain tuning is effective, an estimate value may become abnormal due to disturbance. If you want to obtain stable operation from when the power is turned on, it is recommended to disable the real-time auto-gain tuning.

Real-time auto-gain tuning may not be executed properly under the conditions described below. If not properly executed, change the loading condition or operating pattern, or manually set up the related parameters by referring to the manual adjustment function description.

	Conditions which obstruct real-time auto-gain tuning action
Load inertia	• The load inertia is too small or large compared to the rotor inertia. (less than 3 times or more than 20 times). • The load inertia changes too quickly. • The machine stiffness is extremely low. • Nonlinear characteristics such as backlash exist.
Action pattern	• The motor is running continuously at low speed of 100 [r/min] or lower. • Acceleration/deceleration is slow (2,000 [r/min] per 1 [s] or low). • When the speed condition of 100 [r/min] or more and acceleration/deceleration condition of 2,000 [r/min] per 1 [s] are not maintained for 50 [ms]. • Acceleration/deceleration torque is smaller than unbalanced weighted/viscous friction torque.

3) Real-time auto tuning control parameters
Use the following parameters to set up the operation of real-time auto tuning.

<table>
<tr><th>Class</th><th>No.</th><th>Attri-bute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>02</td><td>B</td><td>Real-time auto-gain tuning setup</td><td>0–6</td><td>—</td><td>You can set up the action mode of the real-time auto-gain tuning.
<table>
<tr><th>Setup value</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Invalid</td><td>Real-time auto-gain tuning function is disabled.</td></tr>
<tr><td>1</td><td>Standard</td><td>Stability-sensitive mode. Do not use unbalanced load, friction compensation or gain switching.</td></tr>
<tr><td>2</td><td>Positioning *1</td><td>Position-sensitive mode. Use this mode for machine using horizontal axis without offset load or ball screw driven machine with small friction.</td></tr>
<tr><td>3</td><td>Vertical axis *2</td><td>This mode adds the following features to those of positioning mode: compensates for offset load in vertical axis and minimizes positioning settling time variations.</td></tr>
<tr><td>4</td><td>Friction compensation *3</td><td>This mode adds the following features to those of vertical axis mode: shortens positioning settling time on large friction system such as belt driven axis.</td></tr>
<tr><td>5</td><td>Load characteristic measurement</td><td>This mode only estimates the load characteristics without changing the basic gain setting or friction compensation setting. Use these features in conjunction with the set-up support software (PANATERM).</td></tr>
<tr><td>6</td><td>Customize *4</td><td>By precisely setting combination of real-time auto tuning functions through Pr 6.32 “Real time auto tuning custom setup”, customization to fit the application can be made.</td></tr>
</table>
*1 Velocity and torque controls are the same as in the standard mode.
*2 Torque control is the same as in the standard mode.
*3 Velocity control is the same as in the vertical axis mode. Torque control is the same as in the standard mode.
*4 Certain function(s) is not available in a specific control mode. Refer to description in Pr 6.32.</td></tr>
<tr><td>0</td><td>03</td><td>B</td><td>Setup of machine stiffness at real-time auto-gain tuning</td><td>0–31</td><td>—</td><td>You can set up the response while the real-time auto-gain tuning is valid. Higher the setup value, higher the velocity response and servo stiffness will be obtained. However, when increasing the value, check the resulting operation to avoid oscillation or vibration.</td></tr>
<tr><td>6</td><td>10</td><td>B</td><td>Function expansion setup</td><td>-32768–32767</td><td>—</td><td>The automatic adjustment of load change inhibit function is enabled with bit14=1.</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</td><td>B</td><td>Real time auto tuning estimation speed</td><td>0–3</td><td>—</td><td>Set up the load characteristics estimation speed with the real time auto tuning being valid. A higher setup value assures faster response to a change in load characteristics but increases variations in disturbance estimation. Result of estimation is saved to EEPROM every 30 minutes.
<table>
<tr><th>Setup value</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>No change</td><td>Stop estimation of load characteristics.</td></tr>
<tr><td>1</td><td>Almost constant</td><td>Response to changes in load characteristics in every minute.</td></tr>
<tr><td>2</td><td>Slower change</td><td>Response to changes in load characteristics in every second.</td></tr>
<tr><td>3 *</td><td>Faster change</td><td>Obtain best suitable estimation in response to changes in load characteristics.</td></tr>
</table>
* If the automatic oscillation detection is enabled by the set-up support software (PANATERM), the setup value 3 is used.</td></tr>
<tr><td>6</td><td>32</td><td>B</td><td>Real time auto tuning custom setup
(To be continued)</td><td>-32768–32767</td><td>—</td><td>When the operation mode of real time auto tuning is set to the customize (Pr 0.02 = 6), set the automatic adjusting function as shown below.
<table>
<tr><th>bit</th><th>Content</th><th>Description</th></tr>
<tr><td>1–0</td><td>Load characteristics estimation *1,*2</td><td>Enable/disable the load characteristics estimation function.
Setup value=0: Disable
Setup value=1: Enable</td></tr>
<tr><td>3–2</td><td>Inertia ratio update *3</td><td>Set up update to be made based on result of the load characteristics estimation of Pr 0.04 “Inertia ratio”.
Setup value=0: Use current setup.
Setup value=1: Update by the estimated value.</td></tr>
<tr><td>6–4</td><td>Torque compensation *4</td><td>Set up the update to be made according to the results of load characteristics estimation of Pr 6.07 “Torque command additional value”, Pr 6.08 “positive direction torque compensation value” and Pr 6.09 “negative direction torque compensation value”.
Setup value=0: Use current setup
Setup value=1: Disable torque compensation Clear the parameters shown above to zero.
Setup value=2: Vertical axis mode Update Pr 6.07. Zero clear Pr 6.08 and Pr 6.09
Setup value=3: Friction compensation (low) Update Pr 6.07. Set low compensation to Pr 6.08 and Pr 6.09.
Setup value=4: Friction compensation (middle) Set middle compensation to Pr 6.08 and Pr.6.09.
Setup value=5: Friction compensation (high) Set high compensation to Pr 6.08 and Pr 6.09.</td></tr>
</table>
*1 If the load characteristics estimation is disabled, the current setup cannot be changed even if the inertia ratio is updated according to the estimated value. When the torque compensation is updated by the estimated value, it is cleared to 0 (invalid).
*2 If the load characteristics estimation is abled, set Pr6.31 "Real-time auto tuning presumption speed" besides 0(stop estimation).</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>32</td><td>B</td><td>Real time auto tuning custom setup (Continued)</td><td>-32768–32767</td><td>—</td><td>
<table>
<tr><th>bit</th><th>Content</th><th>Description</th></tr>
<tr><td>7</td><td>Stiffness Setup *5</td><td>Enable/disable the basic gain setup to be made according to Pr0.03 (Selection of machine stiffness at real-time auto-gain tuning).
Setup value=0: Disable
Setup value=1: Enable</td></tr>
<tr><td>8</td><td>Fixed parameter setup *5</td><td>Enable/disable the change of parameter that is normally set at a fixed value.
Setup value=0: Use current setup
Setup value=1: Set to a fixed value.</td></tr>
<tr><td>10–9</td><td>Gain switching setup *5</td><td>Select the gain switching related parameter to be used when the real time auto tuning is enabled.
Setup value=0: Use current setup
Setup value=1: Disable gain switching.
Setup value=2: Enable gain switching</td></tr>
</table>
*3 If the inertia ratio update is enabled, set bit 1–0 to 1(enable). If neither is effective, the inertia ratio is not updated.
*4 If the torque compensation is abled (setup value=2-5), set bit 3–2(Inertia ratio update) to 1(enable). If neither is effective,the inertia ratio is not updated. The torque compensation alone cannot be updated.
*5 Set bit3–2(Inertia ratio update) to 1(enable) when this setting is set excluding 0. At this time, you can be set whether to inertia ratio update to be effective with bit 1-0(Load characteristics estimation).

Caution) This parameter should be setup bit by bit. Because the operation is not guaranteed when the setting is wrong, use of the set-up support software (PANATERM) is recommended for parameter editing.

Caution) Do not change while the motor is operating. With this parameter is updated, when the motor stopped after the result of load characteristic measurement secured.

<Setup procedure of bitwise parameter>
When setting parameter to a value other than 0, calculate the setup value of Pr 6.32 in the following procedure.
1) Identify the LSB of the setup.
Example: LSB of the torque compensation function is 4.
2) Multiply the setup value by power of 2 (LSB).
Example: To set the torque compensation function to friction compensation (middle) : $2^4 \times 4 = 64$.
3) Perform steps 1) and 2) for every setup, sum up the values which are to be Pr 6.32 setup value.
Example: Load characteristics measurement = enable, inertia ratio update = enable, torque compensation = friction compensation (middle), stiffness setup = enable, fixed parameter = set to a fixed value, gain switching setup = enable, then,
$2^0 \times 1+2^2 \times 1+2^4 \times 4+2^7 \times 1+2^8 \times 1+2^9 \times 2 = 1477$
</td></tr>
</table>

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

4) Parameters changed by real-time auto-gain tuning
The real-time auto-tuning function updates the following parameters according to Pr 0.02 “Real-time auto-gain tuning setup” and Pr 6.32 “Real-time auto-tuning custom setup” and by using the load characteristic estimate values.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	04	B	Inertia ratio	0–10000	%	Updates this parameter when the real-time auto-tuning inertia ratio update is enabled.
6	07	B	Torque command additional value	-100–100	%	Update this parameter when the vertical axis mode for real time auto-tuning is valid.
6	08	B	Positive direction torque compensation value	-100–100	%	Update this parameter when the friction compensation mode for real time auto-tuning is valid.
6	09	B	Negative direction torque compensation value	-100–100	%	Update this parameter when the friction compensation mode for real time auto-tuning is valid.

The real-time auto-tuning function updates the following basic gain setup parameters according to Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”. For details, refer to 7) Basic gain parameter setup table.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	00	B	1st gain of position loop	0–30000	0.1/s	When stiffness setup is valid, updates the parameter based on the setup value.
1	01	B	1st gain of velocity loop	1–32767	0.1 Hz	When stiffness setup is valid, updates the parameter based on the setup value.
1	02	B	1st time constant of velocity loop integration	1–10000	0.1 ms	When stiffness setup is valid, updates the parameter based on the setup value.
1	04	B	1st time constant of torque filter	0–2500	0.01 ms	When stiffness setup is valid, updates the parameter based on the setup value.
1	05	B	2nd gain of position loop	0–30000	0.1/s	When stiffness setup is valid, updates the parameter based on the setup value.
1	06	B	2nd gain of velocity loop	1–32767	0.1 Hz	When stiffness setup is valid, updates the parameter based on the setup value.
1	07	B	2nd time constant of velocity loop integration	1–10000	0.1 ms	When stiffness setup is valid, updates the parameter based on the setup value.
1	09	B	2nd time constant of torque filter	0–2500	0.01 ms	When stiffness setup is valid, updates the parameter based on the setup value.

Real-time auto-tuning function sets the following parameters to the fixed value.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	03	B	1st filter of velocity detection	0–5	—	When fixed parameter setup is valid, set the parameter to 0.
1	08	B	2nd filter of velocity detection	0–5	—	When fixed parameter setup is valid, set the parameter to 0.
1	10	B	Velocity feed forward gain	0–4000	0.1%	When fixed parameter setup is valid, set the parameter to 300 (30%).
1	11	B	Velocity feed forward filter	0–6400	0.01 ms	When fixed parameter setup is valid, set the parameter to 50 (0.5 ms).
1	12	B	Torque feed forward gain	0–1000	0.1%	When fixed parameter setup is valid, set the parameter to 0.
1	13	B	Torque feed forward filter	0–6400	0.01 ms	When fixed parameter setup is valid, set the parameter to 0.

(To be continued)

The real-time auto-tuning function sets the following parameters as the gain is switched.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	14	B	2nd gain setup	0–1	—	Sets to 1 if the current setting is not maintained
1	15	B	Mode of position control switching	0–10	—	Sets to 10 to enable the gain switching. Sets to 0 to disable the gain switching.
1	16	B	Delay time of position control switching	0–10000	0.1 ms	Sets to 50 if the current setting is not maintained.
1	17	B	Level of position control switching	0–20000	—	Sets to 50 if the current setting is not maintained.
1	18	B	Hysteresis at position control switching	0–20000	—	Sets to 33 if the current setting is not maintained.
1	19	B	Position gain switching time	0–10000	0.1 ms	Sets to 33 if the current setting is not maintained.
1	20	B	Mode of velocity control switching	0–5	—	Sets to 0 if the current setting is not maintained.
1	21	B	Delay time of velocity control switching	0–10000	0.1 ms	Sets to 0 if the current setting is not maintained.
1	22	B	Level of velocity control switching	0–20000	—	Sets to 0 if the current setting is not maintained.
1	23	B	Hysteresis at velocity control switching	0–20000	—	Sets to 0 if the current setting is not maintained.
1	24	B	Mode of torque control switching	0–3	—	Sets to 0 if the current setting is not maintained.
1	25	B	Delay time of torque control switching	0–10000	0.1 ms	Sets to 0 if the current setting is not maintained.
1	26	B	Level of torque control switching	0–20000	—	Sets to 0 if the current setting is not maintained.
1	27	B	Hysteresis at torque control switching	0–20000	—	Sets to 0 if the current setting is not maintained.

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

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function expansion setup	-32768–32767	—	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 = 0).
6	23	B	Load change compensation gain	-100–100	%	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	B	Load change compensation filter	10–2500	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	B	Load estimation filter	0–2500	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	B	Torque compensation frequency 1	0–5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	75	B	Torque compensation frequency 2	0–5000	0.1 Hz	Regardless value of the Pr 6.10 bit14 , sets to 0.
6	76	B	Load estimation count	0–8	-	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.

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

5) How to Operate

When Pr 0.02 “Real-time auto-gain tuning setup” is set to a value other than 0, control parameter is automatically set according to Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”.

When the servo is ON, enter operation command after about 100ms. When the load characteristic is correctly estimated, Pr 0.04 “Inertia ratio” is updated. With certain mode settings, Pr 6.07 “Torque command addition value”, Pr 6.08 “Positive direction compensation value” and Pr 6.09 “Negative direction compensation value” will be changed.

When value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” is increased, the motor responsiveness will be improved. Determine the most appropriate stiffness in relation to the positioning setup time and vibration condition.

6) Other cautions

[1] Immediately after the first servo-on upon start up; or after increasing Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”, abnormal sound or oscillation may be generated until the load characteristics is stabilized. If such abnormality lasts or repeats for 3 or more reciprocating operations, take the following countermeasures.

1) Lower the setting value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”.
2) Set Pr 0.02 “Real-time auto-gain tuning setup” to 0 to disable the real-time auto-tuning.
3) Set Pr 0.04 “Inertial ratio” to the calculational value of the equipment and set Pr 6.07 “Torque command addition value”, Pr 6.08 “Positive direction compensation value” and Pr 6.09 “Negative direction compensation value” to 0.
4) Disabling the load variation suppression function. (Pr6.10 bit14 = 0 and it was after bit1 = 0)

[2] When abnormal noise and oscillation occur, Pr 0.04 “Inertia ratio” or Pr 6.07 “Torque command additional value”, Pr 6.08 “Positive direction torque compensation value”, Pr 6.09 “Negative direction torque compensation value” might have changed to extreme values. Take the same measures as described in the step 3) above in these cases.

[3] Among the results of real-time auto-gain tuning, Pr 0.04 “Inertia ratio” and Pr 6.07 “Torque command additional value”, Pr 6.08 “Positive direction torque compensation value”, Pr 6.09 “Negative direction torque compensation value” will be written to EEPROM every 30 minutes. When you turn on the power again, the auto-gain tuning will be executed using the latest data as initial values. If power is turned off within 30 minutes after the end of tuning process, the result of the real-time auto-tuning is not saved. If the result is not saved, manually write parameters to EEPROM and then turn off power.

[4] The control gain is updated when the motor is stopped. Therefore, if motor is not stopped because gain is excessively low or commands are given continually in one direction, the change in Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” may not be reflected. In this case, abnormal sound or oscillation may be generated depending on the stiffness setting that is reflected after the motor stops.

After the stiffness setting is changed, be sure to stop the motor and check that the stiffness setting is reflected before performing next operation.

7) Basic gain parameter setup table

Stiffness	1st gain				2nd gain				For load fluctuation suppression function
	Pr 1.00	Pr 1.01	Pr 1.02	Pr 1.04	Pr 1.05	Pr 1.06	Pr 1.07 *1	Pr 1.09	Pr 6.24
	Position [0.1/s]	Velocity [0.1 Hz]	Velocity loop integration [0.1 ms]	Torque [0.01 ms]	Position [0.1/s]	Velocity [0.1 Hz]	Velocity loop 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

*1 In the vertical axis mode or friction compensation mode (Pr0.02=3, 4), Pr1.07 keeps 9999(hold) until load characteristics estimation completes.

5-1-2 Adaptive filter

This function estimates the resonance frequency from the vibrating component which appears on the motor velocity, and removes the resonance component from the torque command with adaptive filter, thus reduces the resonance vibration.

1) Applicable Range

This function works under the following condition.

	Conditions under which the Adaptive filter is activated
Control mode	Applies to other control modes than torque control.
Others	• Should be servo-on status. • The elements other than control parameters such as torque limit settings are correctly set, assuring that the motor can run smoothly.

2) Caution

In the following condition, normal operation may not be expected–manually set the notch filter to prevent resonance.

	Conditions which obstruct adaptive filter action
Resonance point	• Resonance frequency is lower than the velocity response frequency × 3 (Hz). • Resonance peak is low, or control gain is low where the motor velocity is not affected by this. • Three or more resonance points exist.
Load	• Motor velocity variation with high harmonic component is generated due to non-linear factors such as backlash.
Command	• Acceleration/deceleration is rapid such as 30000 [r/min] per 1 [s].

3) Relevant parameters

Set the operation of the adaptive filter to the following parameter.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	00	B	Adaptive filter mode setup	0–6	—	Select the operation mode of adaptive filter: Setup value 0: Adaptive filter: invalid The adaptive filter is disabled. Parameters related to the 3rd and 4th notch filter hold the current value. Setup value 1: Adaptive filter: 1 filter is valid One adaptive filter is enabled. Parameters related to the 3rd notch filter will be updated based on adaptive performance. Setup value 2: Adaptive filter: 2 filters are valid Two adaptive filters are enabled. Parameters related to the 3rd and 4th notch filters will be updated based on adaptive performance. Setup value 3: Resonance frequency measurement mode Measure the resonance frequency. Result of measurement can be checked with the setup support software PANATERM. Parameters related to the 3rd and 4th notch filter hold the current value. Setup value 4: Clear result of adaptation Parameters related to the 3rd and 4th notch filter are disabled and results of adaptive operation are cleared. Setup value 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. Setup value 6: For manufacturer's use It is the fit gain function of setup support software PANATERM, and internally used. Do not use this setting in normal conditions.

(To be continued)

The adaptive filter automatically sets up the following parameters.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	07	B	3rd notch frequency	50–5000	Hz	Notch frequency is automatically set to the 1st resonance frequency estimated by the adaptive filter. In no resonance point is found, the frequency is set to 5000.
2	08	B	3rd notch width selection	0–20	—	Automatically set when the adaptive filter is active.
2	09	B	3rd notch depth selection	0–99	—	Automatically set when the adaptive filter is active.
2	10	B	4th notch frequency	50–5000	Hz	Notch frequency is automatically set to the 2nd resonance frequency estimated by the adaptive filter. In no resonance point is found, the frequency is set to 5000.
2	11	B	4th notch width selection	0–20	—	Automatically set when 2 adaptive filters are active or in case of high accurate adaptive filter.
2	12	B	4th notch depth selection	0–99	—	Automatically set when 2 adaptive filters are active or in case of high accurate adaptive filter.

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

4) How to Operate

Enter the action command with Pr2.00 “Adaptive filter mode setup” set to a value other than 0.
If the resonance point affects the motor velocity, parameters of 3rd notch filter and/or 4th notch filters are automatically set according to the number of adaptive filters.

5) Other cautions

(1) Immediately after the first servo-on at start up; or after increasing stiffness setting with the real-time auto-tuning enabled, abnormal sound or oscillation may be generated until the adaptive filter stabilizes. If such abnormality lasts or repeats for 3 or more reciprocating operations, take the following countermeasures.
   1) Write the parameters which have given the normal operation into EEPROM.
   2) Lower the setting value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”.
   3) Invalidate the adaptive filter by setting Pr2.00 “Adaptive filter mode setup” to 0.
   4) Set up the notch filter manually.

(2) Abnormal sound or oscillation may excessively change the setup value of 3rd and 4th notch filters. If such change occurs, disable the adaptive filter as described in step 3) above, change setup value of Pr 2.07 “3rd notch frequency” and Pr 2.10 “4th notch frequency” to 5000 (disable), and then enable the adaptive filter again.

(3) The 3rd filters (Pr 2.07) and 4th notch filters (Pr 2.10) are written to EEPROM every 30minutes. Upon power up, these data are used as default values during adaptive process.

5-1-3 Real-time Auto Tuning (Two-degree-of-freedom control mode Standard type)

The Two-degree-of-freedom control mode has two types: standard type and synchronization type.
Standard type : This is a standard mode. Use this mode normally.
Synchronization type : Use this mode for locus control of multiple axes of an articulated robot, etc.

This item is an auto tuning function exclusive for the standard type.

Load characteristic of a machine is estimated on a real-time basis, and using the results, basic gain settings and friction compensation are automatically specified in accordance of hardness parameters.

1) Scope of application

This function is enabled under the following conditions:

	Conditions for real-time auto tuning
Control mode	Position Control, Velocity control or Full-closed control Pr6.47 bit0=1 and bit3=0: Two-degree-of-freedom control mode Standard type
Other	· Should be in servo-on condition · Parameters except control parameters such as torque limit settings are correctly set, assuring that the motor can run smoothly.

2) Cautions

- After the power is turned on, estimate value following may become quicker regardless of Pr6.31 “Real-time auto tuning estimation speed” until operation data effective for the estimation of load characteristics is sufficiently accumulated.

- When real-time auto-gain tuning is effective, an estimate value may become abnormal due to disturbance. If you want to obtain stable operation from when the power is turned on, it is recommended to disable the real-time auto-gain tuning.

Real-time auto-gain tuning may not be executed properly under the conditions described below. If not properly executed, change the loading condition or operating pattern, or manually set up the related parameters by referring to the manual adjustment function description.

	Conditions hindering real-time auto tuning
Load condition	· The load mass is too small or large with reference to the rotor mass (smaller than three times or 20 times or larger). · The load mass varies. · The mechanical stiffness is extremely low. · Any non-linear characteristic exists such as backlash.
Operation pattern	· Continuous use at a low speed of less than 100 [mm/s] · The acceleration is low at 2000 [mm/s] per 1 [s]. · A speed at 100 [mm/s] or higher or a acceleration/deceleration of 2000 [mm/s] per 1 [s] does not continue for 50 [ms] or longer. · The acceleration/deceleration torque is small with reference to the uneven load/ viscous friction torque.

3) Parameters controlling operation of real-time auto tuning

Configure the real-time auto tuning operation by setting the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>02</td><td>B</td><td>Real-time auto-gain tuning setup</td><td>0–6</td><td>—</td><td>Specifies the operation mode of real-time auto tuning.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Invalid</td><td>The real-time auto tuning function is disabled.</td></tr>
<tr><td>1</td><td>Standard response mode</td><td>The mode for the optimum stability.
No uneven load or friction compensation takes place and no gain switching is used.</td></tr>
<tr><td>2</td><td>High response mode 1</td><td>The mode for the optimum positioning. Used for a ball screw-driven device, etc. with no uneven load and little friction, as in a horizontal axis.</td></tr>
<tr><td>3</td><td>High response mode 2</td><td>In addition to the high responce mode 1, compensation against biased load and application of 3rd gain are made to reduce variations in settling time of positioning.</td></tr>
<tr><td>4</td><td>High response mode 3
*1</td><td>In addition to the high responce mode 2, settling time of positioning is reduced for a load where frictions are high.</td></tr>
<tr><td>5</td><td>Load characteristic measurement</td><td>Basic gain settings and friction compensation settings are not changed and load characteristic estimation only is made. This is used in combination with set-up support software(PANATERM).</td></tr>
<tr><td>6</td><td>Fit-gain mode</td><td>Use this mode to fine-adjust the stiffness setting after fit-gain has been completed.</td></tr>
</table>
*1: In velocity control, it is the same as high response mode 2. In addition, Parameters of Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value” 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>B</td><td>Selection of machine stiffness at real-time auto-gain tuning</td><td>0–31</td><td>—</td><td>Specifies the response for enabled real-time auto tuning. A larger setting increases the speed response and servo stiffness but invites more vibration. Gradually increase the setting while monitoring the operation.</td></tr>
<tr><td>6</td><td>10</td><td>B</td><td>Function expansion setup</td><td>-32768–32767</td><td>—</td><td>The automatic adjustment of load change inhibit function is enabled with bit14=1.</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</td><td>B</td><td>Real time auto tuning estimation speed</td><td>0–3</td><td>—</td><td>Specifies the load characteristics estimation speed for enabled real-time auto tuning. A larger setting allows faster follow-up to the variation in the load characteristics but also increases estimation fluctuation due to disturbance. The result of estimation is stored in the EEPROM every 30 minutes.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>No change</td><td>Terminates estimation of load characteristic.</td></tr>
<tr><td>1</td><td>Little change</td><td>Responded against change of load characteristic on the order of minutes.</td></tr>
<tr><td>2</td><td>Gradual change</td><td>Responded against change of load characteristic on the order of seconds.</td></tr>
<tr><td>3 *</td><td>Steep change</td><td>Appropriate estimation is made against change of load characteristic.</td></tr>
</table>
* If oscillation automatic detection is made valid from set-up support software (PANATERM), this setting is ignored and operation is based on settings of setting value 3.</td></tr>
<tr><td>6</td><td>32</td><td>B</td><td>Real time auto tuning custom setup</td><td>-32768–32767</td><td>—</td><td>Not available in two-degrees-of-freedom control mode.
Always set to 0.</td></tr>
</table>

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

4) Parameter changed by real-time auto tuning

The real-time auto tuning function updates the following parameters using load characteristic values, in accordance with Pr0.02 "Real-time auto-gain tuning setup."

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	04	B	Inertia ratio	0–10000	%	Updates this parameter when the real-time auto tuning inertia ratio update is enabled (Pr0.02=1 to 4).
6	07	B	Torque command additional value	-100–100	%	Updates this parameter when high response mode 2 or 3 (Pr0.02=3,4) for real-time auto tuning is selected.
6	08	B	Positive direction torque compensation value	-100–100	%	Updates this parameter when high response mode 3 (Pr0.02=4) for real-time auto tuning is selected.
6	09	B	Negative direction torque compensation value	-100–100	%	Updates this parameter when high response mode 3 (Pr0.02=4) for real-time auto tuning is selected.
6	50	B	Viscous friction compensation gain	0–10000	0.1%/(10000r/min)	Updates this parameter when high response mode 3 (Pr0.02=4) for real-time auto tuning is selected.

The real-time auto tuning function updates the following basic gain setup parameters according to Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”. For details, refer to 7) Basic gain parameter settings table.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	00	B	1st gain of position loop	0–30000	0.1/s	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	01	B	1st gain of velocity loop	1–32767	0.1 Hz	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	02	B	1st time constant of velocity loop integration	1–10000	0.1 ms	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	04	B	1st time constant of torque filter	0–2500	0.01 ms	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	05	B	2nd gain of position loop	0–30000	0.1/s	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	06	B	2nd gain of velocity loop	1–32767	0.1 Hz	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	07	B	2nd time constant of velocity loop integration	1–10000	0.1 ms	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
1	09	B	2nd time constant of torque filter	0–2500	0.01 ms	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value.
2	22	B	Command smoothing filter	0–10000	0.1 ms	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value. In velocity control, it is fixed to primary filter.
6	48	B	Adjust filter	0–2000	0.1 ms	When real-time auto tuning is valid (Pr0.02=1 to 4,6), updates the parameter based on the setup value. In velocity control, it is fixed to primary filter.

Real-time auto-tuning function sets the following parameters to the fixed value.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	03	B	1st filter of velocity detection	0–5	–	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 0.
1	08	B	2nd filter of velocity detection	0–5	–	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 0.
1	10	B	Velocity feed forward gain	0–4000	0.1%	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 1000 (100%).
1	11	B	Velocity feed forward filter	0–6400	0.01 ms	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 0 (invalid).

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	12	B	Torque feed forward gain	0–2000	0.1%	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 1000 (100%).
1	13	B	Torque feed forward filter	0–6400	0.01 ms	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 0 (invalid).
6	10	B	Function expansion setup	-32768–32767	–	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to bit4=1.
6	49	B	Adjust/Torque command attenuation term	0–99	–	When real-time auto tuning is valid (Pr0.02=1 to 4), set the parameter to 15. When Pr0.02=6, set the tenths digit to 1 and maintain the unit digit.

The real-time automatic tuning sets the following parameters depending on Pr0.02 “Real-time auto-gain tuning setup”.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	14	B	2nd gain setup	0–1	–	Sets to 1 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	15	B	Mode of position control switching	0–10	–	For the standard response mode (Pr0.02=1), set the parameter to 0. For high response mode 1 to 3 (Pr0.02=2 to 4), set the parameter to 7.
1	16	B	Delay time of position control switching	0–10000	0.1 ms	Sets to 10 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	17	B	Level of position control switching	0–20000	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	18	B	Hysteresis at position control switching	0–20000	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	19	B	Position gain switching time	0–10000	0.1 ms	Sets to 10 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	20	B	Mode of velocity control switching	0–5	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	21	B	Delay time of velocity control switching	0–10000	0.1 ms	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	22	B	Level of velocity control switching	0–20000	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	23	B	Hysteresis at velocity control switching	0–20000	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	24	B	Mode of torque control switching	0–3	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	25	B	Delay time of torque control switching	0–10000	0.1 ms	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	26	B	Level of torque control switching	0–20000	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
1	27	B	Hysteresis at torque control switching	0–20000	–	Sets to 0 if real-time auto tuning is valid (Pr0.02=1 to 4).
6	05	B	Position 3rd gain valid time	0–10000	0.1 ms	For the standard response mode or high response mode 1 (Pr0.02=1, 2), set the parameter to 0 (invalid). For high response mode 2 or 3 (Pr0.02=3,4), set the parameter to "Pr2.22 × 20". (However, the maximum value is limited to 10000.)
6	06	B	Position 3rd gain scale factor	50–1000	%	For the standard response mode or high response mode 1 (Pr0.02=1,2), set the parameter to 100 (100%). For high response mode 2 or 3 ((Pr0.02=3,4), set the parameter to 200 (200%).

When Pr0.02 “Real-time auto-gain tuning setup” = 1 to 4 or 6,the following settings and parameters are set automatic for enable/disable state of Pr 6.10 “Function expansion setup” load variation suppression function automatic adjustment.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function extension setup	-32768 –32767	-	When set to Pr 6.10 bit14=1, load variation suppression function will become enabled (bit1 = 1). When set to Pr 6.10 bit14=0,it is disabled(bit1 = 0).
6	23	B	Load change compensation gain	-100 –100	%	When set to Pr 6.10 bit14=1, sets to 90%. When set to Pr 6.10 bit14=0, set to 0%.
6	24	B	Load change compensation filter	10– 2500	0.01 ms	When set to Pr 6.10 bit14=1, updates to match rigidity. When set to Pr 6.10 bit14=0, value is held.
6	73	B	Load estimation filter	0–2500	0.01 ms	When set to Pr 6.10 bit14=1, sets to 0.13 ms. When set to Pr 6.10 bit14=0, set to 0 ms.
6	74	B	Torque compensation frequency 1	0–5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	75	B	Torque compensation frequency 2	0–5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	76	B	Load estimation count	0–8	-	When set to Pr 6.10 bit14=1, sets to 4. When set to Pr 6.10 bit14=0, set to 0.

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

5) Usage

When Pr 0.02 “Real-time auto-gain tuning setup” is set to a value other than 0, control parameter is automatically set according to Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”.
When the servo is ON, enter operation command after about 100ms. When the load characteristic is correctly estimated, Pr 0.04 “Inertia ratio” is updated. With certain mode settings, Pr 6.07 “Torque command addition value”, Pr 6.08 “Positive direction compensation value”, Pr6.09 “Negative direction torque compensation value”, and Pr6.50 “Viscous friction compensation gain” will be changed.
When value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” is increased, the motor responsiveness will be improved. Determine the most appropriate stiffness in relation to the positioning setup time and vibration condition.

6) Other cautions

[1] Strange noises or vibrations may occur on the first action of turning on the servo immediately after startup or setting higher value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” until estimation of load characteristic becomes stable. This is not a fault if the function becomes stable soon. If oscillation or continued generation of abnormal noise through three or more reciprocating movements often occurs, take the following steps.

1) Specify lower value for Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”
2) Specify "0" for Pr0.02 “Real-time auto-gain tuning setup” and make real-time auto tuning invalid.
3) Specify a theoretical value of device for Pr0.04 “Inertia ratio” and specify "0" for Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value” and Pr6.50 “Viscous friction compensation gain”.
4) Disabling the load variation suppression function. (Pr6.10 bit14 = 0 and it was after bit1 = 0)

[2] After occurrence of strange noises or vibrations, values of Pr0.04 “Inertia ratio”, Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value”, or Pr6.50 “Viscous friction compensation gain” may have been changed into extreme values. If this is the case, take Step 3) above.

[3] The results of real-time automatic gain tuning, such as Pr0.04 “Inertia ratio”, Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value”, and Pr6.50 “Viscous friction compensation gain” are written in EEPROM in every 30 minutes. Upon restarting of power, auto tuning is performed using the data for initial values. The results of real-time auto gain tuning are not stored if the power is turned off before 30 minutes have elapsed. In this case, manually write the parameters to the EEPROM before turning off the power.

[4] The control gain is updated when the motor is stopped. Therefore, if motor is not stopped because gain is excessively low or commands are given continually in one direction, the change in Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” may not be reflected. In this case, abnormal sound or oscillation may be generated depending on the stiffness setting that is reflected after the motor stops.
After the stiffness setting is changed, be sure to stop the motor and check that the stiffness setting is reflected before performing next operation.
When real-time automatic tuning is valid in torque control under two-degrees-of-freedom control mode, it operates with Pr1.12=0 within the amplifier regardless of the setting value in Pr1.12 “Torque feed forward gain.”
The state in which it operates with torque feed forward invalid will continue until the next operation is executed.
・Pr1.12 is set to a value other than the current parameter (1000) after real-time automatic tuning is switch.

7) Basic gain parameter settings table

Stiffness	1st gain / 2nd gain				Command response		Adjust 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]	Speed [0.1 Hz]	Velocity integral [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 mode 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 Auto Tuning (Two-degree-of-freedom control mode Synchronization type)

The Two-degree-of-freedom control mode has two types: standard type and synchronization type.
Standard type: This is a standard mode. Use this mode normally.
Synchronization type: Use this mode for locus control of multiple axes of an articulated robot, etc.

This item is an auto tuning function exclusive for the synchronization type.

Load characteristic of a machine is estimated on a real-time basis, and using the results, basic gain settings and load fluctuation compensation are automatically specified in accordance of hardness parameters.

1) Scope of application

This function is enabled under the following conditions:

	Conditions for real-time auto tuning
Control mode	Position Control Pr6.47 bit0=1 and bit3=1: Two-degree-of-freedom control mode Synchronization type
Other	· Should be in servo-on condition · Parameters except control parameters such as torque limit settings are correctly set, assuring that the motor can run smoothly.

2) Cautions

- After the power is turned on, estimate value following may become quicker regardless of Pr6.31 “Real-time auto tuning estimation speed” until operation data effective for the estimation of load characteristics is sufficiently accumulated.

- When real-time auto-gain tuning is effective, an estimate value may become abnormal due to disturbance. If you want to obtain stable operation from when the power is turned on, it is recommended to disable the real-time auto-gain tuning.

Real-time auto-gain tuning may not be executed properly under the conditions described below. If not properly executed, change the loading condition or operating pattern, or manually set up the related parameters by referring to the manual adjustment function description.

	Conditions hindering real-time auto tuning
Load condition	· The load mass is too small or large with reference to the rotor mass (smaller than three times or 20 times or larger). · The load mass varies. · The mechanical stiffness is extremely low. · Any non-linear characteristic exists such as backlash.
Operation pattern	· Continuous use at a low speed of less than 100 [mm/s] · The acceleration is low at 2000 [mm/s] per 1 [s]. · A speed at 100 [mm/s] or higher or a acceleration/deceleration of 2000 [mm/s] per 1 [s] does not continue for 50 [ms] or longer. · The acceleration/deceleration torque is small with reference to the uneven load/ viscous friction torque.

3) Parameters controlling operation of real-time auto tuning
Configure the real-time auto tuning operation by setting the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>02</td><td>B</td><td>Real-time auto-gain tuning setup</td><td>0–6</td><td>–</td><td>Specifies the operation mode of real-time auto tuning.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Invalid</td><td>The real-time auto tuning function is disabled.</td></tr>
<tr><td>1</td><td>Synchronization</td><td>Mode for synchronization control.
Offset load compensation and friction compensation are not performed. The command filter will be maintained. Use this mode first. If there is any problem, use the other mode.</td></tr>
<tr><td>2</td><td>Synchronous friction compensation</td><td>In addition to the synchronization mode, dynamic friction/viscous friction compensation is applied. Use this mode for a load with large friction.</td></tr>
<tr><td>3</td><td>Stiffness setup</td><td>Inertia ratio estimation, offset load compensation, and friction compensation are not performed, and only the gain filter setup corresponding to the stiffness table is updated. For a load with large inertia variations, estimate the inertia in the synchronization mode, etc., and then use this mode.</td></tr>
<tr><td>4</td><td>Load characteristic update</td><td>In the gain filter setup, only the inertia ratio and dynamic friction/viscous friction compensation are applied among load characteristics.</td></tr>
<tr><td>5</td><td>Load characteristic measurement</td><td>Basic gain settings and friction compensation settings are not changed and load characteristic estimation only is made. This is used in combination with set-up support software (PANATERM).</td></tr>
<tr><td>6</td><td>Load change support mode</td><td>Use this mode to make robust adjustments in load change.</td></tr>
</table></td></tr>
<tr><td>0</td><td>03</td><td>B</td><td>Selection of machine stiffness at real-time auto-gain tuning</td><td>0–31</td><td>–</td><td>Specifies the response for enabled real-time auto tuning.
A larger setting increases the speed response and servo stiffness but invites more vibration.
Gradually increase the setting while monitoring the operation.</td></tr>
<tr><td>6</td><td>10</td><td>B</td><td>Function expansion setup</td><td>-32768 –32767</td><td>—</td><td>The automatic adjustment of load change inhibit function is enabled with Bit14=1.</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</td><td>B</td><td>Real time auto tuning estimation speed</td><td>0–3</td><td>–</td><td>Specifies the load characteristics estimation speed for enabled real-time auto tuning. A larger setting allows faster follow-up to the variation in the load characteristics but also increases estimation fluctuation due to disturbance. The result of estimation is stored in the EEPROM every 30 minutes.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>No change</td><td>Terminates estimation of load characteristic.</td></tr>
<tr><td>1</td><td>Little change</td><td>Responded against change of load characteristic on the order of minutes.</td></tr>
<tr><td>2</td><td>Gradual change</td><td>Responded against change of load characteristic on the order of seconds.</td></tr>
<tr><td>3 *</td><td>Steep change</td><td>Appropriate estimation is made against change of load characteristic.</td></tr>
</table>
* If oscillation automatic detection is made valid from set-up support software (PANATERM), this setting is ignored and operation is based on settings of setting value 3.</td></tr>
<tr><td>6</td><td>32</td><td>B</td><td>Real time auto tuning custom setup</td><td>-32768–32767</td><td>–</td><td>Not available in two-degrees-of-freedom control mode.
Always set to 0.</td></tr>
</table>

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

4) Parameters changed by real-time auto-tuning

The real-time auto-tuning function updates the following parameters according to Pr0.02 “Real-time auto-gain tuning setup” by using the load characteristic estimate value.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	04	B	Inertia ratio	0–10000	%	Updates this parameter in the case of the synchronization mode (Pr0.02=1), synchronous friction compensation mode (Pr0.02=2) and load characteristic update mode (Pr0.02=4) for real-time auto-tuning.
6	08	B	Positive direction torque compensation value	-100–100	%	Updates this parameter in the case of the synchronous friction compensation mode (Pr0.02=2) and load characteristic update mode (Pr0.02=4) for real-time auto-tuning.
6	09	B	Negative direction torque compensation value	-100–100	%	Updates this parameter in the case of the synchronous friction compensation mode (Pr0.02=2) and load characteristic update mode (Pr0.02=4) for real-time auto-tuning.
6	50	B	Viscous friction compensation gain	0–10000	0.1%/(10000 r/min)	Updates this parameter in the case of the synchronous friction compensation mode (Pr0.02=2) and load characteristic update mode (Pr0.02=4) for real-time auto-tuning.

The real-time auto tuning function updates the following basic gain setup parameters according to Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”. For details, refer to 7) Basic gain parameter settings table.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	00	B	1st gain of position loop	0–30000	0.1/s	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	01	B	1st gain of velocity loop	1–32767	0.1Hz	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	02	B	1st time constant of velocity loop integration	1–10000	0.1ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	04	B	1st time constant of torque filter	0–2500	0.01ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	05	B	2nd gain of position loop	0–30000	0.1/s	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	06	B	2nd gain of velocity loop	1–32767	0.1Hz	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	07	B	2nd time constant of velocity loop integration	1–10000	0.1ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
1	09	B	2nd time constant of torque filter	0–2500	0.01ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.
6	48	B	Adjust filter	0–2000	0.1ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), updates the parameter based on the setup value.

(To be continued)

Real-time auto-tuning function sets the following parameters to the fixed value.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	03	B	1st filter of velocity detection	0–5	–	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to 0.
1	08	B	2nd filter of velocity detection	0–5	–	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to 0.
1	10	B	Velocity feed forward gain	0–4000	0.1%	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to 1000 (100%).
1	11	B	Velocity feed forward filter	0–6400	0.01ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to 0 (invalid).
1	12	B	Torque feed forward gain	0–2000	0.1%	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to 1000 (100%).
1	13	B	Torque feed forward filter	0–6400	0.01ms	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to 0 (invalid).
6	7	B	Torque command additional value	-100–100	%	In the case of the synchronous friction compensation mode (Pr0.02=2) or load characteristic update mode (Pr0.02=4), set the parameter to 0.
6	10	B	Function expansion setup	-32768–32767	–	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the parameter to bit4=1.
6	49	B	Adjust/Torque command attenuation term	0–99	–	In the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6), set the tenths digit to 1 and maintain the unit digit.

The real-time automatic tuning sets the following parameters or uses the current settings, depending on Pr0.02 “Real-time auto-gain tuning setup”.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	14	B	2nd gain setup	0–1	–	Sets to 1 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	15	B	Mode of position control switching	0–10	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	16	B	Delay time of position control switching	0–10000	0.1ms	Sets to 10 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	17	B	Level of position control switching	0–20000	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	18	B	Hysteresis at position control switching	0–20000	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	19	B	Position gain switching time	0–10000	0.1ms	Sets to 10 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	20	B	Mode of velocity control switching	0–5	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	21	B	Delay time of velocity control switching	0–10000	0.1ms	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	22	B	Level of velocity control switching	0–20000	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	23	B	Hysteresis at velocity control switching	0–20000	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	24	B	Mode of torque control switching	0–3	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	25	B	Delay time of torque control switching	0–10000	0.1ms	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	26	B	Level of torque control switching	0–20000	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).
1	27	B	Hysteresis at torque control switching	0–20000	–	Sets to 0 if the case of the synchronization mode, synchronous friction compensation mode, stiffness setup mode, or load change support mode (Pr0.02=1 to 3, 6).

In case Pr 0.02 “Real-time auto-gain tuning setup” = 1 to 3, the following settings and parameters are set automatic for enable/disable state of Pr 6.10 “Function expansion setup” load variation suppression function automatic adjustment.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function extension setup	-32768 –32767	-	When set to Pr 6.10 bit14=1, load variation suppression function will become enabled (bit1 = 1). When set to Pr 6.10 bit14=0,it is disabled(bit1 = 0).
6	23	B	Load change compensation gain	-100–100	%	When set to Pr 6.10 bit14=1, sets to 90%. When set to Pr 6.10 bit14=0, set to 0%.
6	24	B	Load change compensation filter	10–2500	0.01 ms	When set to Pr 6.10 bit14=1, updates to match rigidity. When set to Pr 6.10 bit14=0, value is held.
6	73	B	Load estimation filter	0–2500	0.01 ms	When set to Pr 6.10 bit14=1, sets to 0.13 ms. When set to Pr 6.10 bit14=0, set to 0 ms.
6	74	B	Torque compensation frequency 1	0–5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	75	B	Torque compensation frequency 2	0–5000	0.1 Hz	Regardless value of the Pr 6.10 bit 14, sets to 0.
6	76	B	Load estimation count	0–8	-	When set to Pr 6.10 bit14=1, sets to 4. When set to Pr 6.10 bit14=0, set to 0.

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

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function extension setup	-32768 –32767	-	Load fluctuation suppression function always become enabled (bit1 = 1, bit2=1, bit14=1)
6	23	B	Load change compensation gain	-100–100	%	Sets to 100%.
6	24	B	Load change compensation filter	10–2500	0.01 ms	Updates to match rigidity.
6	73	B	Load estimation filter	0–2500	0.01 ms	Sets to 0.13 ms.
6	74	B	Torque compensation frequency 1	0–5000	0.1 Hz	Updates to match rigidity.
6	75	B	Torque compensation frequency 2	0–5000	0.1 Hz	Updates to match rigidity.
6	76	B	Load estimation count	0–8	-	Sets to 4.

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

5) How to operate

When Pr0.02 “Real-time auto-gain tuning setup” is set to a value other than 0, control parameter is automatically set according to Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”.
Enter an operation command when about 100 ms has elapsed after the servo was turned ON. When the load characteristic is correctly estimated, Pr0.04 “Inertia ratio” is updated. With certain mode settings, Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value”, and Pr6.50 “Viscous friction compensation gain” will also be changed.
When the value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” is increased, the motor responsiveness will be improved. Determine the most appropriate stiffness in relation to the positioning setup time and vibration condition.

6) Other cautions

[1] Immediately after the first servo-on upon start up; or after increasing Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”, abnormal sound or oscillation may be generated until the load characteristics estimation is stabilized. It is not an abnormality if the load characteristic estimation is stabilized soon. If oscillation or abnormal sound lasts or repeats for 3 or more reciprocating operations, however, take the following countermeasures.
   1) Lower the setting value of Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning”.
   2) Set Pr0.02 “Real-time auto-gain tuning setup” to 0 to disable the real-time auto-tuning.
   3) Set Pr 0.04 “Inertial ratio” to the calculational value of the equipment and set Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value”, and Pr6.50 “Viscous friction compensation gain” to 0.
   4) Disabling the load variation suppression function. (Pr6.10 bit14 = 0 and it was after bit1 = 0)

[2] When abnormal noise and oscillation occurs, Pr0.04 “Inertia ratio”, Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value”, and Pr6.50 “Viscous friction compensation gain” might have changed to extreme values. Take the same measures as described in step 3) above in these cases.

[3] Among the results of real-time auto-gain tuning, Pr0.04 “Inertia ratio”, Pr6.07 “Torque command additional value”, Pr6.08 “Positive direction torque compensation value”, Pr6.09 “Negative direction torque compensation value”, and Pr6.50 “Viscous friction compensation gain” will be written to EEPROM every 30 minutes. When you turn on the power again, auto-tuning will be executed using the latest data as initial values. If power is turned off within 30 minutes after the end of the tuning process, the result of the real-time auto-gain tuning is not saved. If the result is not saved, manually write parameters to EEPROM and then turn off power.

[4] The control gain is updated when the motor is stopped. Therefore, if the motor is not stopped because gain is excessively low or commands are given continually in one direction, the change in the set value for Pr0.03 “Selection of machine stiffness at real-time auto-gain tuning” may not be reflected. In this case, abnormal sound or oscillation may be generated depending on the stiffness setting that is reflected after the motor stops.
After the stiffness setting is changed, be sure to stop the motor once and check that the stiffness setting has been reflected before performing the next operation.

7) Basic gain parameter setup table

Stiffness	1st gain/2nd gain				Adjust 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

As explained previously, MINAS-A6N series features the automatic gain tuning function, however, there might be some cases where this automatic gain tuning cannot be adjusted properly depending on the limitation on load conditions. Or you might need to readjust the tuning to obtain the optimum response or stability corresponding to each load.

Here we explain this manual gain tuning method by each control mode and function.

1) Block diagram of position control mode (5-2-1)
2) Block diagram of velocity control mode (5-2-2)
3) Block diagram of torque control mode (5-2-3)
4) Block diagram of full-closed control mode (5-2-4)
5) Gain switching function (5-2-5)
6) Notch filter (5-2-6)
7) Damping control (5-2-7)
8) Model type damping filter (5-2-8)
9) Feed forward function (5-2-9)
10) Load variation suppression function (5-2-10)
11) 3rd gain switching function (5-2-11)
12) Friction torque compensation (5-2-12)
13) Hybrid vibration suppression function (5-2-13)
14) Two-stage torque filter (5-2-14)
15) Quadrant projection suppression function (5-2-15)
16) Two-degree-of-freedom control mode (with position control) (5-2-16)
17) Two-degree-of-freedom control mode (with velocity control) (5-2-17)
18) Two-degree-of-freedom control mode (with full-closed control) (5-2-18)
19) Virtual full-closed control mode function (5-2-19)

5-2-1 Block diagram of position control mode

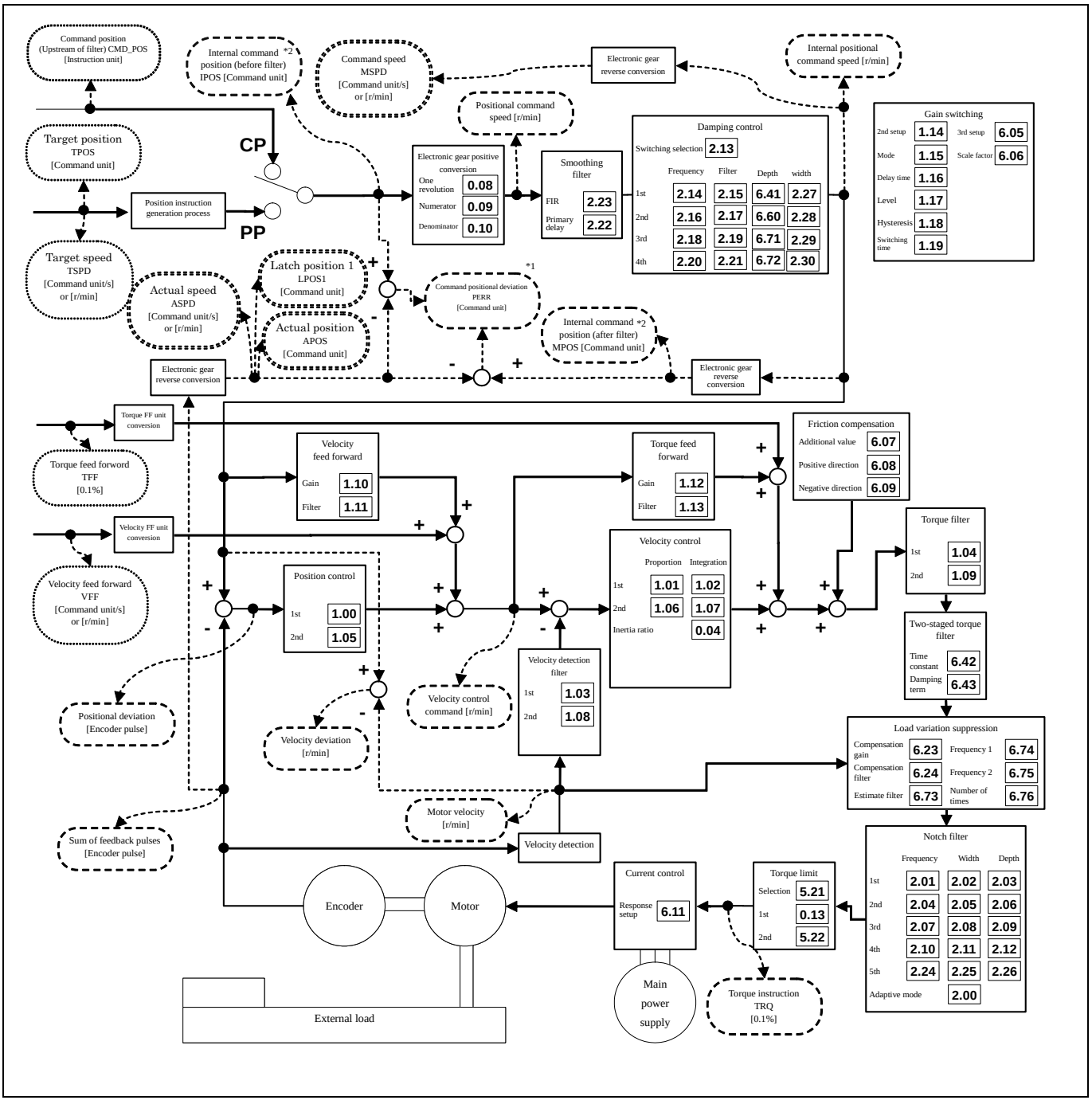
The diagram below shows position control block of MINAS-A6N series.

- Profile position control mode (PP)
- Cyclic position control mode (CP)

RTEX command data

RTEX monitor data

PANATERM/RTEX monitor data



Block diagram of position control

*1 The computation reference for the command positional deviation [command unit] can be changed by bit14 for Pr7.23 "RTEX function extended setup 2".

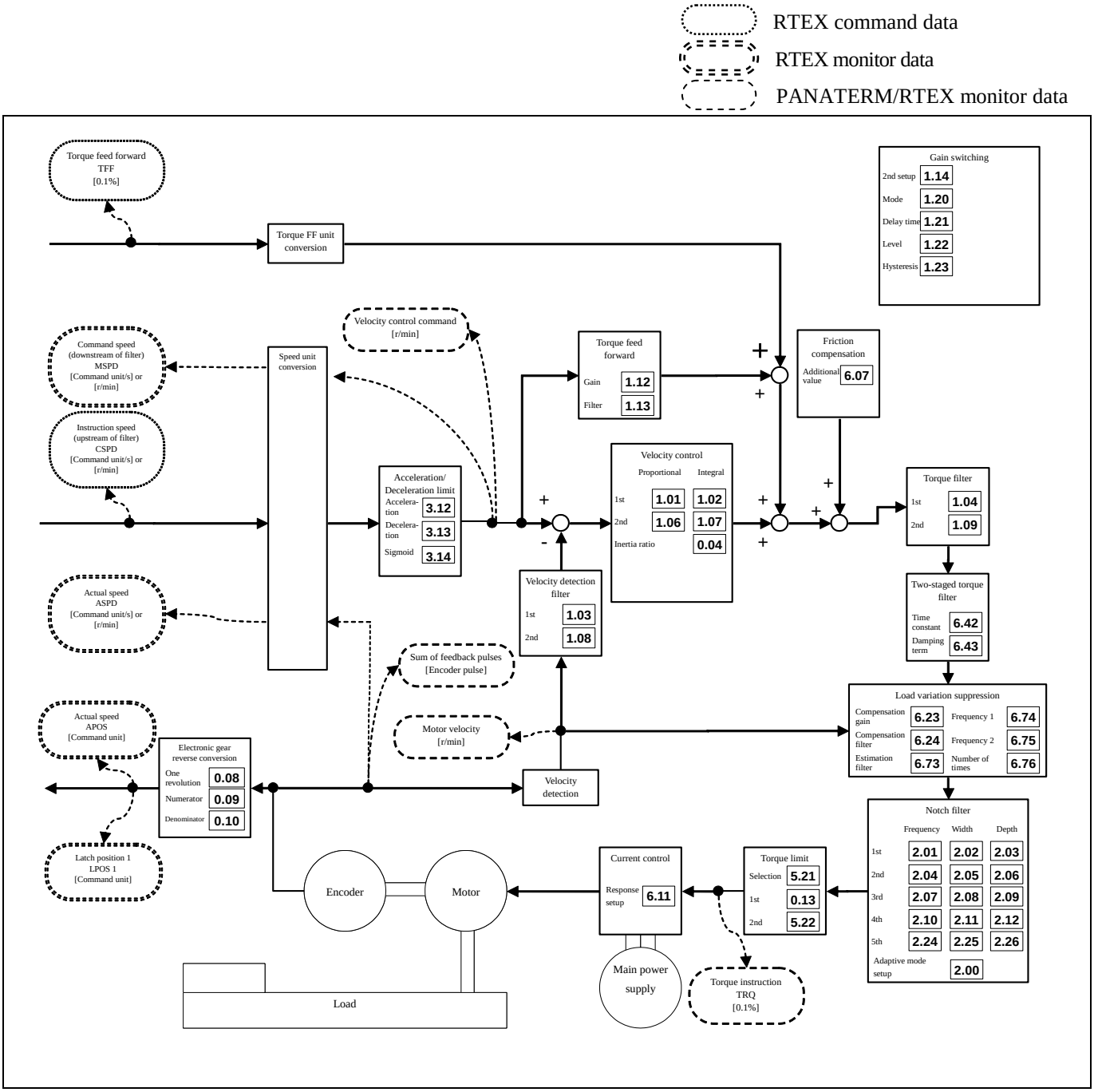
*2 The position command on PANATERM can be switched depending on the setting of the bit3 "Command pulse accumulation value" of Pr7.99 "RTEX function extended setup 6".

*3 When performing test run function, Z phase search, Frequency characteristic analysis (position loop characteristic) from the PANATERM, the driver switches to position control mode internally.

5-2-2 Block diagram of velocity control mode

The diagram below shows velocity control block of MINAS-A6N series.

• Cyclic velocity control mode (CV)



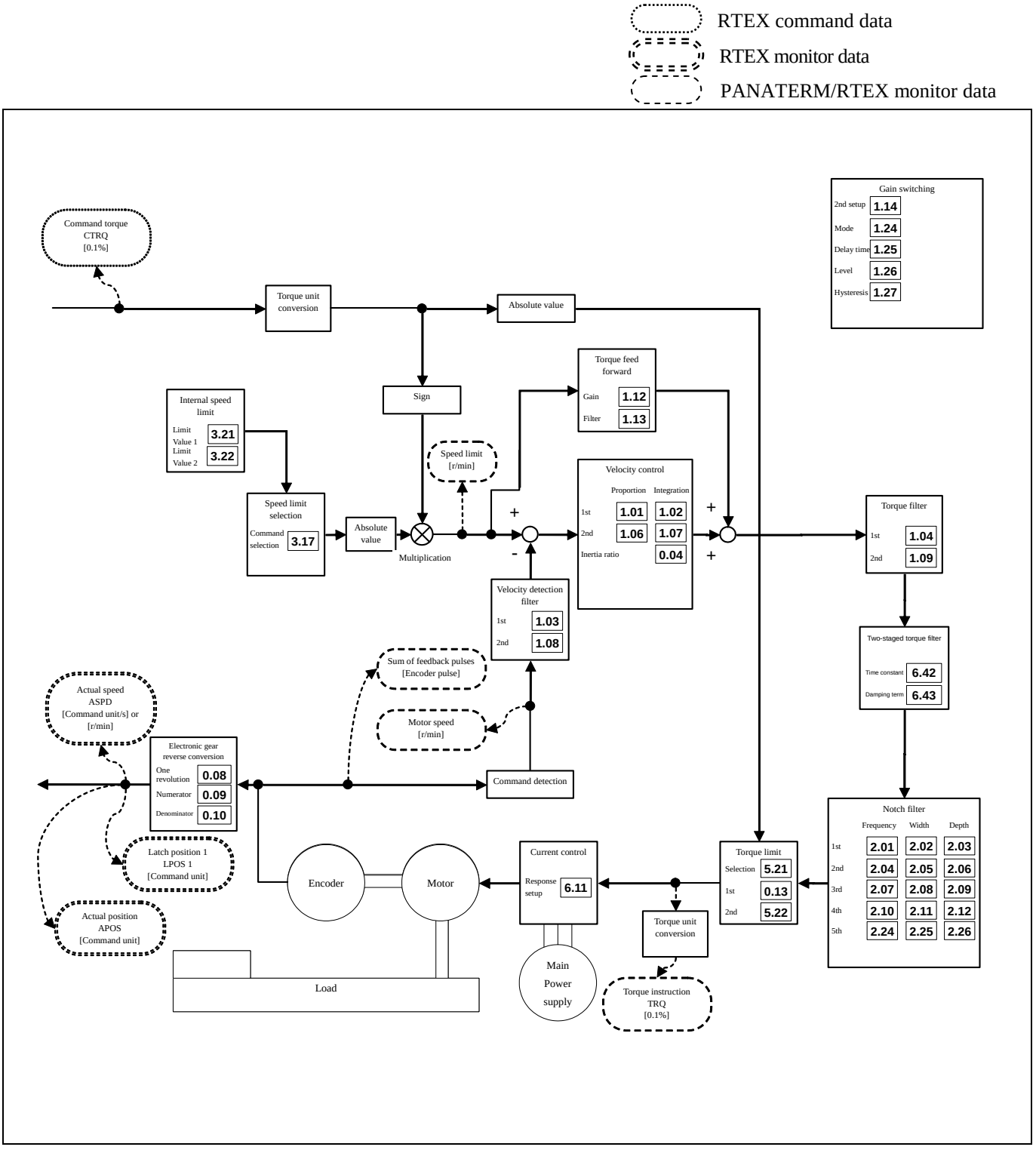
Block diagram of velocity control

*1 When performing Frequency characteristic analysis (speed close loop characteristic, Torque speed(Vertical)) from the PANATERM, the driver switches to velocity control mode internally.

5-2-3 Block diagram of torque control mode

The diagram below shows the torque control block of MINAS-A6N series.

• Cyclic torque control mode (CT)



Block diagram of torque control

*1 When performing Frequency characteristic analysis (Torque speed (normal)) from the PANATERM, the driver switches to torque control mode internally.

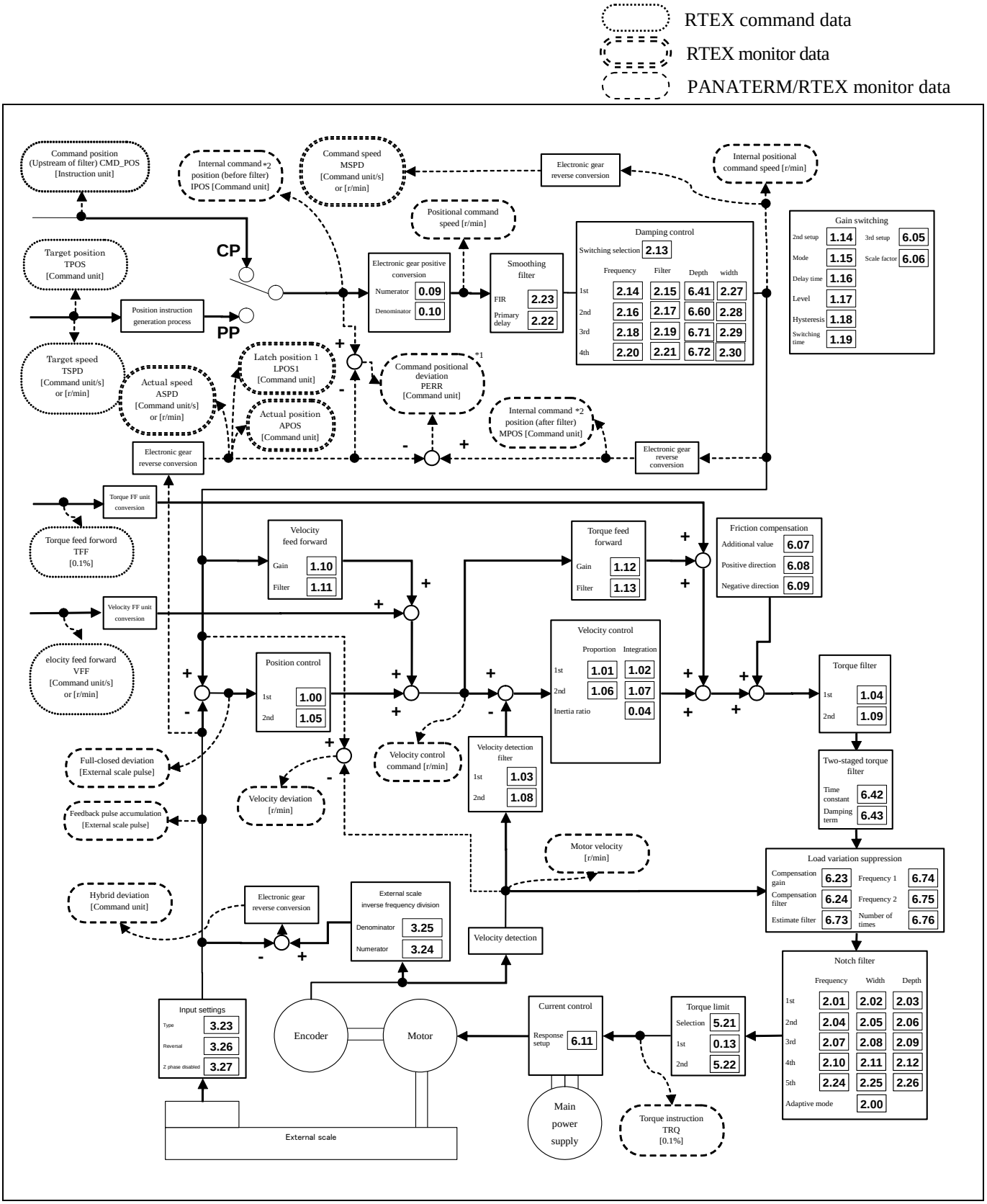
*2 Torque control under two-degrees-of-freedom control mode executes a similar control as torque control under the conventional control mode.
* Err91.1 “RTEX command error protection” occurs when it is switched to torque control under two-degrees-of-freedom control mode in function extended version 4 and earlier versions.

[A6NE]: This function cannot be used.

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

The diagram below shows full-closed control block of MINAS-A6N series.

- Profile position control mode (PP)
- Cyclic position control mode (CP)



Block diagram of full-closed control

*1 The computation reference for the command positional deviation [command unit] can be changed by bit14 for Pr7.23 "RTEX function extended setup 2".

*2 The position command on PANATERM can be switched depending on the setting of the bit3 "Command pulse accumulation value" of Pr7.99 "RTEX function extended setup 6".

5-2-5 Gain Switching Function

By selecting appropriate gain based on internal data or external signal, the following effects can be obtained.

- Decrease the gain at the time of stoppage (servo lock) to reduce vibration.
- Increase the gain at the time of stoppage (setting) to shorten the settling time.
- Increase the gain during operation to improve command compliance.
- Based on condition of the equipment, change the gain with external signal.

1) Relevant parameters

Set the gain switching function using the following parameters.

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>1</td><td>14</td><td>B</td><td>2nd gain setup</td><td>0–1</td><td>—</td><td>Arrange this parameter when performing optimum adjustment by using the gain switching function.
0: Fix the parameter setting to 1st gain and toggle the velocity loop operation between PI and P by using the control bit Gain_SW of RTEX communication.
Gain_SW = 0 -> PI operation
Gain_SW = 1 -> P operation
1: Enable gain switching of 1st gain (Pr 1.00–Pr 1.04) and 2nd gain (Pr 1.05–Pr 1.09).</td></tr>
<tr><td>1</td><td>15</td><td>B</td><td>Mode of position control switching</td><td>0–10</td><td>—</td><td>Set up the triggering condition of gain switching for position 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>RTEX communication gain switching command (Gain_SW)</td></tr>
<tr><td>3</td><td>Torque command</td></tr>
<tr><td>4</td><td>Invalid (Fixed to 1st gain)</td></tr>
<tr><td>5</td><td>Velocity command</td></tr>
<tr><td>6</td><td>Position deviation</td></tr>
<tr><td>7</td><td>Position command exists</td></tr>
<tr><td>8</td><td>Not in positioning complete</td></tr>
<tr><td>9</td><td>Actual speed</td></tr>
<tr><td>10</td><td>Position command exists
+ Actual speed</td></tr>
</table></td></tr>
<tr><td>1</td><td>16</td><td>B</td><td>Delay time of position control switching</td><td>0–10000</td><td>0.1 ms</td><td>For position controlling: When shifting from the 2nd gain to the 1st gain with Pr 1.15 Position control gain switching mode set at 3, 5, 6, 7, 8, 9 or 10, set up the delay time from trigger detection to the switching operation.</td></tr>
<tr><td>1</td><td>17</td><td>B</td><td>Level of position control switching</td><td>0–20000</td><td>Mode dependent</td><td>For position controlling: Set up triggering level when Pr 1.15 “Position control gain switching mode” is set at 3, 5, 6, 9 or 10.
Unit of setting varies with switching mode.
Note: Set the level equal to or higher than the hysteresis.</td></tr>
<tr><td>1</td><td>18</td><td>B</td><td>Hysteresis at position control switching</td><td>0–20000</td><td>Mode dependent</td><td>For position controlling: Set up triggering hysteresis when Pr 1.15 “Position control gain switching mode” is set at 3, 5, 6, 9 or 10.
Unit of setting varies with switching mode.
Note: When level < hysteresis, the hysteresis is internally adjusted so that it is equal to level.</td></tr>
<tr><td>1</td><td>19</td><td>B</td><td>Position gain switching time</td><td>0–10000</td><td>0.1 ms</td><td>For position controlling: If the difference between Pr 1.00 “1st gain of position loop” and Pr 1.05 “2nd gain of poison loop” is large, the increasing rate of position loop gain can be limited by this parameter.
The position loop gain will increase over the time set.</td></tr>
</table>

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>1</td><td>20</td><td>B</td><td>Mode of velocity control switching</td><td>0–5</td><td>—</td><td>For velocity controlling: Set the condition to trigger gain switching.
<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>RTEX communication gain switching command (Gain_SW)</td></tr><tr><td>3</td><td>Torque command</td></tr><tr><td>4</td><td>Velocity command variation is larger.</td></tr><tr><td>5</td><td>Velocity command</td></tr></table></td></tr>
<tr><td>1</td><td>21</td><td>B</td><td>Delay time of velocity control switching</td><td>0–10000</td><td>0.1 ms</td><td>For velocity controlling: When shifting from the 2nd gain to the 1st gain with Pr 1.20 “Velocity control switching mode” set at 3, 4 or 5, set the delay time from trigger detection to the switching operation.</td></tr>
<tr><td>1</td><td>22</td><td>B</td><td>Level of velocity control switching</td><td>0–20000</td><td>Mode dependent</td><td>For velocity controlling: Set up triggering level when Pr 1.20 Velocity control gain switching mode is set at 3, 4 or 5.
Unit of setting varies with switching mode.
Note: Set the level equal to or higher than the hysteresis.</td></tr>
<tr><td>1</td><td>23</td><td>B</td><td>Hysteresis at velocity control switching</td><td>0–20000</td><td>Mode dependent</td><td>For velocity controlling: Set up triggering hysteresis when Pr 1.20 “Velocity control gain switching mode” is set at 3, 4 or 5.
Unit of setting varies with switching mode.
Note: When level < hysteresis, the hysteresis is internally adjusted so that it is equal to level.</td></tr>
<tr><td>1</td><td>24</td><td>B</td><td>Mode of torque control switching</td><td>0–3</td><td>—</td><td>For torque controlling: Set the condition to trigger gain switching
<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>RTEX communication gain switching command (Gain_SW)</td></tr><tr><td>3</td><td>Torque command</td></tr></table></td></tr>
<tr><td>1</td><td>25</td><td>B</td><td>Delay time of torque control switching</td><td>0–10000</td><td>0.1 ms</td><td>For torque controlling: When shifting from the 2nd gain to the 1st gain with Pr 1.24 “Torque control switching mode” set at 3, set up the delay time from trigger detection to the switching operation.</td></tr>
<tr><td>1</td><td>26</td><td>B</td><td>Level of torque control switching</td><td>0–20000</td><td>Mode dependent</td><td>For torque controlling: Set up triggering level when Pr 1.24 Torque control gain switching mode is set at 3.
Unit varies depending on the setup of mode of control switching.
Note: Set the level equal to or higher than the hysteresis.</td></tr>
<tr><td>1</td><td>27</td><td>B</td><td>Hysteresis at torque control switching</td><td>0–20000</td><td>Mode dependent</td><td>For torque controlling: Set up triggering hysteresis when Pr 1.24 Torque control gain switching mode is set at 3.
Unit of setting varies with switching mode.
Note: When level < hysteresis, the hysteresis is internally adjusted so that it is equal to level.</td></tr>
</table>

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

2) How to use
Set the gain switching mode for the control mode to be used, and enable the gain switching function through Pr 1.14 “2nd gain setup” (set Pr 1.14 to 1).

Setup value (Pr1.15)	Switching condition	Gain switching condition
0	Fixed to 1st gain	Fixed to the 1st gain (Pr 1.00 to Pr 1.04).
1	Fixed to 2nd gain	Fixed to the 2nd gain (Pr 1.05 to Pr 1.09).
2	RTEX communication gain switching command is given	1st gain is selected when the gain switching command (Gain_SW) of RTEX communication is 0, or 2nd gain is selected when the switching command is 1.
3	Torque command is large	• Shift to the 2nd gain when the absolute value of the torque command exceeded (level + hysteresis) (%) previously with the 1st gain. • Return to the 1st gain when the absolute value of the torque command was kept below (level–hysteresis) (%) previously during delay time with the 2nd gain.
4	Velocity command variation is larger.	• Valid only during velocity control. • Shift to the 2nd gain when the absolute value of the velocity command variations exceeded (level + hysteresis) (10 r/min/s) previously with the 1st gain. • Return to the 1st gain when the absolute value of the velocity command variations was kept below (level–hysteresis) (10 r/min/s) during delay time previously with the 2nd gain. * The 1st gain is fixed while the velocity control is not applied.
5	Velocity command is large	• Valid for position, velocity and full-closed controls. • Shift to the 2nd gain when the absolute value of the velocity command exceeded (level +hysteresis) (r/min) previously with the 1st gain. • Return to the 1st gain when the absolute value of the velocity command was kept below (level- hysteresis) (r/min) previously during delay time with the 2nd gain.
6	Position deviation is large	• Valid for position and full-closed controls. • Shift to the 2nd gain when the absolute value of the positional deviation exceeded (level +hysteresis) (pulse) previously with the 1st gain. • Return to the 1st gain when the absolute value of the positional deviation was kept below (level–hysteresis) (pulse) previously over delay time with the 2nd gain. * Unit of level and hysteresis (pulse) is set as the encoder resolution for positional control and external scale resolution for full-closed control.

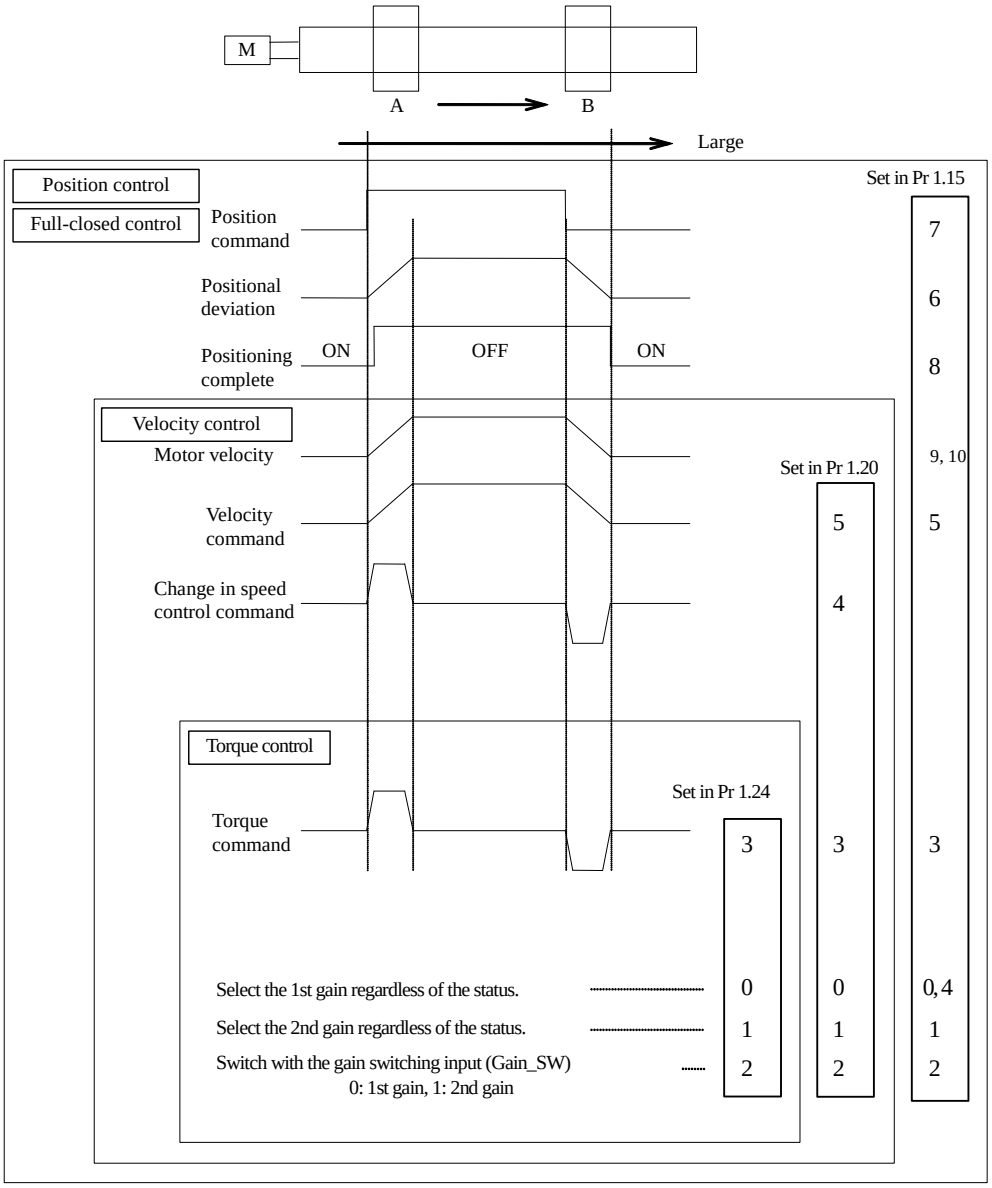
(To be continued)

Setup value (Pr1.15)	Switching condition	Gain switching condition
7	Position command exists	• Valid for position and full-closed controls. • Shift to the 2nd gain when the positional command was not 0 previously with the 1st gain. • Return to the 1st gain when the positional command was kept 0 previously during delay time with the 2nd gain.
8	Not in positioning complete	• Valid for position and full-closed controls. • Shift to the 2nd gain when the positioning was not completed previously with the 1st gain. • Return to the 1st gain when the positioning was kept in completed condition previously during delay time with the 2nd gain.
9	Actual speed is large	• Valid for position and full-closed controls. • Shift to the 2nd gain when the absolute value of the actual speed exceeded (level + hysteresis) (r/min) previously with the 1st gain. • Return to the 1st gain when the absolute value of the actual speed was kept below (level -hysteresis) (r/min) previously during delay time with the 2nd gain.
10	Position command exists + Actual speed	• Valid for position and full-closed controls. • Shift to the 2nd gain when the positional command was not 0 previously with the 1st gain. • Return to the 1st gain when the positional command was kept at 0 during the delay time and the absolute value of actual speed was kept below (level–hysteresis) (r/min) previously with the 2nd gain.

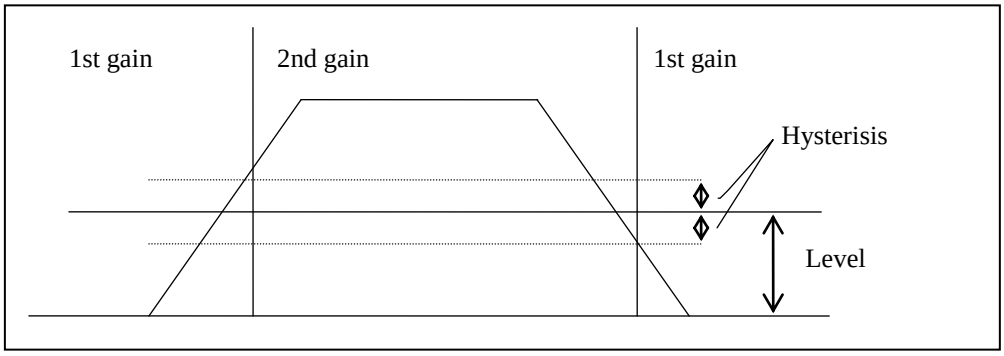
3) How to set

Suppose the load travels from A to B position and the internal status of the drive changes as the fig. below shows. Hereunder we explain how to set up the related parameters when you use the gain switching function.

1) Set up the conditions for gain switching with the following parameters.
Pr 1.15 “Mode of position control switching”
Pr 1.20 “Mode of velocity control switching”
Pr 1.24 “Mode of torque control switching”

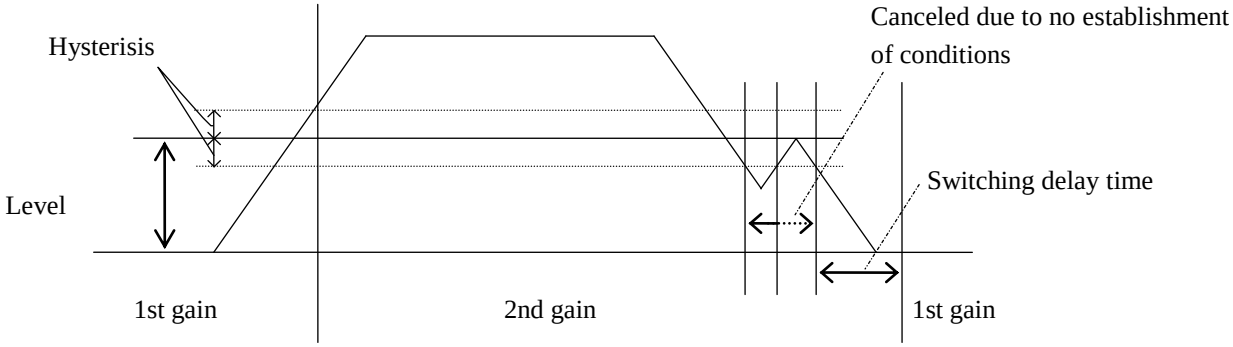


2) Set up the switching level and Hysteresis depending on the switching conditions.



3) Set up the switching delay time.

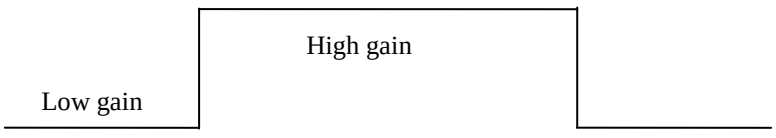
Set up the time delay for switching from 2nd gain to 1st gain.
Switching conditions have to be established continuously during the switching delay time for the switching from the 2nd to the 1st.



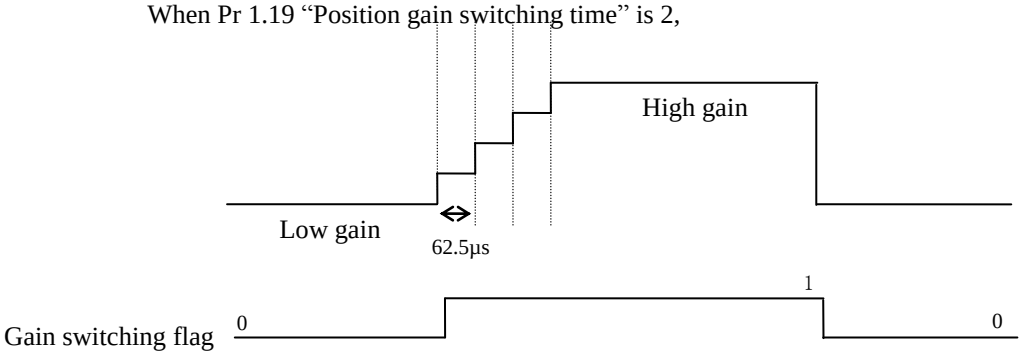
4) Set up the switching time of position gain.

Switch the position loop gain gradually to avoid any trouble caused by a rapid change to a higher gain, while the velocity loop gain, time constant of velocity loop integration, velocity detection filter and time constant of torque filter can be switched instantaneously.
*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

In case of a low machine stiffness, you cannot set up a higher gain because vibration and noise occur due to oscillation caused by axis distortion or other causes. By suppressing the resonance peak at the notch filter, higher gain can be obtained or the level of vibration can be lowered.

1) Relevant parameters
MINAS-A6N series feature 5 normal notch filters. You can adjust frequency and width and depth.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	01	B	1st notch frequency	50–5000	Hz	Set the center frequency of the 1st notch filter. The notch filter function will be invalidated by setting up this parameter to “5000”.
2	02	B	1st notch width selection	0–20	—	Set the width of notch at the center frequency of the 1st notch filter.
2	03	B	1st notch depth selection	0–99	—	Set the depth of notch at the center frequency of the 1st notch filter.
2	04	B	2nd notch frequency	50–5000	Hz	Set the center frequency of the 2nd notch filter. The notch filter function will be invalidated by setting up this parameter to “5000”.
2	05	B	2nd notch width selection	0–20	—	Set the width of notch at the center frequency of the 2nd notch filter.
2	06	B	2nd notch depth selection	0–99	—	Set the depth of notch at the center frequency of the 2nd notch filter.
2	07	B	3rd notch frequency *2)	50–5000	Hz	Set the center frequency of the 3rd notch filter. The notch filter function will be invalidated by setting up this parameter to “5000”.
2	08	B	3rd notch width selection *2)	0–20	—	Set the width of notch at the center frequency of the 3rd notch filter.
2	09	B	3rd notch depth selection *2)	0–99	—	Set the depth of notch at the center frequency of the 3rd notch filter.
2	10	B	4th notch frequency *2)	50–5000	Hz	Set the center frequency of the 4th notch filter. The notch filter function will be invalidated by setting up this parameter to “5000”.
2	11	B	4th notch width selection *2)	0–20	—	Set the width of notch at the center frequency of the 4th notch filter.
2	12	B	4th notch depth selection *2)	0–99	—	Set the depth of notch at the center frequency of the 4th notch filter.
2	24	B	5th notch frequency	50–5000	Hz	Set the center frequency of the 5th notch filter. The notch filter function will be invalidated by setting up this parameter to “5000”.
2	25	B	5th notch width selection	0–20	—	Set the width of notch at the center frequency of the 5th notch filter.
2	26	B	5th notch depth selection	0–99	—	Set the depth of notch at the center frequency of the 5th notch filter.

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

*2) When the adaptive filtering function is used, parameter value is automatically set.

2) How to use
Determine the resonant frequency by using the frequency response analysis function of the setup support software (PANATERM), resonant frequency monitor or waveform graphics function and set it to the notch frequency.

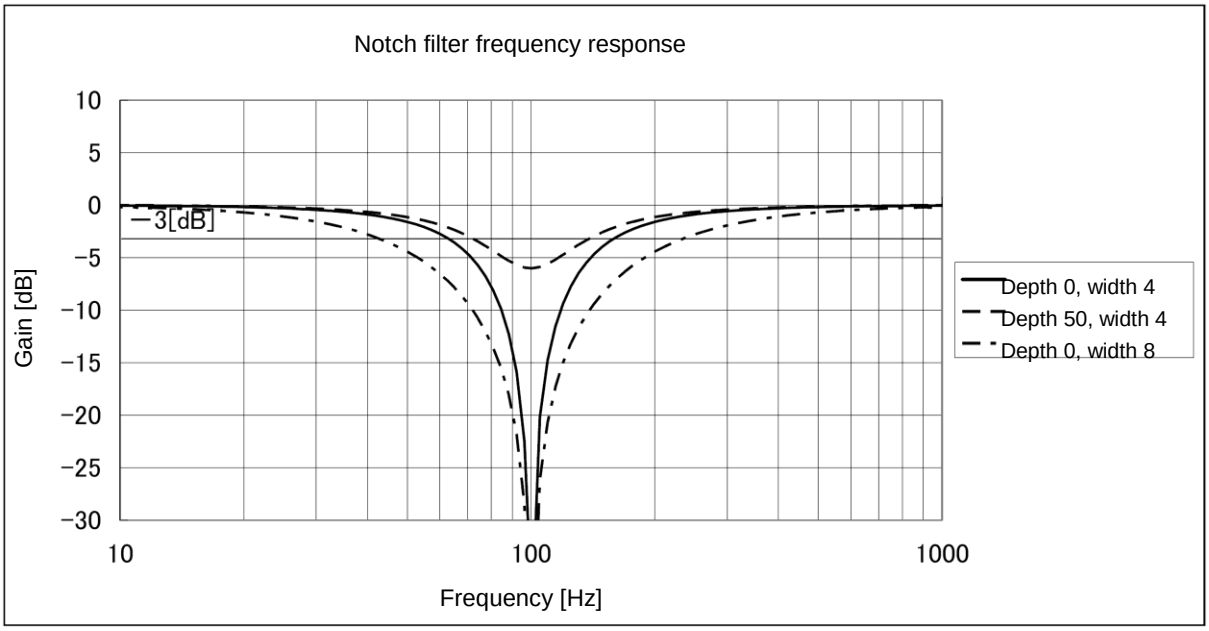
3) Notch width and depth

The width of the notch filter is the ratio of the width of –3 dB attenuation frequency band with respect to the notch frequency at its center when depth is 0, and the value is as shown in the table below.

The notch filter depth indicates I/O ratio where the input at the center frequency is completely shut with setup value 0 but fully received with setup value 100. The table below shows this value in dB on the right.

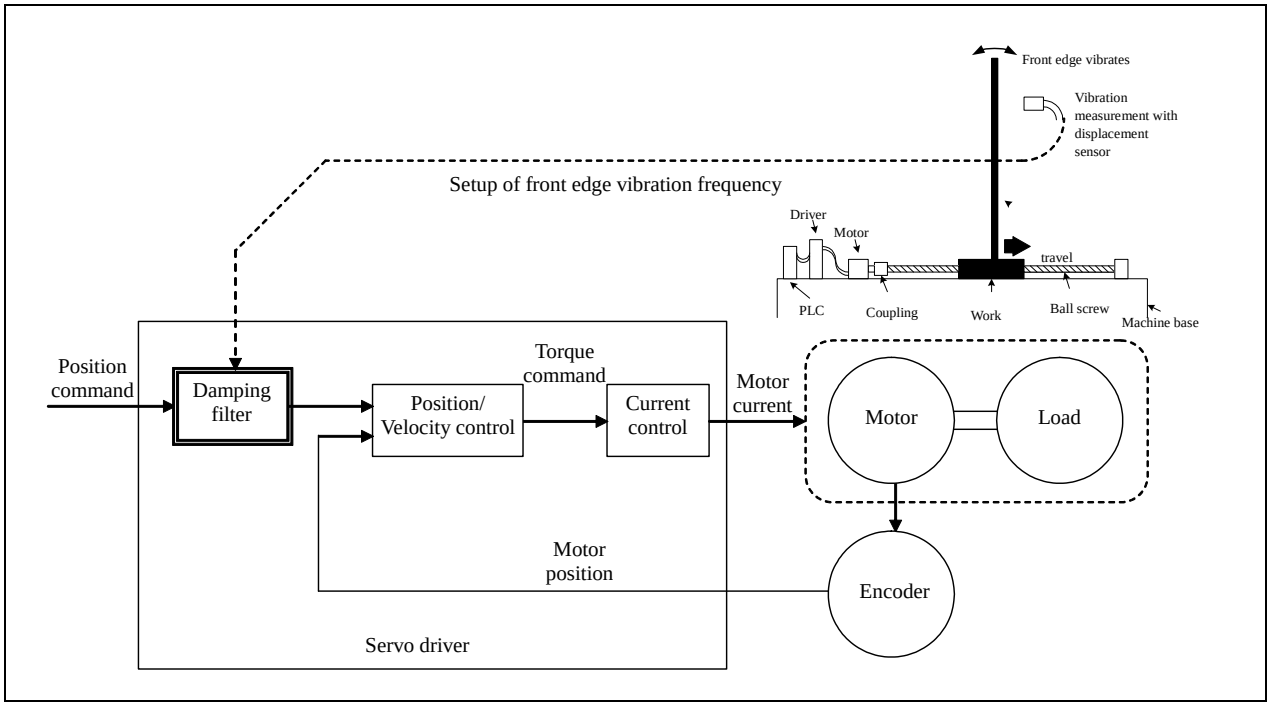
Notch width	Band width/center frequency
0	0.50
1	0.59
2	0.71
3	0.84
4	1.00
5	1.19
6	1.41
7	1.68
8	2.00
9	2.38
10	2.83
11	3.36
12	4.00
13	4.76
14	5.66
15	6.73
16	8.00
17	9.51
18	11.31
19	13.45
20	16.00

Notch depth	I/O ratio	[dB]
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 Control

This function reduces the vibration at the top or on whole of the equipment by removing the vibration frequency components specified by the positional command. Up to 3 frequency settings, out of 4 settings in total, can be used simultaneously.



1) Applicable Range

Damping control is activated under the following conditions.

	Conditions under which the damping control is activated
Control mode	Position control mode or Full-closed control mode.

2) Caution

This function does not work properly or no effect is obtained under the following conditions.

	Conditions which obstruct the damping control effect
Load	• Vibration is triggered by other factors than command (such as disturbance). • Ratio of resonance frequency and anti-resonance frequency is large. • Vibration frequency is out of the range of 0.5–300.0 [Hz].

3) Relevant parameters
Set up damping control operation using the parameters shown below.

<table>
<tr><th>Class</th><th>No.</th><th>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>2</td><td>13</td><td>B</td><td>Selection of damping filter switching</td><td>0–6</td><td>—</td><td>
Among 4 filters select the filters to be used for damping control.
• When setup value is 0: Up to 2 filters can be used simultaneously.
• When setup value is 1 or 2: Reserved for manufacturer's use (do not set this)
• With setup value 3: Select the filter with 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>valid</td><td>invalid</td><td>valid</td><td>invalid</td></tr>
<tr><td>Negative direction</td><td>invalid</td><td>valid</td><td>invalid</td><td>valid</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>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>4</td><td>Enabled</td><td>Enabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>5, 6</td><td colspan="4">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>1st model-type damping</th><th>2nd model-type damping</th></tr>
<tr><td>4</td><td>Enabled</td><td>Enabled</td></tr>
<tr><td>5</td><td colspan="2">for manufacturer's use (do not set this)</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 between the damping frequency and damping filter setting is performed at the rising edge of the command that causes the number of command pluses per command detection period (0.125 ms) (at upstream of position command filter) changes from 0 to any other value while the positioning complete is being output.
Even if the control mode is changed to position control after changing the damping frequency and damping filter settings during velocity control or torque control, the setting is not changed.
Especially, at higher damping frequency, or if it becomes disabled, and wider positioning complete range is set up, and if large pulse (area is equivalent of time integration of the value of position command at upstream of the filter minus the value of position command at downstream of filter) remains in the filter during switching, it is rapidly discharged upon switching and returns to original position, and the motor will move at a speed higher than normal command velocity.

*2 There is delay from setting change of damping frequency or damping filter to internal computation and application of new setting values. If the switching described in *1 occurs during this delay time, application of new value will be suspended.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	14	B	1st damping frequency	0–3000	0.1 Hz	You can set up the 1st damping frequency of the damping control which suppresses vibration at the load edge. The driver measures vibration at load edge. Setup unit is 0.1 [Hz] The setup frequency is 0.5 to 300.0 [Hz]. Setup of 0 to 4 becomes invalid.
2	15	B	1st damping filter setup	0–1500	0.1 Hz	If torque saturation occurs with damping frequency 1st enabled, decrease the setup value, or if the operation is slow, increase it. Usually set it to 0. Note: The maximum setup value is internally limited to the corresponding damping frequency or 3000–damping frequency, whichever is smaller.
6	41	B	1st damping depth	0–1000	—	Specifies a depth corresponding to the 1st damping frequency. The depth is maximum if the setting value is 0. As the setting value increases, the depth decreases. As the depth increases, the damping effect increases, but the delay also increases. As the depth decreases, the delay decreases, but the damping effect also decreases. Use the parameter to fine adjust the damping effect and delay.
2	27	A	1st damping width setting	0–1000	-	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	B	2nd damping frequency	0–3000	0.1 Hz	You can set up the 2nd damping frequency of the damping control which suppresses vibration at the load edge. The driver measures vibration at load edge. Setup unit is 0.1 [Hz]. The setup frequency is 0.5 to 300.0 [Hz]. Setup of 0 to 4 becomes invalid.
2	17	B	2nd damping filter setup	0–1500	0.1 Hz	If torque saturation occurs with damping frequency 2nd enabled, decrease the setup value, or if the operation is slow, increase it. Usually set it to 0. Note: The maximum setup value is internally limited to the corresponding damping frequency or 3000–damping frequency, whichever is smaller.
6	60	A	2nd damping depth	0–1000	-	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	A	2nd damping width setting	0–1000	-	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	B	3rd damping frequency	0–3000	0.1 Hz	You can set up the 3rd damping frequency of the damping control which suppresses vibration at the load edge. The driver measures vibration at load edge. Setup unit is 0.1 [Hz] The setup frequency is 0.5 to 300.0 [Hz]. Setup of 0 to 4 becomes invalid.
2	19	B	3rd damping filter setup	0–1500	0.1 Hz	If torque saturation occurs with damping frequency 3rd enabled, decrease the setup value, or if the operation is slow, increase it. Usually set it to 0. Note: The maximum setup value is internally limited to the corresponding damping frequency or 3000–damping frequency, whichever is smaller.
6	71	A	3rd damping depth	0–1000	-	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	A	3rd damping width setting	0–1000	-	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	B	4th damping frequency	0–3000	0.1 Hz	You can set up the 4th damping frequency of the damping control which suppresses vibration at the load edge. The driver measures vibration at load edge. Setup unit is 0.1 [Hz] The setup frequency is 0.5 to 300.0 [Hz]. Setup of 0 to 4 becomes invalid.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	21	B	4th damping filter setup	0–1500	0.1 Hz	If torque saturation occurs with damping frequency 4th enabled, decrease the setup value, or if the operation is slow, increase it. Usually set it to 0. Note: The maximum setup value is internally limited to the corresponding damping frequency or 3000–damping frequency, whichever is smaller.
6	72	B	4th damping depth	0–1000	-	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	B	4th damping width setting	0–1000	-	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.

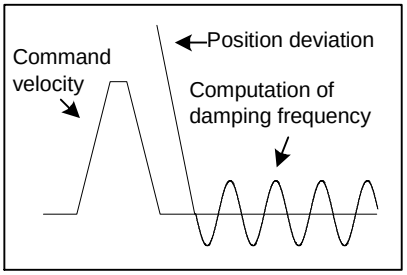
*1) For parameter attribute, refer to Section 9-1.

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 of the front edge of the machine. When you use such instrument as laser displacement meter, and can directly measure the load end vibration, read out the vibration frequency by 0.1 [Hz] from the measured waveform and enter it.

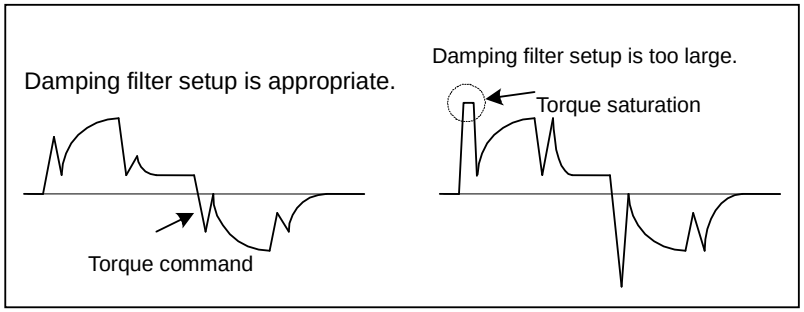
If suitable measuring device is not available, measure the frequency according to the residual vibration of the position deviation waveform measured by the vibration frequency monitor of the setup support software PANATERM or a waveform graphic function.



(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.

You can reduce the settling time by setting up larger value, however, the torque ripple increases at the command changing point as the right fig. shows. Setup within the range where no torque saturation occurs under the actual condition. If torque saturation occurs, damping control effect will be lost.

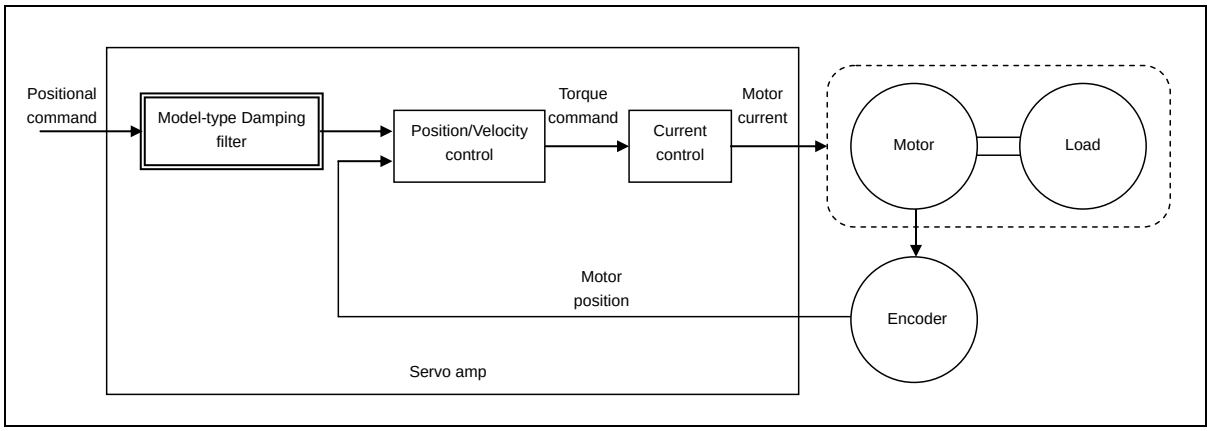


(3) Setup of damping depth (Pr 6.41, Pr 6.60, Pr 6.71, Pr 6.72)
Setup of damping width (Pr 2.27, Pr 2.28, Pr 2.29, Pr 2.30)

First set it to 0, and increase the setting value little by little if settling time needs to be decreased. As the setting value increases, the settling time can be decreased, but the damping effect is also decreased. Make an adjustment while checking the statuses of the settling time and vibration.

5-2-8 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	・The resonance frequency and the anti-resonance frequency do not satisfy the following equation: 5.0 [Hz] or below ≤ Anti-resonance frequency ≤ Resonance frequency ≤ 300.0 [Hz] ・The response frequency and the anti-resonance frequency do not satisfy the following equation: 5.0 [Hz] or below ≤ Anti-resonance frequency ≤ Response frequency ≤ Anti-resonance frequency x 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>At-trib-ute *1)</th><th>Title</th><th>Range</th><th>Unit</th><th>Function</th></tr>
<tr><td>2</td><td>13</td><td>B</td><td>Selection of damping filter switching</td><td>0–6</td><td>-</td><td>
Among 4 filters select the filters to be used for damping control.
• When setup value is 0: Up to 2 filters can be used simultaneously.
• When setup value is 1 or 2: Reserved for manufacturer's use (do not set this)
• With setup value 3: Select the filter with 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>valid</td><td>invalid</td><td>valid</td><td>invalid</td></tr>
<tr><td>Negative direction</td><td>invalid</td><td>valid</td><td>invalid</td><td>valid</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>1st damping</th><th>2nd damping</th><th>3rd damping</th><th>4th damping</th></tr>
<tr><td>4</td><td>Enabled</td><td>Enabled</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>5, 6</td><td colspan="4">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>1st model-type damping</th><th>2nd model-type damping</th></tr>
<tr><td>4</td><td>Enabled</td><td>Enabled</td></tr>
<tr><td>5</td><td colspan="2">for manufacturer's use (do not set this)</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>
<tr><td>6</td><td>61</td><td>B</td><td>1st resonance frequency</td><td>0–3000</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>B</td><td>1st resonance attenuation ratio</td><td>0–1000</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>B</td><td>1st anti-resonance frequency</td><td>0–3000</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>B</td><td>1st anti-resonance attenuation ratio</td><td>0–1000</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>
</table>

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	65	B	1st response frequency	0–3000	0.1Hz	Defines the response frequency of the model-type damping filter's load. The unit is [0.1 Hz].
6	66	B	2nd resonance frequency	0–3000	0.1Hz	Defines the 2nd resonance frequency of the model-type damping filter's load. The unit is [0.1 Hz].
6	67	B	2nd resonance attenuation ratio	0–1000	-	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	B	2nd anti-resonance frequency	0–3000	0.1Hz	Defines the 2nd anti-resonance frequency of the model-type damping filter's load. The unit is [0.1 Hz].
6	69	B	2nd anti-resonance attenuation ratio	0–1000	-	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	B	2nd response frequency	0–3000	0.1Hz	Defines the 2nd response frequency of the model-type damping filter's load. The unit is [0.1 Hz].

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

4) How to use

[1] As preparation, measure the resonance frequency and anti-resonance frequency using the frequency characteristic analysis function of setup support software 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]

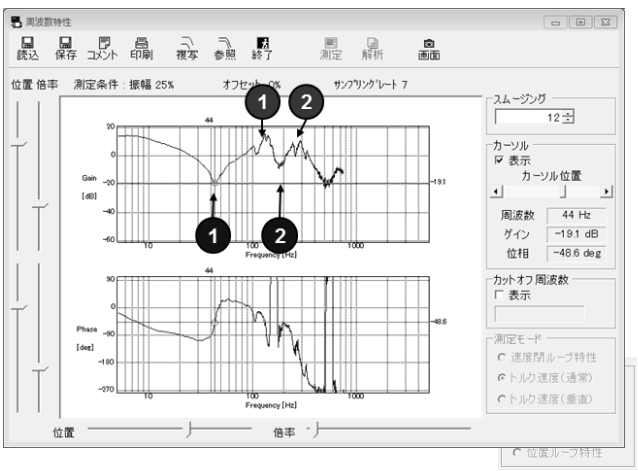
[2] The resonance attenuation ratio and anti-resonance attenuation ratio should have initial values of around 50 (0.050).

[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 “Selection of damping filter switching” 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 analysis with setup support software PANATERM

5-2-9 Feed forward function

When position control or full-closed contorl is used, positional deviation can be further reduced when compared with deviation where control is made only by feedback, and response is also improved, by calculating the velocity control command necessary for operation based on the internal positional command, and by adding velocity feed forward to the velocity command calculated by comparison with position feedback. In certain command, velocity feed forward can be set to the command argument and sent through RTEX communication.
The response time of the velocity control system is also improved by calculating torque command necessary for operation based on the velocity control command and by adding torque feed forward calculated by comparison with velocity feedback to the torque command. In certain command, torque feed forward can be set to the command argument and sent through RTEX communication.
The feed forward given through RTEX communication is added to the feed forward value (internally calculated according to the parameter setting).

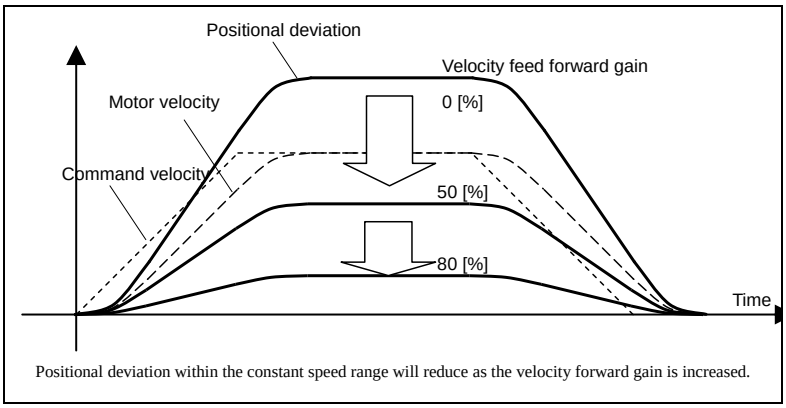
1) Relevant parameters
For MINAS-A6N series, the velocity feed forward and torque feed forward can be used.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	10	B	Velocity feed forward gain	0–4000	0.1%	Multiply the velocity control command calculated according to the internal positional command by the ratio of this parameter and add the result to the velocity command resulting from the positional control process.
1	11	B	Velocity feed forward filter	0–6400	0.01 ms	Set the time constant of 1st delay filter which affects the input of velocity feed forward.
1	12	B	Torque feed forward gain	0–2000	0.1%	Multiply the torque command calculated according to the velocity control command by the ratio of this parameter and add the result to the torque command resulting from the velocity control process.
1	13	B	Torque feed forward filter	0–6400	0.01 ms	Set up the time constant of 1st delay filter which affects the input of torque feed forward.

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

2) Usage example of velocity feed forward
The velocity feed forward will become effective as the velocity feed forward gain is gradually increased with the velocity feed forward filter set at approx. 50 (0.5 ms). The positional deviation during operation at a constant velocity is reduced as shown in the equation below in proportion to the value of velocity feed forward gain.

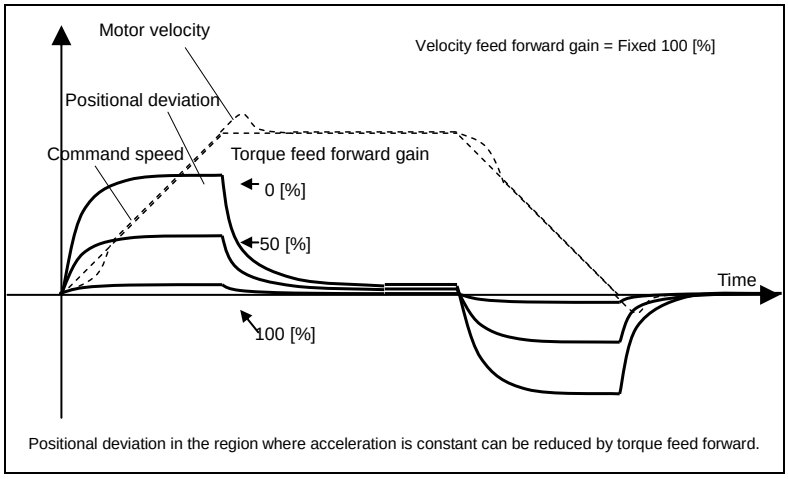
Positional deviation [unit of command] = command velocity [unit of command/s] /
positional loop gain [1/s] × (100–velocity feed forward gain [%]) / 100



Positional deviation within the constant speed range will reduce as the velocity forward gain is increased.

With the gain set at 100%, calculatory positional deviation is 0, but 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 the velocity feed forward is active. If this is the case, use positional command filter (1st delay or FIR smoothing), or increase the velocity forward filter setup value.
Note: Feed forward given through RTEX communication should be filtered at the host device.

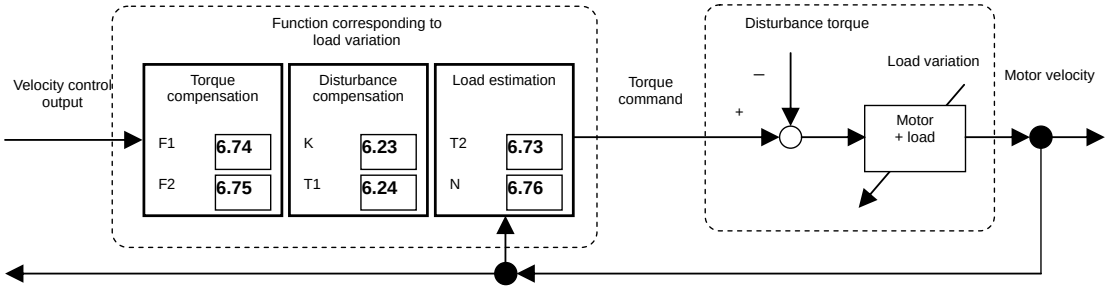
3) Usage example of torque feed forward
To use the torque feed forward, correctly set the inertia ratio. Use the value that was determined at the start of the real time auto tuning, or set the inertia ratio that can be calculated from the machine specification to Pr 0.04 “Inertia ratio”.
The torque feed forward will become effective as the torque feed forward gain is gradually increased with the torque feed forward filter is set at approx. 50 (0.5 ms).
Positional deviation at a constant acceleration/deceleration can be minimized close to 0 by increasing the torque forward gain. This means that positional deviation can be maintained at near 0 over entire operation range while driving in trapezoidal speed pattern under ideal condition where disturbance torque is not active.



Zero positional deviation is impossible in actual situation because of disturbance torque.
As with the velocity feed forward, large torque feed forward filter time constant decreases the operating noise but increases positional deviation at acceleration change point.
Note: ・Feed forward given through RTEX communication should be filtered at the host device.
・If the control mode is changed from other than torque control mode to torque control mode while the motor is in operation, torque feed forward may be applied even if torque control mode.

5-2-10 Load variation suppression function

This function uses the disturbance torque determined by the disturbance observer to reduce effect of disturbance torque and vibration.
This is effective when real-time auto tuning cannot handle load variation sufficiently.



(1) Applicable Range

□ This function can be applicable only when the following conditions are satisfied.

	Conditions under which the disturbance observer is activated
Control model	• Position Control, Velocity control or Full-closed control
Others	• Should be in servo-on condition • Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Caution

□ Effect may not be expected in the following condition.

	Conditions which obstruct disturbance observer action
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.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function expansion setup	-32768–32767	-	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 bit14 0: Disables the load variation suppression function automatic adjustment 1: Enables the load variation suppression function automatic adjustment * The least significant bit is bit0. * When bit14 to 1, it will be bit1 and 2 also 1.
6	23	B	Load change compensation gain	-100–100	%	Defines the compensation gain against load variation.
6	24	B	Load change compensation filter	10–2500	0.01 ms	Defines the filter time constant against load variation.
6	73	B	Load estimation filter	0–2500	0.01 ms	Defines the filter time constant for load estimation.
6	74	B	Torque compensation frequency 1	0–5000	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. 1.0 Hz ≤ Pr. 6.75 ≤ Pr. 6.74 ≤ (Pr. 6.75 x 32)
6	75	B	Torque compensation frequency 2	0–5000	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. 1.0 Hz ≤ Pr. 6.75 ≤ Pr. 6.74 ≤ (Pr. 6.75 x 32)
6	76	B	Load estimation count	0–8	-	Defines the load estimation count.

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

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)

< Basic adjustment >

[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 setup” to enable the load variation suppression function automatic adjustment, and check disturbance suppression effect with the motor rotate.
* This Pr6.10 bit1 and 2 it will be 1.
* 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.

< If further adjustment >

[3] 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 change 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 change 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) (assumed an articulated robot, etc.)

[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.

* This Pr6.10 bit1 and 2 it will be 1.

[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.)

5-2-11 3rd gain switching function

In addition to the normal gain switching function described on 5-2-5, 3rd gain switching function can be set to increase the gain just before stopping. The higher gain shortens positioning adjusting time.

(1) Applicable Range

□ This function can be applicable only when the following conditions are satisfied.

	Conditions under which the 3rd gain switching function is activated
Control mode	• Position Control or Full-closed control.
Others	• Should be in servo-on condition • Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	05	B	Position 3rd gain valid time	0–10000	0.1 ms	Set up the time at which 3rd gain becomes valid.
6	06	B	Position 3rd gain scale factor	50–1000	%	Set up the 3rd gain by a multiplying factor of the 1st gain: 3rd gain = 1st gain × Pr 6.06/100

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

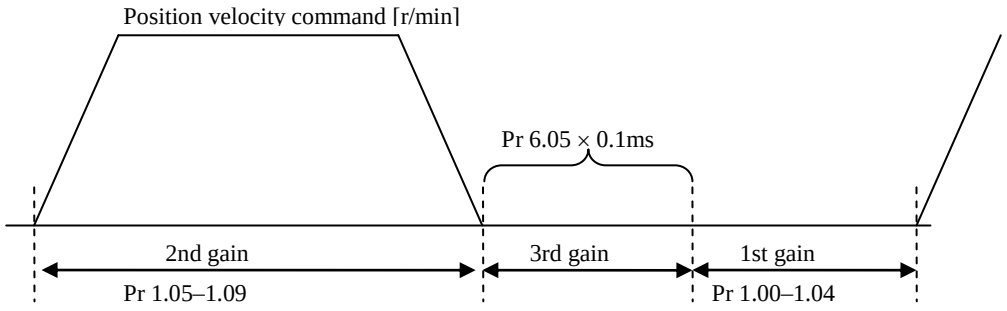
(3) How to use

While in the condition under which the normal gain switching functions, set the 3rd gain application time to Pr 6.05 “Position 3rd gain valid time”, and set the 3rd gain (scale factor with reference to 1st gain) to Pr 6.06 “Position 3rd gain scale factor”.

- If 3rd gain is not used, set Pr 6.05 to 0 and Pr 6.06 to 100.
- The 3rd gain is enabled only for position control/full-closed control.
- During the 3rd gain period, only position loop gain/velocity loop gain becomes 3rd gain, during other periods, 1st gain setting is used.
- When the 2nd gain switching condition is established during 3rd gain period, 2nd gain is used.
- During transition from 2nd gain to 3rd gain, Pr 1.19 “Position gain switching time” is applied.
- Even if the gain is changed from 2nd to the 1st due to parameter change, the 3rd gain period is inserted between them.

Example:

Pr 1.15 “Mode of position control switching” = 7 switching condition: with positional command:



[3rd gain period]

Position loop gain = Pr1.00 × Pr6.06/100

Velocity loop gain = Pr1.01 × Pr6.06/100

Velocity loop integration time constant, velocity detection filter and torque filter time constant directly use the 1st gain value.

5-2-12 Friction torque compensation

To reduce effect of friction represented by mechanical system, 3 types of friction torque compensation can be applied:

- offset load compensation that cancels constant offset torque
- the dynamic friction compensation that varies direction as the operating direction varies
- viscous friction torque correction amount that is varied by the command speed.

(1) Applicable Range

□ This function can be applicable only when the following conditions are satisfied.

	Conditions under which the Friction torque compensation is activated
Control mode	• Specific to individual functions. Refer to “Relevant parameters” shown below.
Others	• Should be in servo-on condition • Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Relevant parameters

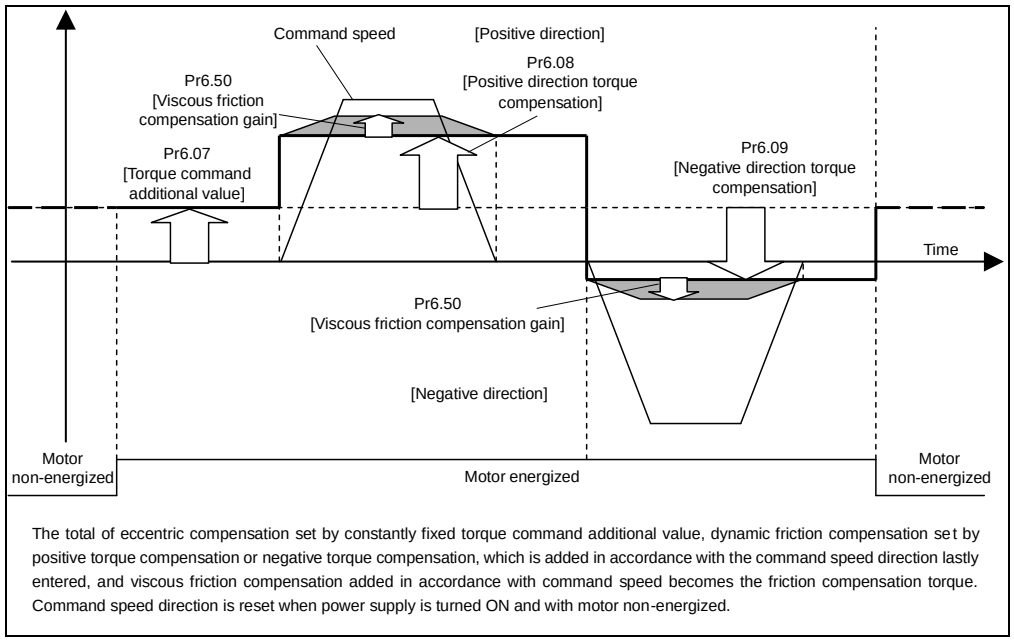
Combine the following 3 parameters to setup appropriate friction torque compensation.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	07	B	Torque command additional value	-100–100	%	Set up the offset load compensation value usually added to the torque command in a control mode except for the torque control mode.
6	08	B	Positive direction torque compensation value	-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	B	Negative direction torque compensation value	-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	B	Viscous friction compensation gain	0–10000	0.1 %/ (10000 r/min)	When Two-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 correction 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.

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

(3) How to use

The friction torque compensation will be added in response to the entered positional command direction as shown below.



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.

- Pr 6.07 “Torque command additional value” reduces variations in positioning operation (performance is affected by direction of movement). These variations occur when constant offset torque resulting from weight on vertical axis is applied to the motor.
- Certain loads such as belt driven shaft requires high dynamic friction torque, which lengthens positioning setting time or varies positioning accuracy. These problems can be minimized by setting the friction torque of every rotating direction into individual parameters. Pr 6.08 “Positive direction torque compensation value” and Pr 6.09 “Negative direction torque compensation value” can be used for this purpose.
- 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.

The offset load compensation and dynamic friction compensation can be used individually or in combination. However, some control modes impose limit on application.

- For torque control: Offset load compensation and dynamic friction compensation are set at 0 regardless of parameter setting.
- For velocity control with servo-off: Offset load compensation per Pr 6.07 is enabled. Dynamic friction compensation is set at 0 regardless of parameter setting.
- For position control or full-closed control with servo-on: Previous offset load compensation and dynamic friction compensation values are maintained until the first positional command is applied where the offset load compensation value is updated according to Pr 6.07. The dynamic friction compensation value is updated to parameters Pr .6.08 and Pr 6.09 depending on command direction.

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) Applicable Range

☐ 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	・Should be in servo-on condition ・Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(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) Relevant parameters

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

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	34	B	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	B	Hybrid vibration suppression filter	0-32000	0.01 ms	Set the hybrid vibration suppression filter.

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

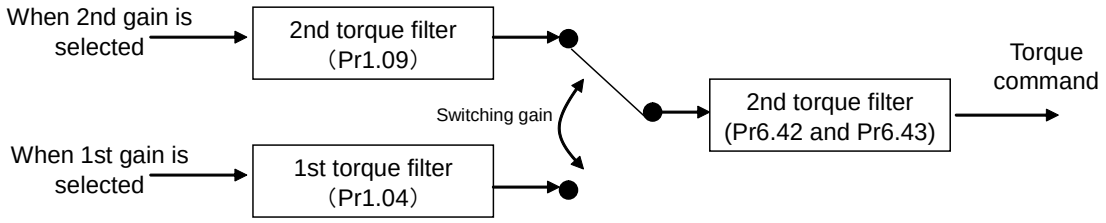
(4) How to use

[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 usual 1st and 2nd torque filters (Pr1.04 and Pr1.09), another torque filter can be set. High-frequency vibration component can be suppressed by the use of the Two-stage torque filter.



(1) Application range

□ This function can't be applied unless the following conditions are satisfied.

	Conditions for operating Two-stage torque filter
Control mode	• Can be used in all control modes.
Others	• Should be in servo-on condition • Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Precautions

- If the setting value is increased excessively, the control may become unstable to produce vibration. Specify proper setting value while checking the status of the device.
- If Pr6.43 "Two-stage torque filter attenuation term" is changed during operation, vibration may be generated. Change the value while the motor is stopped.

(3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	42	B	Two-stage torque filter time constant	0–2500	0.01ms	Sets Two-stage torque filter time constant. The time constant is invalid if 0 is specified. [When used for the secondary filter as Pr6.43 ≥ 50] The time constants that can be used are 4–159 (0.04–1.59 ms). (Equivalent to 100–4000 Hz in frequency) Setting values 1–3 works as 4 (4000 Hz), and 159–2500 works as 159 (100 Hz).
6	43	B	Two-stage torque filter attenuation term	0–1000	—	Sets attenuation term of Two-stage torque filter. The filter degree of the Two-stage torque filter is changed according to the setting value. 0–49: Operates as the 1st filter. 50–1000: Operates as a 2nd filter and becomes a 2nd filter with ζ = 1.0 if setting value is 1000. As the setting value is decreased, the filter becomes vibrational. Use with a setting value 1000 basically.

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

(4) Usage

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 attenuation term" = 1000 (ζ= 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	・Position Control or Full-closed control.
Others	・Should be in servo-on condition ・Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(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.	Attri-bute *1)	Title	Range	Unit	Function
5	45	B	Quadrant glitch positive-direction compensation value	-1000–1000	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	B	Quadrant glitch negative-direction compensation value	-1000–1000	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	B	Quadrant glitch compensation delay time	0–1000	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	B	Quadrant glitch compensation filter setting L	0–6400	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	B	Quadrant glitch compensation filter setting H	0–10000	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	R	Function expansion setup 2	-32768–32767	–	bit14: Enables/disables quadrant projection compensation function. 0: disabled, 1: enabled
6	97	B	Function expansion setup 3	-2147483648 – 2147483647	–	bit0: Enables/disables quadrant projection compensation function extended. 0: disabled, 1: enabled * To set the compensation amount of quadrant projection by inversion direction when the direction of the velocity has changed, set Pr6.97 bit0 to 1.

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

(4) How to use

Adjust the load change inhibit function using the disturbance suppression setup by reference to Section 5-2-10, and measure quadrant projection.

Level is unsatisfactory, conduct further fine adjustment using 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.

* When quadrant projection is delayed from the timing of the movement direction is reversed, try changing Pr 5.47 and Pr 5.48.
* To set the compensation amount of quadrant projection by inversion direction when the direction of the velocity has changed, set Pr6.97 bit0 to 1 and try change Pr5.49.

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

The two-degree-of-freedom control mode is an expanded function of the position control switching mode. Responsiveness is improved by making it possible to set the positional command response and servo stiffness independently.
Either of the standard type or synchronization type of the two-degree-of-freedom control can be used.

(1) Applicable range

☐ This function cannot be applied unless the following conditions are satisfied.

	Operating conditions for the two-degree-of-freedom control mode
Control mode	• Position control mode (semi-close control)
Other	• Should be in servo-on condition • Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Related parameters

First, set Pr6.47 “Function expansion setup 2” to bit0=1 and write the setting to EEPROM, and then reset the control power to enable two-degree-of-freedom control.
After this, make adjustments of the real-time auto-tuning function (refer to Section 5-1-3 or 5-1-4).
Only when further improvement is required, manually fine-tune the following parameters while confirming the response.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	47	R	Function expansion setup 2	-32768–32767	–	Set respective functions in unit of bit. bit0 two-degree-of-freedom control mode 0: Invalid 1: Valid bit3 Selection of real-time auto-tuning of two-degree-of-freedom control 0: Standard type 1: Synchronization type * The least significant bit is bit0. * bit3 (Selection of real-time auto-tuning of two-degree-of-freedom control) can be used only when bit0 is set to 1: Valid.
2	22	B	Command smoothing filter	0–10000	0.1ms	Time constant for the command filter is set in two-degree-of-freedom control. • The maximum value is limited to 2000 (=200.0 ms). *The parameter value itself is not limited, but the value applied in the driver is limited. • Command response can be quickened by decreasing this parameter and slowed by increasing it. • The attenuation term is set by Pr6.49 “Adjust/Torque command attenuation term”.
6	48	B	Adjust filter	0–2000	0.1ms	Set the time constant for the adjust filter. • When the torque filter setting has been changed, set a value close to the real-time auto-tuning setting. • As a result of fine-tuning while checking the encoder position deviation near the setting, overshoot and oscillatory waveforms may be improved. • The attenuation term is set by Pr6.49 “Adjust/Torque command attenuation term”.

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	49	B	Adjust/Torque command attenuation term	0–99	–	Set the attenuation term for the command filter and adjust filter. • A decimal number indication is used. The first digit sets the command filter and the second digit sets the adjust filter. <Each target digit of the set value> 0 to 4: No attenuation term (operated as primary filter) 5 to 9: Secondary filter (Attenuation terms, ζ will be 1.0, 0.86, 0.71, 0.50, and 0.35 in order.) <Setting an example of this parameter> To set the command filter to ζ=1.0 and adjust filter 1 to ζ=0.71, the setting value should be 75 (first digit=5 (ζ=1.0), second digit=7 (ζ=0.71)). For the time constant of the command filter, Pr2.22 “Command smoothing filter” will be applied.
6	50	B	Viscous friction compensation gain	0–10000	0.1%/ (10000r /min)	Add the result of multiplying the command velocity by this setting value to the torque command as the correction amount of the viscous friction torque. • The encoder position deviation near the setting may be improved by setting the viscous friction factor estimation for real-time auto-tuning.

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

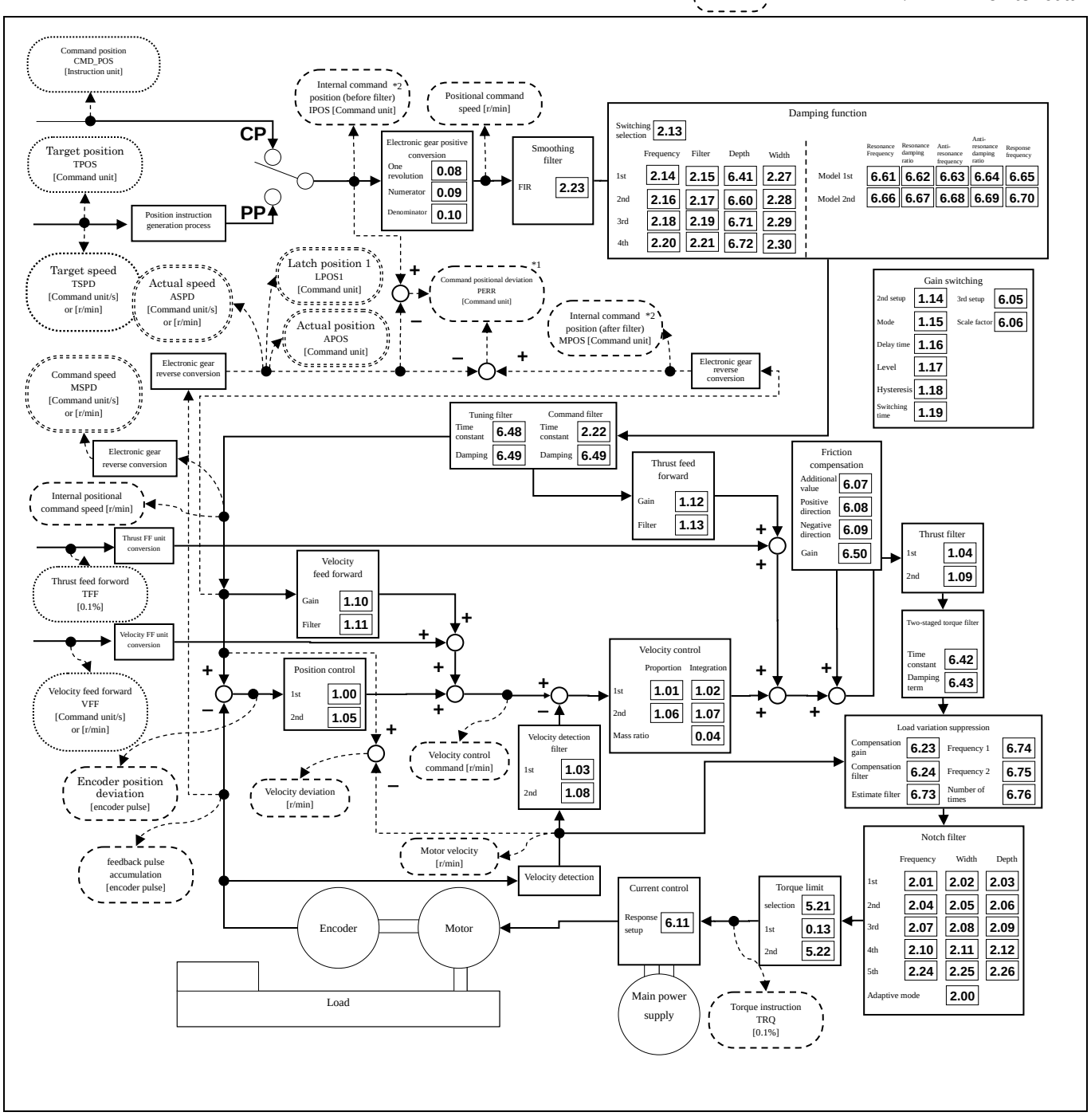
(3) Block diagram of the two-degree-of-freedom control mode

The two-degree-of-freedom control mode (with position control) is configured as shown in the block diagram below.

RTEX command data

RTEX monitor data

PANATERM/RTEX monitor data



Two-degree-of-freedom control mode (with position control) block diagram

*1 The computation reference for the command positional deviation [command unit] can be changed by bit14 for Pr7.23 "RTEX function extended setup 2".

*2 The position command on PANATERM can be switched depending on the setting of the bit3 "Command pulse accumulation value" of Pr7.99 "RTEX function extended setup 6".

*3 When performing test run function, Z phase search, Frequency characteristic measurement (position loop characteristic) from the PANATERM, the driver switches to position control mode internally.

5-2-17 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.

(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	・Real-time auto tuning selection is two-degree-of-freedom control mode standard type. (Note) In the case of the Synchronization s type, Err91.1"RTEX command error protection" occurs. ・Should be in servo-on condition ・Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Related parameters

First of all, set Pr6.47 "Function expansion setup 2":bit0 to 1 and write in EEPROM; then, reset the control power supply to enable the two-degree-of-freedom control mode.

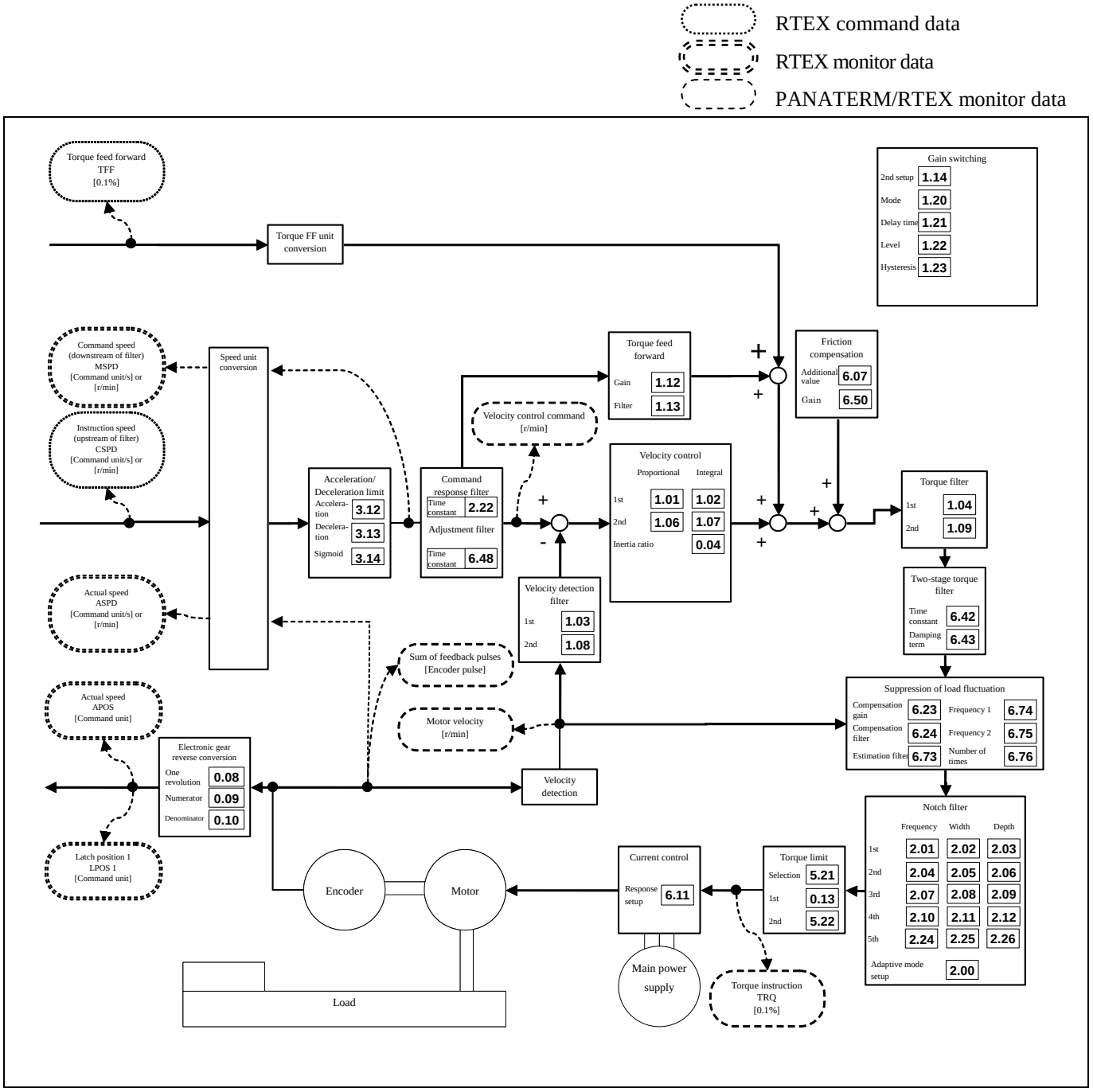
Thereafter, adjust the related parameters by real-time auto-tuning (see 5-1-3). Only when further improvement is required, manually finely adjust the following parameters while confirming responses.

Class	No.	At-trib-ute *1)	Parameter name	Setting range	unit	Functions
6	47	R	Function expansion setup 2	-32767–32768	-	Various functions are set in bit units. bit0 Two-degree-of-freedom mode 0: Invalid 1: Valid bit3 Selection of real-time auto-tuning of two-degree-of-freedom control Fix to 0(Standard type). *The least significant bit is set to bit0.
2	22	B	Command smoothing filter	0–10000	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 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	B	Adjust 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. • 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.

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

(3) Block diagram of the two-degrees-of-freedom control mode

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

*1 When performing Frequency characteristic measurement (speed close loop characteristic, Torque speed(Vertical)) from the PANATERM, the driver switches to velocity control mode internally.

5-2-18 Two-degree-of-freedom control mode (with 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. Do not set if for synchronization 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
Miscellaneous	・Real-time auto tuning selection is two-degree-of-freedom control mode standard type. ・Should be in servo-on condition ・Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Related parameters

First, set Pr6.47 “Function expansion setup 2” to bit0=1 and write the setting to EEPROM, and then reset the control power to enable two-degree-of-freedom control.
After this, make adjustments of the real-time auto-tuning function (refer to Section 5-1-3 or 5-1-4).
Only when further improvement is required, manually fine-tune the following parameters while confirming the response.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	47	R	Function expansion setup 2	-32768–32767	–	Set respective functions in unit of bit. bit0 two-degree-of-freedom control mode 0: Invalid 1: Valid bit3 Selection of real-time auto-tuning of two-degree-of-freedom control Fix to 0(Standard type). * The least significant bit is bit0. * bit3 (Selection of real-time auto-tuning of two-degree-of-freedom control) can be used only when bit0 is set to 1: Valid.
2	22	B	Command smoothing filter	0–10000	0.1ms	Time constant for the command filter is set in two-degree-of-freedom control. • The maximum value is limited to 2000 (=200.0 ms). *The parameter value itself is not limited, but the value applied in the driver is limited. • Command response can be quickened by decreasing this parameter and slowed by increasing it. • The attenuation term is set by Pr6.49 “Adjust/Torque command attenuation term”.
6	48	B	Adjust filter	0–2000	0.1ms	Set the time constant for the adjust filter. • When the torque filter setting has been changed, set a value close to the real-time auto-tuning setting. • As a result of fine-tuning while checking the encoder position deviation near the setting, overshoot and oscillatory waveforms may be improved. • The attenuation term is set by Pr6.49 “Adjust/Torque command attenuation term”.

(to be continued)

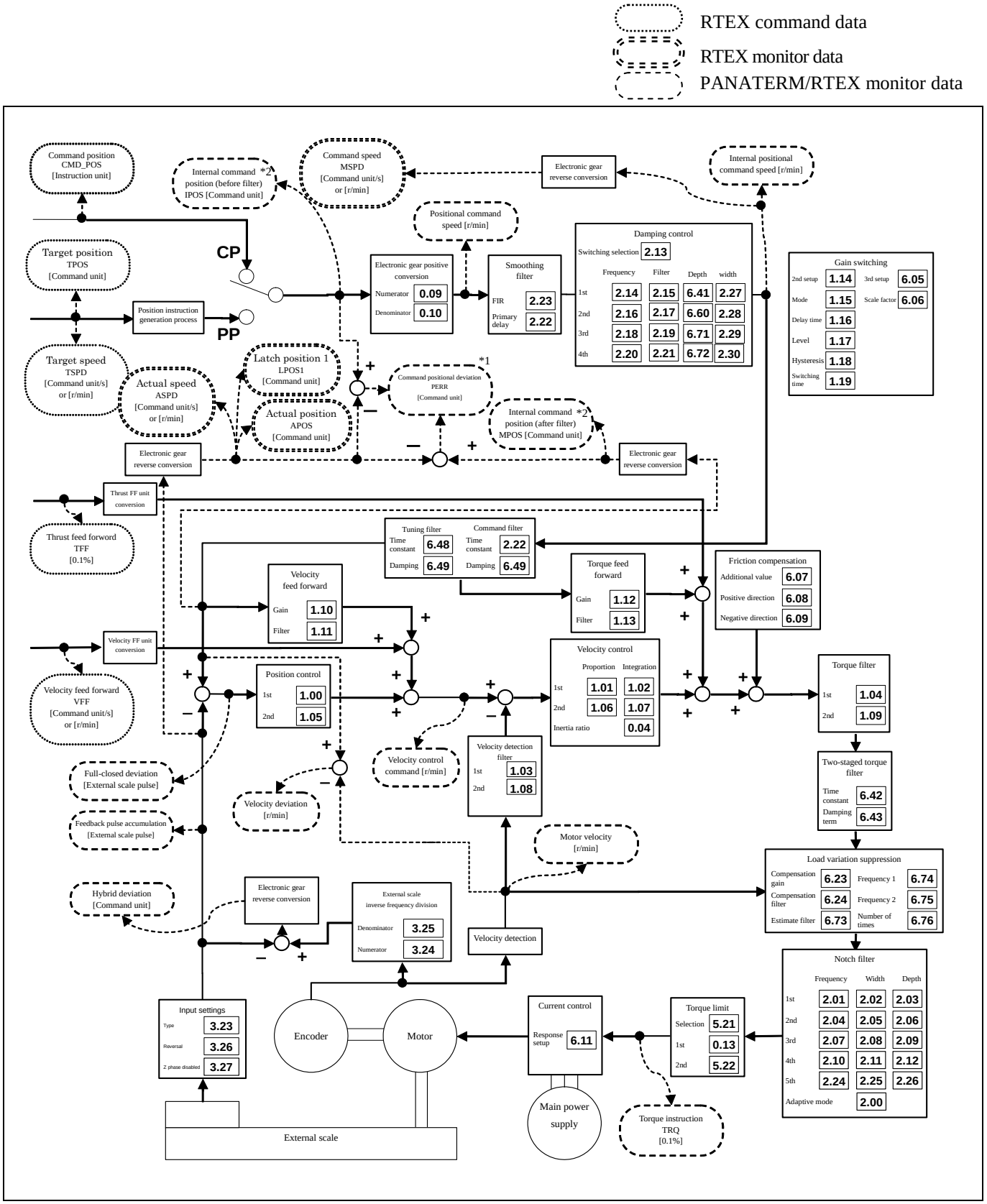
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	49	B	Adjust/Torque command attenuation term	0–99	–	Set the attenuation term for the command filter and adjust filter. • A decimal number indication is used. The first digit sets the command filter and the second digit sets the adjust filter. <Each target digit of the set value> 0 to 4: No attenuation term (operated as primary filter) 5 to 9: Secondary filter (Attenuation terms, ζ will be 1.0, 0.86, 0.71, 0.50, and 0.35 in order.) <Setting an example of this parameter> To set the command filter to ζ=1.0 and adjust filter 1 to ζ=0.71, the setting value should be 75 (first digit=5 (ζ=1.0), second digit=7 (ζ=0.71)). For the time constant of the command filter, Pr2.22 "Command smoothing filter" will be applied.
6	50	B	Viscous friction compensation gain	0–10000	0.1%/ (10000r /min)	Add the result of multiplying the command velocity by this setting value to the torque command as the correction amount of the viscous friction torque. • The encoder position deviation near the setting may be improved by setting the viscous friction factor estimation for real-time auto-tuning.

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

[A6NE]: This function cannot be used.

(3) Block diagram of the two-degrees-of-freedom control mode

Two-degree-of-freedom control mode (with full-closed control) shall be as per the block diagram indicated below.



Two-degree-of-freedom control mode (with full-closed control) block diagram

*1 The computation reference for the positional deviation [command unit] can be changed by bit14 for Pr7.23 “RTEX function extended setup 2”.

*2 The position command on PANATERM can be switched depending on the setting of the bit3 "Command pulse accumulation value" of Pr7.99 "RTEX function extended setup 6".

5-2-19 Virtual full-closed control mode function

Virtual full-closed control mode function is a function to enable axis operation even when the external scale position does not change due to the device mechanism under full-closed control mode, by virtually estimating the external scale position based on the encoder position information.
There are areas where full-closed system cannot be constructed within the motor operation range, and it is an effective function when temporary operation with semi-closed control is required.

(1) Scope

This function works under the following condition.

	Conditions under which virtual full-closed control mode function operates
Control mode	・Full-closed control
Miscellaneous	・The software version shall be function extended version 5 or later. ・External scale type : A, B phase output type Serial communications type (increment specification) ・The elements other than control parameters such as torque limit settings are correctly set, assuring that the motor can run smoothly.

(2) Related parameters

After confirming that this function operates properly with full-closed control, execute EEPROM writing with Pr6.98 “Extended function setup 4” bit9=1, then execute control power supply reset or RTEX communication reset command soft reset mode to enable the virtual full-closed control mode function.

Class	No.	Attribute *1)	Title	Range	Unit	Function
0	01	R	Control mode setup	0～6	-	Select the control mode of the servo driver. 0: semi-closed control (position/velocity/torque control, selectable) 1-5: To be used by the manufacturer but not by the user. 6: Full-closed control(Position control only)
3	23	R	External scale selection	0～6	-	Selects external scale type. 0: AB phase output type 1: Serial communication type (incremental spec.) 2: Serial communication type (absolute spec.) 3: For manufacturer’s use 4: For manufacturer’s use 5: For manufacturer’s use 6: For manufacturer’s use
3	32	R	Judgment threshold for positional variation of external scaleat virtual full-close control mode	0～65534	external scale unit	Set up the judgment threshold value for positional variation of external scale at virtual full-closed control mode.
6	98	R	Function expansion setup 4	-2147483648 ～ 2147483647	-	Sets various function in bit units: bit 0 to 4: For manufacture use. Please set fixed to 0 bit5 to 8: Not used. Please set fixed to 0 bit9:Virtual full-closed control mode *1 0:Ineffective 1:Effective *1 The virtual full-closed control mode function becomes effective, only when Pr0.01=6 and (Pr3.23= 0 or 1) and in addition, Pr6.98 bit9=1. bit10-31 Not used, Fix at 0. *bit 0 is the least significant bit.

(To be continued)

Class	No.	Attribute *1)	Title	Range	Unit	Function
7	23	B	RTEX function extended setup 2	-32768 ～32767	-	bit8: RTEX status selection between In_Progress and AC_OFF 0: In_Progress, 1: AC_OFF * It is connected to the setting of bit15. bit9: Selects whethbit15:Extension of RTEX status selection for the setting value of In_Progress/AC_OFF/Pr7.112 0:Complying with the setting (In_Progress/AC_OFF) of Pr7.23 bit8 1:The signal designated by Pr7.112 is output.
7	110	B	RTEX function extended setup 7	-2147483648 ～ 2147483647	-	Setting of various functions is performed by the unit of 1 bit. bit0-15:Used by the manufacturer. bit16:Judgment of reaching the external scale at the virtual full-closed control mode 0:Judged by upper controller 1:Judged by amplifier bit17-31:Used by the manufacturer.
7	112	B	Selection of RTEX communication status flag	0～1	-	Select the signal returned with the status flag (Byte2 bit1) of RTEX response in the case of Pr7.23 bit15=1 0:RET_status (the status during execution of escape operation) is returned.

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

(3) Block diagram under virtual full-closed control mode (conventional control/two-degrees-of-freedom control)

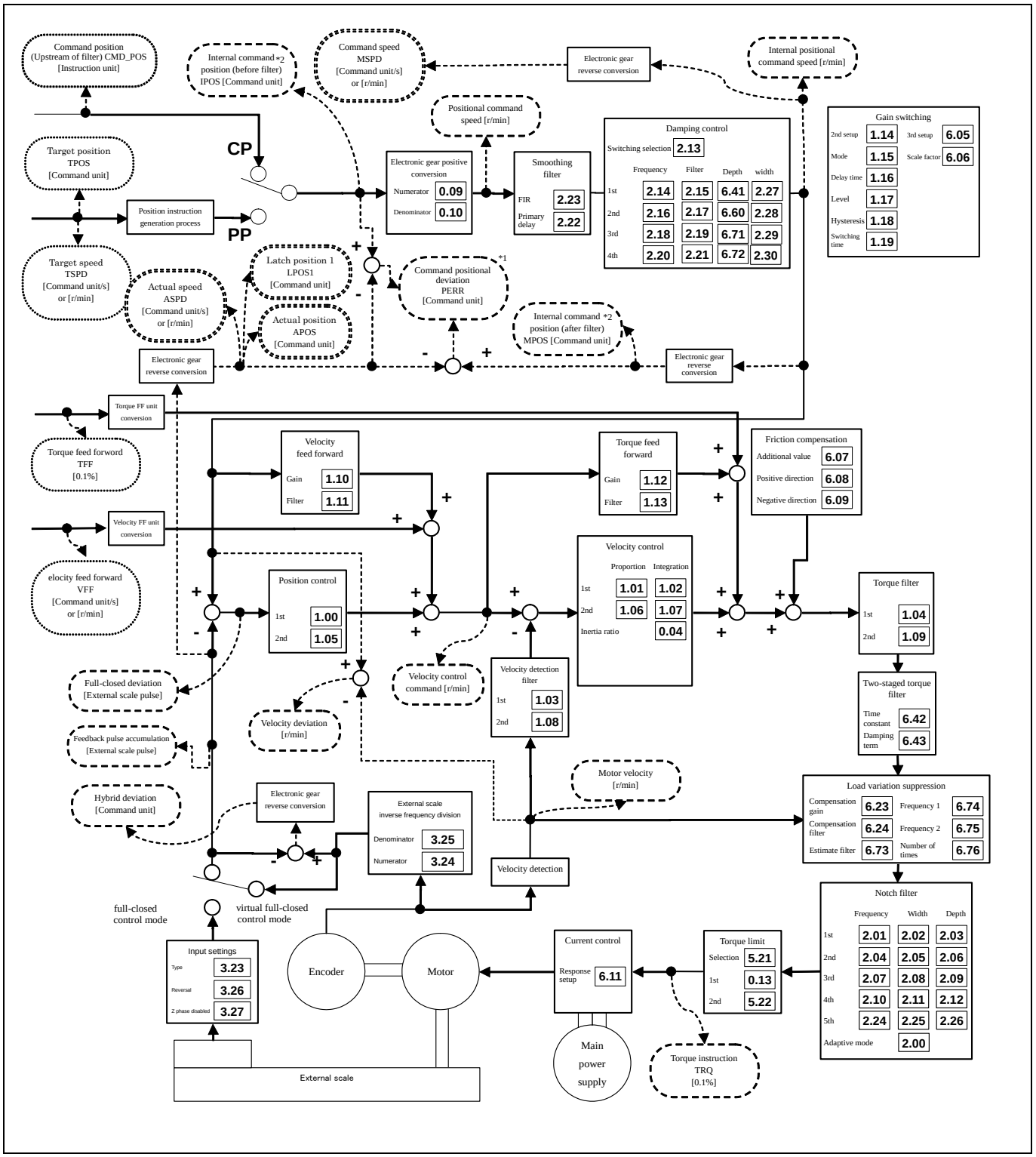
The configuration shown in the block diagram below is used under virtual full-closed control mode (conventional control).

- •Profile position control mode (PP)
- •Cyclic position control mode (CP)

RTEX command data

RTEX monitor data

PANATERM/RTEX monitor data



Block diagram under virtual full-closed control mode (conventional control)

*1 Operation standards for position deviation [command unit] can be changed by bit14 of Pr7.23 “RTEX function extended setup 2.”

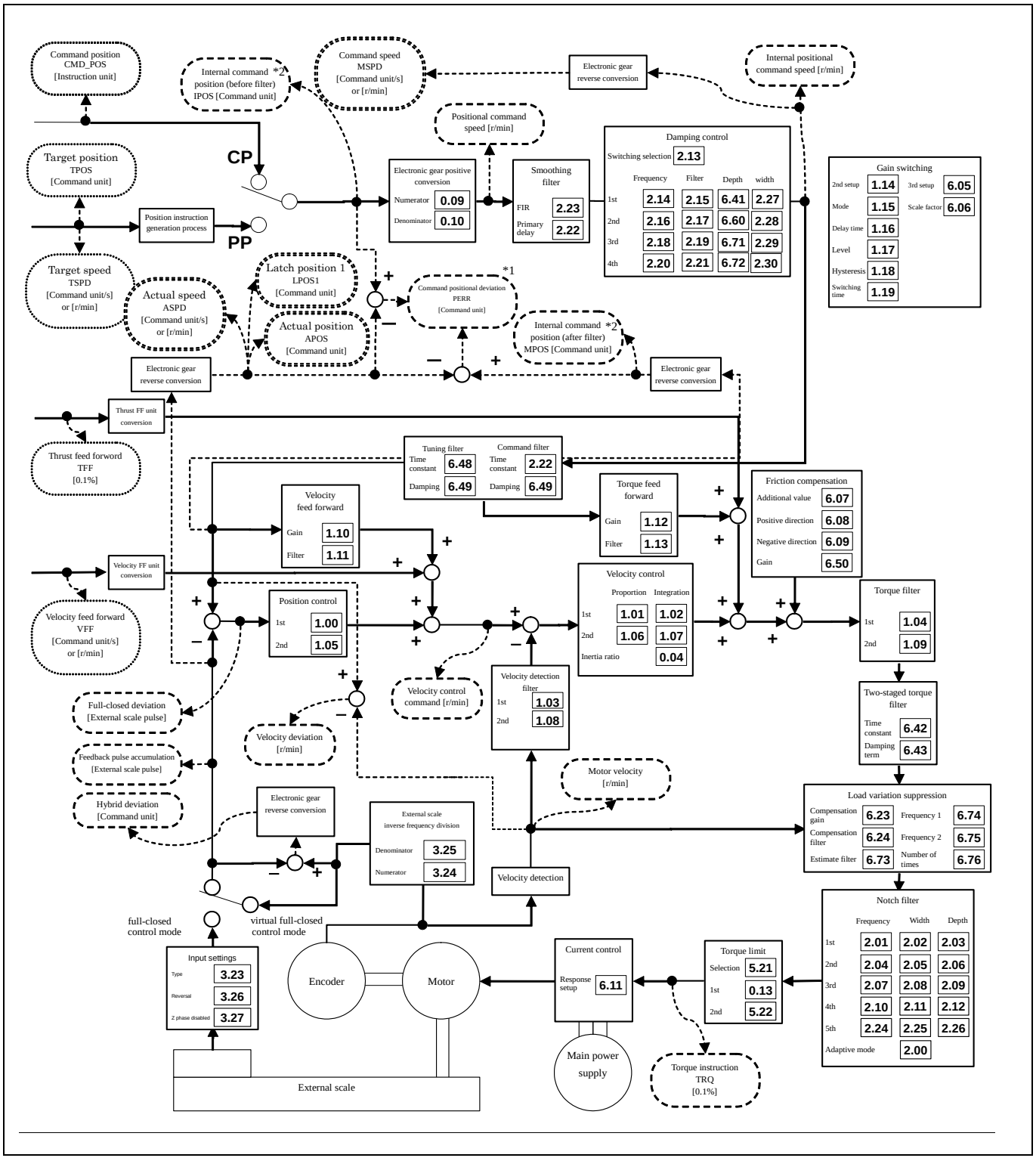
*2 The position instruction on PANATERM varies by the setting for command pulse accumulated value output setting (bit3) of Pr7.99 “RTEX function extended setup 6.”

The configuration shown in the block diagram below is used under virtual full-closed control mode (two-degrees-of-freedom control).

RTEX command data

RTEX monitor data

PANATERM/RTEX monitor data



Block diagram under virtual full-closed control mode (two-degrees-of-freedom control))

*1 Operation standards for position deviation [command unit] can be changed by bit14 of Pr7.23 “RTEX function extended setup 2.”

*2 The position instruction on PANATERM varies by the setting for command pulse accumulated value output setting (bit3) of Pr7.99 “RTEX function extended setup 6.”

(4) How to use

・Please use this function after confirming that it operates normally under full-closed control.
In addition, switch between full-closed control mode/virtual full-closed control mode under the state in which positioning is completed.

■Advance settings

A) After writing in EEPROM with Pr6.98 “Function extended setup 4” bit9=1 (virtual full-closed control mode valid), execute the control power supply reset or soft reset mode of RTEX communication reset command.
* Virtual full-closed control mode becomes invalid when Pr6.98 “Function expanded setup 4” bit9=1 is set while setting Pr0.01 “Control mode setup” to 0 (semi-closed control), or when Pr3.23 “External scale type selection” to 2 (serial communication type (absolute specification))

B) Set up the following parameters to check if the state is in virtual full-closed control mode or not.
Pr7.23 “RTEX communication extended setup 2” bit15 = 1 (according to the setting in Pr7.112)
Pr7.112 “RTEX status flag selection” = 1 (V_Full_Status (virtual full-closed control mode state) is returned)

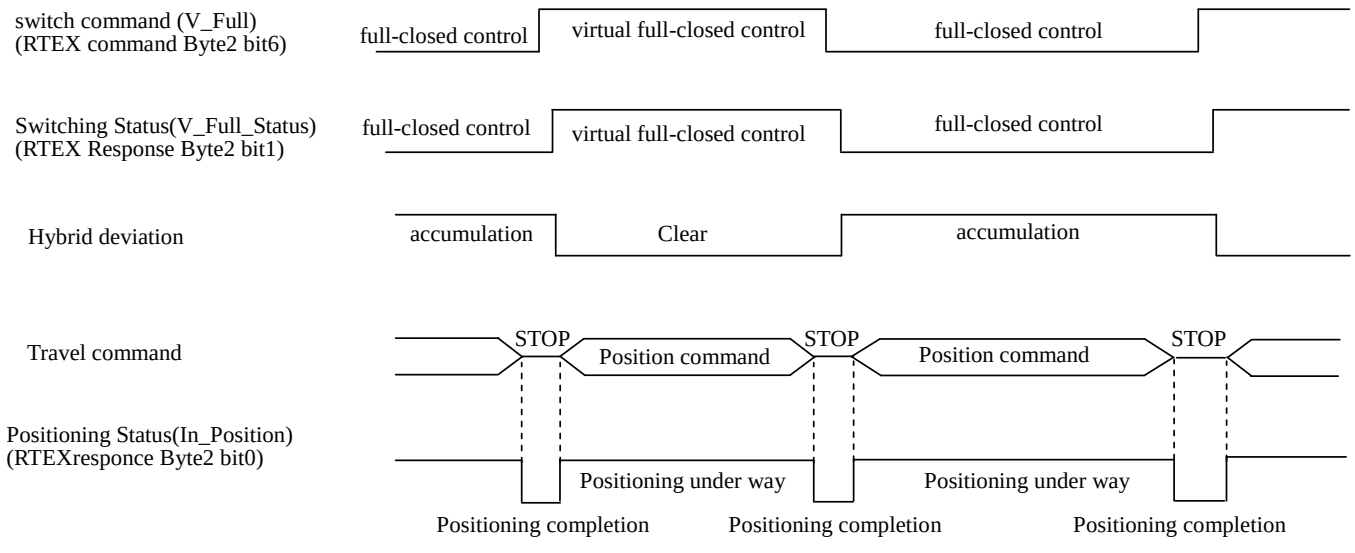
C) Check that it operates properly under full-closed control mode.

■Switching from full-closed control mode to virtual full-closed control mode

① Check that RTEX response Byte2 bit0 (In_Position) is 1 (positioning complete state) with the position command stopped.
② Switch to virtual full-closed control mode by setting the RTEX command Byte2 bit6 (V_Full) to 1.
③ Check that RTEX response Byte2 bit1 (V_Full_Status) is 1 (virtual full-closed control mode).

■Switching from virtual full-closed control mode to full-closed control mode

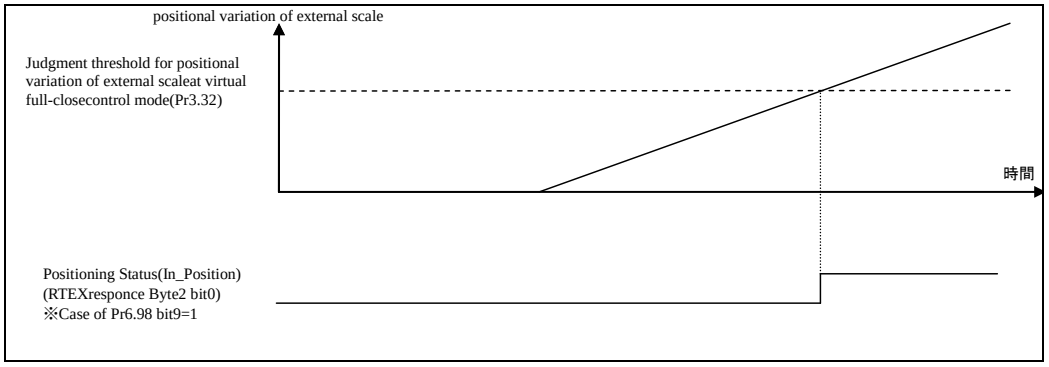
① Check that RTEX response Byte2 bit0 (In_Position) is 1 (positioning complete state) with the position command stopped.
② Switch to full-closed control mode by setting the RTEX command Byte2 bit6 (V_Full) to 0.
③ Check that RTEX response Byte2 bit1 (V_Full_Status) is 0 (full-closed control mode).



(5) Amount of external scale position change judgment function under virtual full-closed control mode

This is a function to notify that the amount of position change in external scale reached the setting value in Pr3.32 “Virtual full-closed control mode amount of external scale position change judgment threshold value” or higher during virtual full-closed control mode operation using RTEX response Byte2 bit0 (In_Position).
Use this as a reference data for executing judgment on amount of external scale position change during the virtual full-closed control mode state from the host device.

To enable this function, set Pr6.98 bit9 “Amount of external scale position change judgment under virtual full-closed control mode” =1 (valid).
The amount of external scale position change will be the amount of change from the external scale position data at transition to virtual full-closed control mode.
If the amount of external scale position change reaches the setting value in Pr3.32 or higher even once, the judgment state remains until it is switched to full-closed control mode.
If the mode is switched to virtual full-closed control mode with this function valid and Pr3.32 = 0, judgment state will constantly remain.



(6) Precautions

・There are areas in motor operation range where full-closed system cannot be constructed, and it is a function which is valid when operation with semi-closed control is temporarily required. Since this function addresses virtual full-closed control with only encoder data but no external scale data, it may vary from the actual position of external scale during the virtual full-scale control mode. Please do not use it for purposes which require positional precision or purposes in which this operation results in unsafe conditions.

・Operation will be executed with virtual full-closed control mode even when the settings in Pr3.24 “External scale division numerator,” Pr3.25 “External scale division denominator,” and Pr3.26 “External scale direction inversion” are incorrect.
An alarm will be generated when the virtual full-closed control mode is switched to full-closed control mode.
Please use this function after checking that it operates properly under full-closed control in advance.

・Virtual full-closed control mode function becomes invalid and Err93.8 “Parameter setup error protection 6” will occur if Pr6.98 “Function extended setup 4” bit9 (virtual full-closed control mode function) is set to 1 (valid) and Pr0.01 “Control mode setup” to 0 (semi-closed control), or Pr3.23 “External scale type selection” is set to 2 (serial communication type (absolute specification)).

・Since this function operates with full-closed control setup, only position control (CP, PP) is supported.
When velocity control (CV) or torque control (CT) command other than position control is executed, Err91.1 “RTEX command error protection” will be generated.

・Since hybrid deviation is constantly cleared during virtual full-closed control mode, Err25.0 “Hybrid deviation excess protection” is not detected.

・Please ensure a period of 2 ms or longer when it is possible to switch between full-closed control mode and virtual full-closed control mode. Err91.1 “RTEX command error protection” will be generated if switching between full-closed control mode and virtual full-closed control mode is executed within 2 ms.

・Please do not use position compare output function or pulse regeneration function during virtual full-closed control mode state.

・The following operations will not start up during virtual full-closed control mode state but command error 5Bh will be returned.
- Return to origin command (□4h)
- Profile command (17h) Profile position latch absolute positioning (12h)
  Profile position latch relative positioning (13h)
  Return to profile origin (31h to 34h, 36h)
- Reset command (□1h) Attribute C parameter enable mode (11h)

・Trial operation, FFT, Z phase search and fit gain by setup support software (PANATERM) cannot be used during virtual full-closed control mode state.

・Command error 5Bh will be returned when virtual full-closed control mode switch command is received during the operation of the following.
- Return to origin command (□4h)
- When latch is incomplete after latch function is started with return to origin command (□4h) and shifting to a command other than return to origin command.

* Switching becomes possible after latch completion.
- Profile command (17h) Profile position latch absolute positioning (12h)
  Profile position latch relative positioning (13h)
  Return to profile origin (31h to 34h, 36h)
- Reset command (□1h) Attribute C parameter enable mode (11h)
- During trial operation, FFT, Z phase search or fit gain execution from setup support software (PANATERM)

6. Application

6-1 Torque limit switching function

This function changes the torque limit value according to the operation direction or torque limit switching command (TI_SW) of RTEX communication.
For details, refer to Technical Reference RTEX Communication Specification ”Section 4-2-3-3”.

(1) Applicable range

□ This function can be applicable only when the following conditions are satisfied.

	Conditions under which the Torque limit switching function is activated
Control mode	• Position control, velocity control or full-closed control. *1)
Others	• Should be in servo-on condition • Parameters except for controls are correctly set, assuring that the motor can run smoothly.

*1) 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 “1st torque limit” only is validated.

(2) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	13	B	1st torque limit	0–500	%	You can set up the 1st limit value of the motor output torque.
5	21	B	Selection of torque limit	0–4	—	You can set up the torque limiting method. *If 0 is set for this parameter, 1 is internally set.
5	22	B	2nd torque limit	0–500	%	You can set up the 2nd limit value of the motor output torque.
5	23	B	Torque limit switching setup 1	0–4000	ms/100 %	Set the rate of change (gradient) from value 1 to value 2 during torque limit change.
5	24	B	Torque limit switching setup 2	0–4000	ms/100 %	Set the rate of change (gradient) from value 2 to value 1 during torque limit change.
5	25	B	Positive direction torque limit	0–500	%	Set up positive direction torque limit upon receiving torque limit switching.
5	26	B	Negative direction torque limit	0–500	%	Set up negative direction torque limit upon receiving torque limit switching.

Setup value	TL_SW = 0		TL_SW = 1	
	Negative direction	Positive direction	Negative direction	Positive direction
1	Pr 0.13			
2	Pr 5.22	Pr 0.13	Pr 5.22	Pr 0.13
3	Pr 0.13		Pr 5.22	
4	Pr 5.22	Pr 0.13	Pr 5.26	Pr 5.25

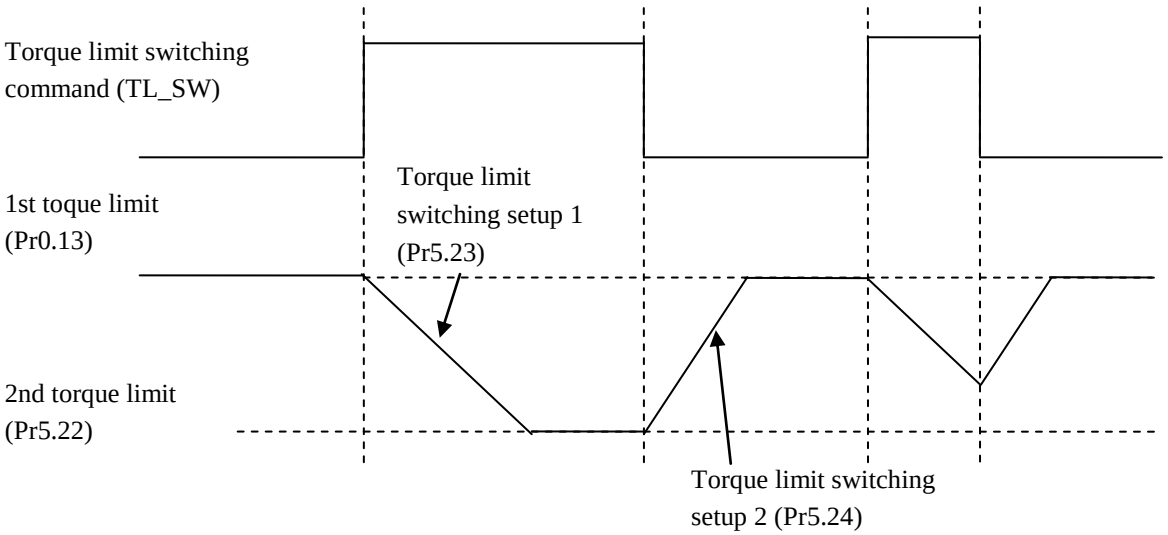
*1) For parameter attribute, refer to Section 9-1.

(3) Content

• The torque limit switching mode is shown in the table below:

Pr5.21	Torque limit switching command (TL_SW)	Torque limit switching setting (Change rate setting) (Pr5.23 and Pr5.24)	Positive direction torque limit	Negative direction torque limit
1	-	-	Pr0.13	
2	-	-	Pr0.13	Pr5.22
3	OFF	Effective	Pr0.13	
	ON		Pr5.22	
4	OFF	-	Pr0.13	Pr5.22
	ON		Pr5.25	Pr5.26

• Setting of change rate at the time of torque limit switching:
When the motor is used with Pr5.21 “Selection of torque limit” = 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 setup 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 setup 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 setup 1” or Pr5.24 “Torque limit switching setup 2” to 0 instantaneously switches the torque limit.



Note) When the 1st torque limit (Pr0.13) and the 2nd torque limit (Pr5.22) is changed from the setup support software PANATERM or RTEX 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 command (TL_SW).

6-2 Motor working range setup function

If the motor with respect to the position command input range exceeds the motor operating range that is set by Pr5.14“Motor working range setup”, it can be alarm stop at the Err34.0 “motor movable range set 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 “motor movable range set protection” will be detected.

(1) Applicable range

□ This function can be applicable only when the following conditions are satisfied.

	Conditions under which the software limit works
Control mode	• Position control or full-closed control.
Others	• Should be in servo-on condition • Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

(2) Caution

- This function is not a protection against the abnormal position command.
- When this software limit protection is activated, the motor decelerates and stops according to Pr 5.10“Sequence at alarm”.
  The work (load) may collide to the machine end and be damaged depending on the load during this deceleration, hence set up the range of Pr 5.14 including the deceleration movement.
- When changing the control mode (for the purpose of only to control velocity or torque), do not use this function. Instead, use software limit function or drive inhibit input.
- When any of the following values ([encoder pulse] or [external scale pulse]) managed internally in the amplifier, exceeds $\pm 2^{31}$, Err34.0 “motor movable range set protection” detection process will be invalidated’ *1
  - －Position command input range
  - －Actual motor position for judgment
  - －Motor movable range
- During the virtual full close control mode, the motor movable range is judged by using the information that virtually estimated the external scale position from the encoder position information.
- In case any of the following conditions are satisfied, the position command input range and the actual motor position for judgment managed inside the amplifier will be cleared and Err34.0 “Motor movable range setting error protection” detection process will be invalidated.
  - －When the control power is turned on
  - －Servo-OFF state
  - －Velocity control state or torque control state
  - －During frequency response measurement using setup support software (PANATERM).
  - －During the time position deviation is cleared (position deviation cleared for servo OFF or for decelerated stop from alarm, etc.).
  - －During test run or Z phase search operation using setup support software (PANATERM).
  - －Under absolute clear using setup support software (PANATERM)
  - －Pr5.14 = 0
  - －When Pr5.14 satisfies the following formula (when the value of Pr5.14 converted into external pulse units exceeds 2^{31}). *1
    Pr5.14 > $((2^{31} -1) * Pr3.24 * 10) / (Encoder\ resolution * Pr3.25)$
  - －When clearing position deviation during deceleration to stop due to over-travel inhibit input
  - －When returning to home

*1 However, it is possible to generate Err34.0 by force even when the Err34.0 detection process is disabled, by enabling the following setting.

Pr6.97 “Function expansion setup 3”

bit2 Expansion of Allowable motor operating range abnormal protection 0: Invalid, 1: Valid

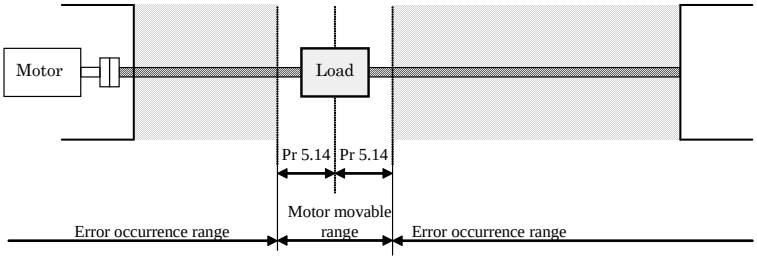
(3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	14	A	Motor working range setup	0–1000	0.1 revolution	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	B	Function expansion setup 3	-2147483648 – 2147483647	-	Sets various function in bit units: bit 2: Expansion of Allowable motor operating range abnormal protection 0: Invalid, 1: valid

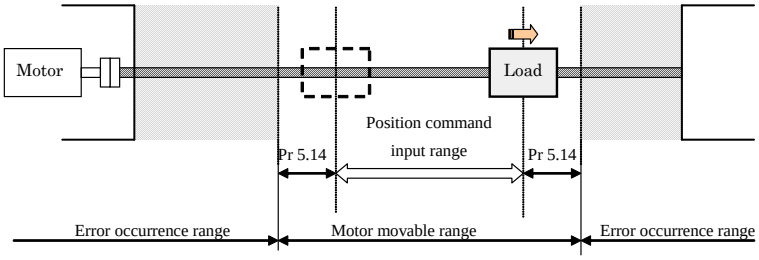
*1) For parameter attribute, refer to Section 9-1.

(4) Example of movement

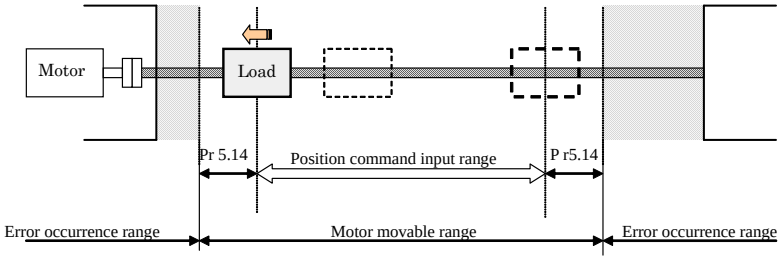
(1) When no position command is entered (Servo-ON status)
The motor movable range will be the travel range which is set at both sides of the motor with Pr5.14 since no position command is entered. When the load enters to the Err34.0 occurrence range (oblique line range), software limit protection will be activated.



(2) When the load moves to the right (at Servo-ON)
When the position command to the right direction is entered, the motor movable range will be expanded by entered position command, and the movable range will be the position command input range + Pr5.14 setups in both sides.



(3) When the load moves to the left (at Servo-ON)
When the position command to the left direction, the position command input range will be expanded further.



6-3 Operating setting of various sequence

Desired sequence can be set under various operating conditions.

6-3-1 Sequence upon inputting of over-travel inhibition (POT, NOT) (under review)

Set up the operating sequence when the over-travel inhibition is input (POT, NOT).

(1) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	04 *2)	C	Over-travel inhibit input setup	0–2	—	Set up the operation of the over-travel inhibition (POT, NOT) inputs. Set the parameter according to the specification of upper controller. Normally it should be set to 1 (disabled) because the operation is controlled by an upper controller. 0: POT → inhibits CW drive, NOT → inhibits CCW drive. When POT is input during CW driving, stops the drive according to Pr 5.05"Sequence at over-travel inhibit". The similar function NOT is applied in reverse direction. 1: Sequence upon inputting of over-travel inhibition are disabled, having no effect on operation. *3) 2: POT or NOT input activates Err 38.0 Run-inhibition input protection.
5	05 *2)	C	Sequence at over-travel inhibit	0–2	—	When Pr 5.04 "Over-travel inhibit input setup" = 0, specify the status during deceleration and stop after application of the over-travel inhibition (POT, NOT).
5	11	B	Torque setup for emergency stop	0–500	%	Set up the torque limit at emergency stop. When setup value is 0, the torque limit for normal operation is applied.
7	23	B	RTEX function extended setup 2	-32768 –32767	—	[bit 2] RTEX status response condition setting while sequence upon inputting of over-travel inhibition is disabled (Pr 5.04 = 1). 0: RTEX status is enabled (system responses) 1: RTEX status is also disabled (does not response) [bit 3] Arrangement set up of RTEX status bit of POT/NOT 0: POT is bit 1, NOT is bit 0 1: NOT is bit 1, POT is bit 0 [bit 6] RTEX status logical setting of POT/NOT 0: Without inversion (1: active) 1: Inversion (0: active)

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

*2) The Pr5.04 "Over-travel inhibit input setup" and Pr5.05 "Sequence at over-travel inhibit" settings are temporarily invalid during profile home position return.
If profile home position return function is used without using the over-travel inhibit input, don't assign over-travel inhibit input (POT/NOT) to general purpose input. The setting is not invalidated only by setting the Pr5.04 to 1.
For more information on profile home position return, refer to Technical Reference RTEX Communication Specification.

*3) With POT allocated to SI6 or NOT allocated to SI7, and Pr 5.04 "Over-travel inhibit input setup" is set to other than 1 (Invalid), Err38.2 "Over-travel inhibit input protection 3" occurs.

(2) Contents

• Details of Pr 5.05 “Sequence at over-travel inhibit”

Pr 5.04 *4)	Pr 5.05	During deceleration *6)		After stalling (Approx. 30 r/min or below)	
		Stopping method	Deviation	Operation after stopping	Deviation
0	Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *9)	—	• Control mode depends on the command. *2)	—
	0	• Dynamic brake action *7)	Clear *3)	• Torque command=0 towards inhibited direction	Hold
	1	• Free run (DB OFF)	Clear *3)	• Torque command=0 towards inhibited direction	Hold
	2	• Emergency stop *5) *8) *9) • Torque limit=Pr 5.11	Clear *3)	• Torque limit and torque command are as usual.	Hold

*1) During deceleration, the system is forced to perform position control, forcibly stopping the internal position command generating process.

*2) Stop a command in over-travel inhibit direction with the over-travel inhibit input set to ON. If a command is issued in over-travel inhibit direction, the command is neglected. If the bit 9 of the parameter for RTEX function extended setup 2 (Pr7.23) is set to 1 at this time, a command error is returned.

*3) During deviation clearing, the process that lets the internal command position to follow the feedback position is activated. At the instantaneous stopping and at the end of deceleration, position deviations/external scale deviations accumulated during deceleration are cleared.

*4) When setting value of Pr 5.04 “Over-travel inhibit input setup” is 2, Err 38.0 “Over-travel inhibit input protect” occurs when POT or NOT is turned on. Therefore, the system operates according to Pr 5.10 “Sequence at alarm” but not to this setting. Pr 5.10 “Sequence at alarm” has always priority if any other error occurs.

*5) Emergency stop refers to a controlled immediate stop with servo-on.
The torque command value is limited during this process by Pr 5.11 “Torque setup for emergency stop”.
In an emergency stop, normal operation is performed during the time between the input of the signal and the start of the emergency stop. If a command is stopped concurrently with the input of the signal, a torque disallowed by normal torque limitation may be output.
To allow a stop with the torque specified in the Emergency stop torque setup, continue to send the normal command at least 4 ms after the input of the signal.

*6) Deceleration period is the time required for the running motor to speed down to 30 r/min. Once the motor speed drops below 30 r/min, it is treated as in stop state regardless of its speed.

*7) Stopping method is Free run (DB OFF) in dynamic brake non-compatible models.

*8) Pr6.14 "Emergency stop time at alarm" setting is invalid.

*9) If Slow Stop function is enabled at bit10 and bit15 of Pr6.10 “function extended setup,” it will not emergency stop but come to a Slow Stop. For details, please see Section 6-3-7.

6-3-2 Sequence at Servo-off

Set up the servo-off sequence.

(1) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	06	B	Sequence at Servo-Off	0–9	—	Specify the status during deceleration and after stop, after servo-off.
5	11	B	Torque setup for emergency stop	0–500	%	Set up the torque limit at emergency stop. When setup value is 0, the torque limit for normal operation is applied.

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

(2) Contents

• Details of Pr 5.06 “Sequence at Servo-off”

Pr 5.06	During deceleration *4)		After stalling (Approx.30 r/min or below)	
	Stopping method	Deviation	Operation after stopping	Deviation
Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *8)	—	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *8)	—
0,4	• Dynamic brake action *6)	Clear *2)	• Dynamic brake action *6)	Clear *2)
1,5	• Free run (DB OFF)	Clear *2)	• Dynamic brake action *6)	Clear *2)
2,6	• Dynamic brake action *6)	Clear *2)	• Free run (DB OFF)	Clear *2)
3,7	• Free run (DB OFF)	Clear *2)	• Free run (DB OFF)	Clear *2)
8	• Emergency stop *3) *7) *8) • Torque limit =Pr 5.11	Clear *2)	• Dynamic brake action *6)	Clear *2)
9	• Emergency stop *3) *7) *8) • Torque limit =Pr 5.11	Clear *2)	• Free run (DB OFF)	Clear *2)

*1) During deceleration sequence or at the stop (servo OFF), the system has to control the position and to stop the generation of internal position command.

*2) During deviation clearing process, the system causes the internal command position to follow up the feedback position. When executing the interpolation feed system command after servo ON, re-set the command coordinate of the host controller. The motor may operate sharply.

*3) Emergency stop refers to a controlled immediate stop with servo-on. The torque command value is limited during this process by Pr 5.11 “Torque setup for emergency stop”.
In an emergency stop, normal operation is performed during the time between the input of the signal and the start of the emergency stop. If a command is stopped concurrently with the input of the signal, a torque disallowed by normal torque limitation may be output.
To allow a stop with the torque specified in the Emergency stop torque setup, continue to send the normal command at least 4 ms after the input of the signal.

*4) Deceleration period is the time required for the running motor to speed down to 30 r/min. Once the motor speed drops below 30 r/min, it is treated as in stop state regardless of its speed.

*5) If an error occurs during servo-off, follow Pr 5.10 “Sequence at alarm”. If the main power is turned off during servo-off, follow Pr 5.07 “Sequence at main power off”. least 4 ms after the input of the signal.

*6) Stopping method is Free run (DB OFF) in dynamic brake non-compatible models.

*7) Pr6.14 "Emergency stop time at alarm" setting is invalid.

*8) If Slow Stop function is enabled at bit10 and bit15 of Pr6.10 “function extended setup,” it will not emergency stop but come to a Slow Stop. For details, please see Section 6-3-7.

6-3-3 Sequence at main power OFF

Set up the main power OFF sequence.

(1) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	07	B	Sequence at main power off	0–9	—	Specify the status during deceleration after main power interrupt or after stoppage.
5	08	B	LV trip selection at main power off	0-3	—	Select LV trip or servo OFF upon occurrence of main AC power alarm. Setup the condition to detect main AC power OFF alarm when the main AC power is kept interrupted for a time longer than the time set by Pr7.14. bit 0 0: Select servo OFF according to the setting of Pr 5.07 and then return to servo ON by turning ON main AC power. 1: Trip with Err 13.1 Main power undervoltage protection.*2) bit 1 0: Detect main AC power OFF alarm only when servo is in ON state. 1: Always detect main AC power OFF alarm.
5	09	C	Detection time of main power off	20-2000 *3)	ms	Set the main power alarm detection time. When 2000 is set, main power OFF detection is disabled.
5	11	B	Torque setup for emergency stop	0–500	%	Set up the torque limit at emergency stop. When setup value is 0, the torque limit for normal operation is applied
6	36	R	Dynamic brake operation input setup	0–1	—	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

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

*2) Err13.1 "Main power supply shortage voltage protection (AC off detection)" will not occur during execution of retreat operation using main power off as the trigger.

*3) To use this setting with a smaller value than the shipment value, please check matching with your power supply environment.

(2) Contents

• Details of Pr 5.07"Sequence at main power off"

Pr5.07	During deceleration *4)		After stalling (Approx.30 r/min or below)		
	Stopping method	Deviation	Operation after stopping		Deviation
			Pr6.36 = 0	Pr6.36 = 1	
Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *9)	–	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *9)		–
0,4	• Dynamic brake action *6)	Clear *2)	• Dynamic brake action *6)	Operation of dynamic brake is subjected to the state of dynamic brake switching input (DB-SEL). *7)	Clear *2)
1,5	• Free run (DB OFF)	Clear *2)	• Dynamic brake action *6)		Clear *2)
2,6	• Dynamic brake action *6)	Clear *2)	• Free run (DB OFF)		Clear *2)
3,7	• Free run (DB OFF)	Clear *2)	• Free run (DB OFF)		Clear *2)
8	• Emergency stop *3) *8) *9) • Torque limit =Pr 5.11	Clear *2)	• Dynamic brake action *6)		Clear *2)
9	• Emergency stop *3) *8) *9) • Torque limit =Pr 5.11	Clear *2)	• Free run (DB OFF)		Clear *2)

*1) During deceleration sequence or at the stop (main power OFF), the system must control the position and stop the generation of internal position command.

*2) During deviation clearing process, the system causes the internal command position to follow up the feedback position. When executing the interpolation feed system command after servo ON, re-set the command coordinate of the host controller. The motor may operate sharply.

*3) Emergency stop refers to a controlled immediate stop with servo-on. The torque command value is limited during this process by Pr 5.11 “Torque setup for emergency stop”.
In an emergency stop, normal operation is performed during the time between the input of the signal and the start of the emergency stop. If a command is stopped concurrently with the input of the signal, a torque disallowed by normal torque limitation may be output.
To allow a stop with the torque specified in the Emergency stop torque setup, continue to send the normal command at least 4 ms after the input of the signal.

*4) Deceleration period is the time required for the running motor to speed down to 30 r/min. Once the motor speed drops below 30 r/min, it is treated as in stop state regardless of its speed.

*5) If an error occurs with the main power supply turned off, Pr 5.10 “Sequence at alarm” is applied to the operation. When the main power supply is turned off with servo-on state, Err13.1 “Main power undervoltage error” occurs if Pr 5.08 “LV trip selection at main power off” = 1, and the operation follows Pr 5.10 “Sequence at alarm”.

*6) Stopping method is Free run (DB OFF) in dynamic brake non-compatible models.

*7) When Pr6.36 “Dynamic brake operation input” = 1, dynamic brake switch input (DB-SEL) will be valid. In input/output signal assignment, dynamic brake built into the amplifier is canceled by connection with COM- with a-contact setting, and dynamic brake built into the amplifier will operate when connection with COM- is opened.
This input will become invalid for Servo-ON, during trips, safety state or when the main power supply is switched ON and will follow the normal sequence setting.

*8) Pr6.14 "Emergency stop time at alarm" setting is invalid.

*9) If Slow Stop function is enabled at bit10 and bit15 of Pr6.10 “function extended setup,” it will not emergency stop but come to a Slow Stop. For details, please see Section 6-3-7.

6-3-4 Sequence at alarm

Set the operation sequence under alarm condition.

(1) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	10	B	Sequence at alarm	0–7	—	Specify the status during deceleration and after stop, after occurrence of alarm.

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

(2) Contents

• Details of Pr 5.10 “Sequence at alarm”

Pr 5.10	During deceleration *4)			After stalling (Approx.30 r/min or below)	
	Stopping method		Deviation	Operation after stopping	Deviation
Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *6)		—	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1) *6)	—
0	• Dynamic brake action *5)		Clear *2)	• Dynamic brake action *5)	Clear *2)
1	• Free run (DB OFF)		Clear *2)	• Dynamic brake action *5)	Clear *2)
2	• Dynamic brake action *5)		Clear *2)	• Free run (DB OFF)	Clear *2)
3	• Free run (DB OFF)		Clear *2)	• Free run (DB OFF)	Clear *2)
4	Action A *3)	• Emergency stop *3) *6) • Torque limit =Pr 5.11	Clear *2)	• Dynamic brake action *5)	Clear *2)
	Action B *3)	• Dynamic brake action *5)	Clear *2)		
5	Action A *3)	• Emergency stop *3) *6) • Torque limit =Pr 5.11	Clear *2)	• Dynamic brake action *5)	Clear *2)
	Action B *3)	• Free run (DB OFF)	Clear *2)		
6	Action A *3)	• Emergency stop *3) *6) • Torque limit =Pr 5.11	Clear *2)	• Free run (DB OFF)	Clear *2)
	Action B *3)	• Dynamic brake action *5)	Clear *2)		
7	Action A *3)	• Emergency stop *3) *6) • Torque limit =Pr 5.11	Clear *2)	• Free run (DB OFF)	Clear *2)
	Action B *3)	• Free run (DB OFF)	Clear *2)		

*1) During deceleration sequence or at the stop (during alarm or servo OFF), the system must control the position and stop the generation of internal position command.

*2) During deviation clearing process, the system causes the internal command position to follow up the feedback position. When executing the interpolation feed system command after servo ON, first re-set the command coordinate of the host controller. The motor may operate sharply.

*3) Action of A/B: When an alarm requiring emergency stop occurs, the action A is selected when the setup value in the table is set within the range 4 to 7, causing emergency stop of operation. When an alarm not requiring emergency stop occurs, it triggers dynamic braking (DB) specified by action B, or free-running. (Refer to Section 6-3-5.)
Hold the main circuit power until deceleration stop is completed.
For the alarm requiring emergency stop, refer to Section 7-1 “Protective function list”.

*4) Deceleration period is the time required for the running motor to speed down to 30 r/min. Once the motor speed drops below 30 r/min, and changes its status after stoppage, it is treated as in stop state regardless of its speed.

*5) Stopping method is Free run (DB OFF) in dynamic brake non-compatible models.

*6) If Slow Stop function is enabled at bit10 and bit15 of Pr6.10 “function extended setup,” it will not emergency stop but come to a Slow Stop. For details, please see Section 6-3-7.

6-3-5 Emergency stop upon occurrence of alarm

When an alarm requiring emergency stop occurs, the system controls and immediately stops the motor.

(1) Relevant parameters

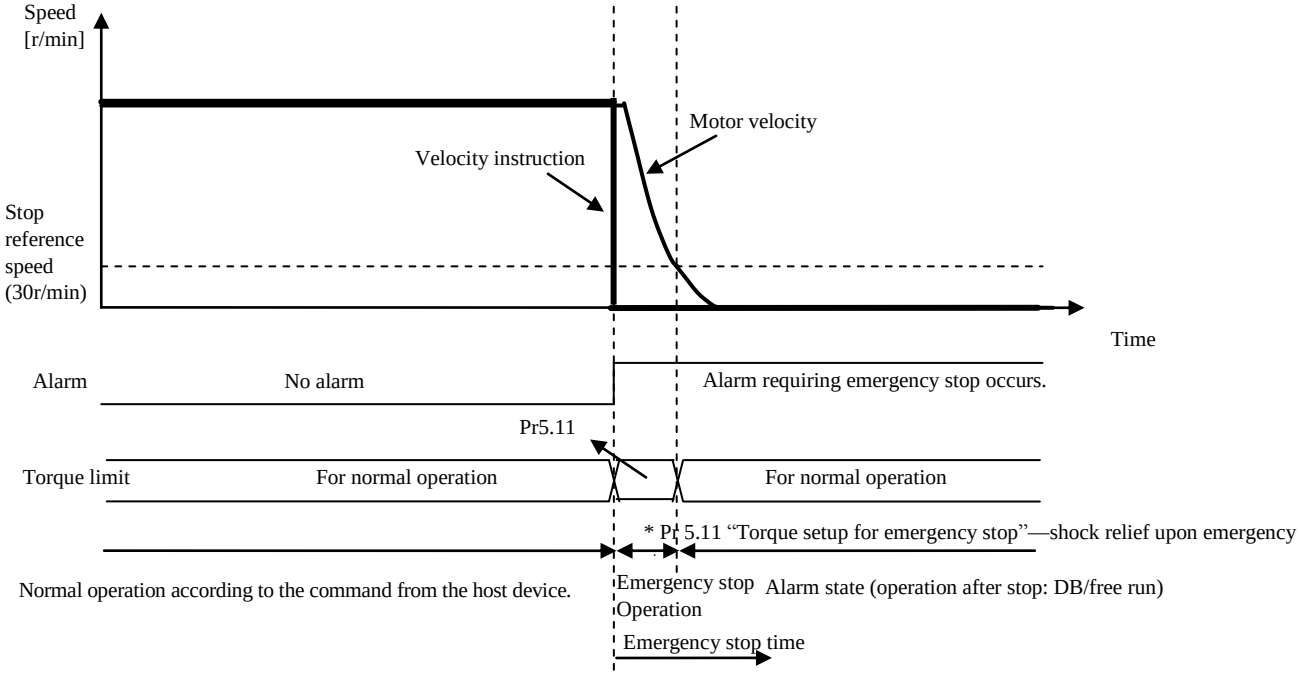
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	10	B	Sequence at alarm	0–7	—	Specify the status during deceleration and after stop, after occurrence of alarm.Setting the parameter to one of 4 to 7, enables emergency stop.
5	11	B	Torque setup for emergency stop	0–500	%	Set up the torque limit at emergency stop. When setup value is 0, the torque limit for normal operation is applied
5	13	B	Over-speed level setup	0–20000	r/min	If the motor speed exceeds this setup value, Err26.0 “Over-speed Protection” occurs.The over-speed level becomes internal value of the over-speed protection level. speed by setting up this to 0. *2)
6	14	B	Emergency stop time at alarm	0–1000	ms	Set up the time allowed to complete emergency stop in an alarm condition. Exceeding this time puts the system in alarm state. When setup value is 0, immediate stop is disabled and the immediate alarm stop is enabled.
6	15	B	2nd over-speed level setup	0–20000	r/min	When the motor speed exceeds this setup time during emergency stop sequence in an alarm condition, Err 26.1 “2nd over-speed protection” will be activated. The over-speed level becomes internal value of the over-speed protection level. speed by setting up this to 0. *2)

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

*2) Except for some motor.

(2) Description

• Emergency stop sequence upon occurrence of an alarm requiring emergency stop.



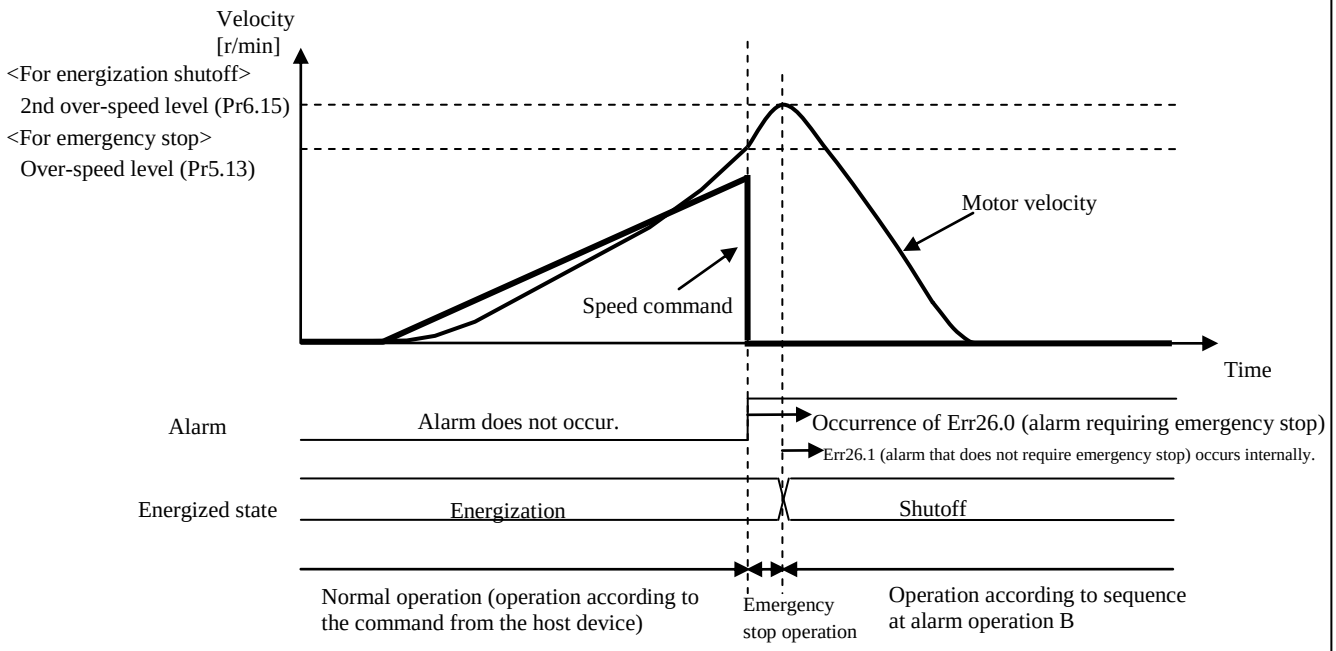
After occurrence of an alarm requiring emergency stop: when the speed has not dropped down to 30 r/min after the elapse of time set by Pr 6.14 “Emergency stop time at alarm”, the system generates the alarm. The system also enters the alarm state if an alarm that does not require emergency stop occurs in the driver during the sequence of the emergency stop.

・When an alarm requiring emergency stop occurs, normal operation (the normal torque limit is enabled) continues until an emergency stop is started. Therefore, if the command is interrupted during this period, the torque controlled with the normal torque limit may be output.
To stop operation with the emergency stop torque limit when an alarm requiring emergency stop occurs, continue to send the normal command for at least 4 ms from the alarm notification.
<Bad example>
Turning on Forced alarm input(E-STOP) and stopping command at the same time.

• Setting of Pr5.13 “Over-speed level setup” and Pr6.15 “2nd over-speed level setup”

The motor may not stop normally even if the emergency stop function is used.
For example, when the motor velocity exceeds Pr5.13 “Over-speed level setup” as shown in the figure below, the motor velocity may increase if normal control cannot be accomplished even after the start of emergency stop operation.
As a safety measure in case of this case, Err26.1 “2nd over-speed protection” is provided.
As Err26.1 is an alarm that does not require emergency stop, energization to the motor is shut off and the motor is stopped according to sequence at alarm, operation B. Set an allowable over-speed level for Pr6.15 “2nd over-speed level setup”.

In addition, set Pr5.13 to a small value with a sufficient margin for Pr6.15. If the margin is insufficient or the set value is the same, both Err26.0 and Err26.1 may be detected. In this case, Err26.0 will be displayed. However, because Err26.1 is also activated internally, priority is given to the alarm that does not require emergency stop, and emergency stop is not executed.
Furthermore, if the Pr6.15 setting is smaller than the Pr5.13 setting, Err26.1 occurs prior to Err26.0. Thus, emergency stop is not executed.



If the velocity has exceeded the value set in Pr6.15 "2nd over-speed level setup", energization is shut off and operation is performed according to sequence at alarm operation B.

6-3-6 Fall prevention function in the event of alarms

Since the servo drive cuts off motor energization when alarm occurs, a workpiece may fall from the vertical axis such as a robot arm during the period from when brake release output (BRK-OFF) becomes OFF to when external brake actually operates.

This function can prevent a fall when alarm occurs by setting the sequence at alarm to immediate stop.
This function cannot be used for alarm that does not support immediate stop.

For details of Sequence at alarm, refer to Section 6-3-4 and 6-3-5.
Refer to Section 7-1 for the details of alarm that supports immediate stop.

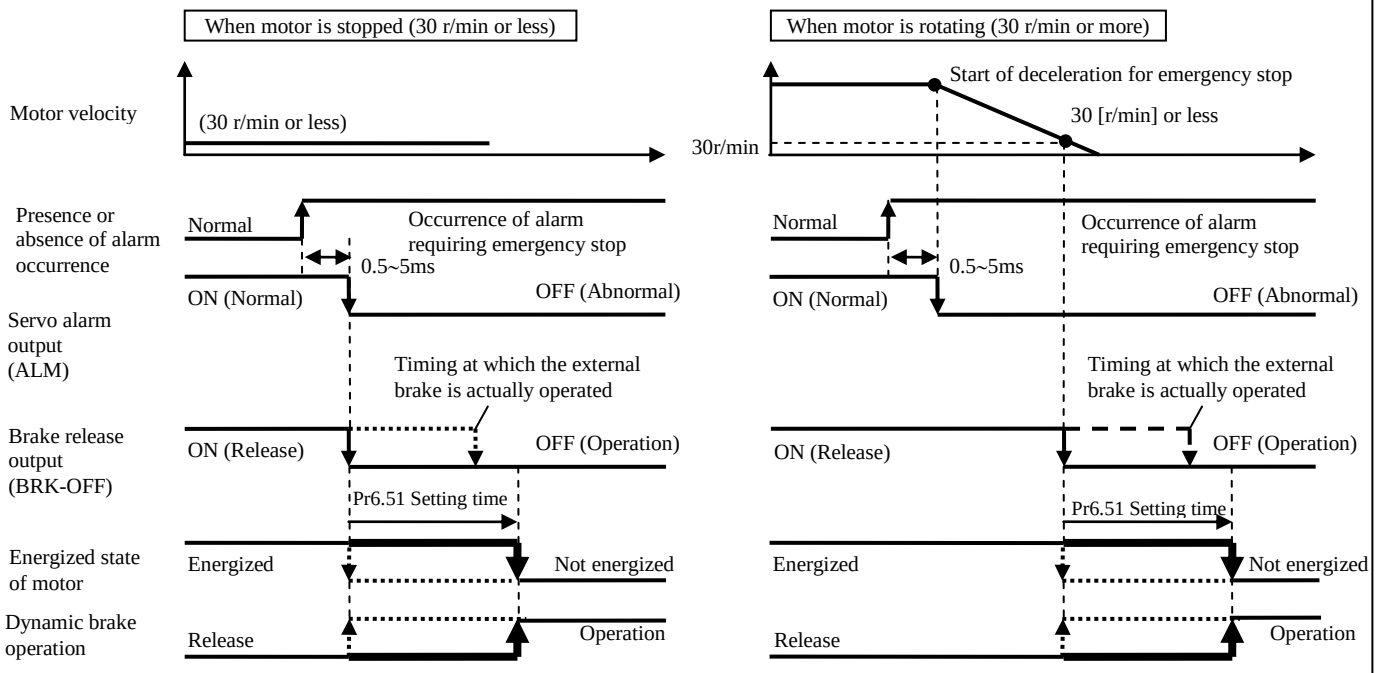
(1) Related parameters

Class	No.	Attri-bute *1)	Title	Range	Unit	Function
5	10	B	Sequence at alarm	0–7	—	Specify the status during deceleration and after stop, after occurrence of alarm.Setting the parameter to one of 4 to 7, enables emergency stop.
6	10	B	Function expansion setup	-32768–32767	–	Set the bit related to the fall prevention function. bit10 Fall prevention function in case of alarms 0: Invalid 1: Valid To enable the fall prevention function, normally set this parameter to 1. *The least significant bit is bit0.
6	51	B	Immediate cessation completion wait time	0–10000	ms	Set the time to keep motor power-on after brake release output (BRK-OFF) is turned OFF when an alarm requiring emergency stop occurs. When 0 is set, the fall prevention function is disabled. *This parameter is enabled even when Pr6.10 “Function expansion setup” is not set to bit10=1. To enable the fall prevention function, however, be sure to set Pr6.10 “Function expansion setup” to bit10=1.

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

(2) Contents

- Operation of the fall prevention function in the event of an alarm requiring emergency stop



6-3-7 Slow stop function

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, velocity control or torque control. *1) *2)
Others	・Should be in servo-on condition ・Parameters except for controls such as torque limit setup, are correctly set, assuring that the motor can run smoothly.

*1) During immediate stop, it is forced to become position control.

*2) It is not supported in versions corresponding to function extended edition 1 or earlier.
Since function extended edition 2 supports only position control, please disable Slow Stop function under velocity control, torque control or full-closed control.

(2) Related parameters

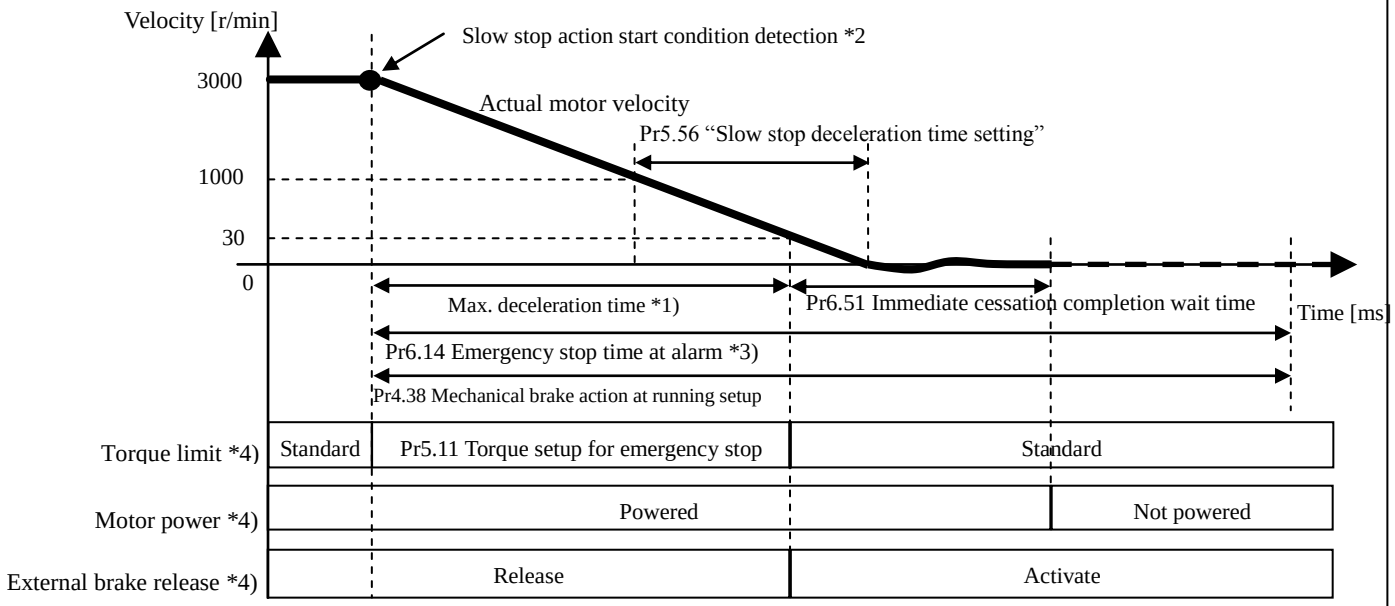
Class	No.	Attribute *1)	Parameter name	Set range	Units	Functions
5	05	C	Sequence at over-travel inhibit	0–2	—	When Pr 5.04 "Over-travel inhibit input setup" = 0, specify the status during deceleration and stop after application of the over-travel inhibition (POT, NOT). *Set up emergency stop to enable Slow Stop function.
5	06	B	Sequence at Servo-Off	0–9	—	Specify the status during deceleration and after stop, after servo-off. *Set up emergency stop to enable Slow Stop function.
5	07	B	Sequence at main power off	0–9	—	Specify the status during deceleration after main power interrupt or after stoppage. *Set up emergency stop to enable Slow Stop function.
5	10	B	Sequence at alarm	0–7	—	Specify the status during deceleration and after stop, after occurrence of alarm. *Set up emergency stop to enable Slow Stop function.
5	56	B	Slow stop deceleration time setting	0 – 10000	ms / (1000 r/min)	Sets the deceleration time under slow stop. This function will become effective when Pr6.10 "Function expansion setup" bit 15 is set to 1.
5	57	B	Slow stop S-shape acceleration and deceleration setting	0 – 1000	ms	Sets the S-shape time for deceleration under slow stop. This function will become effective when Pr6.10 "Function expansion setup" bit 15 is set to 1.
6	10	B	Function expansion setup	-32768 – 32767	-	bit 10: Fall prevention function in case of alarms 0 :Invalid 1: Valid * To enable the slow stop function, set to 1. bit 15: Slow stop function 0 :Invalid 1: Valid
6	14	B	Emergency stop time at alarm	0 – 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. This parameter is valid only for Sequence at alarm. This parameter is invalid for Sequence upon inputting of over-travel inhibition, Sequence at Servo-Off and Sequence at main power OFF. * Please refer to (3) of this item for maximum deceleration time.

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

(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.

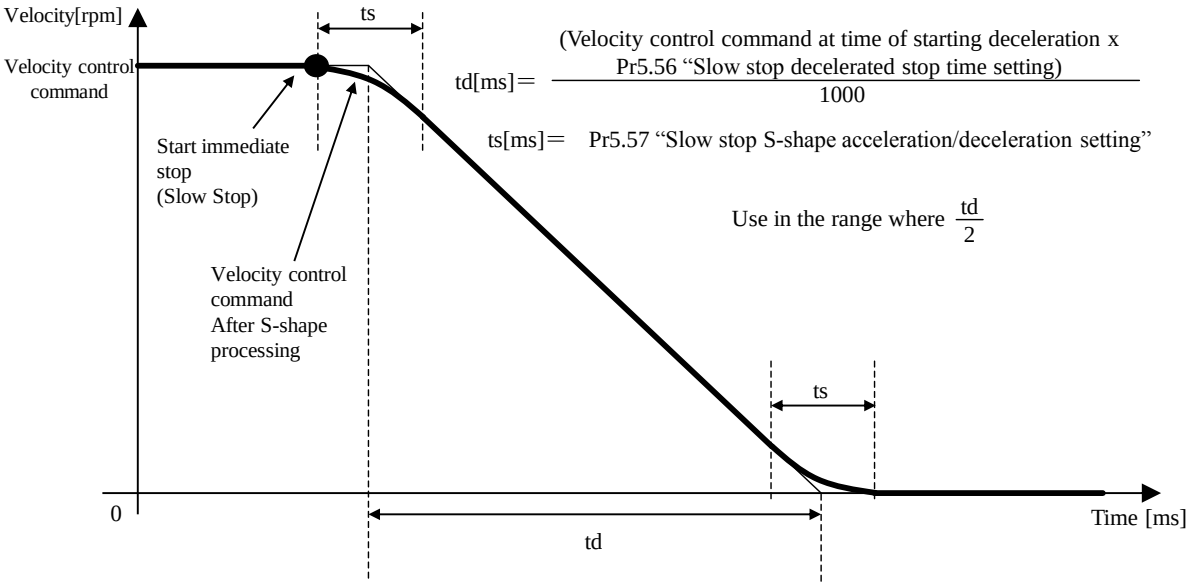
*3) Please set Pr6.14 “Emergency stop time at alarm” to a value that is sufficiently long in length than the completion of slow stop operation. The stop judgment under slow stop operation is based on actual velocity. Therefore, the time required for the actual deceleration may take longer than the maximum deceleration time.
In the immediate stop operation from immediate stop response alarm, in case the immediate stop continuation duration exceeds Pr6.14 “Emergency stop time at 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.
Also,Pr6.14 ”Emergency stop time at alarm” is valid only for Sequence at alarm.
Pr6.14 ”Emergency stop time at alarm” is invalid for Sequence upon inputting of over-travel inhibition, Sequence at Servo-Off and Sequence at main power OFF.

*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.



$$td[ms] = \frac{\text{(Velocity control command at time of starting deceleration x Pr5.56 “Slow stop decelerated stop time setting)}}{1000}$$

ts[ms]= Pr5.57 “Slow stop S-shape acceleration/deceleration setting”

Use in the range where $\frac{td}{2}$

*) 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]

$$= \frac{\text{(Velocity control command at time of starting deceleration [r/mom])} \times \text{Pr5.56 [ms/(1000)[r/min]}}{1000 \times 1000}$$

Linear deceleration brake distance [revolution]

$$= \frac{\text{(Velocity control command at time of starting deceleration [r/min])} \times \text{Linear decelerating time [s]}}{60 \times 2}$$

$$= \frac{\text{(Velocity control command at time of starting deceleration [r/min])}^2 \times \text{Pr5.56 [ms/(1000)[r/min]}}{60 \times 2 \times 1000 \times 1000}$$

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.

6-4 Torque saturation protection function

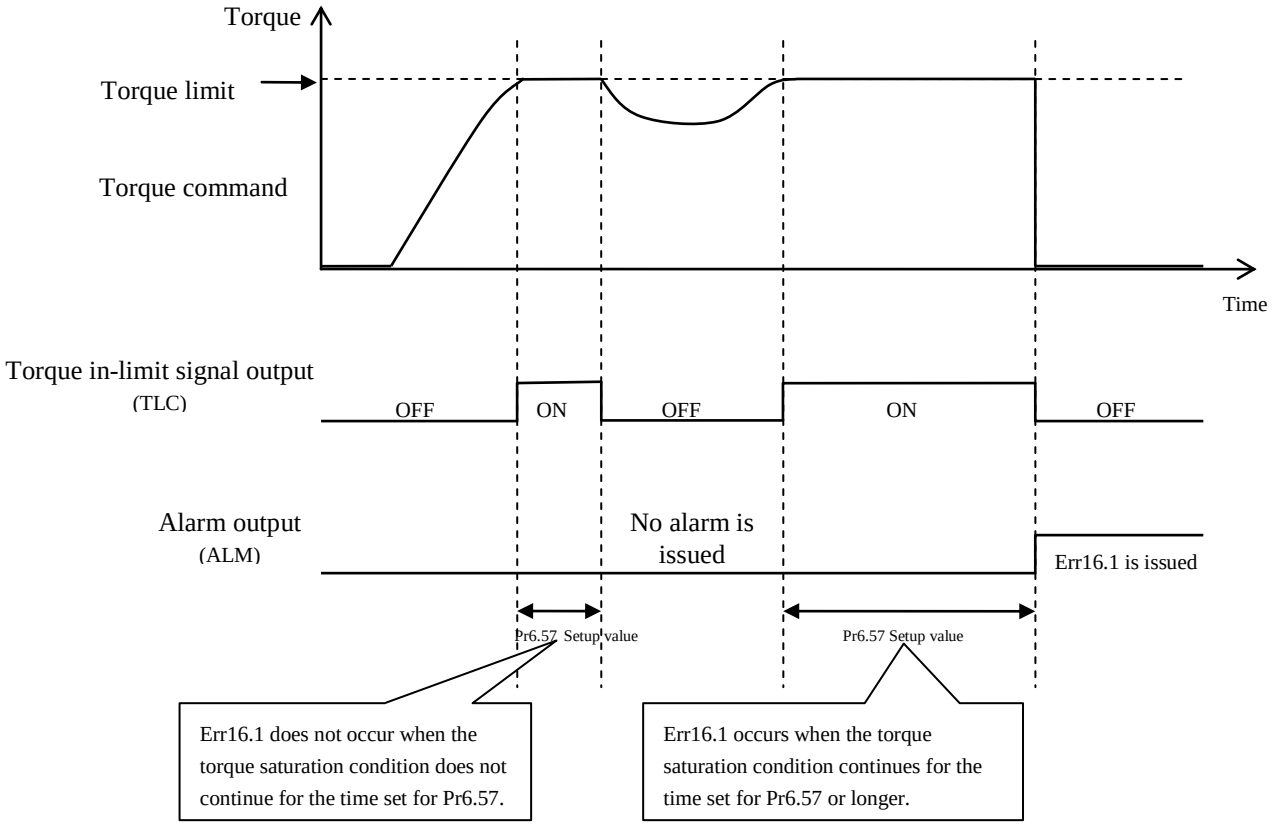
If torque saturated has continued for a fixed period, an alarm can be activated.

(1) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	57	B	Torque saturation error protection detection time	0–5000	ms	Set the torque saturation error protection detection time. If torque saturation occurs for more than a set time, Err16.1 "Torque saturation error protection" occurs. When 0 is set, the value set for Pr7.16 is enabled. *To use this setting value in a version corresponding to function extended edition 2 or earlier, please specify the setting value to 2 or larger.
7	16	B	Torque saturation error protection frequency	0–30000	time	If torque saturated is continued during a preset frequency, Err 16.1 "Torque saturation protection" will be activated. The number of times is counted up every 0.25 ms. For example, when 30000 is set, Err16.1 occurs if the torque saturation condition continues for 7.5 seconds. The count is cleared when the torque saturation condition is removed. When the value set for Pr6.57 is other than 0, the value set for Pr6.57 is enabled. *To use this setting value in a version corresponding to function extended edition 2 or earlier, please specify the setting value to 6 or larger.

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

- Set both Pr6.57 and Pr7.16 to 0 to make this function disabled.
- When torque is controlled, this function is disabled and Err 16.1 will not be activated.
- If the immediate stop alarm is activated, this function is disabled and Err 16.1 will not be activated.
- Count cycle is different from the MINAS-A5N series.
  In the case of the same setting, the time until Err16.1 occurs, A6N is longer than A5N.



6-5 Position comparison output function

This function enables a general-purpose output or encoder output terminal to output a pulse signal when the actual position passes the position set for the parameter.

(1) Specification

Trigger output	I/F	3-outputs：Photocoupler (Open collector) or 3-outputs：Line driver
	Logic	Parameter settings (The polarity can be set for each output)
	Pulse width	Parameter settings 0.1–3276.7ms (0.1ms unit)
	Delay compensation	Available
Compare source	Encoder (Communication)	Available
	External scale (Communication)	Available
	External scale (A,B-phase)	Available
Compare value	Setting points	8-points
	Setting range	Signed 32bit

(2) Applicable range

□ This function cannot be applied unless the following conditions are satisfied.

	Operating conditions for position comparison output function
Control mode	・Available in all control modes(except for virtual full-closed control mode)
Other	・RTEX communication has been established. ・Home position return has been completed. (The status flag bit2“Homing_Complete” of RTEX communication is 1) ・Parameters except for controls are correctly set, assuring that the motor can run smoothly.

(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.

  Do not use this function during operation of virtual full-closed control mode.

(4) Related parameters

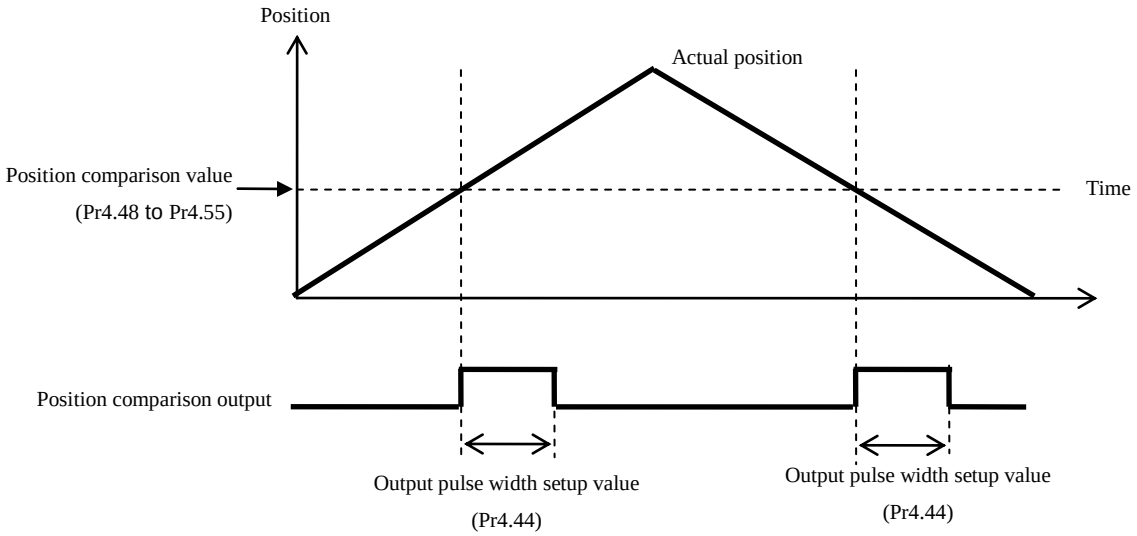
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	44	R	Position comparison output pulse width setting	0–32767	0.1 ms	Set the pulse width of position comparison output. No pulse is output when 0 is set.
4	45	R	Position comparison output polarity selection	0–7	—	Set the polarity of position comparison output by bit setup for each output terminal. ・Setup bits *2) *3) bit0: SO1,OCMP1 bit1: SO2,OCMP2 bit2: SO3,OCMP3 ・Setup values of Each setting bit 0: The output photocoupler is turned ON for SO1 to 3 and is set to L level for OCMP1 to 3, respectively, during pulse output. 1: The output photocoupler is turned OFF for SO1 to 3 and is set to H level for OCMP1 to 3, respectively, during pulse output. Basically, use this function as 0.
4	47	R	Pulse output selection	0–1	—	Select the signal to be output from the pulse output terminal or position comparison output terminal. *3) 0: Encoder output signal(OA、OB) 1: Position comparison output signal(OCMP1～3)
4	48	A	Position comparison value 1	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 1.
4	49	A	Position comparison value 2	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 2.
4	50	A	Position comparison value 3	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 3.
4	51	A	Position comparison value 4	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 4.
4	52	A	Position comparison value 5	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 5.
4	53	A	Position comparison value 6	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 6.
4	54	A	Position comparison value 7	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 7.
4	55	A	Position comparison value 8	-2147483648 –2147483647	Command unit	Set the comparison value for position comparison value 8.
4	56	R	Position comparison output delay compensation amount	-32768– 32767	0.1 us	Compensate the delay in the position comparison output signaled by the circuit.
4	57	R	Position comparison output assignment setting	-2147483648 –2147483647	—	Set the output terminals corresponding to position comparison values 1 to 8 by bit setup. Multiple position comparison values can be set up on one output terminal. ・Setup bits bit0 to 3 : Position comparison value 1 bit4 to 7 : Position comparison value 2 bit8 to 11 : Position comparison value 3 bit12 to 15 : Position comparison value 4 bit16 to 19 : Position comparison value 5 bit20 to 23 : Position comparison value 6 bit24 to 27 : Position comparison value 7 bit28 to 31 : Position comparison value 8 ・Setup values of Each setting bit *2) *3) 0000b : Output disabled 0001b : Allocated to SO1,OCMP1 0010b : Allocated to SO2,OCMP2 0011b : Allocated to SO3,OCMP3 Other than above : For manufacturer's use (Do not set.)

*1) For parameter attributes, see Section 9-1.

*2) When general-purpose outputs (SO1 to SO3) are used as position comparison outputs, allocate the position comparison output (CMP-OUT) to Pr4.10 to Pr4.12 for all control modes.
It is not possible to monitor the position converter output from PANATERM or RTEX communication.
*3) When the encoder output signals (OCMP1 to OCMP3) are used as position comparison outputs, set Pr4.47 to "1".

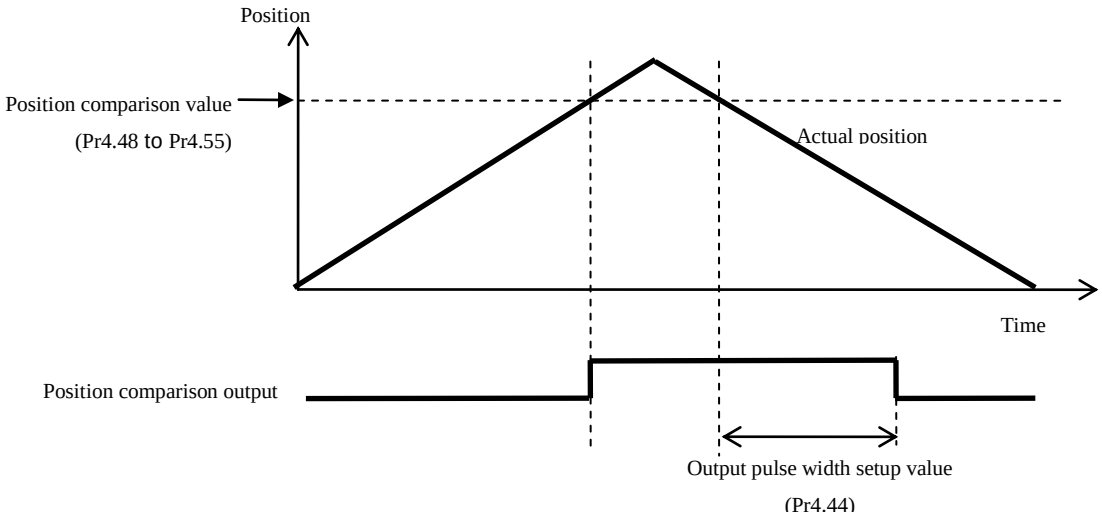
(5) Operation

・When the actual position of the encoder passes a position comparison value (Pr4.48 to Pr4.55), a pulse with the time width set for the position comparison output pulse width setting (Pr4.44) is output (Figure 6-5-1).



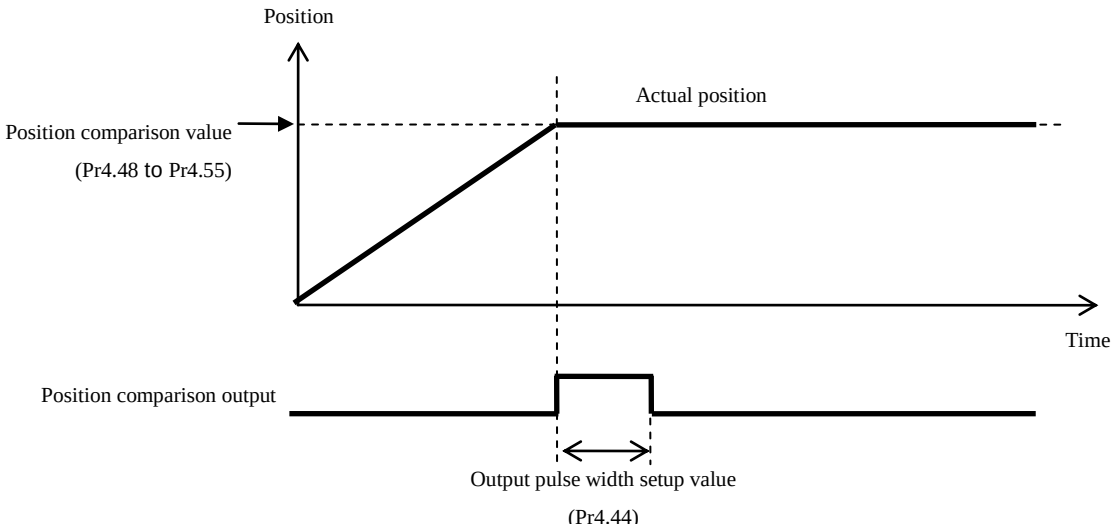
<Figure 6-5-1>

・A pulse is output when the position comparison value is passed and the relationship in size changes, irrespective of the passing direction of the encoder position.
・Multiple position comparison values can be set up on one position comparison output.
・If, during pulse output, the encoder position or external scale position passes the position comparison value in situations such as when the operation direction is reversed or multiple position comparison values are set, the ON status of pulse output continues throughout the period between the point of the last passage and the output pulse width setup value (Figure 6-5-2).



<Figure 6-5-2>

・Also when the position stops at the same position as the position comparison value, the pulse is output only once as with the case of passage.
(Figure 6-5-3)



<Figure 6-5-3>

・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 correction can also be adjusted with the setup of the amount of position comparison output delay correction (Pr4.56).

6-6 Single-turn absolute function

This function uses the absolute encoder as an absolute system only for single-turn absolute position data without connecting the battery power.
The movable range of the motor is limited by single-turn data of the absolute encoder.

1) Applicable Range

This function operates under the following conditions.

	Operating conditions for the single-turn absolute function
Control mode	• Position control, velocity control, torque control
Others	• The absolute encoder must be connected.

2) Caution

- This function is enabled by setting Pr0.15 “Absolute encoder setup” to 3.
- If the motor (encoder) position exceeds the motor working range (single-turn data of the encoder), Err34.1 “Single-turn absolute working range error protection” occurs.
- When Err34.1 “Single-turn absolute working range error protection” has been activated, the motor is decelerated and stopped according to Pr5.10 “Sequence at alarm”.
- If the command position for RTEX communication is set to the outside of the motor working range, a command error is returned.
- When this function is enabled, multi-turn data for the absolute encoder is not used. Thus, alarms related to multi-turn data (Err40.0 “Absolute system down error protection”, Err41.0 “Absolute counter over error protection”, Err42.0 “Absolute over-speed error protection”, and Err45.0 “Absolute multi-turn counter error protection”) and battery alarms are not detected.

3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	15	C	Absolute encoder setup	0–4	–	Select the use method of the absolute encoder. *2) 0: Use as an absolute system (absolute mode). 1: Use as an incremental system (incremental mode). 2: Use as an absolute system (absolute mode), however ignore the multi-turn counter over. 3: Use as an absolute system, however not use the multi-turn counter (single-turn absolute mode). 4: Used as an absolute system (absolute mode), however any upper limit value can be set for the multi-turn counter, and ignore the multi-turn counter over. (continuous rotating absolute mode)
7	13	C	Absolute home position offset	-107374182–1073741823	Command unit	When using an absolute encoder (external absolute scale), set up the offset value on the encoder position (external scale position) and mechanical coordinate system position.

*1) For parameter attribute, refer to Section 9-1.
*2) Absolute encoder will be handled as an incremental system (Set value =1) in internal control under full-closed control.

4) Input range of the command position for RTEX communication

The following shows the input range of the command position when the single-turn absolute function is enabled.

Note that the value below is the input range when the electronic gear ratio is 1/1 and the absolute home position offset is 0.

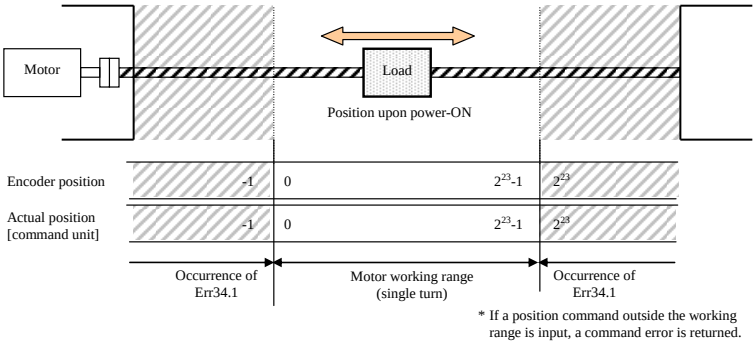
For the input range when the electronic gear ratio and absolute home position offset are set, refer to the operation example in 5).

		Position command input range
Absolute encoder	23bit	0 ~2^{23}-1 (8388607)

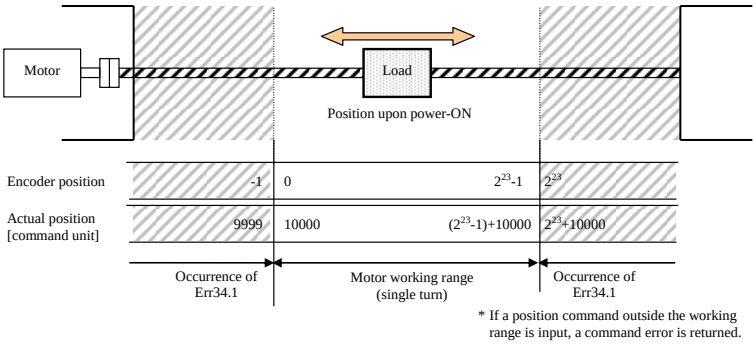
(5) Operation example

When using a 23 bit absolute encoder, the effective range of a single turn is as follows.

i) CCW = Positive direction, electronic gear ratio (Pr0.09/Pr0.10) = 1/1, Pr7.13 “Absolute home position offset” = 0



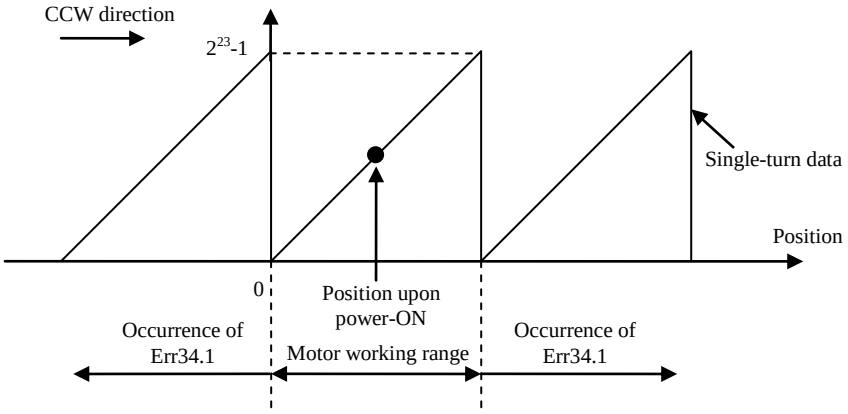
ii) CCW = Normal direction, electronic gear ratio (Pr0.09/Pr0.10) = 1/1, Pr.7.13 “Absolute home position offset” = 10000



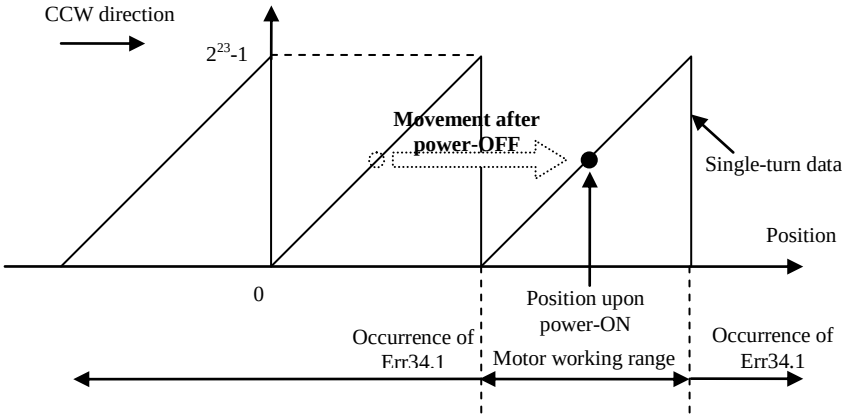
(6) Cautions on the motor position upon power-ON

The motor working range is determined depending on the motor position upon power-ON.
(Operation example with a 23 bit absolute encoder)

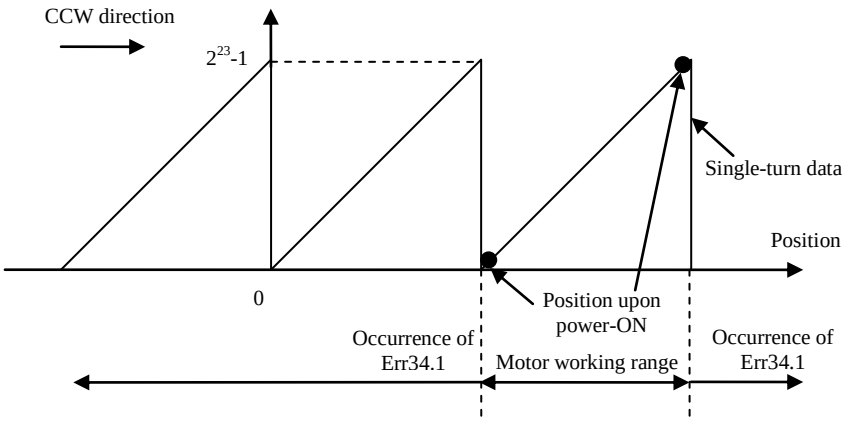
i) When the power-ON position is as shown in the figure below, the motor working range is the single-turn data range from the power-ON position.



ii) When the power is turned off at the position in Figure i) and then turned on again after the motor is moved to the position in the figure below, the motor working range will be changed.

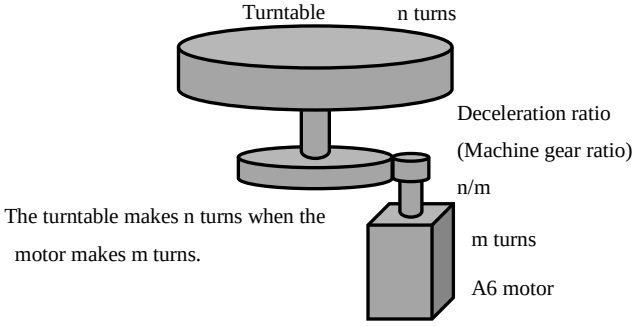


iii) If the power is turned on when the power-ON position is near the limit of the motor working range, the motor working range is exceeded if the motor operates even if only slightly, causing Err34.1 “Single-turn absolute working range error protection”.



6-7 Continuous rotating absolute encoder function

This function allows you to set any upper limit value for absolute encoder multi-turn data.
With this function, it is possible to determine the turn angle (position) of a turntable and such other applications, even in the case of continuous turn in one direction.
In addition, because this is an absolute encoder, the home position return after the power is re-powered on is unnecessary.



(1) Applicable range

□ This function cannot be applied unless the following conditions are satisfied.

	Operating conditions for continuous rotating absolute encoder function
Control mode	・Position control, velocity control, torque control
Other	・The encoder is a 23 bit resolution absolute encoder. ・The following equation holds and the solution is an integer: Command position per turn of turntable = Encoder resolution (2^{23})/electronic gear ratio/reduction ratio is an integer less than or equal to (2^{31}-1). ・Parameters except for controls are correctly set, assuring that the motor can run smoothly.

(2) Related parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	15	C	Absolute encoder setup	0–4	-	Select the use method of the absolute encoder. *2) 0: Use as an absolute system (absolute mode). 1: Use as an incremental system (incremental mode). 2: Use as an absolute system (absolute mode), however ignore the multi-turn counter over. 3: Use as an absolute system, however not use the multi-turn counter (single-turn absolute mode). 4: Used as an absolute system (absolute mode), however any upper limit value can be set for the multi-turn counter, and ignore the multi-turn counter over. (continuous rotating absolute mode)
6	88	C	Absolute encoder multi-turn data upper-limit value	0–65534	-	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.
7	13	C	Absolute home position offset	-107374182–1073741823	Com-mand unit	When using an absolute encoder (external absolute scale), set up the offset value on the encoder position (external scale position) and mechanical coordinate system position.

*1) For parameter attribute, refer to Section 9-1.
*2) Handled as an incremental system (Set value =1) in internal control under full-closed control.

(3) Notes

- This function is available when Pr0.15 “Absolute encoder setup” is set to “4” with control power cycle or RTEX reset command,attribute C parameter is enabled.
- Set Pr6.88 “Absolute encoder multi-turn data upper-limit value” to “(m-1)”.
  “m” corresponds to the denominator of the deceleration ratio.
- The actual position wraps around at the position at which multi-turn data wraps around.
  Give a position command so that the position will agree with this actual position.
  For the detail of the wraparound process, refer to Technical Reference RTEX Communication Specification “Section 7-1-4-2”.
- Set Pr6.88 “Absolute encoder multi-turn data upper-limit value” while not allowing the RTEX actual position and command position to exceed 2^{31}.

  When ((Pr6.88+1) × Encoder’s resolution performance) – 1 exceeds 231, Err93.8 “Parameter setting fault protection 6” is generated.
  The actual position is based on Pr0.00 “Rotational direction setup” and Pr7.13 “Absolute home position offset” and so on.
  For details, refer to Technical Reference RTEX Communication Specification “Section 7-2-4-1”.
- When this function is used for the first time, or Pr6.88 is changed to an arbitrary value and control power is re-input, Err92.3 “Inconsistency fault protection of multiple rotation data’s upper limit values” is always generated. However, it is not a fault.
  Once the driver control power is re-powered on, the error will not occur from the next time.
- Refer to Section 4-6-1-1 for structure of absolute system.
- Set Pr7.13 “Absolute home position offset” between "0" to "((Pr6.88 set value +1)* encoder resolution)-1".
  When wrong valuse is set, the servo amplifiers shows Err93.8 “Parameter setting error protection 6”.

(4) Operation example

The operation is as follows in the case of the deceleration ratio (m = 50, n = 4) where the turntable makes 4 turns when the motor makes 50 turns.

(1) Set Pr0.15=4 and Pr6.88=49, and write to EEPROM.

(2) Re-power on the driver control power (or execute the attribute C enable command).

(3) The upper-limit value of the multi-turn data on the encoder side is automatically updated when the driver is started up.

(4) Err.92.3 “Multi-turn data upper-limit value disagreement error protection” occurs.

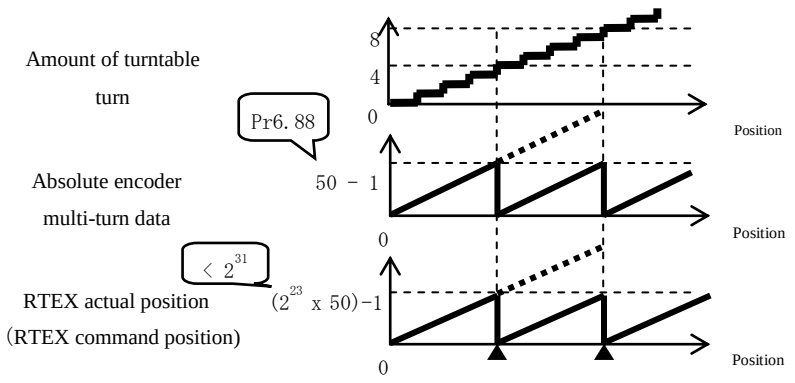
(5) Re-power on the driver control power.

(6) The multi-turn data upper-limit value is enabled and the RTEX actual position is generated as shown in the figure below.

(7) The host device reads the RTEX actual position, and the RTEX command position is initialized.

(8) Because the RTEX actual position wraps around at 2^{23} x 50 - 1, allow for operation with the RTEX command position wrapped around in agreement with this.

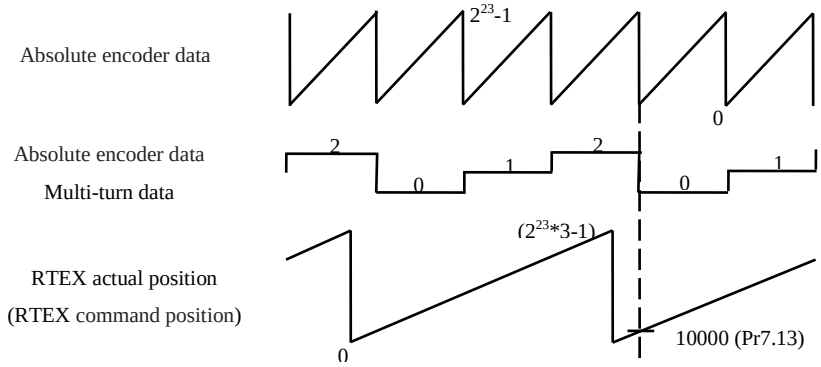
*Because the multi-turn data upper-limit value is retained with the battery power supply connected to the encoder, follow the steps from (6) above when you turn on the driver control power at the next and subsequent operations.



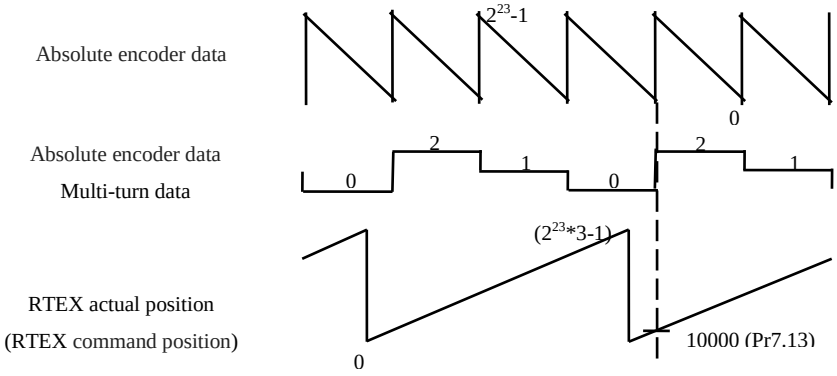
(5) Absolute home position offset

When 23bit absolute encoder is used, the absolute home position offset is as shown below.

i) CCW = Positive direction, electronic gear ratio (Pr0.09/Pr0.10) = 1/1, Pr6.88 “Absolute encoder multi-turn data upper-limit value” = 2, Pr7.13 “Absolute home position offset” = 10000



ii) CW = Positive direction, electronic gear ratio (Pr0.09/Pr0.10) = 1/1, Pr6.88 “Absolute encoder multi-turn data upper-limit value” = 2, Pr7.13 “Absolute home position offset” = 10000



6-8 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.	At-trib-ute *1)	Parameter name	Set range	Units	Functions
5	66	A	Deterioration diagnosis convergence judgment time	0–10000	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 convergence velocity). * When Pr6.31 (real-time auto tuning convergence velocity) = 0, the deterioration diagnosis warning judgment for load characteristics estimate will be invalid.
5	67	A	Deterioration diagnosis inertia ratio upper limit value	0–10000	%	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	A	Deterioration diagnosis inertia ratio lower limit value	0–10000	%	
5	69	A	Deterioration diagnosis unbalanced load upper limit value	-1000–1000	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	A	Deterioration diagnosis unbalanced load lower limit value	-1000–1000	0.1%	
5	71	A	Deterioration diagnosis dynamic friction upper limit value	-1000–1000	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	A	Deterioration diagnosis dynamic friction lower limit value	-1000–1000	0.1%	
5	73	A	Deterioration diagnosis viscous friction upper limit value	0–10000	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	A	Deterioration diagnosis viscous friction lower limit value	0–10000	0.1%/ (10000 r/min)	
5	75	A	Deterioration diagnosis velocity setting	-20000 –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	A	Deterioration diagnosis torque average time	0–10000	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.

(To be continued)

Class	No.	At-trib-ute *1)	Parameter name	Set range	Units	Functions
5	77	A	Deterioration diagnosis torque upper limit value	-1000–1000	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	A	Deterioration diagnosis torque lower limit value	-1000–1000	0.1%	
6	97	B	Function expansion setup 3	-2147483648 – 2147483647	-	bit 1 to set the deterioration diagnosis warning function to valid or invalid 0: invalid, 1: valid

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

(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.
- Due to the USB communication delay, the average torque command value acquired via USB is compared with the actual value inside the amplifier
  It may be different. (0 may be displayed even when the actual value is not 0.)

(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(Inertia ratio, Unbalanced load, Dynamic friction, Viscous friction)

- 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 WngACh.

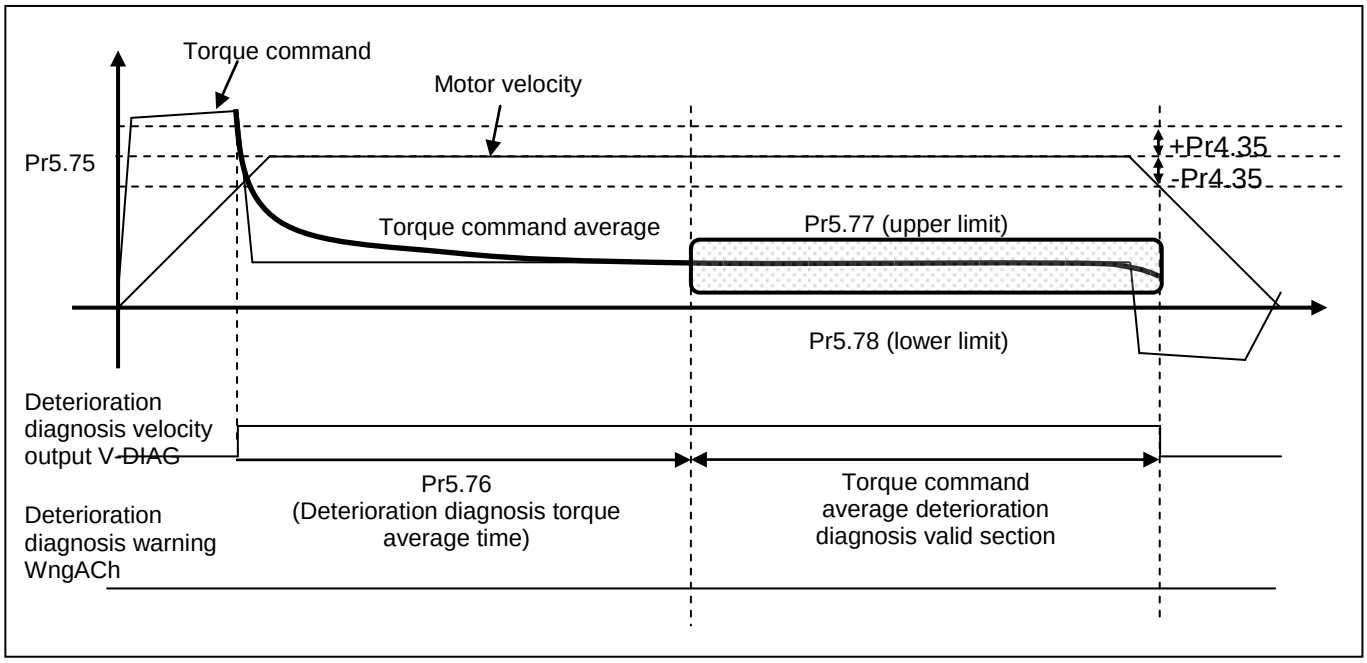
	(4-1-1)	(4-1-2)	(4-1-3)	(4-1-4)
	Inertia ratio	Unbalanced load	Dynamic friction	Viscous friction
Upper limit value	Pr5.67	Pr5.69	Pr5.71	Pr5.73
Lower limit value	Pr5.68	Pr5.70	Pr5.72	Pr5.74

* 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.

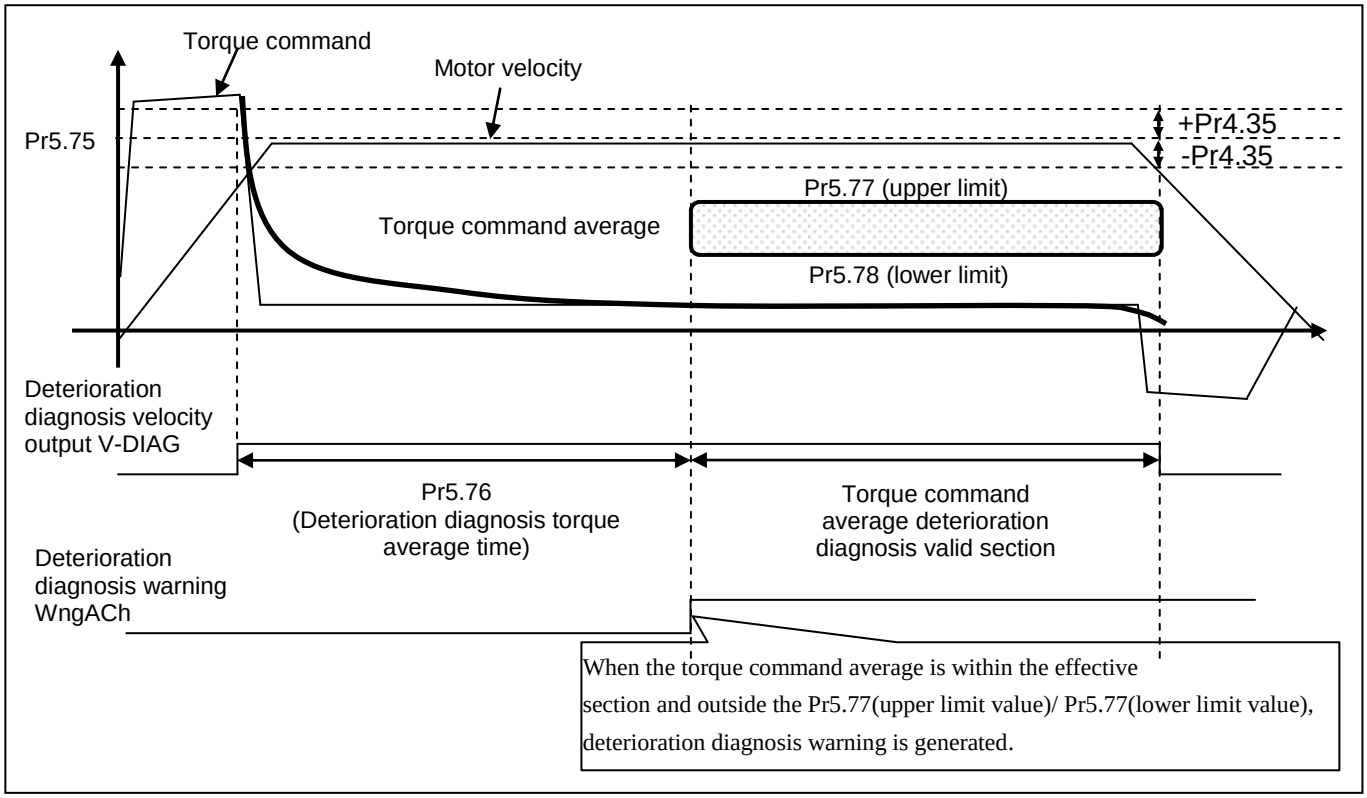
(4-2) Deterioration diagnosis warning for constant velocity torque command average value

- Deterioration diagnosis velocity output (V-DIAG) is ON when the motor velocity is within the range of Pr4.35 “Speed coincidence range” of Pr5.75 “Deterioration diagnosis velocity setting”.
- When deterioration diagnosis velocity output (V-DIAG) is turned ON, torque command average calculation will start and after lapse of the set time of Pr5.76, deterioration diagnosis judgment by torque command average will become effective. This will continue while deterioration diagnosis velocity output (V-DIAG) remains output ON, however will return to invalid condition when the output is turned OFF.
- The upper limit and lower limit values for torque command average can be set by parameters Pr5.77 and 5.78 respectively. Deterioration diagnostic warning number WngACh is generated in case these upper or lower limit values have been exceeded for changes in the load characteristic estimates.

i) Example when deterioration diagnosis warning for torque command average value is not generated



ii) Example when deterioration diagnosis warning for torque command average value is generated



6-9 Latch mode with stop function

This is the function to stop at the latched position with the input/output timing of latch trigger signal with stop function (hereafter referred to as the trigger signal), without initialization of position information.

This function can be used to set up external input signal (EXT1, EXT2, or EXT3) as a trigger signal. It is also possible to set up the amplifier output signal in function extended version 5 or later versions.

When this function is started with an external input signal (EXT1, EXT2, or EXT3) specified as the trigger signal, motor will be controlled according to the commanded position from the host device until a trigger signal is input, and it will stop at the latch position while neglecting the commanded position from the host device when a trigger signal is input.

When this function is started with an amplifier output signal specified as the trigger signal, it will stop at the latch position while neglecting the commanded position from the host device when the amplifier detects a condition for output signal.

In this function, position command filter is disabled during the period from trigger signal detection until it stops at trigger signal detection position in order to reduce the command output period until the stop position.

Selection of the trigger signal (external input signal or amplifier output signal) is specified by RTEX communication command.

For other details, refer to technical document RTEX Communication Specification (Section 6-5-5).

(1) Applicable range

□ This function cannot be applied unless the following conditions are satisfied.

	Operating conditions for Latch mode with stop function
Control mode	・Position control、full-closed control(CP)
Other	・The software version shall be function extended version 4 or later. ・Should be in servo-on condition ・Parameters except for controls are correctly set, assuring that the motor can run smoothly. ・The communication cycle shall be set to 0.5 ms and command update cycle to 1.0 ms. ・The electronic gear ratio shall be set to 1 or larger.

(2) Relevant parameters

Class	No.	Attri-Bute *1)	Title	Range	Unit	Function
7	78	C	Signal reading setting for latch trigger with stop function	0–3	-	The number of readings from external input latch trigger signal input until internal logic confirmation by amplifier with Latch mode with stop function is selected. 0:0.1875ms (3 readings) 1:0.0625ms (1 reading) 2:0.125ms (2 readings) 3:0.1875ms (3 readings)
7	111	C	Trigger signal allocation setting of latch mode with stop function	0–64	-	Select the output signal to be used as the trigger signal in latch mode with stop function. 0:Ineffective 1-5:Used by the manufacturer. 6:Output during torque limitation (TLC) 7-64:Used by the manufacturer.

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

(3) Caution

・Latch mode with stop function does not start up with the following settings, but returns command error(005Fh).
- With settings other than cyclic position control (CP),
- With settings other than command update cycle 1.0 ms and communication cycle 0.5 ms, and
- With electronic gear ratio setting smaller than 1. *3)

・To start up latch mode with stop function while specifying an external input signal as the trigger signal, assign the trigger signal to one of SI5 to SI7 which is available as an external latch input.
Command error (0058h) is returned if it is started without assignment of the trigger signal.

・To start up latch mode with stop function while specifying the amplifier output signal as the trigger signal, set “6 (output during torque limitation (TLC))” in Pr7.111.
A command error (0058h) will be returned when “0 (invalid)” is set in Pr7.111.

・To use this function on an axis for which the commanded position in command unit wraps around, including an axis turning infinitely in one direction, set the electronic gear ratio to an integral multiple.*3)
(Refer to Section 7-1-4-2 of RTEX communication specification edition of the Technical Reference for wrap around.)

・Err91.3 “RTEX command error protection 2” is generated if cancellation of latch mode with stop function is executed between input/output of the trigger signal and completion of operation.
If this may be a problem, cancel without detection of the trigger signal, such as stopping the motor.

・If the trigger signal is an external input signal, the amount of delay for trigger signal detection will vary depending on the operating environment or aging degradation.
Set up the correction period for amount of delay as necessary if latch precision is required.
For details, refer to Section 6-5-4-4 of technical document RTEX Communication Specification.
There will be no effect of amount of delay correction period if the trigger signal is the amplifier output signal.

*3) This is a restriction only for function extended version 4.

6-10 Retreat operation function

When retreat operation startup conditions are satisfied, retreat operation is executed at the speed and amount of travel set in parameters.
An alarm will be generated at completion of retreat operation.

(1)Applicable range

This function cannot be applied unless the following conditions are satisfied.

	Conditions in which retreat operation function operates
Control mode	・Available in all control modes Note) Do not switch the control mode during retreat operation.
Other	・The software version shall be function extended version 5 or later. ・Communication cycle shall be 0.25 ms or longer. ・Should be in servo-on condition ・Parameters except for controls are correctly set, assuring that the motor can run smoothly. ・Trial operation and Frequency characteristic measurement function are not operating

(2) Caution

・Check that retreat operation is being executed with status flag (response Byte2) bit1 after setting Pr7.23 (RTEX function extended setting 2) bit15=1 and Pr7.112 bit0=0.
0: Retreat operation not started/completed, 1: Retreat operation being executed

・The operation when retreat operation is started during return to origin operation is not guaranteed.

・The operation when return to origin operation is started during retreat operation is not guaranteed.

・Make sure that the origin position and the RET input position do not overlap.

・The control mode specified by the host device will be neglected and position control executed by force during retreat operation.
Please note that application of various filters, assignment of input/output signals and so forth under position control will therefore be enabled during retreat operation.

・Change the value after retreat operation has completed when changing the control mode.
A command error (002Eh) will be returned if there is a command to change the control mode during retreat operation.

・Please note the direction of retreat operation as Pr8.17 (retreat operation relative amount of travel) is a data with a sign.
For safety, check the direction of retreat operation while setting Pr8.17 to a small value in the initial setting.

・Set Pr5.09 (main power supply off detection period) to a value other than 2000 when using main power supply off as the trigger.
Retreat operation will not be executed as power supply off detection itself is invalid when Pr5.09 is 2000.

・Err13.1 “Main power supply shortage voltage protection (AC off detection detection)” will not occur during retreat operation execution using main power off as the trigger.
However, it is possible that Err13.0 “Main power supply shortage voltage protection (voltage shortage between PN)” may occur before completion of retreat operation depending on the case, as retreat operation is executed on the residual voltage in the capacitor.

・It will result in return to origin incomplete state (Homing_Complete =0) after completion of retreat operation (generation of Err85.0, Err85.2, Err87.1, or Err87.3) with incremental mode.
Execute return to origin again after clearing the alarm.

・For RTEX communication commands which can be accepted during retreat operation, please refer to the RTEX communication specification edition of the Technical Reference (Section 4-2).

(3) Related parameters

Class	No.	Attri-Bute *1)	Title	Range	Unit	Function
5	08	B	LV trip selection at mai n power off	0～3	—	Select LV trip or servo OFF upon occurrence of main AC power alarm. Setup the condition to detect main AC power OFF alarm when the main AC power is kept interrupted for a time longer than the time set by Pr7.14. bit 0 0:Select servo OFF according to the setting of Pr 5.07 and then return to servo ON by turning ON main AC power. 1:Trip with Err 13.1 Main power undervoltage protection. bit 1 0:Detect main AC power OFF alarm only when servo is in ON state. 1:Always detect main AC power OFF alarm.
5	09	C	Detection time of main power off	20～2000 *2)	ms	Set up the main power alarm detection time. When 2000 is set, main power off detection is disabled.
6	85	C	Condition setting for escape operation	-32768～ 32767	-	Select the Start-up of retreat operation and Judgment condition of stopping. bit3 - 0:Start-up condition for retreat operation (I/O) 0: Retreat operation by I/O input is ineffective. 1:RET input 2:RET/HOME input 3:Main power off detection *1) 4-15:Err85.2 or Err87.3 is generated due to setting failure. *2) bit7 - 4: For manufacture use. Please set fixed to 0 bit9 - 8:Judgment condition for stopping retreat operation *3) bit9=0, bit8=0: Completion judgment of delivery before filtering, and completion judgment of positioning are ineffective. bit9=0,bit8=1:Completion judgment of delivery after filtering, and completion judgment of positioning are ineffective. bit9=1,bit8=0:Completion judgment of delivery before filtering, and completion judgment of positioning are effective. bit9=1,bit8=1:Completion judgment of delivery after filtering, and completion judgment of positioning are effective. bit15-10:The case other than 0 is setting failure. Err85.2 or Err87.3 is generated. *2) 1) When main power supply off is used as the trigger, set Pr5.09 (main power supply off detection period) to a value other than 2000. When Pr5.09 is 2000, detection of main power off itself becomes invalid. *2) Alarm is switched by Pr6.86 bit15. *3) RTEX communication monitor (status flag) In_Position is used. Example) When bit8=0 and bit9=0 are set,position command transfer judgment is executed before the filter, and positioning judgment disabled is used as the condition for retreat operation stop.
6	86	C	Alarm setting for escape operation	-32768～ 32767	-	Set the clearing attribute of the retreat operation alarm. bit0: Err85.0/Err87.1 (Completion of retreat operation (I/O)) 0:Clearing is impossible, 1:Clearing is possible. bit1: For manufacture use. Please set fixed to 0 bit2: Err85.2/Err87.3(retreat operation failure) 0:Clearing is impossible, 1:Clearing is possible. bit3 - 14:Unused Fix at 0. bit15:Switching of retreat operation-related alarm 0 :Generation of Err85.0 to 85.2 (A5N compatible specification) 1 :Generation of Err87.1 to 87.3 (A6B compatible specification)
7	23	B	RTEX function extended setup 2	-32768～ 32767	-	bit8: RTEX status selection between In_Progress and AC_OFF 0: In_Progress, 1: AC_OFF * It is connected to the setting of bit15. bit15:Extension of RTEX status selection for the setting value of In_Progress/AC_OFF/Pr7.112 0:Complying with the setting (In_Progress/AC_OFF) of Pr7.23 bit8 1:The signal designated by Pr7.112 is output.
7	25	C	RTEX speed unit setup	0～1	-	Set up the unit of speed data used in RTEX communication. Set up the unit both for both command data such as command speed and for response data such as actual speed. 0: r/min 1: Command unit/s

(To be continued)

Class	No.	Attri-Bute *1)	Title	Range	Unit	Function
7	112	B	Selection of RTEX communication status flag	0～1	-	Select the signal returned with the status flag (Byte2 bit1) of RTEX response in the case of Pr7.23 bit15=1 0:RET_status (the status during execution of escape operation) is returned.
8	01	B	Profile linear acceleration constant	1～429496	10000 Command unit /s^2	Set up the acceleration under profile position control (PP) and retreat operation. Be sure to set before starting operation.
8	04	B	Profile linear deceleration constant	1～429496	10000 Command unit /s^2	Set up the deceleration under profile position control (PP) and retreat operation. Be sure to set before starting operation.
8	17	B	Relative displacement of retreat operation *3)	-2147483648 ～ 2147483647	Command unit	Set the displacement at retreat operation. Err85.0 or Err87.1 will occur when retreat operation is not executed and the amount of travel after electronic gear is 0. Be sure to set before start-up of operation.
8	18	B	Speed of retreat operation	0～ 2147483647	Command unit/s or r/min	Set the speed at retreat operation Set the unit with Pr7.25 (RTEX speed unit setting). The maximum value is limited with the max. motor speed by internal processing. * When setting by the unit of r/min, the unit is converted to the unit for command/s at internal computing, and the converted value is limited within the following range. 00000001h-7FFFFFFFh(1-2147483647) Be sure to set before start-up of operation.

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

*2) To use this setting with a smaller value than the shipment value, please check matching with your power supply environment.

*3) It is the relative amount of travel with the commanded position before the filter used as reference.

*4) Err13.1 “Main power supply shortage voltage protection (AC off detection)” will not occur during execution of retreat operation using the main power off as the trigger.

*5) Set Pr5.09 (main power supply off detection period) to a value other than 2000 when using main power supply off as the trigger.

*6) The alarm generated by Pr6.86 “Retreat operation alarm setup” bit15 will be switched.
Example) When bit15=0, Err85.0 and Err85.2 will occur (A5N compatible specification), and when bit15=1, Err87.1 and Err87.3 will occur (A6B compatible specification).

*7) RTEX communication monitor (status flag) In_Position will be used.
Example) When bit8=0 and bit9=0 are set, position command transfer completion judgment is executed at the value before the filter and positioning judgment invalid is used as the condition for retreat operation stop.

(4) Related alarms

Error No.		Protective function	Causes	Measures
Main	Sub			
33	0	Input duplicated allocation error 1 protection	Input signals (SI1, SI2, SI3, SI4) are assigned with two functions.	Allocate correct function to each connector pin.
33	1	Input duplicated allocation error 2 protection	Input signals (SI5, SI6, SI7, SI8) are assigned with two functions.	Allocate correct function to each connector pin.
85	0	Retracting operation completion (I/O) *1)	The retracting operation by I/O is successfully completed. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• This is a security precaution, and there is no problem if it is an intended retracting operation. • It is an error that notifies the retracting operation execution. • Make sure that return to origin is performed after the alarm is cleared.
85	2	Retracting operation error *1)	When execution of escape operation is impossible • In the case where setting of Pr6.85 “Condition setting for escape operation” is abnormal • In the case where escape operation is effective, and communication cycle setting is less than 0.25 ms • When over-travel inhibit input (POT/NOT) or retreat operation stop input (STOP) in the direction of retreat is detected during retreat operation • In the case where the status has become Main power OFF (when Pr6.85 “Condition setting for escape operation” bit0-3 is other than 3)/ Servo off/ Alarm generation/ STO input, during escape operation • When retreat operation execution condition is satisfied with over-travel inhibit input (POT/NOT) or retreat operation (STOP) in retreat direction detected • In the case where the executing condition of escape operation has been satisfied, during operation (test operational function, frequency measurement function) other than by a communication command from the upper system • In the case where it was not possible to start escape operation, due to the Servo off status, etc. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• Check whether no problem exists on the parameter setting. • Check whether no problem exists on the operating environment. • After executing Alarm Clear, be sure to execute home position return.

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
87	1	Retracting operation completion (I/O) *1)	The retracting operation by I/O is successfully completed. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• This is a security precaution, and there is no problem if it is an intended retracting operation. • It is an error that notifies the retracting operation execution. • Make sure that return to origin is performed after the alarm is cleared.
	3	Retracting operation error *1)	When execution of escape operation is impossible • In the case where setting of Pr6.85 “Condition setting for escape operation” is abnormal • In the case where escape operation is effective, and communication cycle setting is less than 0.25 ms • When over-travel inhibit input (POT/NOT) or retreat operation stop input (STOP) in the direction of retreat is detected during retreat operation • In the case where the status has become Main power OFF (when Pr6.85 “Condition setting for escape operation” bit0-3 is other than 3)/ Servo off/ Alarm generation/ STO input, during escape operation • When retreat operation execution condition is satisfied with over-travel inhibit input (POT/NOT) or retreat operation (STOP) in retreat direction detected • In the case where the executing condition of escape operation has been satisfied, during operation (test operational function, frequency measurement function) other than by a communication command from the upper system • In the case where it was not possible to start escape operation, due to the Servo off status, etc. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• Check whether no problem exists on the parameter setting. • Check whether no problem exists on the operating environment. • After executing Alarm Clear, be sure to execute home position return.

*1) The generated alarm at retreat operation is switched by Pr6.86 bit15 (Retreat operation-related alarm switching).
Example) When bit15=0, Err85.0 and Err85.2 will occur (A5N compatible specification), and when bit15=1, Err87.1 and Err87.3 will occur (A6B compatible specification).

*2) This is not supported by software versions earlier than function extended version 4.

(5) Retreat operation details

(5-1) Retreat operation startup condition

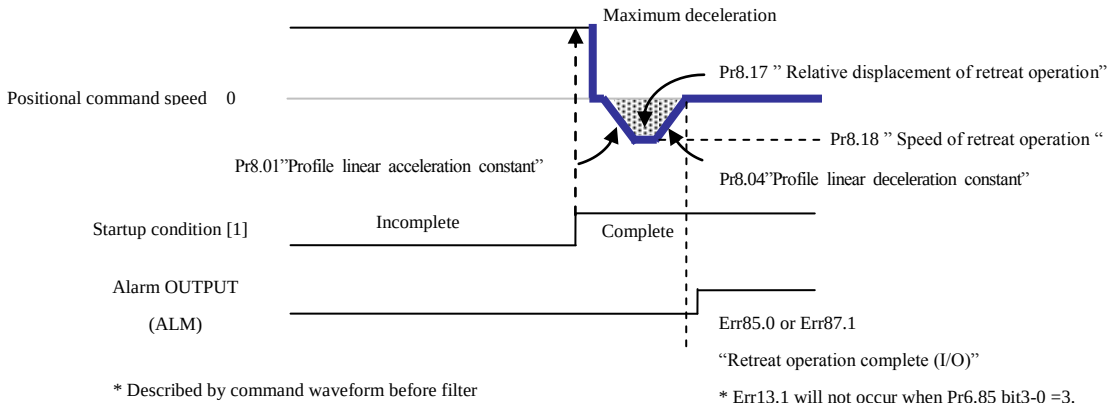
Retreat operation is started when Condition [1] is satisfied.

Condition [1]

Pr6.85 bit3-0 = 1 retreat operation input (RET) is turned on,

Pr6.85 bit3-0 = 2 retreat operation input (RET) and near origin input (HOME) are both turned on, and

Pr6.85 bit3-0 = 3 main power supply off is detected.



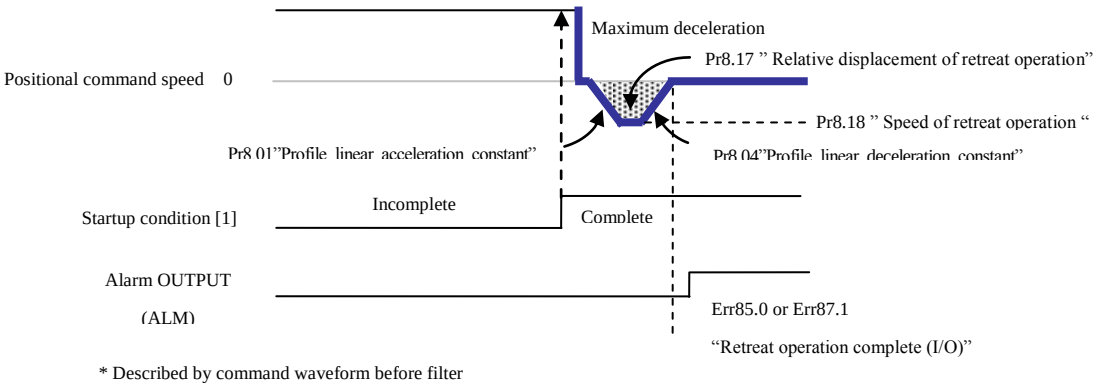
(5-2) External brake control at completion of retreat operation

It is possible to prevent falling of the robot arm and so forth by maintaining electricity supply to motor and so forth during the period from brake cancellation output (BRK-OFF) until the external brake actually operates in case Err85.0/Err87.1 occurs at completion of retreat operation.

For details, refer to "6-3-6 Fall prevention function in the event of alarms."

(5-3) Retreat operation startup during motor operation

When retreat operation startup Condition [1] is satisfied during operation, it will stop at maximum deceleration and execute retreat operation.

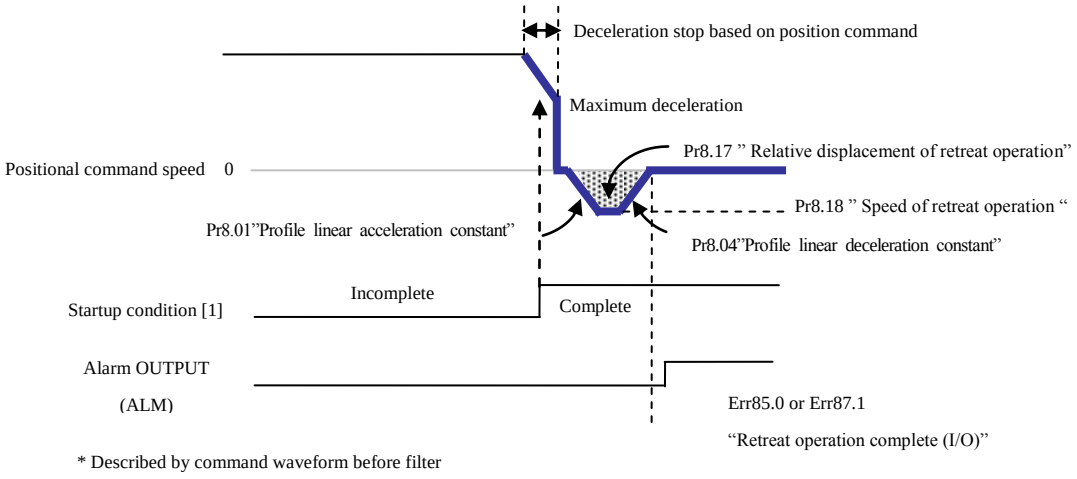


(5-4) Retreat operation startup during motor deceleration

When retreat operation startup Condition [1] is satisfied during deceleration and stop operation based on position command, it will stop at maximum deceleration and execute retreat operation.

When retreat operation startup Condition [1] is satisfied during deceleration and stop operation in immediate stop operation by over-travel inhibit input, retreat operation will be executed after immediate stop.

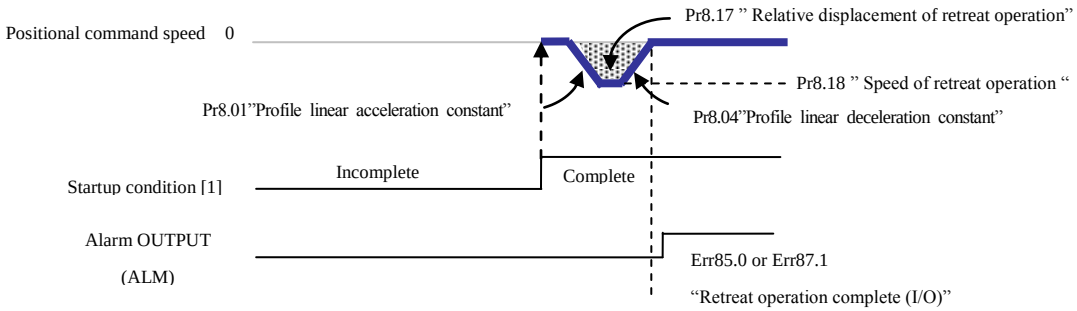
Retreat operation will not be executed, but Err85.2 or Err87.3 will be generated with position command sto pping and deceleration starting according to the deceleration sequence in case of alarm, if retreat operation startup Condition [1] is satisfied during servo off, main power off (except when Pr6.85 bit3-0=3 Main po wer off is the condition for retreat operation startup), deceleration and stop operation by alarm gener ation, DB by over-travel inhibit input, or free run.



* Described by command waveform before filter

(5-5) Retreat operation from motor stop state

Retreat operation will be executed when retreat operation startup Condition [1] is satisfied while it is stopped.



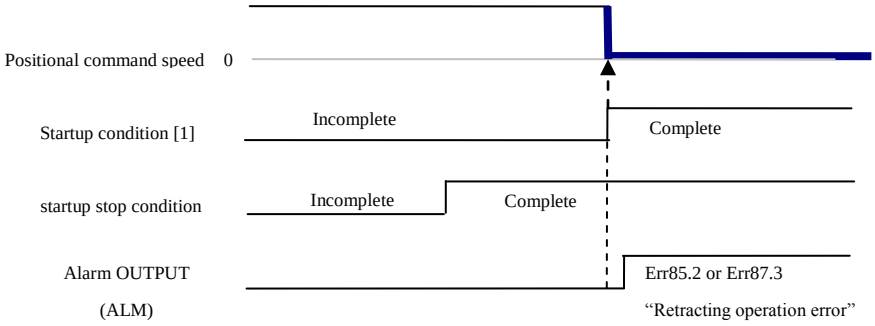
* Described by command waveform before filter

(5-6) Retreat operation startup stop condition during motor operation

When one of the following startup stop conditions is satisfied, retreat operation will not be executed but position command will stop, with deceleration started according to the deceleration sequence in case of alarm and Err85.2 or Err87.3 generated, even if retreat operation startup Condition [1] is satisfied.

[Startup stop conditions]

- Over-travel inhibit input (POT, NOT) in retreat operation direction is ON,
- Retreat operation stop input (STOP) is ON,
- When RTEX communication is not established (trial operation mode, etc.),
- Servo off,
- Alarm generation,
- Main power supply off (* When Pr6.85 bit3-0 is not 3), and
- STO input



* Described by command waveform before filter

(5-7) Retreat operation execution abort condition

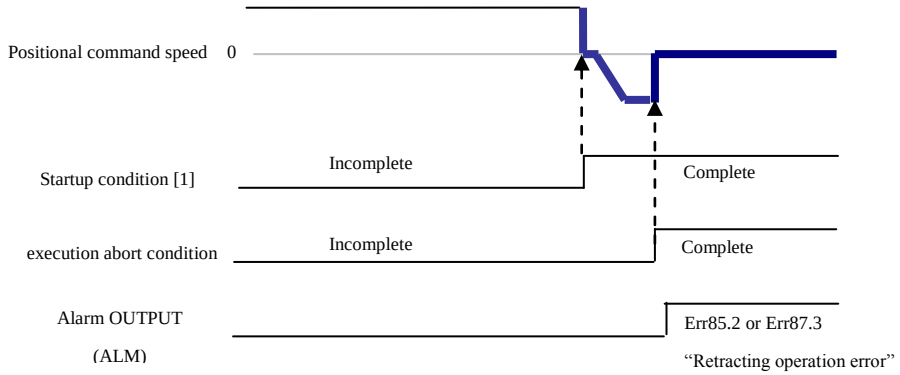
If one of the following execution abort conditions is satisfied during retreat operation, execution of the retreat operation will be aborted, and Err85.2 or Err87.3 will occur with the position command stopping, depending on the execution abort condition and following the alarm operation sequence.

* If retreat operation startup condition is no longer satisfied during retreat operation, the current operation will be continued.

[Execution abort condition]

- Over-travel inhibit input (POT, NOT) in retreat operation direction is ON,
- Retreat operation stop input (STOP) is ON,
- Servo off command comes from the host device when retreat operation execution Condition [1] is satisfied.
- Alarm generation,
- STO input
- Main power supply off (* When Pr6.85 bit3-0 is not 3)

  * To prevent retreat operation abort by main power supply off when Pr6.85 bit3-0 is not 3, setting Pr5.09 (Main power supply off detection period) = 2000 (invalid) is recommended.
  However, Err13.0 (Main power supply shortage voltage protection (voltage shortage between PN)) occurs and retreat operation is aborted when the voltage between PN in main power supply converter block drops and reaches the specified value or lower.



* Described by command waveform before filter

7. Protective function/Alarm function

7-1 List of protective function

This servo driver incorporates various protective functions. When a protective function is enabled, the servo driver turns OFF the alarm signal (ALM) and displays the error number on 7-segment LED of the panel section at front surface.

Error No.		Alarm	Attribute		
Main	Sub		History	Can be cleared	Emergency stop *6
11	0	Control power supply undervoltage protection		○	
12	0	Over-voltage protection	○	○	
13	0	Main power supply undervoltage protection (between P to N)		○	○
	1	Main power supply undervoltage protection (AC interception detection)		○	○
14	0	Over-current protection	○		
	1	IPM error protection	○		
15	0	Over-heat protection	○		○
	1	Encoder overheat error protection	○		○
16	0	Over-load protection	○	○*1	
	1	Torque saturation error protection	○	○	
18	0	Over-regeneration load protection	○		○
	1	Over-regeneration Tr error protection	○		
21	0	Encoder communication disconnect 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	Over-speed protection	○	○	○
	1	2nd over-speed protection	○	○	
27	1	Absolute clear protection	○		
	4	Command error protection	○		○
	5	Command generation error protection	○		○
	6	Operation command contention protection	○	○	
	7	Position information initialization error protection	○		
28	0	Limit of pulse replay error protection	○	○	○
29	1	Counter overflow protection 1	○		
	2	Counter overflow protection 2	○		
31	0	Safety function error protection 1	○		
	2	Safety function error protection 2	○		
33	0	Overlaps allocation error 1 protection	○		
	1	Overlaps allocation error 2 protection	○		
	2	Input function number error 1 protection	○		
	3	Input function number error 2 protection	○		
	4	Output function number error 1 protection	○		
	5	Output function number error 2 protection	○		
	8	Latch input allocation error protection	○		
34	0	Software limit protection	○	○	
	1	One revolution absolute working range error	○	○	
36	0–1	EEPROM parameter error protection			
37	0–2	EEPROM check code error protection			
38	0	Over-travel inhibit input protection 1		○	
	1	Over-travel inhibit input protection 2		○	
	2	Over-travel inhibit input protection 3	○		

(To be continued)

Error No		Alarm	Attribute		
Main	Sub		History	Can be cleared	Emergency stop *6
40	0	Absolute system down error protection	○	○*2	
41	0	Absolute counter over error protection	○		
42	0	Absolute over-speed error protection	○	○*2	
44	0	Single turn counter error protection	○		
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	○		
72	0	Thermal relay error protection	○		
80	3	PLL incomplete error protection	○	○	
82	0	RTEX node addressing error protection	○		
83	0	RTEX communication error protection 1	○	○	○
	1	RTEX communication error protection 2	○	○	○
84	0	RTEX communication time out error protection	○	○	○
	3	RTEX communication synchronization error protection	○		
	5	RTEX communication cycle error protection	○	○	○
85	0	Retracting operation completion (I/O) *7	○	*8	○
	2	Retracting operation error *7	○	*8	○
86	0	RTEX cyclic data error protection 1	○	○	○
	1	RTEX cyclic data error protection 2	○	○	○
	2	RTEX update counter error protection	○		○
87	0	Compulsory alarm input protection		○	○
	1	Retracting operation completion (I/O) *7	○	*8	○
	3	Retracting operation error *7	○	*8	○
90	2	Multi-axis synchronization establishment error protection	○		
91	1	RTEX command error protection	○	○	
	3	RTEX command error protection 2	○	○	
92	0	Encoder data recovery error protection	○		
	1	External scale date recovery error protection	○		
	3	Multi-turn data upper-limit value disagreement error protection	○		
93	0	Parameter setting error protection 1	○		
	2	Parameter setting error protection 2	○		
	3	External scale connection error protection	○		
	5	Parameter setting error protection 4	○		
	8	Parameter setting error protection 6	○		
94	2	Home position return error protection	○	○	
	3	Home position return error protection2	○	○	

(To be continued)

Error No		Alarm	Attribute		
Main	Sub		History	Can be cleared	Emergency stop *6
95	0–4	Motor automatic recognition error protection			
96	2	Control unit error protection 1	○		
	3	Control unit error protection 2	○		
	4	Control unit error protection 3	○		
	5	Control unit error protection 4	○		
	6	Control unit error protection 5	○		
	7	Control unit error protection 6	○		
98	1	RTEX hardware error protection 1	○		
	2	RTEX hardware error protection 2	○		
	3	RTEX hardware error protection 3	○		
Other		Other error	—	—	—

*1: When Err 16.0 “overload protection” is triggered, you can clear it in 10 sec or longer after the error occurs. Recognized as alarm clear command and used for clearing process as the condition becomes ready for process.

*2: When Err 40.0 “Absolute system down error protection” or Err 42.0 “Absolute over-speed error protection” occurs, the alarm cannot be cleared until the absolute encoder is reset.

*3: When an alarm that cannot be cleared occurs, it can be cleared by removing the cause of the error and then re-powering on the control power supply or using the RTEX software reset command.

*4: If the alarm can be cleared, clear it through the RTEX or USB communication (setup support software PANATERM): Be sure to clear the alarm during stop after removing the cause of the error and securing safety.

*5: If the servo driver internal control circuit malfunctions due to excessive noise etc., the display will show as follows:

Immediately turn OFF power.

*6 : Emergency stop is triggered if Pr 5.10 “Sequence at alarm” is set to one of 4 to 7 and corresponding alarm is detected. For details, refer to 6-3-4 Sequence at alarm.

*7 : The alarm generated by Pr6.86 “Retreat operation alarm setup” bit15 will be switched.Example)
When bit15=0,Err85.0 and Err85.2 will occur (A5N compatible specification),
and when bit15=1, Err87.1 and Err87.3 will occur (A6B compatible specification).

*8 : Based on the settings in Pr6.86 bit0 and 2, whether alarm is cleared or not is switched.

bit0: Err85.0/Err87.1 (retreat operation completion (I/O)) alarm clear attribute
bit2: Err85.2/Err87.3 (retreat operation error) alarm clear attribute
For either case, 0: Alarm clear invalid, 1: Alarm clear valid

7-2 Details of Protective function

Error No. Main	Error No. Sub	Protective function	Causes	Measures
11	0	Control power supply undervoltage protection	Voltage between P and N of the converter portion of the control power supply has fallen below the specified value. 1) Power supply voltage is low. Instantaneous power failure has occurred 2) Lack of power capacity...Power supply voltage has fallen down due to inrush current at the main power-on. 3) Failure of servo driver (failure of the circuit)	Measure the voltage between lines of connector and terminal block (L1C–L2C). 1) Increase the power capacity. Change the power supply. 2) Increase the power capacity. 3) Replace the driver with a new one.
12	0	Over-voltage protection	Power supply voltage has exceeded the permissible input voltage. = Voltage between P and N of the converter portion of the control power supply has exceeded the specified value. Source voltage is high. Voltage surge due to the phase-advancing capacitor or UPS (Uninterruptible Power Supply) have occurred. 1) Disconnection of the regeneration discharge resistor 2) External regeneration discharge resistor is not appropriate and could not absorb the regeneration energy. 3) Failure of servo driver (failure of the circuit)	Measure the voltage between lines of connector (L1, L2 and L3). Enter correct voltage. Remove a phase advancing capacitor. 1) Measure the resistance of the external resistor connected between terminal P and B of the driver. Replace the external resistor if the value is ∞. 2) Change to the one with specified resistance and wattage. 3) Replace the driver with a new one.
13	0	Main power supply undervoltage protection (PN)	Instantaneous power failure has occurred between L1 and L3 for longer period than the preset time with Pr 5.09 “Detection time of main power off” while Pr 5.08 bit0 “LV trip selection at main power off” is set to 1. Or the voltage between P and N of the converter portion of the main power supply has fallen below the specified value during Servo-ON. * When executing an escape operation with the trigger of main power off, Err13.1 does not occur. 1) Power supply voltage is low. Instantaneous power failure has occurred 2) Instantaneous power failure has occurred. 3) Lack of power capacity...Power supply voltage has fallen down due to inrush current at the main power-on. 4) Phase lack...3-phase input driver has been operated with single phase input. 5) Failure of servo driver (failure of the circuit)	Measure the voltage between lines of connector (L1, L2 and L3). 1) Increase the power capacity. Change the power supply. Remove the causes of the shutdown of the magnetic contactor or the main power supply, then re-enter the power. 2) Set up the longer time to Pr 5.09 “Detection time of main power off”. Set up each phase of the power correctly. 3) Increase the power capacity. For the capacity, refer to Reference specification “Driver and List of Applicable Peripheral Equipments” of Preparation. 4) Connect each phase of the power supply (L1, L2 and L3) correctly. For single phase, 100 V and 200 V driver, use L1 and L3. 5) Replace the driver with a new one.
14	0	Over-current protection	Current through the converter portion has exceeded the specified value. 1) Failure of servo driver (failure of the circuit, IGBT or other components) 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.	1) Turn to Servo-ON, while disconnecting the motor. If error occurs immediately, replace with a new driver. 2) Check that the motor wire (U, V and W) is not shorted, and check the branched out wire out of the connector. Make a correct wiring connection. 3) Measure the insulation resistance between motor wires, U, V and W and earth wire. In case of poor insulation, replace the motor. 4) Check the balance of resister between each motor line, and if unbalance is found, replace the motor. 5) Check the loose connectors. If they are, or pulled out, fix them securely.
	1	IPM error protection (IPM: Intelligent Power Module)	6) Welding of relay contact for dynamic braking due to frequent servo ON/OFF operations. 7) Timing of command input is the same as or earlier than that of Servo-ON. 8) The dynamic brake circuit was overheated and the thermal fuse is blown. (Only size E and F)	6) Replace the servo driver. Do not use servo ON/OFF during operation. 7) Enter the command 100 ms or longer after Servo-ON. 8) Replace the driver.

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
15	0	Over-heat protection	Temperature of the heat sink or power device has been risen over the specified temperature. 1) Ambient temperature has risen over the specified temperature. 2) Over-load	Check the operating temperature range of the servo driver. 1) Improve the ambient temperature and cooling condition. 2) Increase the capacity of the servo driver and motor. Set up longer acceleration/ deceleration time. Lower the load.
	1	Encoder overheat error protection	The temperature of the encoder reaches the encoder overheat error level or higher. 1) The ambient temperature of the servo motor is high. 2) Use with an overload	1) Improve the ambient temperature and cooling conditions of the servo motor. 2) Increase the capacity of the servo driver and motor. Set a longer acceleration/deceleration time. Reduce the load.
16	0	Over-load protection	Torque command value has exceeded the over-load level set with Pr 5.12 “Over-load level setup” and resulted in overload protection according to the time characteristics (described later). 1) Load was heavy and actual torque has exceeded the rated torque and kept running for a long time. 2) Oscillation and hunching action due to poor adjustment of gain. Motor vibration, abnormal noise. Inertia ratio (Pr 0.04) setup error. 3) Miswiring, disconnection of the motor. 4) Machine has collided or the load has gotten heavy. Machine has been distorted. 5) Electromagnetic brake has been kept engaged. 6) While wiring multiple axes, miswiring has occurred by connecting the motor cable to other axis. 7) P5.12 “Over-load level setup” is too low. ■ The over-load protection time characteristics are described on the end of this section.	Check that the torque (current) does not oscillates nor fluctuate up and down very much on the graphic screen of the network. Check the over-load alarm display and load factor with the network. 1) Increase the capacity of the servo driver and motor. Set up longer acceleration/ deceleration time. Lower the load. 2) Make a re-adjustment of gain. 3) Make a wiring as per the wiring diagram. Replace the cables. 4) Remove the cause of distortion. Lower the load. 5) Measure the voltage between brake terminals. Release the brake 6) Make a correct wiring by matching the correct motor and encoder wires. 7) Set Pr5.12 “Over-load level setup” to 0 (Set the maximum value allowed for the motor).
	1	Torque saturation error protection	Torque saturated has continued for the period set to Pr 7.16 “Torque saturation error protection frequency” or Pr6.57 “Torque saturation error protection detection time”.	• Check the operating state of the driver. • Take the same measure as done against Err16.0.
18	0	Over-regeneration load protection	Regenerative energy has exceeded the capacity of regenerative resistor. 1) Due to the regenerative energy during deceleration caused by a large load inertia, converter voltage has risen, and the voltage is risen further due to the lack of capacity of absorbing this energy of the regeneration discharge resistor. 2) Regenerative energy has not been absorbed in the specified time due to a high motor rotational speed. 3) Active limit of the external regenerative resistor has been limited to 10% duty. Caution: Install an external protection such as thermal fuse without fail when you set up Pr 0.16 to 2. Otherwise, regenerative resistor loses the protection and it may be heated up extremely and may burn out.	Check the load factor of the regenerative resistor from the front panel or via communication. Do not use in the continuous regenerative brake application. 1) Check the running pattern (speed monitor). Check the load factor of the regenerative resistor and over-regeneration warning display. Increase the capacity of the driver and the motor, and loosen the deceleration time. Use the external regenerative resistor. 2) Check the running pattern (speed monitor). Check the load factor of the regenerative resistor. Increase the capacity of the driver and the motor, and loosen the deceleration time. Lower the motor rotational speed. Use an external regenerative resistor. 3) Set up Pr 0.16 “External regenerative resistor setup” to 2.
	1	Regenerative transistor error protection	Regenerative driver transistor on the servo driver is defective.	Replace the driver.

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
21	0	Encoder communication disconnection error protection	Communication between the encoder and the driver has been interrupted in certain times, and disconnection detecting function has been triggered.	Make a wiring connection of the encoder as per the wiring diagram. Correct the miswiring of the connector pins.
	1	Encoder communication error protection	Communication error has occurred in data from the encoder. Mainly data error due to noise. Encoder cables are connected, but communication data has some errors.	• Secure the power supply for the encoder of 5 VDC ±5% (4.75 to 5.25 V)...pay an attention especially when the encoder cables are long. • Separate the encoder cable and the motor cable if they are bound together. • Connect the shield to FG.
23	0	Encoder communication data error protection	Data communication between the encoder is normal, but contents of data are not correct. Mainly data error due to noise. Encoder cables are connected, but communication data has some errors.	• Secure the power supply for the encoder of 5 VDC ±5% (4.75 to 5.25 V)...pay an attention especially when the encoder cables are long. • Separate the encoder cable and the motor cable if they are bound together. • Connect the shield to FG.
24	0	Position deviation excess protection	Deviation pulses have exceeded the setup of Pr 0.14. 1) The motor movement has not followed the command. 2) Setup value of Pr 0.14 “Position deviation excess setup” is small.	1) Check that the motor follows to the position command pulses. Check that the output toque has not saturated in torque monitor. Make a gain adjustment. Set up maximum value to Pr 0.13 and Pr 5.22. Make a encoder wiring as per the wiring diagram. Set up the longer acceleration/deceleration time. Lower the load and speed. 2) Set up a larger value to Pr 0.14.
	1	Speed deviation excess protection	The difference between the internal positional command speed and actual speed (speed deviation) exceeds the setup vale of Pr 6.02. Note: If the internal positional command speed is forcibly set to 0 due to instantaneous stop caused by the CW/CCW over-travel inhibit input, the speed deviation rapidly increases at this moment. Pr 6.02 setup value should have sufficient margin because the speed deviation also largely increases on the rising edge of the internal positional command speed.	• Increase the setup value of Pr 6.02. • Lengthen the acceleration/deceleration time of internal positional command speed, or improve the follow-up characteristic by adjusting the gain. • Disable the excess speed deviation detection (Pr 6.02 = 0).
25	0	Hybrid deviation excess error protection	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 setup.”	• 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.
26	0	Over-speed protection	The motor rotational speed has exceeded the setup value of Pr 5.13.	• Do not give an excessive speed command. • Check the command pulse input frequency and division/multiplication ratio. • Make a gain adjustment when an overshoot has occurred due to a poor gain adjustment. • Make a wiring connection of the encoder as per the wiring diagram.
	1	2nd Overspeed protection	The motor rotational speed has exceeded the setup value of Pr 6.15.	

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
27	1	Absolute clear protection	Multi-turn clear of absolute encoder is made through USB communication (setup support software PANATERM).	• Check if multi-turn clear of absolute encoder has been made through USB communication(setup support software PANATERM). Note: Checking is for the purpose of safety and not the cause of error. Multi-turn clearing through RTEX communication does not cause an alarm. However, be sure to reset the control power.
	4	Command error protection	Position command variation (value after electronic gear) exceeds the specified value.	• Check whether the position command was significantly changed due to cyclic position control (CP). • Check electronic gear ratio. • Check whether Update_Counter is changed in the correct period. • In case of changes from servo-off to servo-on, check whether the position command was initialized by the actual position when Servo_Active is 0. • Check whether parameter settings related to the communication cycle or the command update cycle are consistent with the specifications of the host controller.
	5	Command generation error protection	Position command generation process exceeded the computation range.	• Make sure that the electronic gear ratio and velocity control conform to limit requirements.
	6	Operation commands contention protection	• When Pr7.99 bit0 = 0, RTEX communications established during test run of FFT operating on the amplifier alone. • When Pr7.99 bit0 = 1, servo ON command by RTEX communications received during test run of FET operating on the amplifier alone. • During execution of test operation, FFT, phase Z search, and Fit gain, a request for switching to the virtual full-closed control mode was received from PANATERM. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• Check that RTEX has not been established during FFT test run when Pr7.99 bit0 = 0. • Check that servo ON command by RTEX communication has not been sent from a host unit during FFT test run when Pr7.99 bit0 =1. • Check whether a request for switching to the virtual full-closed control mode is transmitted from PANATERM or not, during execution of test operation, FFT, phase Z search, and Fit gain.
	7	Position information initialization error protection	•During validation mode of attribute C parameter of reset command of RTEX communication, servo was turned ON. Note: It is not supported in versions corresponding to function extended edition 2 or earlier. •Cancellation of the homing command was executed from the host device during homing command (Type_Code: 11h to 1Dh) between home position detection and completion of return to home position. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• Check to see that the servo is OFF during validation mode of attribute C parameter of reset command of RTEX communication. •Check if homing command is canceled near the home position signal.
28	0	Pulse regeneration limit protection	The output frequency of pulse regeneration has exceeded the limit.	• Check the setup value of Pr0.11 “Output pulse counts per one motor revolution” and Pr5.03 “Denominator of pulse output division”. • To disable the detection, set Pr5.33 “Pulse regenerative output limit setup” to 0.
29	1	Counter overflow protection 1	The calculated value of the absolute encoder (absolute external scale) position [in pulse units] or the electric gear ratio exceeded 32 bits in position information initialization that was performed after turning on the control power in absolute mode, after executing the attribute C parameter enabling mode, when clearing absolute encoder multi-turn via PANATERM or RTEX, when PANATERM operation (trial run, frequency characteristic analysis, Z phase search, or fit gain) is completed, or when pin assignment is made by PANATERM.	• Confirm the operating range of absolute encoder (absolute external scale) position and review the electronic gear ratio.
	2	Counter overflow protection 2	Position deviation in unit of pulse has reached $\pm 2^{30}$-1 (1073741823) or more. Or, position deviation in unit of command has exceeded $\pm 2^{30}$ (1073741824).	• Check that the motor runs as per the position command pulses. • Check that the output toque has not saturated in torque monitor. • Make a gain adjustment. • Set up maximum value to torque limit setting. • Make a wiring connection of the encoder 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		

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
33	0	Input duplicated allocation error 1 protection	Input signals (SI1, SI2, SI3, SI4) are assigned with two functions.	Allocate correct function to each connector pin.
	1	Input duplicated allocation error 2 protection	Input signals (SI5, SI6, SI7, SI8) are assigned with two functions.	Allocate correct function to each connector pin.
	2	Input function number error 1 protection	Input signals (SI1, SI2, SI3, SI4) are assigned with undefined number. Or, logical setup is not correct.	Allocate correct function to each connector pin.
	3	Input function number error 2 protection	Input signals (SI5, SI6, SI7, SI8) are assigned with undefined number. Or, logical setup is not correct.	Allocate correct function to each connector pin.
	4	Output function number error 1 protection	Output signals (SO1) are assigned with undefined number.	Allocate correct function to each connector pin.
	5	Output function number error 2 protection	Output signals (SO2,SO3) are assigned with undefined number.	Allocate correct function to each connector pin.
	8	Latch input allocation error protection	Error has occurred during function assignment of latch correction pins (SI5, SI6, and SI7). • EXT1 must be allocated to SI5. EXT2 to SI6 and EXT3 to SI7: but these are assigned to other pins. • HOME is allocated to SI6 or SI7; POT is allocated to SI5 or SI7; NOT is allocated to SI5 or SI6. • Function not allocated to one or more control modes.	Allocate correct function to each connector pin.
34	0	Software limit protection	When a position command within the specified input range is given, the motor operates outside its working range specified in Pr 5.14 “Motor working range setup”. 1) Gain is not appropriate. 2) Pr 5.14 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. Note: It is not supported in versions corresponding to function extended edition 1 or earlier.	1) Check the gain (balance between position loop gain and velocity loop gain) and inertia ratio. 2) Increase the setup value of Pr 5.14. Or, Set Pr 5.14 to 0 to disable the protective function. 3) Check the setting and operation conditions. (See precaution of 6-2.)
	1	One revolution absolute working range error	At the time of absolute encoder is used, When Pr0.15 “Absolute encoder setup”=3, the motor (encoder) position crossed motor working range (encoder 1 revolution data).	• The working range of an absolute encoder (absolute scale) position including absolute home position offset is checked. • A motor (encoder) position is returned in motor working range (inside of encoder 1 revolution data).
36	0	EEPROM parameter error protection	Data in parameter storage area has been damaged when reading the data from EEPROM at power-on.	• Set up all parameters again. • If the error persists, replace the driver (it may be a failure.) Return the product to the dealer or manufacturer.
	1			
37	0	EEPROM check code error protection	Data for writing confirmation to EEPROM has been damaged when reading the data from EEPROM at power-on.	Replace the driver. (it may be a failure). Return the product to a dealer or manufacturer.
	1			
	2			
38	0	Over-travel inhibit input protection 1	With Pr 5.04 “over-travel inhibit input setup” = 0, both positive and negative over-travel inhibit inputs (POT/NOT) have been ON. With Pr 5.04 = 2, positive or negative over-travel inhibit input has turned ON.	Check that there are not any errors in switches, wires or power supply which are connected to positive direction/ negative direction over-travel inhibit input. Check that the rising time of the control power supply (12 to 24 VDC) is not slow.
	1	Over-travel inhibit input protection 2	RTEX communication is OFF with Pr 5.04 = 0, and POT or NOT is ON, and then operation command (e.g. trial run, FFT) is given through USB communication (setup support software PANATERM). Or, POT or NOT is turned ON while the system is operating according to the command given through USB communication(setup support software PANATERM).	Check that there are not any errors in switches, wires or power supply which are connected to positive direction/ negative direction over-travel inhibit input. Check that the rising time of the control power supply (12 to 24 VDC) is not slow.

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
38	2	Over-travel inhibit input protection 3	With POT allocated to SI6 or NOT to SI7, Pr 5.04 “Over-travel inhibit input setup” is set to a value other than 1 (disabled).	• When POT is allocated to SI6 or NOT allocated to SI7, make sure that Pr 5.04 “Over-travel inhibit input setup” is set to 1 (disabled).
40	0	Absolute system down error protection	Voltage of the built-in capacitor has fallen below the specified value because the power supply or battery for the absolute encoder has been down.	After connecting the power supply for the battery, clear the 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 Pr 0.15 “Absolute encoder setup” to the appropriate value. • Limit the travel from the machine origin within 32767 revolutions.
42	0	Absolute overspeed error protection	The motor speed has exceeded the specified value when only the supply from the battery has been supplied to encoder during the power failure.	• Check the supply voltage at the encoder side (5 V ±5%) • Check the connecting condition of the connector, CN X6. 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.
45	0	multi-turn counter error protection	Multi turn counter error has been detected.	Replace the motor.
47	0	Absolute status error protection	Encoder has been running at faster speed than the specified value at power on.	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 of external scale in the Reference specification.
	2	External scale communication data error protection	The data from the external scale was not a communication error, but the contents of the data became an error. Data error mainly caused by noise. External 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.	

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
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.	
72	0	Thermal error protection	Thermal has some error.	
80	3	PLL incomplete error protection	Phase lock between communication and servo (PLL lock) could not be completed even after 1s of starting synchronization process.	• Check that communication cycle set in Pr7.20 “RTEX communication cycle setup” and Pr7.91 “RTEX communication cycle enhancement setting” match the transmission cycle from the host unit. • Check that the synchronization mode among multiple axis in Pr7.22 “RTEX function extended setup 1” bit1 matches the setting of the host unit. • Check that there are no problems in the processing of the host side units. • Check that there are no abnormalities in the transmission cycle of RTEX communication data from the host unit. • Design the accuracy of RTEX communication data transmission cycle from the host device within ±0.05%. If the communication cycle is 250 us or less, Update_Counter must be varied correctly even when the command update cycle equals the communicate cycle. Please check if there is a problem in Update_Counter. • Shut down and reclose the power supply. • It may be a failure if indication continues to be displayed and error persists. Terminate use and replace the motor and the servo amplifier. • Return to the supplier store for investigation (repairs).
82	0	RTEX node addressing error protection	On power up of the control power, node address setting rotary switch on the servo drive has been set to a value outside the valid value.	• Check the setting of the node address setting switch. • Set node address setting switch to a value within the range of 0 and 31 and then turn on control power to the servo driver.
83	0	RTEX continues communication error protection 1	Error (CRC error) detection for the read of receive data sent to the node itself continued for the number of times set for Pr7.95 “Number of RTEX continuous communication error protection 1 detections”.	• Check the communication cable for excessive noise. • Check the communication cable for length, layout arrangement and connections, • Communication cable must be category 5-e or higher (6 or higher grade is recommended) shielded twisted pair cable (STPC) specified by TIA/EIA-568. • Replace the cable with the one recommended as above, if not a recommended one. • Attach the ferrite core to the cable if effective. • Increase the value set for Pr7.95 or Pr7.96.
	1	RTEX continues communication error protection 2	Error detection for the read of receive data sent to the node itself continued for the number of times set for Pr7.96 “Number of RTEX continuous communication error protection 2 detections”. Note: This alarm assumes an error if CRC error, receiving failure, or cyclic data error occurs.	

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
84	0	RTEX communication timeout error protection	The condition, in which the receive interrupt startup signal was not output from the RTEX communication IC with no reception of communication data, continued for the number of times set for Pr7.97 “Number of RTEX communication timeout error protection detections”.	• If the frequency of occurrence is changed by the exchange of communication cable, there is a possibility of a connection failure of the connector. Please change the manufacturer of the connector plug. • Check to see that the cable is disconnected or broken. • Check that the upstream node is ready for transmission (power is ON, not reset). • Make sure that the host device can transmit the signal at the correct timing and speed. • The communication cycle set by Pr 7.20 “RTEX communication cycle setup” and Pr7.91 “RTEX communication cycle expansion setting” must match the transmission cycle of the host device. • Increase the value set for Pr7.97. • If one or more requirements are not met, take the corrective action by referring to description of Err 83.0.
	3	RTEX synchronization error protection	An error occurred in the communication-servo synchronization processing.	• Turn off the power once, then re-enter. • If error repeats, this might be a failure. Stop using the products, and replace the motor and the driver. • Return the products to the dealer or manufacturer.
	5	RTEX communication cycle error protection	The receive interrupt startup signal was output from the RTEX communication IC, but the communication got out of sync with the servo with an error in output cycle.	• Make sure that the host device can transmit the signal at the correct timing and speed. • The communication cycle set by Pr 7.20 “RTEX communication cycle settup” and Pr7.91 “RTEX communication cycle expansion setting” must match the transmission cycle of the host device. • If one or more requirements are not met, take the corrective action by referring to description of Err 83.0.
85	0	Retracting operation completion (I/O) *1)	The retracting operation by I/O is successfully completed. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• This is a security precaution, and there is no problem if it is an intended retracting operation. • It is an error that notifies the retracting operation execution. • Make sure that return to origin is performed after the alarm is cleared.
	2	Retracting operation error *1)	When execution of escape operation is impossible • In the case where setting of Pr6.85 “Condition setting for escape operation” is abnormal • In the case where escape operation is effective, and communication cycle setting is less than 0.25 ms • When over-travel inhibit input (POT/NOT) or retreat operation stop input (STOP) in the direction of retreat is detected during retreat operation • In the case where the status has become Main power OFF (when Pr6.85 “Condition setting for escape operation” bit0-3 is other than 3)/ Servo off/ Alarm generation/ STO input, during escape operation • When retreat operation execution condition is satisfied with over-travel inhibit input (POT/NOT) or retreat operation (STOP) in retreat direction detected • In the case where the executing condition of escape operation has been satisfied, during operation (test operational function, frequency measurement function) other than by a communication command from the upper system • In the case where it was not possible to start escape operation, due to the Servo off status, etc. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• Check whether no problem exists on the parameter setting. • Check whether no problem exists on the operating environment. • After executing Alarm Clear, be sure to execute home position return.

*1) The alarm generated during retreat operation is switched by Pr6.86 bit15 (Retreat operation-related alarm switching).

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
86	0	RTEX cyclic data error protection 1	The condition, in which there is an error in cyclic command area data (C/R, MAC-ID) or there is an error in Sub_Chk during 32-byte mode, continued for the number of times set for Pr7.98 “Number of RTEX cyclic data error protection 1/2 detections”.	• Check the data in the cyclic command field (at location as described on the left column). • Check process performed on the host device. • Increase the value set for Pr7.98.
	1	RTEX cyclic data error protection 2	The condition, in which there is an error in the cyclic command code, continued for the number of times set for Pr7.98 “Number of RTEX cyclic data error protection 1/2 detections”.	
	2	RTEX_ Update_Counter error protection	The setup value for Pr 7.38 “RTEX_Update_Counter error protection setup” has been exceeded and the Update_Counter has not been updated correctly.	• Check for any trouble in the process performed on the host device. • Please check whether there is any problem in a periodic setup of the host device, and a periodic setup of the driver. • Increase the setup value for Pr 7.38. • Please repeal this alarm when the ratio of the communication cycle to the cycle which a command updates is 1:1 and you do not use Update_Counter.
87	0	Forced alarm input protection	Forced alarm input (E-STOP) is applied.	Check the wiring of forced alarm input (E-STOP).
	1	Retracting operation completion (I/O) *1)	The retracting operation by I/O is successfully completed. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• This is a security precaution, and there is no problem if it is an intended retracting operation. • It is an error that notifies the retracting operation execution. • Make sure that return to origin is performed after the alarm is cleared.
	3	Retracting operation error *1)	When execution of escape operation is impossible • In the case where setting of Pr6.85 “Condition setting for escape operation” is abnormal • In the case where escape operation is effective, and communication cycle setting is less than 0.25 ms • When over-travel inhibit input (POT/NOT) or retreat operation stop input (STOP) in the direction of retreat is detected during retreat operation • In the case where the status has become Main power OFF (when Pr6.85 “Condition setting for escape operation” bit0-3 is other than 3)/ Servo off/ Alarm generation/ STO input, during escape operation • When retreat operation execution condition is satisfied with over-travel inhibit input (POT/NOT) or retreat operation (STOP) in retreat direction detected • In the case where the executing condition of escape operation has been satisfied, during operation (test operational function, frequency measurement function) other than by a communication command from the upper system • In the case where it was not possible to start escape operation, due to the Servo off status, etc. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	• Check whether no problem exists on the parameter setting. • Check whether no problem exists on the operating environment. • After executing Alarm Clear, be sure to execute home position return.
90	2	RTEX multi-axis synchronization establishment error protection	Communication error occurred or communication was lost during transition to synchronization establishment in full synchronization mode.	• Take the same measure as done against Err83.0 or Err84.0.

*1) The alarm generated during retreat operation is switched by Pr6.86 bit15 (Retreat operation-related alarm switching).

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
91	1	RTEX command error protection	• Disagreement in the combination of communication cycle, 16/32 byte mode, semi-closed/full-closed(also including the virtual full-closed control mode) and control mode • The control mode is changed within a period shorter than 2 ms. • Control mode was changed during profile position latch positioning/profile home position return (Type_Code = 12h, 13h, 31h, 32h, 33h,34h,36h). • Control mode was changed while non-cyclic command (Busy = 1) was processed. • Home position return command (4h) was executed during profile position latch positioning/profile home position return (Type_Code = 12h, 13h, 31h, 32h, 33h,34h,36h). • Initialization mode (Type_Code = 1□h, 31h) for home position return command (4h) was performed during profile positioning/profile continuous rotation (Type_Code = 10h, 11h, 20h). • Type_Code was changed during profile position control (pp). • Type_Code = 1□h/2□h for home position return command (4th) was performed at the time of velocity control (CV)/ torque control (CT). • the control mode is except NOP, and the external scale position information monitoring facility at the semi-closed control is effective, and the communication cycle is 0.0625ms or less at 16 byte modes. • During the two-degrees-of-freedom control mode (standard type), the control mode was switched to other than position/velocity control (semi-closed control). (Note) It is not supported by function extended version 5 and later versions. • During the two-degrees-of-freedom control mode (synchronization type), the control mode was switched to other than position control.	• Check the process of upper device f56or any problem.
	3	RTEX command error protection 2	• Cancellation of Latch mode with stop function was executed by the host device for Latch mode with stop function (Type_Code: **F1h) of homing command between trigger signal detection and completion of the operation.** **Note: It is not s**upported in versions corresponding to function extended edition 3 or earlier. • Cancellation of return to origin command was executed from the host device during position information initialization process immediately before return to origin completion. (Note) It is not supported by function extended version 4 and earlier versions. • A return to origin cancellation phenomenon occurred during the return operation immediately after origin detection in PP return to origin. (Note) It is not supported by function extended version 4 and earlier versions.	• Check if cancellation of Latch mode with stop function is executed near the trigger signal • Check if the return to origin command is cancelled near the origin signal (cancelling after stopping is recommended if possible)..

(To be continued)

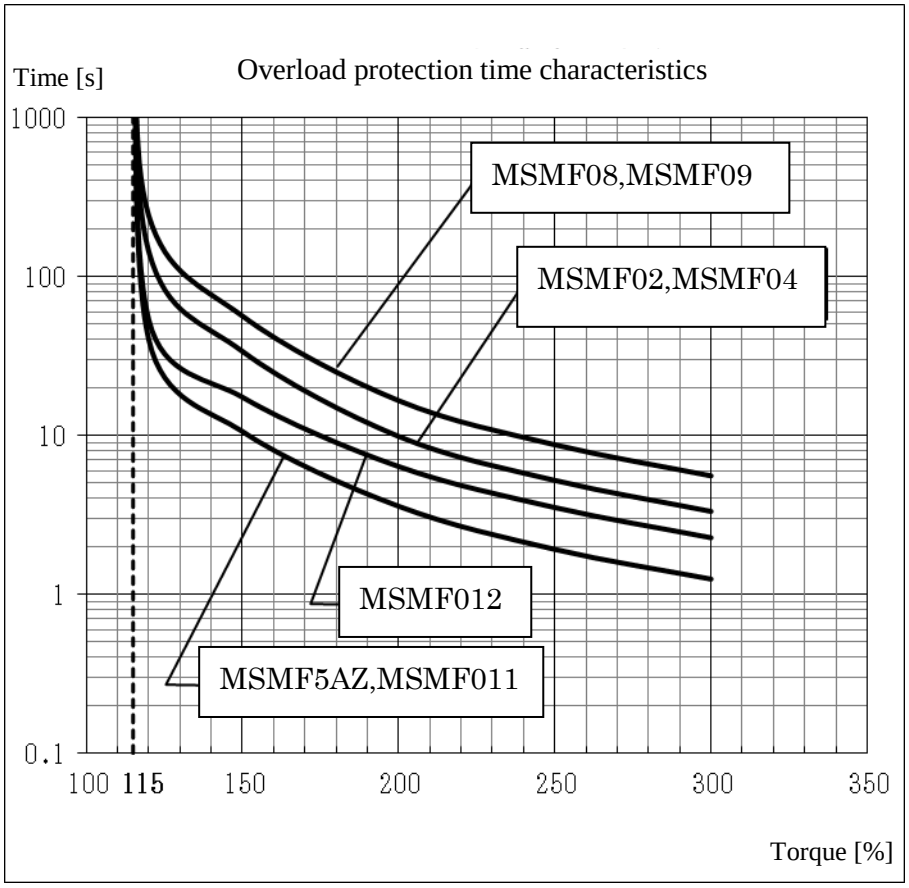
Error No.		Protective function	Causes	Measures
Main	Sub			
92	0	Encoder data recovery error protection	In the absolute mode with semi-closed control, internal position data has not been correctly initialized.	• Regulate the power source of the encoder to 5 VDC ±5% (4.75–5.25 V). Measure the voltage at the encoder cable end if it is long. • If the motor cable and encoder cable are bundled together, separated them. • Connect the shield to FG.
	1	External scale data recovery error protection	Initialization processing of the internal positional information was not correctly executed at full-closed control and in the absolute mode.	• 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 the connection diagram of external scale in the Reference specification.
	3	Multi-turn data upper-limit value disagreement 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.	Check the value set for the parameter.
93	0	Parameter setup error protection 1	Electronic gear ratio exceeds the allowable range.	• Check the setting value of the parameter. • Electronic gear ratio must be in the range 1/1000 to 8000.
	2	Parameter setup error protection 2	External scale ratio has exceeded the allowable range.	• Please confirm the set values of parameters. • Use external scale ratio in the range of 1/40 to 125200 times
	3	External scale connection error protection	Set value for Pr3.23 “External scale selection” and the connected serial communication type external scale type to not match.	• Set Pr3.23 to match the type of the connected external scale
	5	Parameter setup error protection 4	• The combination conditions of Pr 7.20“RTEX communication cycle setup”, Pr7.91 “RTEX communication cycle expansion setting”, Pr 7.21 “RTEX command updating cycle setup” and bit0 (RTEX communication data size) of Pr 7.22 “RTEX function extended setup 1” and electronic gear ratio are not met. • Feed forward settings of Pr7.35–Pr7.37 are duplicated.	• Check settings of the parameters. • For correct setting conditions, refer to the technical document RTEX Communication Specification ”Section 2-5”.
	8	Parameter setting error protection 6	• The continuous rotating absolute encoder function was set to enable with other than the 23-bit motor. • Absolute home position offset is set outside the range in continuous rotating absolute mode • Although the virtual full-closed mode is set as effective, it has not become the full-closed mode (Pr0.01 = 6), or the external scale type of absolute type has been set. Note: It is not supported in versions corresponding to function extended edition 4 or earlier.	Check the value set for the parameter.

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
94	2	Home position return error protection	• An error with profile home position return occurred.	• Check sensor installation status etc. for any problem.
	3	Home position return error protection2	• With Pr7.41 (RTEX function extended setting 5) bit7 being set to 1, the positive or negative direction drive inhibit input (POT/NOT) has become on while returning to the detected Z phase position in Z-phase origin returning. ・Returning amount to the detected Z phase position becomes abnormal when returning to the origin by using the Z phase.	• Enlarge the distance between the Z phase and positive direction/negative direction run inhibit input (POT/NOT). • After checking the safety, set Pr7.41 bit 7 (setting of detection of run inhibit input when returning to the origin of Z phase) to 0 (disabled).
95	0–4	Motor automatic recognition error protection	The motor and the driver have not been matched.	Replace the motor which matches to the 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.
	3	Control unit error protection 2		
	4	Control unit error protection 3	The servo driver received an RTEX communication frame in an invalid timing.	• Check whether the host device transmits RTEX communication frames in unstable cycles. • Keep the accuracy of the transmission cycle of the host device within ±0.05%.
	5	Control unit error protection 4	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.
	6	Control unit error protection 5		
	7	Control unit error protection 6		
98	1	RTEX hardware error protection 1	Fault is determined in RTEX communication related peripheral device.	• Turn off the power once, then re-enter. • If error repeats, this might be a failure. Stop using the products, and replace the motor and the driver. • Return the products to the dealer or manufacturer.
	2	RTEX hardware error protection 2		
	3	RTEX hardware error protection 3		
Other No.		Other error	•Control circuit has malfunctioned due to excess noise or other causes. •Some error has occurred inside of the driver while triggering self-diagnosis function of the driver.	• Turn off the power once, then re-enter. • If error repeats, this might be a failure. Stop using the products, and replace the motor and the driver and External scale. Return the products to the dealer or manufacturer.

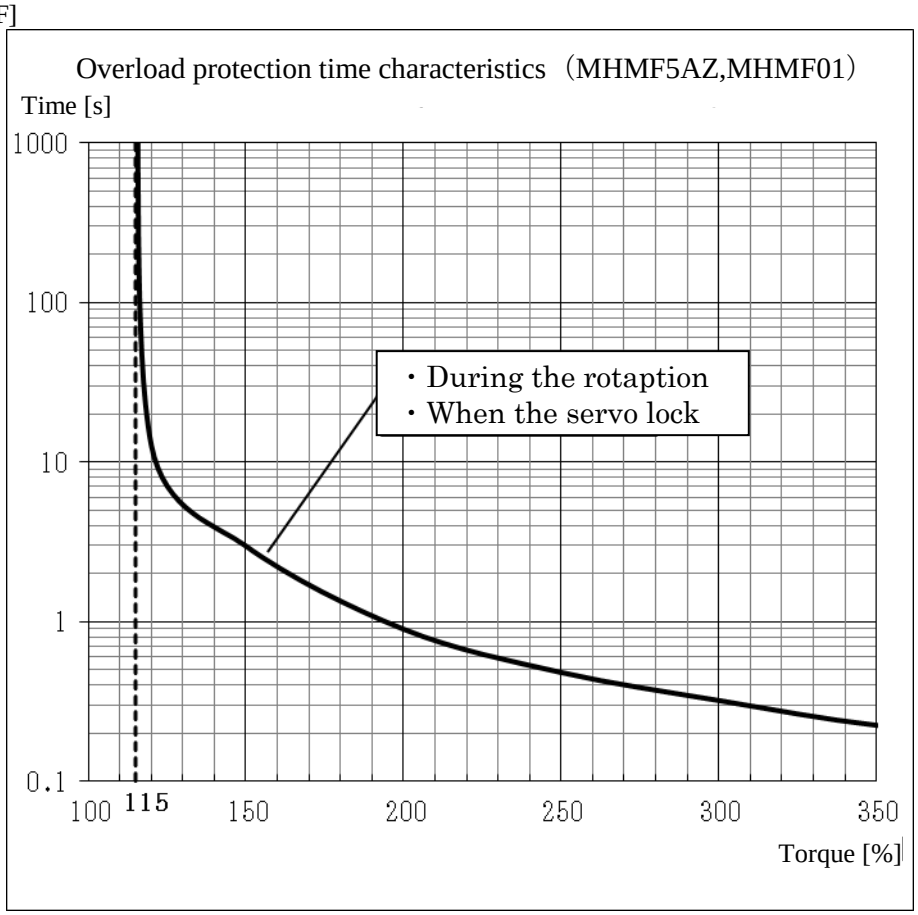
Overload protection time characteristics

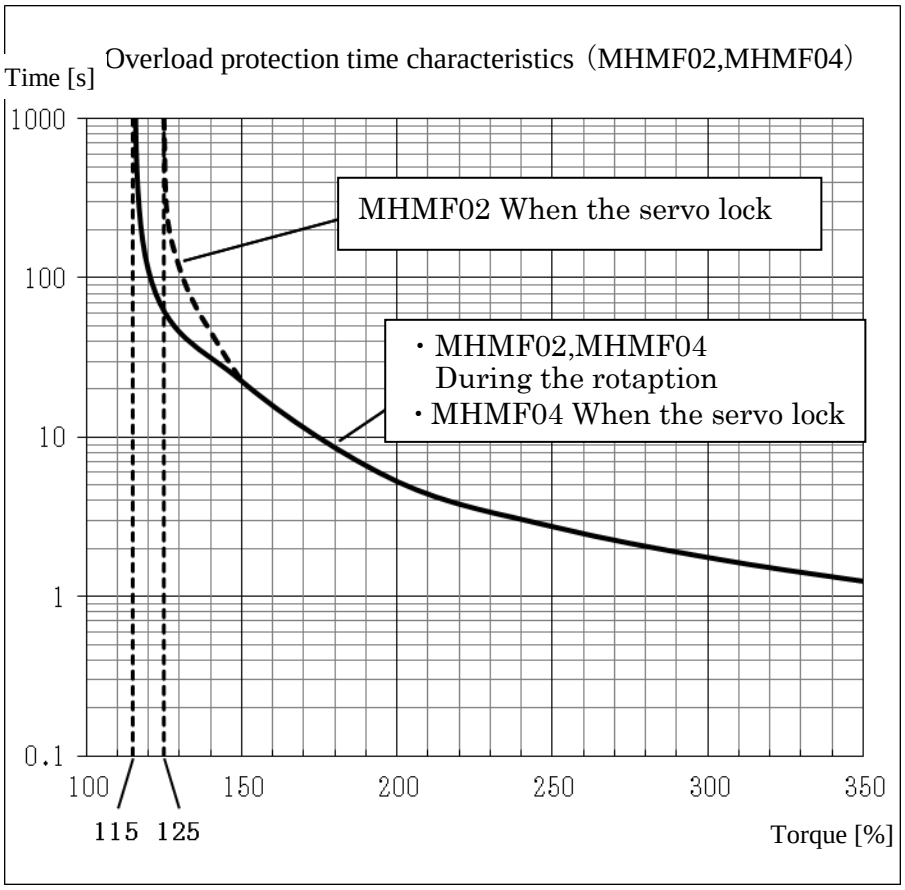
[Small type MSMF]



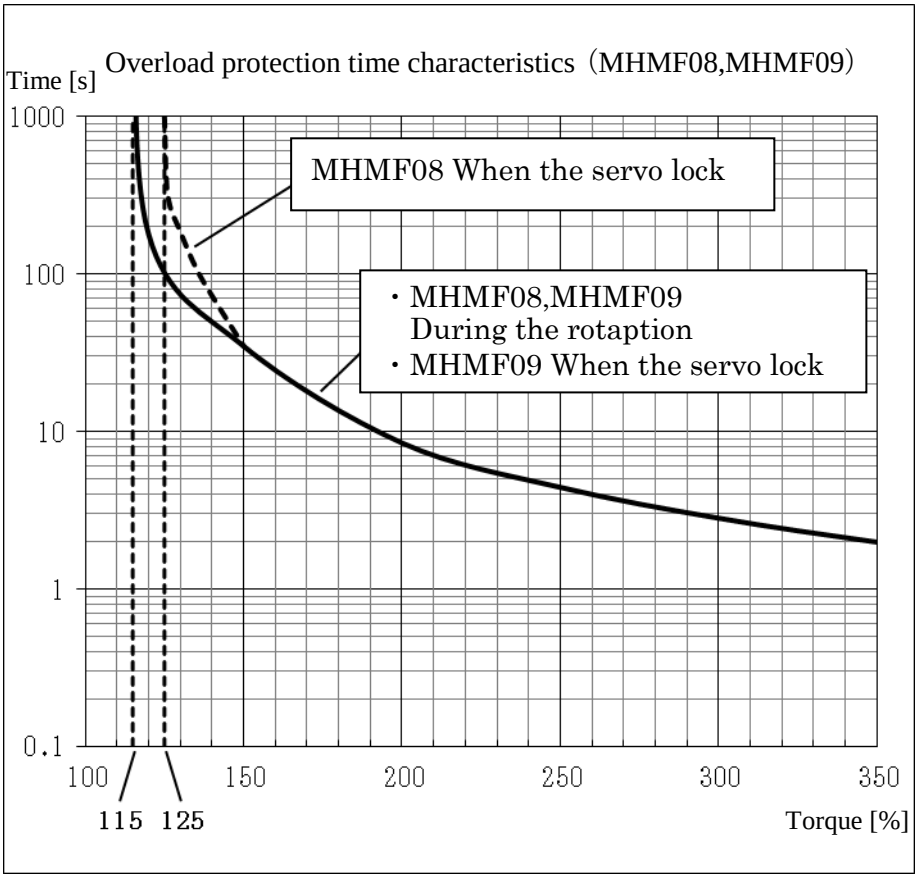
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor. Check the motor specification for “S-T characteristic.”

[Small type MHMF]



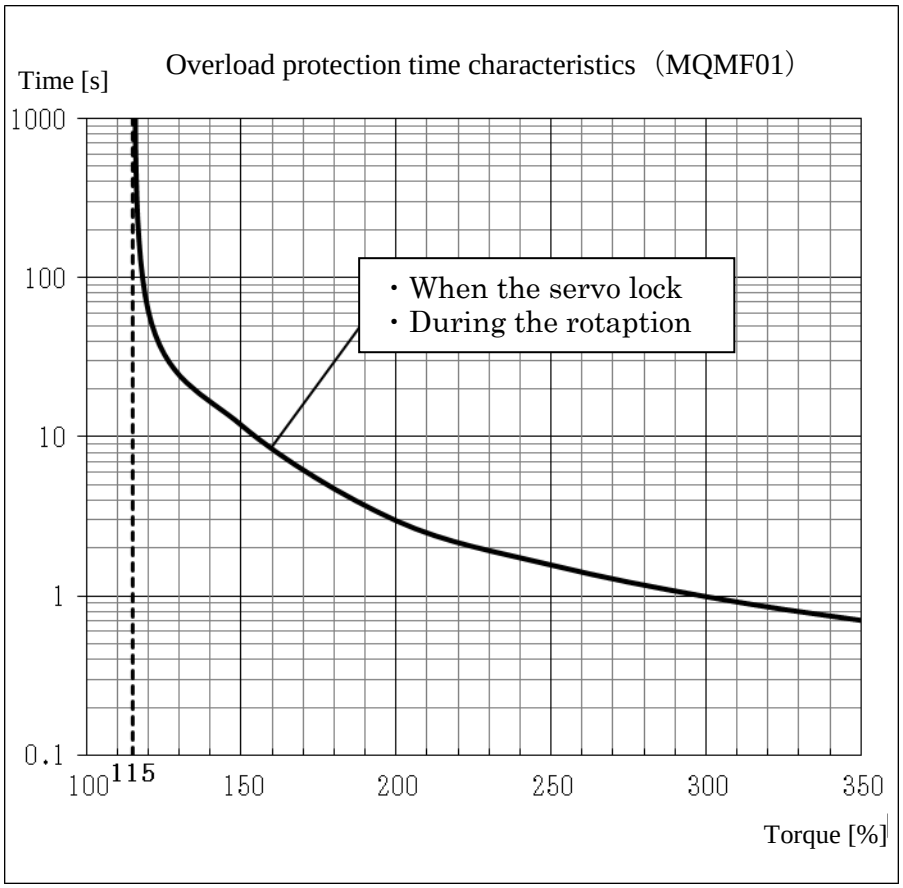


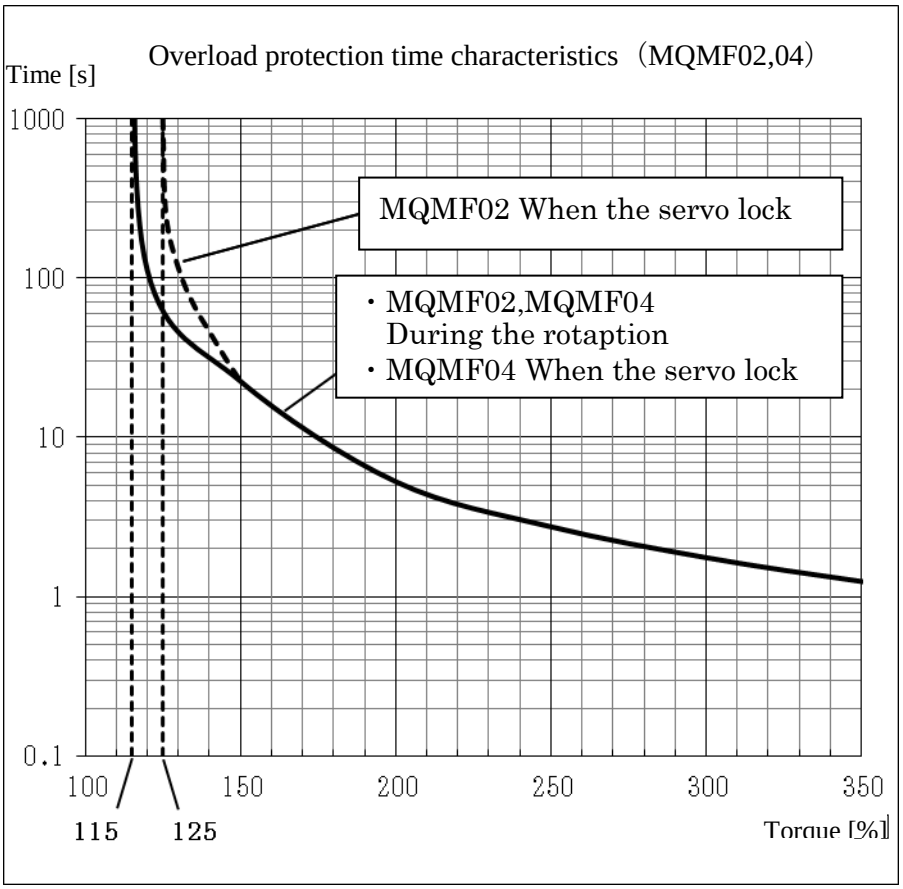
NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”



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.”

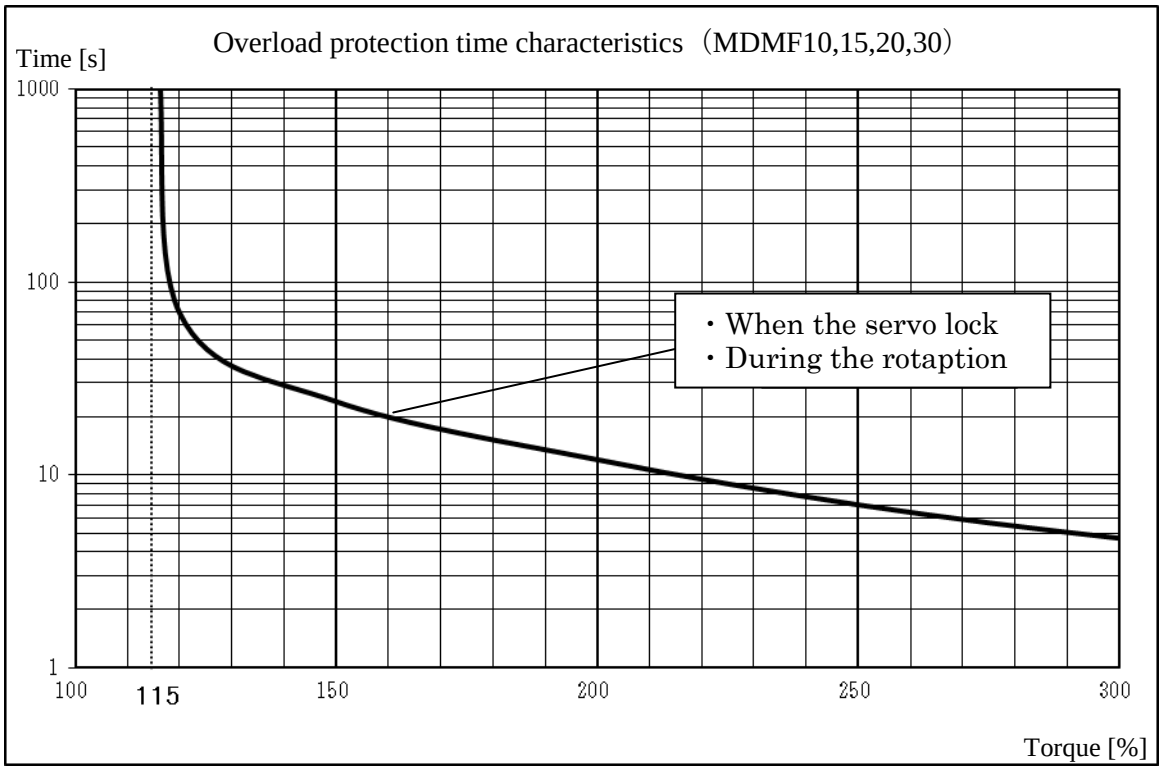
[Small type MQMF]

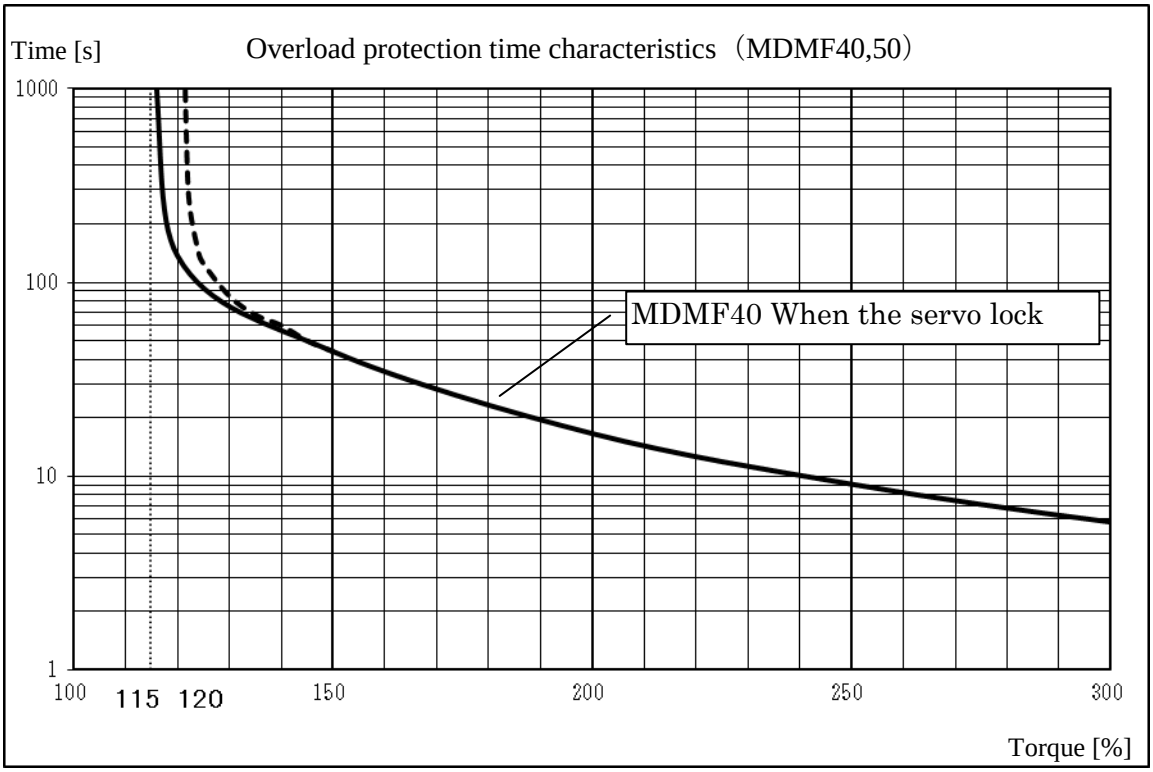




NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

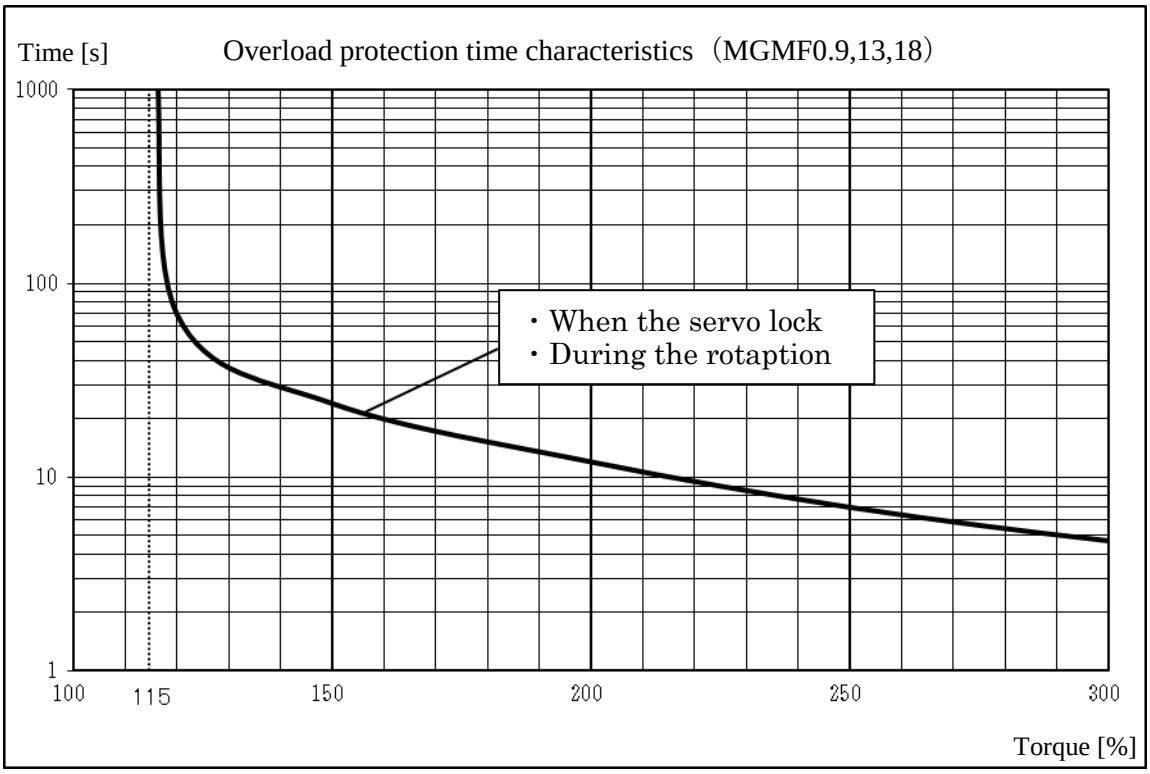
[Large type MDMF]

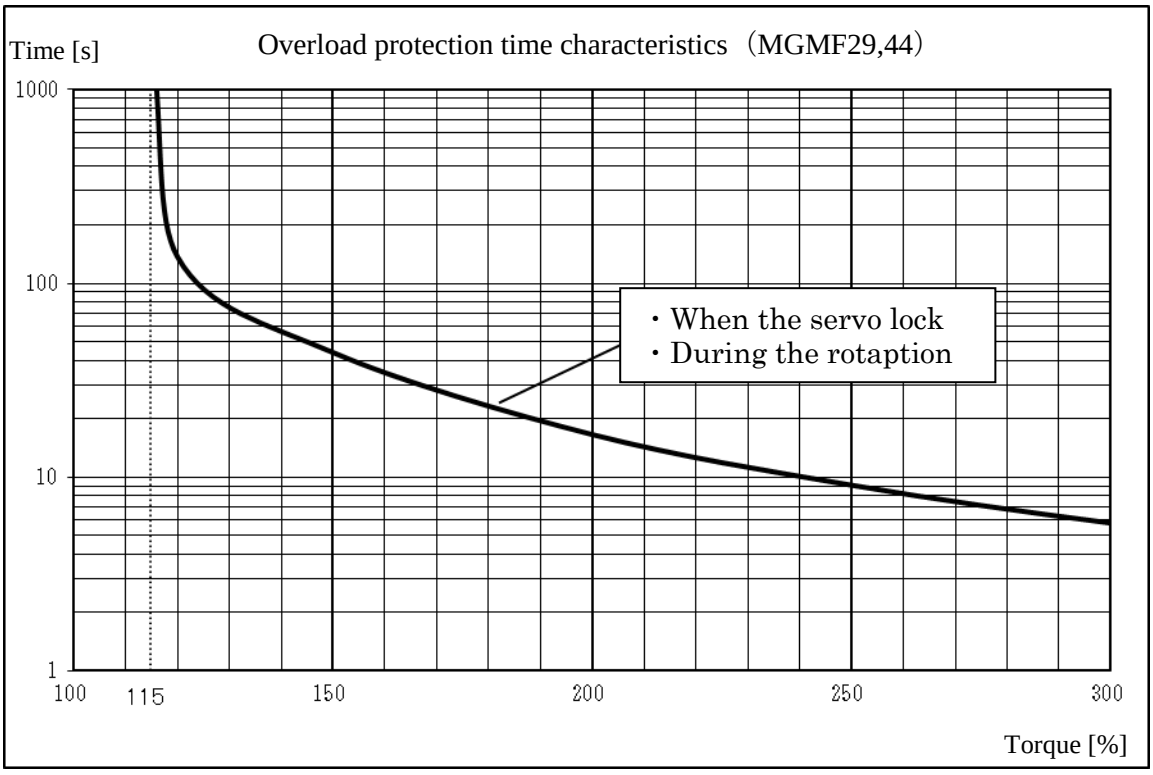




NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor.
Check the motor specification for “S-T characteristic.”

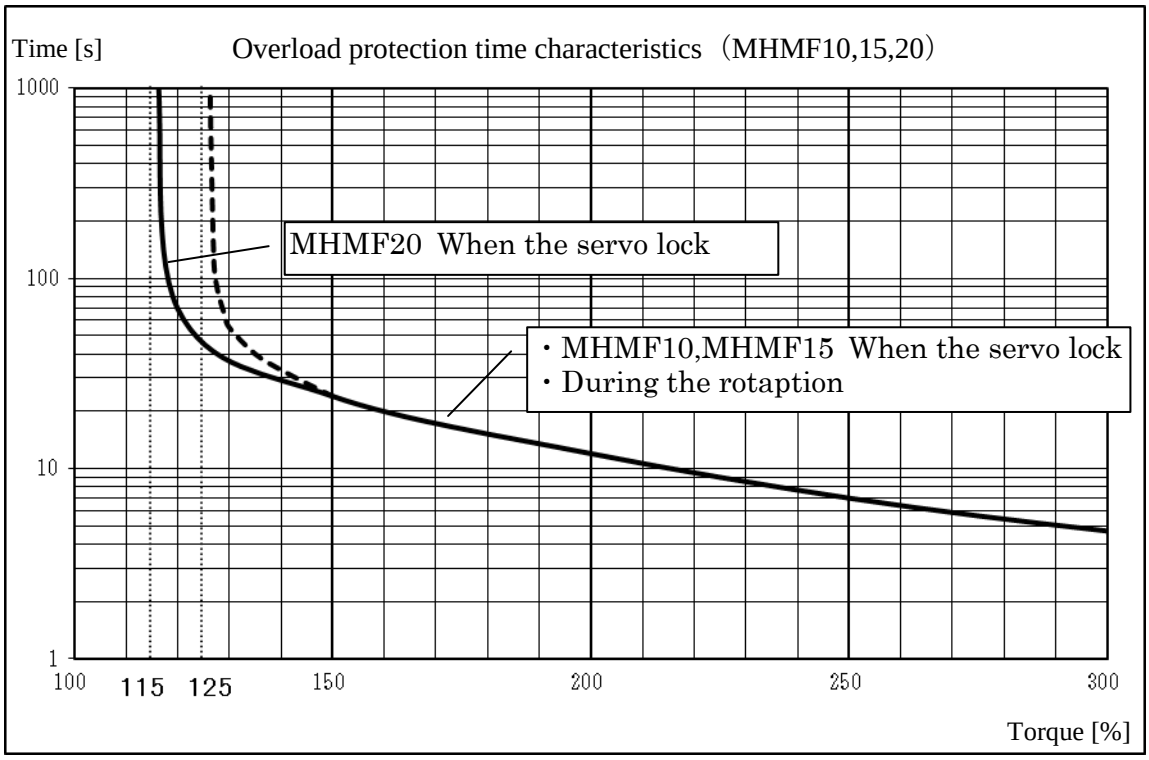
[Large type MGMF]

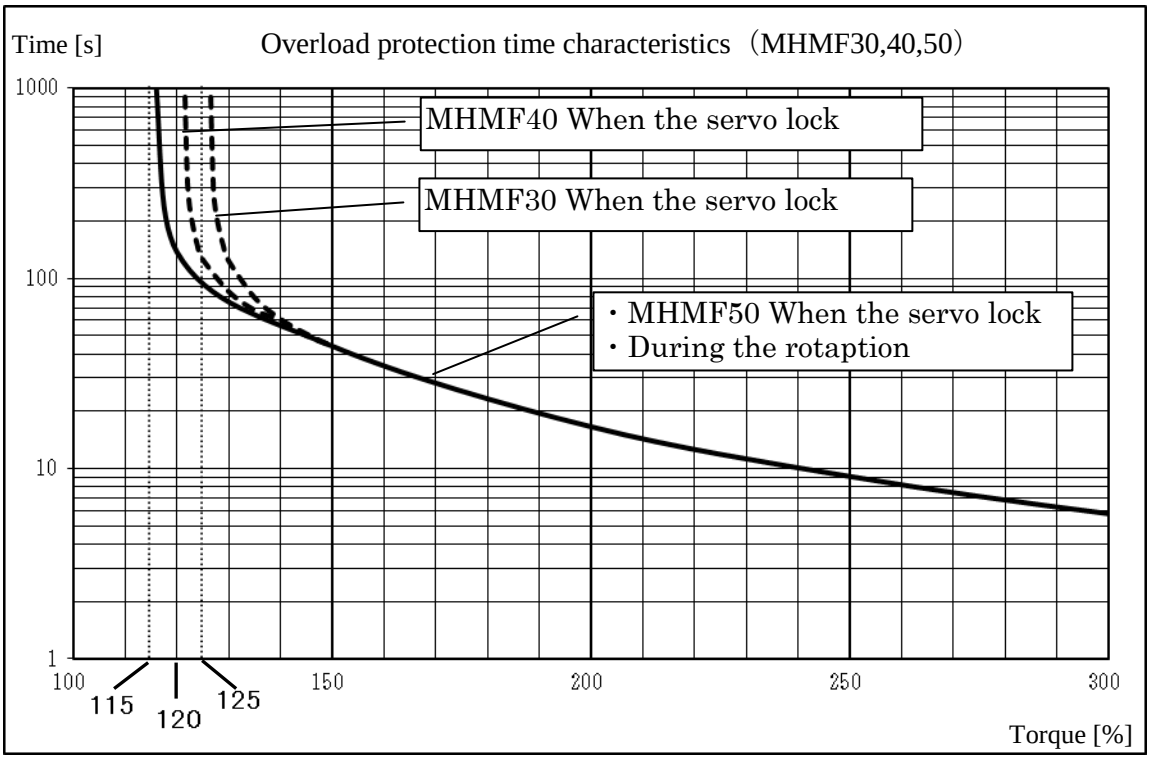




NOTE) Use the motor so that actual torque stays in the continuous running range shown in S-T characteristic of each motor. Check the motor specification for “S-T characteristic.”

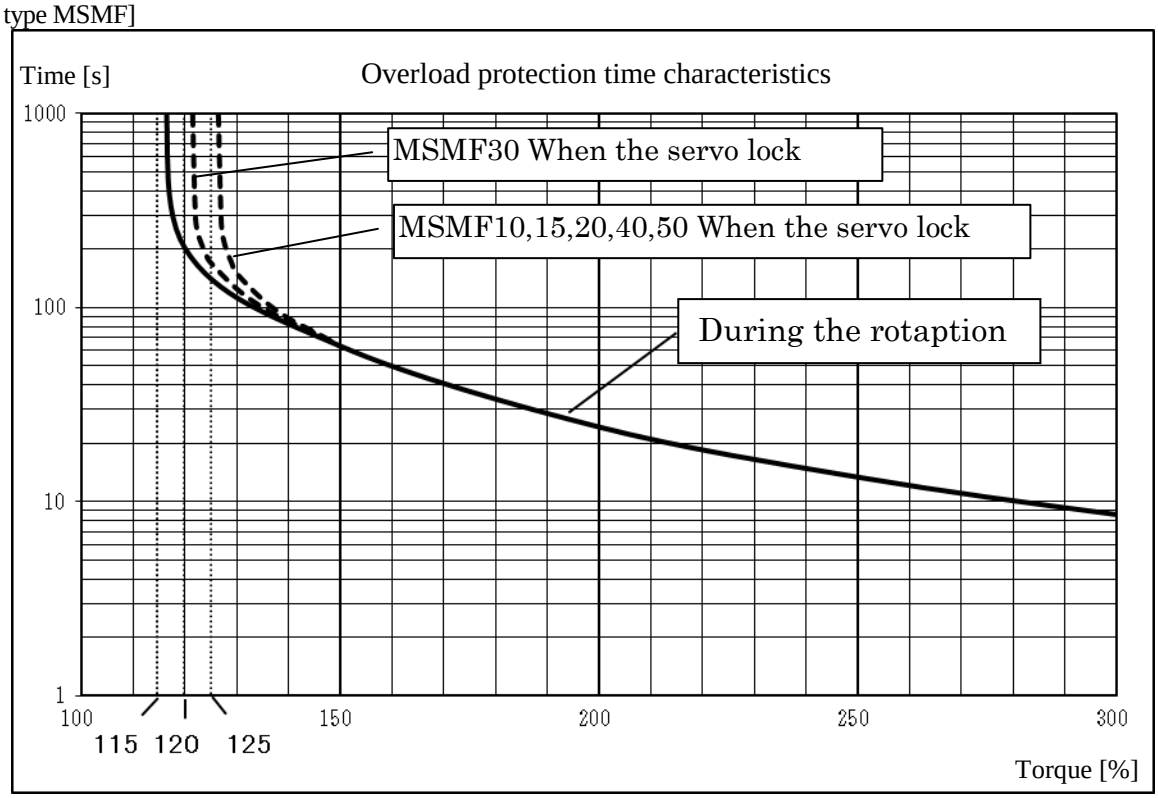
[Large type MHMF]





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.”

[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 Alarm function

The alarm will be triggered before the protective function is activated, and you can check the conditions such as overload beforehand.
One of the following warning modes can be selected through the setting of Pr 6.27 “Warning latch state setup”: the warning non-latch mode in which the warning is automatically cleared 1 sec. after the cause of warning is removed, and the warning latch mode in which the warning is kept issued even after the cause of warning is removed. To clear the latched state, use the alarm clearing procedure described in previous alarm section.
Note that the battery warning is latched by the encoder: after unlatching at the encoder, the warning is cleared.

(1) Relevant parameters

Class	No.	At-trib-ute	Title	Range	Unit	Function
4	40	A	Selection of alarm output 1	0–40	—	Select the type of alarm issued as the alarm output 1 (WARN1). Setup value 0: ORed output of all alarms. For 1 and subsequent see the table in the next page.
4	41	A	Selection of alarm output 2	0–40	—	Select the type of alarm issued as the alarm output 2.(WARN2) Setup value 0: ORed output of all alarms. For 1 and subsequent see the table in the next page.
6	27	C	Warning latch state setup	0–3	—	Set the latching state of warning. General warning and extended warning can be specified. bit 0: Extended warning 0: unlatch, 1: latch bit 1: General warning 0: unlatch, 1: latch
6	37	B	Oscillation detecting level	0–1000	0.1%	Set the threshold of oscillation detection. When torque vibration beyond this setting is detected, an oscillation detection alarm is activated. If the set value is 0, this function is disabled and the alarm is not activated.
6	38	C	Warning mask setting	-32768 –32767	—	Set the warning detection mask. To disable detection of a warning, place 1to the corresponding bit.
6	39	C	Warning mask setting 2	-32768 –32767	—	
7	14	C	Main power off warning detection time	0–2000	1 ms	Specifies a time to wait until a main power off warning is detected when main power shut-off continues. TREX communication status AC_OFF becomes 1 when main power off is detected. 0–9, 2000: Warning detection is disabled. 10–1999: Unit is [ms]
7	26	A	RTEX continuous error warning setup	0–32767	No. of times	WngC0h (RTEX continuous communication error warning) is generated as the number of continuous communication errors reaches the parameter setting. When the setting is 0, the function is disabled and warning is not generated.
7	27	A	RTEX accumulated error warning setup	0–32767	No. of times	WngC1h (RTEX accumulated communication error warning) is generated as number of accumulated communication errors reaches the parameter setting. When the setting is 0, the function is disabled and warning is not generated.
7	28	A	RTEX_Update_Counter error warning setup	0–32767	No. of times	If Update_Counter is accumulated exceeding the setting value of this parameter and correct update fails, WngC2h (RTEX_Update_Counter error warning) is issued. When the setting is 0 or 1, the function is disabled and warning is not generated.

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

(2) Alarm types

■ General warning

Alarm No. (Hex.)	Alarm	Content	Warning latch	Output setting	Waning mask
			Pr 6.27 *1)	Pr 4.40/ Pr 4.41 *2)	Pr 6.38/Pr 6.39 Corresponding bit *3)
A0	Overload protection	Load factor is 85% or more the protection level.	○	1	Pr 6.38 bit 7
A1	Over-regeneration alarm	Regenerative load factor exceeded 85% of protection level.	○	2	Pr 6.38 bit 5
A2	Battery alarm *4)	Battery voltage is 3.2 V or lower.	Latch fixed	3	Pr 6.38 bit 0
A3	Fan alarm	Fan has stopped for 1 sec.	○	4	Pr 6.38 bit 6
A4	Encoder communication alarm	The number of successive encoder communication errors exceeds the specified value.	○	5	Pr 6.38 bit 4
A5	Encoder overheat alarm	The encoder detects overheat alarm.	○	6	Pr 6.38 bit 3
A6	Oscillation detection alarm	Oscillation or vibration is detected.	○	7	Pr 6.38 bit 13
A7	Lifetime detection alarm	Life expectancy of capacitor or fan becomes short.	Latch fixed	8	Pr 6.38 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

■ Extended warning

Alarm No. (Hex.)	Alarm	Content	Warning latch	Output setting	Waning mask
			Pr 6.27 *1)	Pr 4.40/ Pr 4.41 *2)	Pr 6.38/Pr 6.39 Corresponding bit *3)
C0	RTEX continuous communication error warning	The No. of detected continuous reading errors (CRC error) of the data delivered to the local node reaches the number specified by Pr 7.26 “RTEX continuous error warning setup”.	○	11	Pr 6.38 bit 9
C1	RTEX accumulated communication error warning	The accumulated number of detected reading errors (CRC error) of the data delivered to the local node reaches the number specified by Pr 7.27 “RTEX accumulated error warning setup”.	Latch fixed	12	Pr 6.38 bit 10
C2	RTEX_Update_Counter error warning	Accumulated amount exceeded the times specified by Pr7.28 “RTEX_Update_Counter error warning setup”, so that Update_Counter was not updated.	Latch fixed	13	Pr 6.38 bit 11
C3	Main power off warning	When setting of Pr7.14 “Main power off warning detection time” is 10-1999, instantaneous power interruption occurs between L1 and L3 and lasts for a time longer than the setting of Pr7.14.	Latch fixed	14	Pr 6.38 bit 12
D2	PANATERM command execution warning	When bit0 of Pr7.99”RTEX function Extended setup 6” is 1 RTEX communication was established, the operation command (such as test run and FFT) by setup support software (PANATERM) was executed.	○	30	Pr6.39 bit8

*1) The mark circle indicates that the warning status can be maintained or cleared by the setting of Pr 6.27 “Warning latch state setup”. Battery alarm and lifetime detection alarm will be in the lath mode only.

*2) Select the warning output signal 1 (WARN 1) or warning output signal 2 (WARN 2) through Pr 4.40 “Selection of alarm output 1” or Pr 4.41 “Selection of alarm output 2”. When the set value is 0, all warnings are ORed before being output. Do not set to any value other than those specified in the table above.

*3) A waning detection can be disabled through Pr 6.38 “Warning mask setup” and Pr 6.39 “Warning mask setup 2”, by setting the bit shown below to 1.
For extended warning, warning detection can be disabled by parameter settings.
Also note that bit arrangements of these masks are different from those of general purpose type MINAS-A6 series.

*4) When the single-turn absolute function is enabled, a battery alarm is not detected.

*5) The alarm can be cleared by the alarm clearing operation. If the cause of the alarm is not yet removed, the alarm will be detected again even after clearing.

*6) Invalidated when Pr6.97 “Function expansion setup 3” bit1 = 0.

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) Setup of over-travel inhibit input
By inputting the limit sensor signal to the driver, the bumping against mechanical end can be prevented. Refer to interface specification, positive/negative direction overtravel inhibit input (POT/NOT). Set the following parameters which are related to overtravel inhibit input.
Pr 5.04 “Over-travel inhibit input setup”
Pr 5.05 “Sequence at over-travel inhibit”

2) Setup of torque limit
By limiting motor maximum torque, damage caused by failure or disturbance such as bite of the machine and collision will be minimized. To uniformly limit maximum torque by using the parameter Pr 0.13 “1st torque limit”, first set Pr 5.21 “Selection of torque limit” to 0 or 1.
If the torque limit setup is lower than the value required during the actual application, the following two protective features will be triggered: over-speed protection when overshoot occurs, and excess positional deviation protection when response to the command delays.
By allocating the torque in-limit output (TLC) of interface specification to the output signal, torque limit condition can be detected externally.

3) Setup of over-speed protection
Generates Err 26.0 “Over-speed protection” when the motor speed is excessively high.
Default setting is the applicable motor over-speed level.
If your application operates below the motor maximum speed, set Pr 5.13 “Over-speed level setup” by using the formula below.

Pr 5.13 Setup of over-speed level = Vmax × (1.2 to 1.5) Vmax: motor maximum speed [r/min] in operating condition Factor in ( ) is margin to prevent frequent activation of over-speed protection.

When running the motor at a low speed during initial adjustment stage, setup the overspeed protection by multiplying the adjusting speed by a certain margin to protect the motor against possible oscillation.

4) Setup of the excess positional deviation protection

During the position control or full-closed control, this function detects potential excessive difference between the positional command and motor position and issues Err 24.0"Excess positional deviation protection".
Excess positional deviation level can be set to Pr 0.14 "Position deviation excess setup". The deviation can be detected through command positional deviation [pulse (command unit)] and encoder positional deviation [pulse (encoder unit)] or full-closed deviation [pulse (external scale unit)], and one of which can be selected by Pr 5.20 "Position setup unit select". (See the control block diagram.)
Because the positional deviation during normal operation depends on the operating speed and gain setting, fill the equation below based on your operating condition and input the resulting value to Pr 0.14.

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)

➢ Using command positional deviation (after filter) (Pr7.23 bit14=0)

* In this case, the position deviation cannot be obtained through calculation formula. Set the value including allowance, by estimating the maximum value of command position deviation (Pmax) from the actual operation waveform that could be used. Pr0.14 "Setup of positional deviation excess" = Pmax × (1.2 to 2.0) Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection.

➢ Using command positional deviation (before filter) (Pr7.23 bit14=1)

Pr0.14 "Setup of positional deviation excess" = (P1 + P2 + P3 + P4) × (1.2 to 2.0) Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection.

Position command smoothing (second-order) accumulator pulse count
: P1 = Vc × (set value for Pr2.22 / 10000) × 2
Position command FIR filter accumulator pulse count : P2 = Vc × (set value for Pr2.23 / 10000) / 2
Adjustment filter accumulator pulse count : P3 = Vc × (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 through encoder positional deviation and full-closed positional deviation)

* In this case, the positional deviation cannot be calculated by a formula. So estimate the maximum Pmax of the encoder positional deviation or the full-closed positional deviation by the waveform of a real machine that may be used, and set a value on the safe side. Pr0.14 "Setup of positional deviation excess" = Pmax × (1.2 to 2.0) Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection.

・Measure with the smallest value when switching position loop gain Kp.

・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 by command position deviation)

➢ Using command positional deviation (after filter) (Pr7.23 bit14=0)

Pr0.14 “Setup of positional deviation excess” = P1 × (1.2 to 2.0) Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection.

Command positional deviation : P1 = Vc / Kp × ((100 - (set value for Pr1.10 / 10)) / 100)

・Vc : maximum frequency of positional command pulse [pulse (command unit)/s]
・Kp : Position loop gain [1/s] (When switching position loop gain Kp, select the smallest value for calculation.)

➢ Using command positional deviation (before filter) (Pr7.23 bit14=1)

Pr0.14 “Setup of positional deviation excess” = (P1 + P2 + P3 + P4) × (1.2 to 2.0) Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection.

Command positional deviation : P1 = Vc / Kp × ((100 - (set value for Pr1.10 / 10)) / 100)
Position command smoothing (first-order) accumulator pulse count
: P2 = Vc × (set value for Pr2.22 / 10000)
Position command FIR filter accumulator pulse count : P3 = Vc × (set value for Pr2.23 / 10000) / 2
Damping filter accumulator pulse count : P4 = Vc / (π × damping frequency [Hz])

・Vc : maximum frequency of positional command pulse [pulse (command unit)/s]
・Kp : Position loop gain [1/s] (When switching position loop gain Kp, select the smallest value for calculation.)
・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 through encoder positional deviation and full-closed positional deviation)

Pr0.14 “Setup of positional deviation excess” = P1 × (1.2 to 2.0) Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection.

Encoder positional deviation and the full-closed positional deviation
: P1 = Ve / Kp × ((100 - (set value for Pr1.10 / 10)) / 100)

・Ve : Maximum operating frequency [pulse/s] in encoder units or full-closed units
・Kp : Position loop gain [1/s] (When switching position loop gain Kp, select the smallest value for calculation.)
・Setting of command filter and damping control will not have any effect in case Pr 5.20 = 1.

Notes: When switching from the velocity control to position control, position deviation correcting function is used, which will increase calculation value and error. To cope with these problems, increase the margin.

5) Setup of motor working range
During the position control or full-closed control, this function detects the motor position which exceeds the revolutions set to Pr 5.14 “Motor working range setup”, and issues Err 34.0 “Software limit protection”.
For details, refer to 6-2 Motor working range setup 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 setup.”
For details, refer to 4-5-3 Motor working range setup function.

7-5 About the protection function setting while returning to the origin by using the Z phase

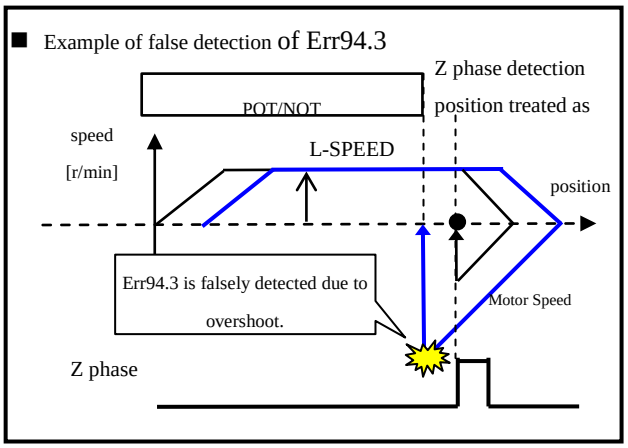
If the following parameters are set, the run inhibit input (POT, NOT) is detected when returning to the Z phase detection position, which is treated as the origin, with the operation for returning to origin by using the Z phase.
If run inhibit input is detected during the return operation, the protection function used for interrupting and stopping energization can be enabled by making Err94.3 “returning to origin error 2” occur.

Pr7.41 bit7 “RTEX function extended setup 5”
(Run inhibit input detection setting when returning to origin of Z phase) =1

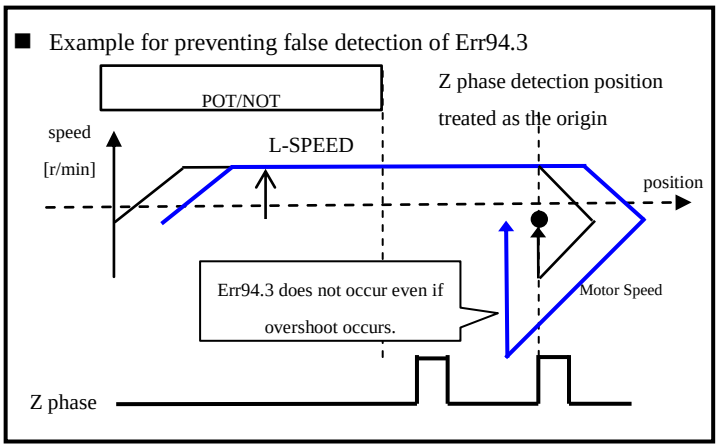
(Caution)

- If the above value is set to the parameter and the Z phase in the vicinity of run inhibit input (POT/NOT) is configured as the origin, Err94.3 may be erroneously detected because overshoot occurs while returning to the Z phase detection position treated as the origin.
  In this case, the position at run inhibit is input needs to be separated from the Z phase, which is treated as the position for completing return to the origin; therefore be sure to prevent occurrence of returning operation in the vicinity of run inhibit input (POT/NOT).

■ Example of false detection of Err94.3



■ Example for preventing false detection of Err94.3



- If the above value is not set for the parameter, detection of run inhibit input (POT/NOT) while returning to the Z phase detection position, which is treated as the origin when returning to the origin by use of the Z phase, is disabled.

(1) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	04 *2)	C	Over-travel inhibit input setup	0–2	—	Set up the operation of the run-inhibition (POT, NOT) inputs. Set the parameter according to the specification of upper controller. Normally it should be set to 1 (disabled) because the operation is controlled by an upper controller. 0: POT → inhibits CW drive, NOT → inhibits CCW drive. When POT is input during CW driving, stops the drive according to Pr 5.05 "Sequence at over-travel inhibit". The similar function NOT is applied in reverse direction. Regardless of operating condition, torque in over-travel inhibition direction is 0. 1: POT and NOT are disabled, having no effect on operation. 2: POT or NOT input activates Err 38.0 Run-inhibition input protection.
7	41	R	RTEX function extended setup 5	-32768-32767	—	bit0-6: For manufacturer's use bit7: Run inhibit input detection setting when returning to origin of Z phase. 0:Invalid 1:Valid

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

*2) While returning to the profile origin, settings of Pr5.04 "Over-travel inhibit input setup" and Pr5.05 "Sequence at over-travel inhibit" are temporarily disabled; therefore we recommend setting Pr7.41 bit 7 to 1. When using the function for returning to the profile origin without using the run inhibit input, do not assign the run inhibit input (POT/NOT) to general-purpose input. This setting is not disabled only if Pr5.04 is set to 1. Refer to the technical reference RTEX Communication Specification(sections 7-5-7, 7-5-8, 7-5-9, 7-5-10 and 7-5-11) for details of the function for returning to the profile origin.

(2) Relevant protective function

Error No.		Protective function	Causes	Measures
Main	Sub			
94	3	Home position return error protection2	• With Pr7.41 (RTEX function extended setting 5) bit7 being set to 1, the positive or negative direction drive inhibit input (POT/NOT) has become on while returning to the detected Z phase position in Z-phase origin returning. • Returning amount to the detected Z phase position becomes abnormal when returning to the origin by using the Z phase.	・Enlarge the distance between the Z phase and positive direction/negative direction run inhibit input (POT/NOT). ・After checking the safety, set Pr7.41 bit 7 (setting of detection of run inhibit input when returning to the origin of Z phase) to 0 (disabled).

8. Safety function

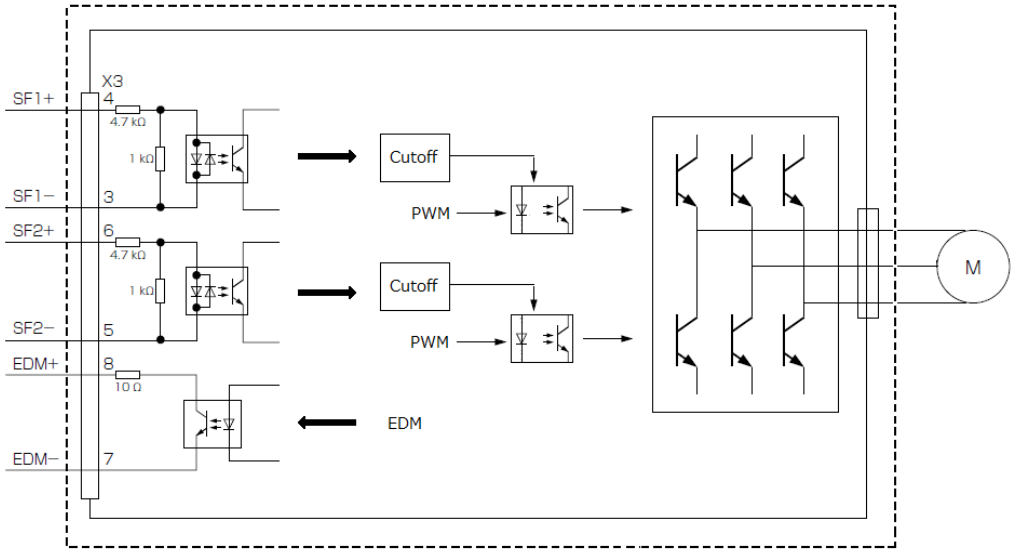
This servo driver has safety function built in. [A6NE] This function is not available.

<<Change point from A5N series>>

	A5N	A6N	
STO operation	Alarm generation Err30.0	No alarm 7-segment LED is "st"	
Release STO status	Release of the factors of STO 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.

8-2 Input/output signal specification

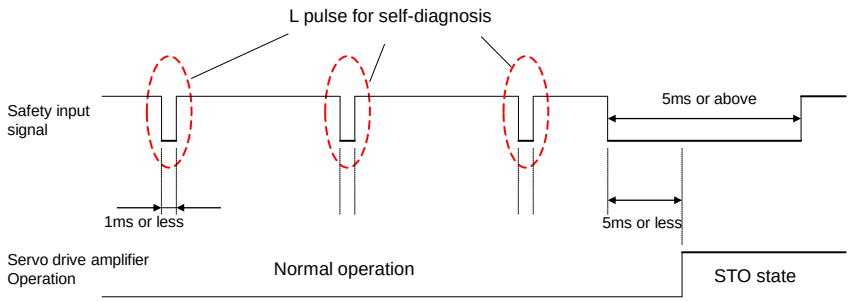
8-2-1 Safety input signal

• Two safety input circuit channels that trigger STO function are provided.

Class	Signal name	Signal	Connector pin number	Content	Control mode			
					Position	Speed	Torque	Full-closed
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	Speed	Torque	Full-closed
Output	EDM output	EDM +	X3-8	• Output monitor signal that is used to check the safety function.	○			
		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.

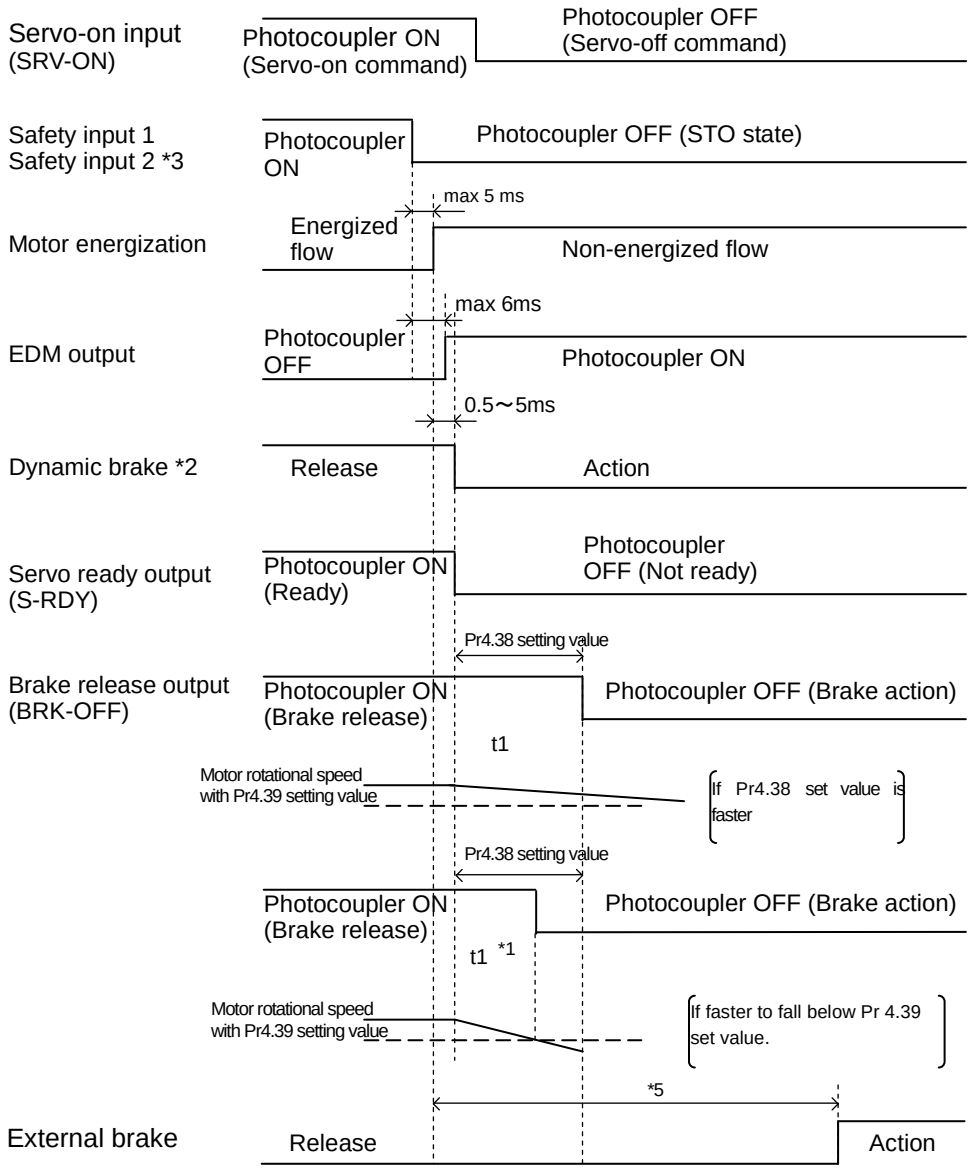
• Maximum delay time from input of safety 1 and 2 signals to output of EDM signal is 6 ms.

• 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 8 hours, and at the time of safety input.

8-3 Description of functions

8-3-1 Activation to STO state, timing diagram



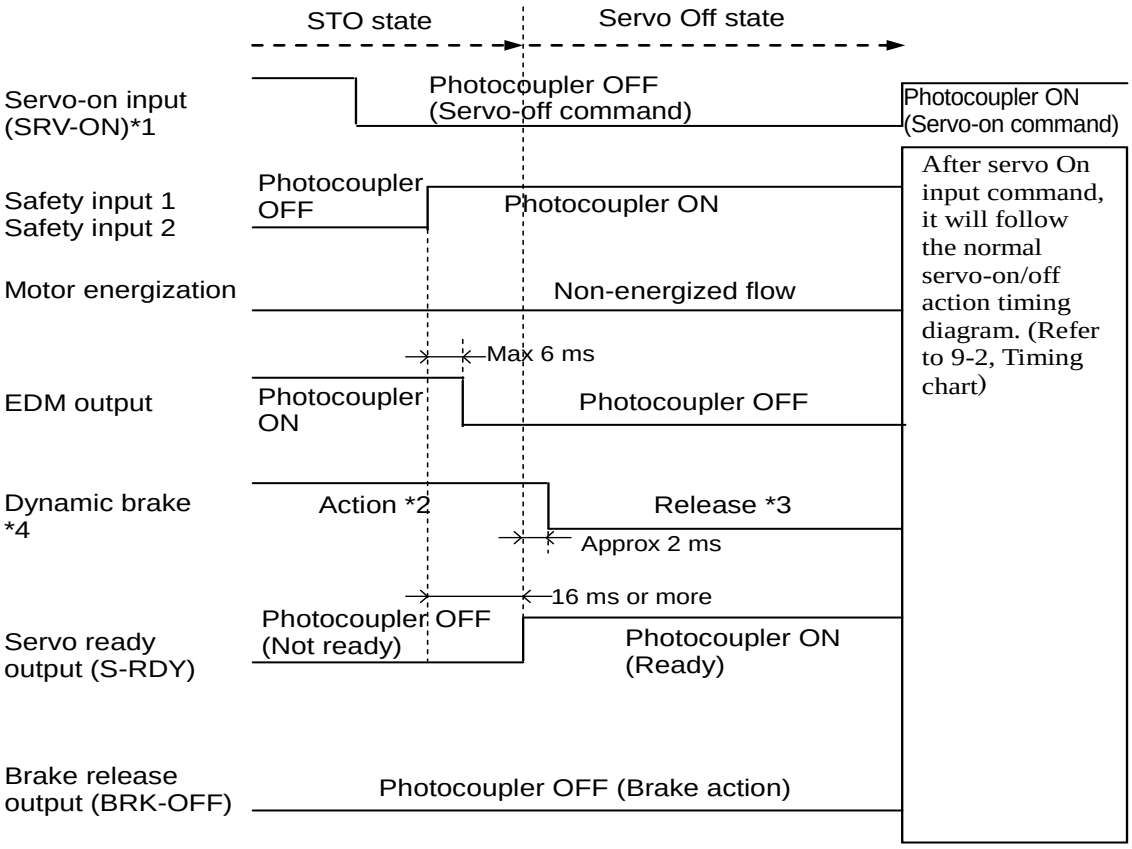
*1. t1 will be a shorter time of either the setup value of Pr4.38 “Mechanical brake action at running setup” or elapsing time for the motor speed to fall below Pr4.39 “Brake release speed setup.”

*2. Dynamic brake operates to the setting of Pr5.10 Sequence at alarm.
(In the STO state, even if an alarm does not occur, “Sequence at alarm” is applied.)

*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.” (Even if an alarm does not occur, “Sequence at alarm” is applied.)

*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.

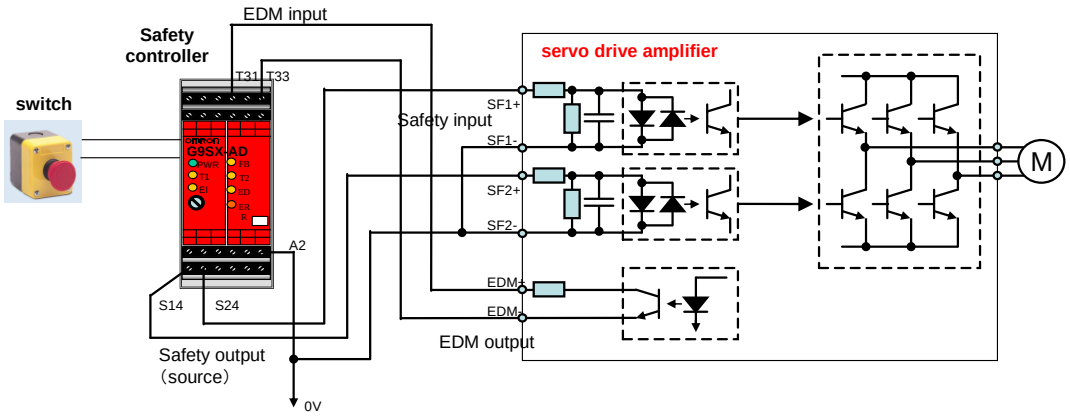
《MINAS-A5 series》

② Turn off servo ON input
③ Return the photo couplers for safety input 1 and 2 to ON.
④ Release the alarm.

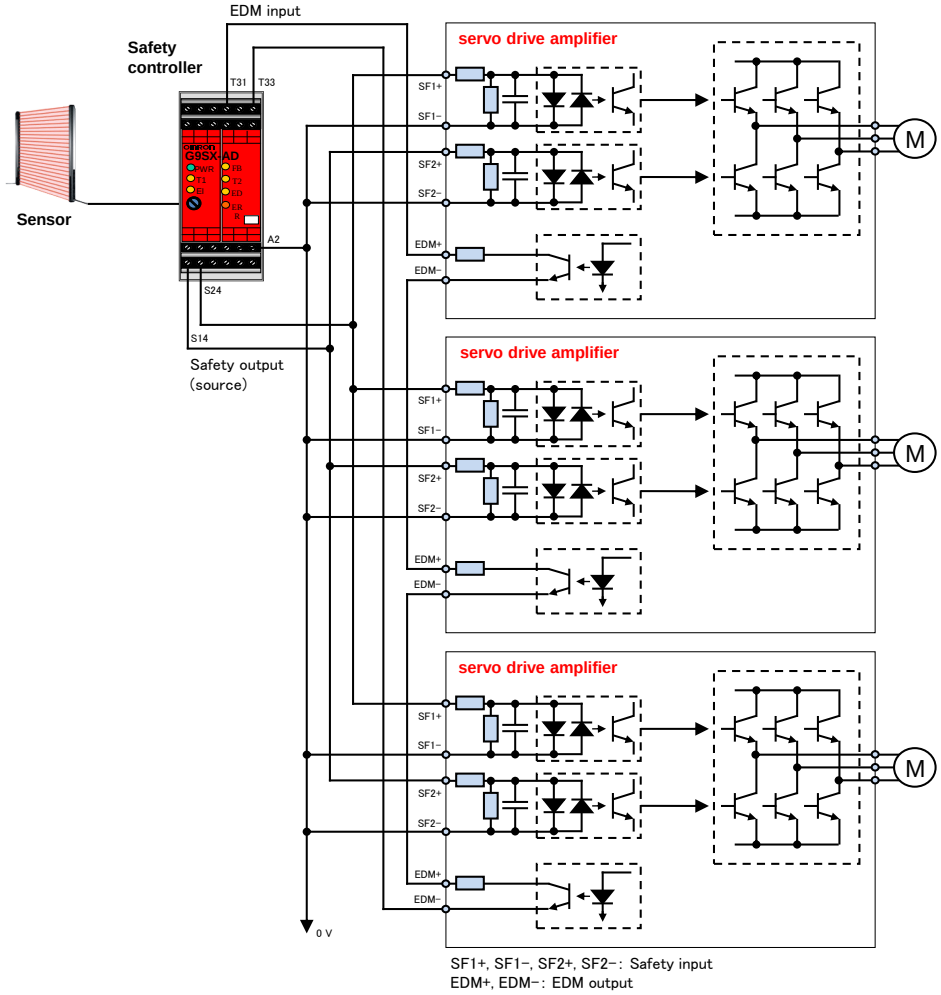
《MINAS-A6 series》

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 value is for reference.
When connecting EDM output in series, since the collector saturation voltage Vce (sat) of the built-in photocoupler is approx. 1 V, the maximum number of connectable axes is limited. This Vce (sat) changes depending on the collector current.
In addition, since approx. 5 mA per circuit is carried to SF input, as the number of connected axes increases, this current increases proportionally. It is required to limit the number of connected axes in order to prevent from exceeding the maximum output current on the safety controller side.

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.
    (In the STO state, even if an alarm does not occur, “Sequence at alarm” is applied.)
  - 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

The attribute of a parameter indicates the point at which the modified parameter setting becomes effective.

A : Always effective

B : Do not change while the motor is operating or command is transferred.
Reflection timing of parameter change made during the motor operation or command transfer is not defined.

C : Becomes valid upon resetting of control power, in software reset mode of RTEX communication reset command, or after execution of attribute C parameter validation mode.

R : Becomes valid upon resetting of control power or execution of software reset mode of RTEX communication reset command.
• Does not become valid after execution of attribute C parameter validation mode of RTEX communication reset command.

Class 0: Basic setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
0	00	Rotational direction setup	—	0–1	2	Setup the relationship between the direction of command and direction of motor rotation. 0: CW = positive, 1: CCW = positive	C	All	4-1
	01	Control mode setup	—	0–6	2	Select the control mode of the servo driver. 0: semi-closed control (position/velocity/torque control, selectable) 1–5: To be used by the manufacturer but not by the user. 6:Full-closed control(Position control only)	R	All	—
	02	Real-time auto-gain tuning setup	—	0–6	2	You can set up the action mode of the real-time auto-gain tuning.	B	All	5-1-1 5-1-3 5-1-4
	03	Selection of machine stiffness at real-time auto-gain tuning	—	0–31	2	Set the machine stiffness after tuning real-time auto-gain.	B	All	5-1-1 5-1-3 5-1-4
	04	Inertia ratio	%	0–10000	2	You can set up the ratio of the load inertia against the rotor (of the motor) inertia.	B	All	—
	08	Command pulse counts per one motor revolution	pulse	0–2^{23}	4	Specifies the number of command pulses per revolution of motor.	C	All	4-2-2
	09	Numerator of electronic gear	—	0–2^{30}	4	Set the numerator of electronic gear ratio.	C	All	4-2-2
	10	Denominator of electronic gear	—	1–2^{30}	4	Set the denominator of electronic gear ratio.	C	All	4-2-2
	11	Output pulse counts per one motor revolution	pulse /r	1–2097152	4	Set A/B phase output counts per motor revolution.	R	All	4-2-5
	12	Reversal of pulse output logic/ output source selection	—	0–3	2	You can set up the B-phase logic and the output source of the pulse output.	R	All	4-2-5
	13	1st torque limit	%	0–500	2	You can set up the 1st limit value of the motor output torque. The limit of parameter value is determined by the maximum torque of the motor connected.	B	All	6-1 7-4
	14	Position deviation excess setup	Command unit	0–2^{30}	4	Set excess range of positional deviation by the command unit. Err24.0“Error detection of position deviation excess” becomes invalid when you set up this to 0. Use the unit specified by Pr 5.20 “Position setup unit select”.	A	Position, full-closed	7-4
	15	Absolute encoder setup	—	0–4	2	Select the use method of the absolute encoder. *1 0: Use as an absolute mode. 1: Use as an incremental mode. 2: Use as an absolute mode, but ignore the multi-turn counter over. 3: Use as a single-turn absolute mode. 4: Use as an absolute mode; however, any value can be set for the upper limit of the multi-turn counter. *1Absolute encoder will be handled as an incremental mode in internal control under full-closed control.	C	Position, velocity, torque	4-7-1 6-6 6-7
	16	External regenerative resistor setup	—	0–3	2	Set up items related to regenerative resistor.	C	All	4-6
	17	Load factor of external regenerative resistor selection	—	0–4	2	Select the computation method of loading factor for external regenerative resistor.	C	All	4-6
	18	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-

Class1: Gain adjustment

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
1	00	1st gain of position loop	0.1/s	0–30000	2	Set up the 1st gain of position loop.	B	Position, full-closed	5-2
	01	1st gain of velocity loop	0.1 Hz	1–32767	2	Set up 1st velocity proportional gain.	B	All	5-2
	02	1st time constant of velocity loop integration	0.1 ms	1–10000	2	Set up 1st velocity integration time constant. Keep integration if setting value is 9999. Becomes invalid if setting value is 10000.	B	All	5-2
	03	1st filter of velocity detection	-	0–5	2	Set 1st velocity detection filter to 1 of 6 levels.	B	All	5-2
	04	1st time constant of torque filter	0.01 ms	0–2500	2	Set up the time constant of the 1st torque filter.	B	All	5-2
	05	2nd gain of position loop	0.1/s	0–30000	2	Set up the 2nd position loop gain.	B	Position, full-closed	5-2
	06	2nd gain of velocity loop	0.1 Hz	1–32767	2	Set up 2nd velocity proportional gain.	B	All	5-2
	07	2nd time constant of velocity loop integration	0.1 ms	1–10000	2	Set up 2nd velocity integration time constant. Keep integration if setting value is 9999. Becomes invalid if setting value is 10000.	B	All	5-2
	08	2nd filter of velocity detection	-	0–5	2	Set 2nd velocity detection filter to 1 of 6 levels.	B	All	5-2
	09	2nd time constant of torque filter	0.01 ms	0–2500	2	Set up the time constant of the 2nd torque filter.	B	All	5-2
	10	Velocity feed forward gain	0.1%	0–4000	2	Set up the velocity feed forward gain.	B	Position, full-closed	5-2-9
	11	Velocity feed forward filter	0.01 ms	0–6400	2	Set up the time constant of velocity feed forward filter.	B	Position, full-closed	5-2-9
	12	Torque feed forward gain	0.1%	0–2000	2	Set up the torque feed forward gain.	B	All	5-2-9
	13	Torque feed forward filter	0.01 ms	0–6400	2	Set up the torque feed forward filter.	B	All	5-2-9
	14	2nd gain setup	-	0–1	2	Using the gain select function, set this parameter for the best tuning.	B	All	5-2-5
	15	Mode of position control switching	-	0–10	2	Set up the condition of gain switching for position control.	B	Position, full-closed	5-2-5
	16	Delay time of position control switching	0.1 ms	0–10000	2	Set up the delay time when switching from 2nd to 1st gain.	B	Position, full-closed	5-2-5
	17	Level of position control switching	-	0–20000	2	Set up the gain switching level.	B	Position, full-closed	5-2-5
	18	Hysteresis at position control switching	-	0–20000	2	Set up the hysteresis at gain switching.	B	Position, full-closed	5-2-5
	19	Position gain switching time	0.1 ms	0–10000	2	Set up the position gain switching time upon gain switching.	B	Position, full-closed	5-2-5
	20	Mode of velocity control switching	-	0–5	2	Set the condition of gain switching for velocity control	B	Velocity	5-2-5
	21	Delay time of velocity control switching	0.1 ms	0–10000	2	Set up the delay time when switching from 2nd to 1st gain.	B	Velocity	5-2-5
	22	Level of velocity control switching	-	0–20000	2	Set up the gain switching level.	B	Velocity	5-2-5
	23	Hysteresis at velocity control switching	-	0–20000	2	Set up the hysteresis at gain switching.	B	Velocity	5-2-5
	24	Mode of torque control switching	-	0–3	2	Set the condition of gain switching for torque control	B	Torque	5-2-5
	25	Delay time of torque control switching	0.1 ms	0–10000	2	Set up the delay time when switching from 2nd to 1st gain.	B	Torque	5-2-5
	26	Level of torque control switching	-	0–20000	2	Set up the gain switching level.	B	Torque	5-2-5
	27	Hysteresis at torque control switching	-	0–20000	2	Set up the hysteresis at gain switching.	B	Torque	5-2-5

(To be continued)

Class1: Gain adjustment

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
1	28	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	29	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	30	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	31	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	32	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	33	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	34	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	35	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	36	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	37	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	38	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	39	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	40	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	41	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	42	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	43	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	44	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	45	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	46	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	47	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	48	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	49	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	50	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	51	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	52	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	53	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	54	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	55	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	56	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	57	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	58	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	59	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	60	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	61	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	62	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	63	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	64	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	65	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	66	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	67	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	68	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	69	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	70	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	71	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	72	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	73	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	74	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	75	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	76	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	77	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-
	78	For manufacturer's use	-	-	2	Do not change factory default settings.	-	-	-

Class 2: Damping control

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
2	00	Adaptive filter mode setup	-	0–6	2	Set up the operation of adaptive filter.	B	Position, velocity, full-closed	5-1-2
	01	1st notch frequency	Hz	50–5000	2	Set up the notch frequency of 1st resonance suppression notch filter. Set the notch frequency to the resonance frequency of the machine.	B	All	5-2-6
	02	1st notchwidth selection	-	0–20	2	Set up the notch width of 1st resonance suppression notch filter.	B	All	5-2-6
	03	1st notch depth selection	-	0–99	2	Set up the notch depth of 1st resonance suppression notch filter.	B	All	5-2-6
	04	2nd notch frequency	Hz	50–5000	2	Set up the notch frequency of 2nd resonance suppression notch filter. Set the notch frequency to the resonance frequency of the machine.	B	All	5-2-6
	05	2nd notch width selection	-	0–20	2	Set up the notch width of 2nd resonance suppression notch filter.	B	All	5-2-6
	06	2nd notch depth selection	-	0–99	2	Set up the notch depth of 2nd resonance suppression notch filter.	B	All	5-2-6
	07	3rd notch frequency	Hz	50–5000	2	Set up the notch frequency of 3rd resonance suppression notch filter. Set the notch frequency to the resonance frequency of the machine. Automatically set when the adaptive notch is enabled.	B	All	5-1-2 5-2-6
	08	3rd notch width selection	-	0–20	2	Set up the notch width of 3rd resonance suppression notch filter. Automatically set when the adaptive notch is enabled.	B	All	5-1-2 5-2-6
	09	3rd notch depth selection	-	0–99	2	Set up the notch depth of 3rd resonance suppression notch filter. Automatically set when the adaptive notch is enabled.	B	All	5-1-2 5-2-6
	10	4th notch frequency	Hz	50–5000	2	Set up the notch frequency of 4th resonance suppression notch filter. Set the notch frequency to the resonance frequency of the machine. Automatically set when the adaptive notch is enabled.	B	All	5-1-2 5-2-6
	11	4th notch width selection	-	0–20	2	Set up the notch width of 4th resonance suppression notch filter. Automatically set when the adaptive notch is enabled.	B	All	5-1-2 5-2-6
	12	4th notch depth selection	-	0–99	2	Set up the notch depth of 4th resonance suppression notch filter. Automatically set when the adaptive notch is enabled.	B	All	5-1-2 5-2-6
	13	Selection of damping filter switching	-	0–6	2	Select the filters to be used for damping control.	B	Position, full-closed	5-2-7 5-2-8
	14	1st damping frequency	0.1 Hz	0–3000	2	You can set up the 1st damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 5 (= 0.5 Hz) or higher is valid.	B	Position, full-closed	5-2-7
	15	1st damping filter setup	0.1 Hz	0–1500	2	Fine tune the 1st filter damping control. Decrease the setting value to avoid torque saturation or increase the value to improve the response.	B	Position, full-closed	5-2-7
	16	2nd damping frequency	0.1 Hz	0–3000	2	You can set up the 2nd damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 5 (= 0.5 Hz) or higher is valid.	B	Position, full-closed	5-2-7
	17	2nd damping filter setup	0.1 Hz	0–1500	2	Fine tune the 2nd filter damping control. Decrease the setting value to avoid torque saturation or increase the value to improve the response.	B	Position, full-closed	5-2-7
	18	3rd damping frequency	0.1 Hz	0–3000	2	You can set up the 3rd damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 5 (= 0.5 Hz) or higher is valid.	B	Position, full-closed	5-2-7
	19	3rd damping filter setup	0.1 Hz	0–1500	2	Fine tune the 3rd filter damping control. Decrease the setting value to avoid torque saturation or increase the value to improve the response.	B	Position, full-closed	5-2-7
	20	4th damping frequency	0.1 Hz	0–3000	2	You can set up the 4th damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 5 (= 0.5 Hz) or higher is valid.	B	Position, full-closed	5-2-7
	21	4th damping filter setup	0.1 Hz	0–1500	2	Fine tune the 4th filter damping control. Decrease the setting value to avoid torque saturation or increase the value to improve the response.	B	Position, full-closed	5-2-7

(To be continued)

Class 2: Damping control

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
2	22	Command smoothing filter	0.1 ms	0–10000	2	[For position control,full-closed control] • For conventional control (Pr 6.47 bit 0 = 0) Will set primary delay filter time constant against position command. • 2 For free 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. • 2 For free 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 “Adjust/Torque command attenuation term”.	B	Position, velocity, full-closed	4-2-3 5-2-16 5-2-17 5-2-18
	23	Command FIR filter	0.1 ms	0–10000	2	Set up the time constant of the 1st delay filter in response to the positional command.	B	Position, full-closed	4-2-3
	24	5th notch frequency	Hz	50–5000	2	Set the notch frequency for the 5th resonance suppression notch filter. Set the notch frequency to the resonance frequency of the machine.	B	All	5-2-6
	25	5th notch width selection	-	0–20	2	Set the notch width for the 5th resonance suppression notch filter.	B	All	5-2-6
	26	5th notch depth selection	-	0–99	2	Set the notch depth for the 5th resonance suppression notch filter.	B	All	5-2-6
	27	1st damping width setting	-	0–1000	2	Fine tune the 1st damping control function.	B	Position, full-closed	5-2-7
	28	2nd damping width setting	-	0–1000	2	Fine tune the 2nd damping control function.	B	Position, full-closed	5-2-7
	29	3rd damping width setting	-	0–1000	2	Fine tune the 3rd damping control function.	B	Position, full-closed	5-2-7
	30	4th damping width setting	-	0–1000	2	Fine tune the 4th damping control function.	B	Position, full-closed	5-2-7
	31	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	32	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	33	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	34	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	35	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	36	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	37	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-

Class 3: Velocity/ Torque/ Full-closed control

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
3	04	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	05	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	12	Acceleration time setup	ms/ (1000 r/min)	0– 10000	2	Set up acceleration processing time in response to the velocity instruction input.	B	Velocity	4-3-3
	13	Deceleration time setup	ms/ (1000 r/min)	0– 10000	2	Set up deceleration processing time in response to the velocity instruction input.	B	Velocity	4-3-3
	14	Sigmoid acceleration/ deceleration time setup	ms	0–1000	2	Set S-curve time for acceleration/deceleration process when the velocity instruction is applied.	B	Velocity	4-3-3
	17	Selection of speed limit	-	0–1	2	Set up the speed limit	B	Torque	4-4-1
	21	Speed limit value 1	r/min	0– 20000	2	Set up the speed limit The internal value is limited by the smallest setting speed of Pr 5.13 "Over-speed level setup", Pr 6.15 "2nd over-speed level setup" and internal value of the over-speed protection level.	B	Torque	4-4-1
	22	Speed limit value 2	r/min	0– 20000	2	Set the speed limit value when Pr 3.17 Selection of speed limit = 1 and SL_SW is 1. The internal value is limited by the smallest setting speed of Pr 5.13 "Over-speed level setup", Pr 6.15 "2nd over-speed level setup" and internal value of the over-speed protection level.	B	Torque	4-4-1
	23	External scale selection	-	0– 6	2	Selects external scale type. 0: AB phase output type 1: Serial communication type (incremental spec.) 2: Serial communication type (absolute spec.) 3: For manufacturer's use 4: For manufacturer's use 5: For manufacturer's use 6: For manufacturer's use	R	All	4-5-1 4-8
	24	Numerator of external scale division	-	$0 - 2^{23}$	4	Sets external scale division numerator	R	Full-closed	4-5-2
	25	Denominator of external scale division	-	$1 - 2^{23}$	4	Sets external scale division denominator	R	Full-closed	4-5-2
	26	Reversal of direction of external scale	-	$0 - 3$	2	Sets polarity of external scale feedback pulse	R	All	4-5-1 4-8
	27	External scale Z phase disconnection detection disable	-	$0 - 1$	2	Validate/invalidate Z-phase disconnection detection when using AB phase output type external scale. 0: Valid, 1: Invalid	R	All	-
	28	Hybrid deviation excess setup	command units	$1 - 2^{27}$	4	Sets threshold value for Err 25.0 "Hybrid deviation excess error protection".	C	Full-closed	4-5-3 7-4
	29	Hybrid deviation clear setup	rotation	$0 - 100$	2	Clears hybrid deviation to zero at every set numbers of revolutions.	C	Full-closed	4-5-3
	32	Judgment threshold for positional variation of external scale at virtual full-closed control mode	external scale unit	0 – 65534	2	Set up the judgment threshold value for positional variation of external scale at virtual full-closed control mode.	R	Full-closed	5-2-19

Class 4: I/O monitor setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
4	00	SI1 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI1.	C	All	2-4-1
	01	SI2 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI2.	C	All	2-4-1
	02	SI3 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI3.	C	All	2-4-1
	03	SI4 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI4.	C	All	2-4-1
	04	SI5 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI5.	C	All	2-4-1
	05	SI6 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI6.	C	All	2-4-1
	06	SI7 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI7.	C	All	2-4-1
	07	SI8 input selection	-	0–00FFFFFFh	4	Set up function and logic of SI8.	C	All	2-4-1
	10	SO1 output selection	-	0–00FFFFFFh	4	Set up SO1 function allocation.	C	All	2-4-2
	11	SO2 output selection	-	0–00FFFFFFh	4	Set up SO2 function allocation.	C	All	2-4-2
	12	SO3 output selection	-	0–00FFFFFFh	4	Set up SO3 function allocation.	C	All	2-4-2
	16	Type of analog monitor 1	-	0–28	2	Select the type of monitor for analog monitor 1.	A	All	3-4
	17	Analog monitor 1 output gain	-	0–214748364	4	Set up the output gain of analog monitor 1.	A	All	3-4
	18	Type of analog monitor 2	-	0–28	2	Select the type of monitor for analog monitor 2.	A	All	3-4
	19	Analog monitor 2 output gain	-	0–214748364	4	Set up the output gain of analog monitor 2.	A	All	3-4
	21	Analog monitor output setup	-	0–2	2	Select output voltage format of the analog monitor.	A	All	3-4
	22	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	23	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	24	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	31	Positioning complete (In-position) range	Instruc-tion unit	0–2097152	4	Set up allowable No. of pulses for positioning complete signal (INP). Use the unit specified by Pr 5.20 "Position setup unit select".	A	Position, full-closed	4-2-4
	32	Positioning complete (In-position) output setup	-	0–10	2	Set up the condition for positioning complete output.	A	Position, full-closed	4-2-4
	33	INP hold time	ms	0–30000	2	Set up the hold time	A	Position, full-closed	4-2-4
	34	Zero-speed	r/min	10–20000	2	Set up threshold for zero speed (ZSP) detection.	A	All	2-4-2
	35	Speed coincidence range	r/min	10–20000	2	Set up threshold for detection of speed coincident (V-COIN), by detecting the difference between the speed command and actual speed.	A	Velocity, Torque	4-3-2
	36	At-speed (Speed arrival)	r/min	10–20000	2	Set the detection timing of the speed arrival output (AT-SPEED).	A	Velocity, Torque	4-3-1
	37	Mechanical brake action at stalling setup	ms	0–10000	2	Set up mechanical brake operating time at stalling.	B	All	9-2-2
	38	Mechanical brake action at running setup	ms	0–32000	2	Set up mechanical brake operating time at running.	B	All	9-2-3 9-2-4
	39	Brake release speed setup	r/min	30–3000	2	Set up the speed timing of brake output checking during operation.	B	All	9-2-3 9-2-4
	40	Selection of alarm output 1	-	0–40	2	Select the type of alarm issued as the alarm output 1.	A	All	7-3
	41	Selection of alarm output 2	-	0–40	2	Select the type of alarm issued as the alarm output 2.	A	All	7-3
	42	2nd Positioning complete (In-position) range	Instruc-tion unit	0–2097152	4	Set up acceptable No. of pulses for positioning complete signal 2 (INP2). Use the unit specified by Pr 5.20 "Position setup unit select".	A	Position, full-closed	4-2-4

(To be continued)

Class 4: I/O monitor setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
4	44	Position comparison output pulse width setting	0.1ms	0–32767	2	Set the pulse width of the signal that is output for position comparison. The signal is not output when 0 is set.	R	All	6-5
	45	Position comparison output polarity selection	-	0–7	2	Set the polarity of position comparison output by bit setup for each output terminal. ・Setup bits bit0: SO1,OCMP1 bit1: SO2,OCMP2 bit2: SO3,OCMP3 ・Setup values of Each setting bit 0: The output photocoupler is turned ON for SO1 to 3 and is set to L level for OCMP1 to 3, respectively, during pulse output. 1: The output photocoupler is turned OFF for SO1 to 3 and is set to H level for OCMP1 to 3, respectively, during pulse output. Basically, use this function as 0.	R	All	6-5
	47	Pulse output selection	-	0–1	2	Select the signal to be output from the pulse output terminal or Position comparison output terminal. 0: Encoder output signal 1: Position comparison output signal	R	All	4-2-5 6-5
	48	Position comparison value 1	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 1.	A	All	6-5
	49	Position comparison value 2	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 2.	A	All	6-5
	50	Position comparison value 3	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 3.	A	All	6-5
	51	Position comparison value 4	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 4.	A	All	6-5
	52	Position comparison value 5	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 5.	A	All	6-5
	53	Position comparison value 6	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 6.	A	All	6-5
	54	Position comparison value 7	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 7.	A	All	6-5
	55	Position comparison value 8	Command unit	-2147483648 –2147483647	4	Set the comparison value for position comparison output 8.	A	All	6-5
	56	Position comparison output delay compensation amount	0.1us	-32768 –32767	2	Compensate the delay in the position comparison output signaled by the circuit.	R	All	6-5
	57	Position comparison output assignment setting	-	-2147483648 –2147483647	4	Set the output terminals corresponding to position comparison values 1 to 8 by bit setup. Multiple position comparison values can be set up on one output terminal. ・Setup bits bit0 to 3 : Position comparison output 1 bit4 to 7 : Position comparison output 2 bit8 to 11 : Position comparison output 3 bit12 to 15 : Position comparison output 4 bit16 to 19 : Position comparison output 5 bit20 to 23 : Position comparison output 6 bit24 to 27 : Position comparison output 7 bit28 to 31 : Position comparison output 8 ・Setup values of Each setting bit 0000b : Output disabled 0001b : Assigned to SO1,OCMP1 0010b : Assigned to SO2,OCMP2 0011b : Assigned to SO3,OCMP3 Other than above: For manufacturer's use (Do not set.)	R	All	6-5

Class 5: Enhancing setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	03	Denominator of pulse output division	—	0–8388608	4	Use this setting when specifying No. of output pulses/motor revolution by the ratio of numerator and denominator of division.	R	All	4-2-5
	04	Over-travel inhibit input setup	—	0–2	2	Set up the operation of the inhibit positive/ negative direction travel inputs.	C	All	6-3-1 7-4 7-5
	05	Sequence at over-travel inhibit	—	0–2	2	Set up the sequence when over-travel inhibit is input.	C	All	6-3-1 7-4
	06	Sequence at Servo-off	—	0–9	2	Set up the sequence while servo is OFF.	B	All	6-3-2
	07	Sequence at main power off	—	0–9	2	Set up the sequence while main AC power is OFF.	B	All	6-3-3
	08	LV trip selection at main power off	—	0–3	2	Select LV trip or servo OFF upon occurrence of main AC power alarm. Setup the condition to detect main AC power OFF alarm when the main AC power is kept interrupted for a time longer than the time set by Pr7.14. bit 0 0: Select servo OFF according to the setting of Pr 5.07 and then return to servo ON by turning ON main AC power. 1: Trip with Err 13.1 Main power undervoltage protection. bit 1 0: Detect main AC power OFF alarm only when servo is in ON state. 1: Always detect main AC power OFF alarm.	B	All	6-3-3
	09	Detection time of main power off	ms	20–2000 *1	2	Set up the main power alarm detection time. When 2000 is set, main power off detection is disabled.	C	All	6-3-3
	10	Sequence at alarm	—	0–7	2	Set up the sequence used upon occurrence of an alarm.	B	All	6-3-4 6-3-5 6-3-6
	11	Torque setup for emergency stop	%	0–500	2	Set up the torque limit at emergency stop. When setup value is 0, the torque limit for normal operation is applied.	B	All	6-3-1 6-3-2 6-3-3 6-3-5
	12	Over-load level setup	%	0–500	2	You can set up the over-load level. It becomes 115% by setting up this to 0. The setup value of this parameter is limited by 115% of the motor rating.	A	All	—
	13	Over-speed level setup	r/min	0–20000	2	Set up the detection level of Err.26.0 Over-speed protection. When the setting value is 0, the over-speed level of applicable motor is set. The internal value is limited to the over-speed level of applicable motor.	B	All	6-3-5 7-4
	14	Motor working range setup	0.1 rot	0–1000	2	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 6-2.	A	Position, full-closed	6-2 7-4
	15	Control input signal reading setup	—	0–3	2	Select reading period of the control input signal: 0: 0.25 ms, 1: 0.5 ms, 2: 1 ms and 3: 2 ms However, except in the following cases: When using POT/NOT/HOME as the origin reference trigger and an external latch input 1/2/3 (EXT1/2/3) (Note) MINAS-A5N series different read cycle.	C	All	—
	20	Position setup unit select	—	0–1	2	Specify the unit to determine the range of positioning complete and excessive positional deviation. 0: Command unit, 1: Encoder unit (external scale unit) Note: Positioning complete detection threshold of RTEX communication status is always in terms of command unit regardless of the setting of this parameter.	C	Position, full-closed	7-4 4-2-4
	21	Selection of torque limit	—	0–4	2	Select positive direction or negative direction torque limit. When 0 is set, 1 will be internally set.	B	Position, velocity, full-closed	6-1

*1) To use this setting with a smaller value than the shipment value, please check matching with your power supply environment.

(To be continued)

Class 5: Enhancing setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	22	2nd torque limit	%	0–500	2	You can set up the 2nd limit value of the motor output torque. The value of parameter is limited to the maximum torque of the applicable motor.	B	Position, velocity, full-closed	6-1
	23	Torque limit switching setup 1	ms /100%	0–4000	2	Sets the rate of change (gradient) from 1st to 2nd during torque limit change.	B	Position, velocity, full-closed	6-1
	24	Torque limit switching setup 2	ms /100%	0–4000	2	Sets the rate of change (gradient) from 2nd to 1st during torque limit change.	B	Position, velocity, full-closed	6-1
	25	Positive direction torque limit	%	0–500	2	With Pr 5.21 “Selection of torque limit” set to 4, set the positive direction torque limit when TL_SW is at 1. Note that the parameter value is limited to the maximum torque of the motor connected.	B	Position, velocity, full-closed	6-1
	26	Negative direction torque limit	%	0–500	2	With Pr 5.21 “Selection of torque limit” set to 4, set the negative direction torque limit when TL_SW is at 1. Note that the parameter value is limited to the maximum torque of the motor connected.	B	Position, velocity, full-closed	6-1
	29	For manufacturer’s use	—	—	2	Permanently set at 2.	—	—	—
	31	USB axis address	—	0–127	2	Set up the axis number for USB communication.	C	All	—
	33	Pulse regenerative output limit setup	—	0–1	2	Enable/disable detection of Err 28.0 “Pulse regenerative limit protection”. 0: Invalid 1: Valid	C	All	4-2-5
	34	For manufacturer’s use	—	—	2	Permanently set at 4.	—	—	—
	36	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	45	Quadrant glitch positive-direction compensation value	0.1%	-1000–1000	2	Set the positive-direction high-precision torque compensation value for quadrant glitches.	B	Position, full-closed	5-2-15
	46	Quadrant glitch negative-direction compensation value	0.1%	-1000–1000	2	Set the negative-direction high-precision torque compensation value for quadrant glitches.	B	Position, full-closed	5-2-15
	47	Quadrant glitch compensation delay time	ms	0–1000	2	Set the compensation timing delay time for quadrant glitches.	B	Position, full-closed	5-2-15
	48	Quadrant glitch compensation filter setting L	0.01 ms	0–6400	2	Set the compensation value LPF time constant for quadrant glitches.	B	Position, full-closed	5-2-15
	49	Quadrant glitch compensation filter setting H	0.1 ms	0–10000	2	Set the compensation value HPF time constant for quadrant glitches.	B	Position, full-closed	5-2-15
	50	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	51	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	52	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	53	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	54	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	55	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	56	Slow stop deceleration time setting	ms/ (1000 r/min)	0 – 10000	2	Sets deceleration time for immediate stop deceleration stop deceleration processing. This parameter will become valid when Pr6.10 “Function expansion setup” bit 15 = 1	B	Position, velocity, torque	6-3-7
	57	Slow stop S-shape acceleration and deceleration setting	ms	0 – 1000	2	Sets the S-shape time for immediate stop deceleration stop deceleration processing. This parameter will become valid when Pr6.10 “Function expansion setup” bit 15 = 1	B	Position, velocity, torque	6-3-7
	66	Deterioration diagnosis convergence judgment time	0.1s	0 – 10000	2	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.	A	All	6-8

(To be continued)

Class 5: Enhancing setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	67	Deterioration diagnosis inertia ratio upper limit	%	0 – 10000	2	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. * The set resolution shall be in units of 0.2%.	A	All	6-8
	68	Deterioration diagnosis inertia ratio lower limit	%	0– 10000	2		A	All	6-8
	69	Deterioration diagnosis unbalanced load upper limit	0.1%	-1000 – 1000	2	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%.	A	All	6-8
	70	Deterioration diagnosis unbalanced load lower limit	0.1%	-1000 – 1000	2		A	All	6-8
	71	Deterioration diagnosis dynamic friction upper limit	0.1%	-1000 – 1000	2	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%.	A	All	6-8
	72	Deterioration diagnosis dynamic friction lower limit	0.1%	-1000 – 1000	2		A	All	6-8
	73	Deterioration diagnosis viscous friction upper limit	0.1%/ (10000r /min)	0– 10000	2	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%.	A	All	6-8
	74	Deterioration diagnosis viscous friction lower limit	0.1%/ (10000r /min)	0– 10000	2		A	All	6-8
	75	Deterioration diagnosis velocity setting	r/min	-20000 – 20000	2	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.	A	All	6-8

(To be continued)

Class 5: Enhancing setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	76	Deterioration diagnosis torque average time	ms	0–10000	2	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.	A	All	6-8
	77	Deterioration diagnosis torque upper limit	0.1%	-1000 – 1000	2	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.	A	All	6-8
	78	Deterioration diagnosis torque lower limit	0.1%	-1000 – 1000	2		A	All	6-8

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	02	Velocity deviation excess setup	r/min	0–20000	2	Set threshold of Err 24.1 “Speed over deviation protection”. This protection is not detected when the setup value is 0.	A	Position	—
	05	Position 3rd gain valid time	0.1 ms	0–10000	2	Set up 3rd gain valid time of 3 gain level adjustment.	B	Position, full-closed	5-2-11
	06	Position 3rd gain scale factor	%	50–1000	2	Set up the 3rd gain by a multiplying factor of the 1st gain	B	Position, full-closed	5-2-11
	07	Torque command additional value	%	-100–100	2	Set up the offset torque to be added to the torque command.	B	Position, velocity, full-closed	5-2-12
	08	Positive direction torque compensation value	%	-100–100	2	Set up the value to be added to the torque command for positive direction operation.	B	Position, full-closed	5-2-12
	09	Negative direction torque compensation value	%	-100–100	2	Set up the value to be added to the torque command for negative direction operation.	B	Position, full-closed	5-2-12
	10	Function expansion setup	-	-32768–32767	2	Set up the function in unit of bit. bit0 unused. Always set to 0. bit1 Load change inhibit function 0:Invalid 1:Valid bit2 Load change stabilization setting 0:Invalid 1:Valid. bit3 For manufacturer’s use. Always se to 0. bit4 Current response improvement 0:Invalid 1: Valid bit5 For manufacturer’s use. Always se to 0. bit6 unused. Always set to 0. bit7 For manufacturer’s use. Always se to 0. bit8 unused. Always set to 0. bit9: For manufacturer’s use. Always set to 0. bit10 Fall prevention function in case of alarms 0:Invalid 1: Valid bit11 Encoder overheat error protection detection 0: Invalid 1: Valid *1 bit12 Not used. Always set to 0. bit13 For manufacturer's use. Always set to 0. bit14 Load change inhibit function automatic setting 0: Invalid 1: Valid *2 bit15 Slow stop function.. 0: Invalid 1: Valid • bit 0 = LSB *1 When an encoder overheat warning occurs, Err15.1 “Encoder overheat error protection" also occurs concurrently. *2 When bit14 to 1, it will be bit1 and 2 also 1.	B	All	5-1-1 5-1-3 5-1-4 5-2-10 6-3-6 6-3-7
	11	Current response setup	%	10–100	2	Fine tune the current response with respect to default setup (100%).	B	All	-
	14	Emergency stop time at alarm	ms	0–1000	2	Set up the time allowed to complete emergency stop in an alarm condition.	B	All	6-3-5 6-3-7
	15	2nd over-speed level setup	r/min	0–20000	2	When the motor speed exceeds this setup time during emergency stop sequence in an alarm condition, Err26.1 “2nd overspeed protection” will be activated.	B	All	6-3-5
	18	Power-up wait time	0.1 s	0–100	2	Set up the standard initialization time approx. 1.5 s + α(setting value×0.1s) after power-up. For example, in the case of the preset value 10, it is set to 1.5s+(10×0.1 s) = approx. 2.5s.	R	All	9-2-1
	19	For manufacturer’s use	-	-	2	Permanently set at 0.	—	-	-
	20	For manufacturer’s use	-	-	2	Permanently set at 0.	—	-	-
	21	For manufacturer’s use	-	-	4	Permanently set at 0.	—	-	-
	22	A, B phase external scale pulse output method selection	-	0 – 1	2	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 *When "signal regenerated", which regenerates OA and OB duties on the driver side, is selected, waveform disturbance can be reduced.	R	Full-closed	4-2-5

(To be continued)

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	23	Load change compensation gain	%	-100–100	2	Set the compensation gain for a load change.	B	Position, velocity, full-closed	5-2-10
	24	Load change compensation filter	0.01 ms	10–2500	2	Set the filter time constant for a load change.	B	Position, velocity, full-closed	5-2-10
	27	Warning latch state setup	-	0–3	2	Determine whether to latch warning state. General warning and Extended warning can be specified. bit 0 Extended warning 0: unlatched 1: latched bit 1 General warning 0: unlatched 1: latched	C	All	7-3
	30	For manufacturer's use	-	-	2	Permanently set at 0.	—	-	-
	31	Real time auto tuning estimation speed	-	0–3	2	Set up the load characteristics estimation speed with the real time auto tuning being valid.	B	All	5-1-1 5-1-3 5-1-4
	32	Real time auto tuning custom setup	-	-32768–32767	2	Set up details of real time auto tuning customize mode.	B	All	5-1-1
	34	Hybrid vibration suppression gain	0.1/s	0–30000	2	Sets the hybrid vibration suppression gain to be applied when full-closed control is used.	B	Full-closed	5-2-13
	35	Hybrid vibration suppression filter	0.01 ms	0– 32000	2	Sets the time constant of the hybrid vibration suppression filer for full-closed control.	B	Full-closed	5-2-13
	36	Dynamic brake operation input setup	-	0–1	2	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	R	All	6-3-3
	37	Oscillation detecting level	0.1%	0–1000	2	Set up the oscillation detecting level. Upon detection of a torque vibration whose level is higher than this setup value, the oscillation detection alarm will be issued. If the set value is 0, this function is disabled and the alarm is not activated.	B	All	7-3
	38	Warning mask setup	-	-32768–32767	2	Set up the warning detection mask. Placing 1 to the corresponding bit position disables detection of the warning condition.	C	All	7-3
	39	Warning mask setup2	-	-32768–32767	2		C	All	7-3
	41	1st damping depth	-	0–1000	2	Specifies the damping depth of the 1st damping function.	B	Position, full-closed	5-2-7
	42	Two-stage torque filter time constant	0.01 ms	0–2500	2	Specifies the filter time constant for the torque command. The filter is disabled if the setting value is 0. This setting remains valid irrespective of gain selection state.	B	All	5-2-14
	43	Two-stage torque filter attenuation term	-	0–1000	2	Specifies the attenuation term of the Two-stage torque filter.	B	All	5-2-14

(To be continued)

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	47	Function expansion setup 2	-	-32768 –32767	2	Set respective functions in unit of bit. bit0 Mode of Two-degrees-of-freedom control 0:Invalid 1: Valid bit1 Not used Permanently set at 0. bit2 Encoder communication error / warning decision setting 0: Standard specification 1: Relaxation specification bit3 Real-time Two-degrees-of-freedom control Selection of auto-tuning 0: Standard type 1: Synchronization type bit4-7 Not used Permanently set at 0. bit8-13 For manufacturer's use Permanently set at 0. bit14 Quadrant glitch inhibit function 0: Invalid 1: Valid bit15 For manufacturer's use Always set to 0. * The least significant bit is bit0. * Bit3 (Selection of real-time auto-tuning of Two-degrees-of-freedom control) can be used only when bit0 is set to 1: Valid. For details on the types, see 5-1-3 “Real-time auto tuning (Two-degrees-of-freedom control mode, standard type)” and 5-1-4 “Real-time auto tuning (Two-degrees-of-freedom control mode, sync type)”.	R	All	5-2-15 5-2-16 5-2-17 5-2-18
	48	Adjust filter	0.1ms	0–2000	2	Set the time constant for the adjust filter in 2 degrees of freedom control.	B	Position, velocity, full-closed	5-2-16 5-2-17 5-2-18
	49	Adjust/Torque command attenuation term	-	0–99	2	Set the attenuation term for the command filter and adjust filter in 2 degrees of freedom control. A decimal number indication is used. The first digit sets the command filter and the second digit sets the adjust filter. Target digit 0 to 4: No attenuation term, ζ (operated as primary filter) 5 to 9: Secondary filter (Attenuation terms will be 1.0, 0.86, 0.71, 0.50, and 0.35 in order.) Example) To set the command filter to ζ=1.0 and adjust filter 1 to ζ=0.71, the setting value should be 75 (first digit=5 (ζ=1.0), second digit=7 (ζ=0.71)). For the time constant of the command filter, Pr2.22 "Command smoothing filter" will be applied.	B	Position, full-closed	5-2-16 5-2-18

(To be continued)

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	50	Viscous friction compensation gain	0.1%/ (10000r/min)	0–10000	2	The command velocity is multiplied by this setting value, which becomes a correction amount added to the torque command. The unit is [rated torque 0.1%/ (10000 r/min)].	B	Position, velocity, full-closed	5-2-16 5-2-17 5-2-18
	51	Immediate cessation completion wait time	ms	0–10000	2	Set the time to maintain the motor energization after the brake release output (BRK-OFF) is turned OFF in the event of an alarm requiring emergency stop. * Enabled even when Pr6.10 “Function expansion setup” is set to a value other than bit10=1.	B	All	6-3-6
	52	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	53	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	54	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	57	Torque saturation error protection detection time	ms	0–5000	2	Set the torque saturation error protection detection time. If torque saturation continues for the set time or more, Err16.1 “torque saturation error protection” occurs. When 0 is set, the value set for Pr7.16 is enabled. *To use this setting value in a version corresponding to function extended edition 2 or earlier, please specify the setting value to 2 or larger.	B	Position, velocity, full-closed	6-4
	58	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	59	For manufacturer’s use	-	-	2	Permanently set at 0.	-	-	-
	60	2nd damping depth	-	0–1000	2	Set the damping depth for the 2nd damping function.	B	Position, full-closed	5-2-7
	61	1st resonance frequency	0.1Hz	0–3000	2	Set the resonance frequency of the load for the 1st model type damping filter.	B	Position	5-2-8
	62	1st resonance attenuation ratio	-	0–1000	2	Set the resonance attenuation ratio of the load for the 1st model type damping filter.	B	Position	5-2-8
	63	1st anti-resonance frequency	0.1Hz	0–3000	2	Set the anti-resonance frequency of the load for the 1st model type damping filter.	B	Position	5-2-8
	64	1st anti-resonance attenuation ratio	-	0–1000	2	Set the anti-resonance attenuation ratio of the load for the 1st model type damping filter.	B	Position	5-2-8
	65	1st response frequency	0.1Hz	0–3000	2	Set the response frequency of the load for the 1st model type damping filter.	B	Position	5-2-8
	66	2nd resonance frequency	0.1Hz	0–3000	2	Set the resonance frequency of the load for the 2nd model type damping filter.	B	Position	5-2-8
	67	2nd resonance attenuation ratio	-	0–1000	2	Set the resonance attenuation ratio of the load for the 2nd model type damping filter.	B	Position	5-2-8
	68	2nd anti-resonance frequency	0.1Hz	0–3000	2	Set the anti-resonance frequency of the load for the 2nd model type damping filter.	B	Position	5-2-8
	69	2nd anti-resonance attenuation ratio	-	0–1000	2	Set the anti-resonance attenuation ratio of the load for the 2nd model type damping filter.	B	Position	5-2-8
	70	2nd response frequency	0.1Hz	0–3000	2	Set the response frequency of the load for the 2nd model type damping filter.	B	Position	5-2-8
	71	3rd damping depth	-	0–1000	2	Set the damping depth for the 3rd damping function.	B	Position, full-closed	5-2-7
	72	4th damping depth	-	0–1000	2	Set the damping depth for the 4th damping function.	B	Position, full-closed	5-2-7
	73	Load estimation filter	0.01 ms	0–2500	2	Set the filter time constant for load estimation.	B	Position, Velocity, full-closed	5-2-10
	74	Torque compensation frequency 1	0.1 Hz	0–5000	2	Set the filter frequency 1 for velocity control output.	B	Position, velocity, full-closed	5-2-10
	75	Torque compensation frequency 2	0.1 Hz	0–5000	2	Set the filter frequency 2 for velocity control output.	B	Position, velocity, full-closed	5-2-10
	76	Load estimation count	—	0–8	2	Set the number of times regarding load estimation.	B	Position, velocity, full-closed	5-2-10

(To be continued)

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	85	Condition setting for escape operation	—	-32768– 32767	2	Select the Start-up of retreat operation and Judgment condition of stopping. bit3 - 0:Start-up condition for retreat operation (I/O) 0: Retreat operation by I/O input is ineffective. 1:RET input 2:RET/HOME input 3:Main power off detection *1) 4-15:Err85.2 or Err87.3 is generated due to setting failure. *2) bit7 - 4: For manufacture use. Please set fixed to 0 bit9 - 8:Judgment condition for stopping retreat operation *3) bit9=0, bit8=0: Completion judgment of delivery before filtering, and completion judgment of positioning are ineffective. bit9=0,bit8=1:Completion judgment of delivery after filtering, and completion judgment of positioning are ineffective. bit9=1,bit8=0:Completion judgment of delivery before filtering, and completion judgment of positioning are effective. bit9=1,bit8=1:Completion judgment of delivery after filtering, and completion judgment of positioning are effective. bit15-10:The case other than 0 is setting failure. Err85.2 or Err87.3 is generated. *2) 1) When main power supply off is used as the trigger, set Pr5.09 (main power supply off detection period) to a value other than 2000. When Pr5.09 is 2000, detection of main power off itself becomes invalid. *2) Alarm is switched by Pr6.86 bit15. *3) RTEX communication monitor (status flag) In_Position is used. Example) When bit8=0 and bit9=0 are set, position command transfer judgment is executed before the filter, and positioning judgment disabled is used as the condition for retreat operation stop.	C	All	6-10
	86	Alarm setting for escape operation	—	-32768– 32767	2	Set the clearing attribute of the retreat operation alarm. bit0: Err85.0/Err87.1 (Completion of retreat operation (I/O)) 0:Clearing is impossible, 1:Clearing is possible. bit1: For manufacture use. Please set fixed to 0 bit2: Err85.2/Err87.3(retreat operation failure) 0:Clearing is impossible, 1:Clearing is possible. bit3 - 14:Unused Fix at 0. bit15:Switching of retreat operation-related alarm 0 :Generation of Err85.0 to 85.2 (A5N compatible specification) 1 :Generation of Err87.1 to 87.3 (A6B compatible specification)	C	All	6-10
	87	For manufacturer's use	-	-	4	Permanently set at 0.	-	-	-

(To be continued)

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	88	Absolute encoder multi-turn data upper-limit value	-	0–65534	4	Set the maximum value for absolute encoder multi-turn data. If multi-turn data exceeds the set value, the multi-turn data changes to 0 instead of the set value. When the multi-turn data falls below 0, multi-turn data will change to the set value. When set to Pr0.15 = 0 or 2(absolute mode), the upper limit of the absolute rotation data becomes 65535, regardless of this setting.	C	All	6-7
	97	Function expansion setup 3	-	-2147483648 – 2147483647	4	Set various functions on a bit basis. bit0: Enables/disables quadrant projection compensation function extended. 0: disabled 1: enabled * To set the compensation amount of quadrant projection by inversion direction when the direction of the velocity has changed, set Pr6.97 bit0 to 1. bit 1:Deterioration diagnosis warning function: 0: Invalid, 1: valid bit 2: Expansion of Allowable motor operating range abnormal protection: 0: Invalid, 1: valid bit3 to 31: Not used Please set fixed to 0 *bit 0 is the least significant bit.	B	All	5-2-15 6-2 6-8
	98	Function expansion setup 4	-	-2147483648 – 2147483647	4	Sets various function in bit units: bit 0 to 2: For manufacture use. Please set fixed to 0 bit3:Effective bit switching in multi-turn data. 0:Valid(-32768～32767 Turn) 1:Invalid(-256～255 Turn) bit4: For manufacture use. Please set fixed to 0 bit5 to 8: Not used. Please set fixed to 0 bit9:Virtual full-closed control mode *1 0:Ineffective 1:Effective *1 The virtual full-closed control mode function becomes effective, only when Pr0.01=6 and (Pr3.23= 0 or 1) and in addition, Pr6.98 bit9=1. bit10-31 Not used, Fix at 0. *bit 0 is the least significant bit.	R	All	-

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	00	Display on LED	—	0–32767	2	Select type of data displayed on front panel 7-seg LED.	A	All	3-2
	01	Display time setup upon power-up	100 ms	-1–1000	2	Sets node address display time upon turning ON of control power. When the setting value is 0 to 6, it is processed in 600ms. When the setting value is -1, a node address is shown from control power-on until the RTEX communication is established (communication and servo synchronization).	R	All	3-2
	03	Output setup during torque limit	—	0–1	2	Set up judgment condition of output while torque is limited by torque control. 0: Turn ON at torque limit including torque command value 1: Turn ON at torque limit excluding torque command value	A	Torque	—
	04	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	05	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	06	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	07	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	08	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	09	Correction time of latch delay 1	25ns	-2000–2000	2	Set the correction time for delay of the latch trigger signal detection. This parameter can be switched by Pr7.24 bit5. bit5 is 0: The correction time is reflected in both the latch signal rising edge detection and the latch signal falling edge detection. bit5 is 1: The correction time is reflected in the latch signal rising edge detection. *Signal state of edge detection means the following The rising edge detection means the photocoupler is turned ON. The falling edge detection means the photocoupler is turned OFF.	B	All	RTEX
	10	Software limit function	—	0–3	2	Specifies whether to enable/disable soft limit function during profile position control (PP). When selecting enable, set the software limit value through Pr 7.11 "Positive side software limit value" and Pr 7.12 "Negative side software limit value". 0: Positive and negative limits valid 1: Positive limit invalid; Negative limit valid 2: Positive limit valid; Negative limit invalid 3: Positive and negative limits invalid Note: Limit signals made invalid in this setting (PSL/NSL): RTEX communication status is 0 and 0 when return to home position is not completed.	A	Position, full-closed (PP)	RTEX
	11	Positive side software limit value	Command unit	-1073741823 –1073741823	4	Set up software limit on positive and negative direction. When the limit is exceeded, RTEX communication status PSL/NSL will be turned ON (=1). Note: Positive side software limit value must be larger than negative side software limit value.	A	Position, full-closed (PP)	RTEX
	12	Negative side software limit value	Command unit	-1073741823 –1073741823	4		A	Position, full-closed (PP)	RTEX
	13	Absolute home position offset	Command unit	-1073741823 –1073741823	4	Set up the offset value on encoder position (external scale position) when using absolute encoder (external absolute scale) and mechanical coordinate system position.	C	All	6-6 6-7 RTEX
	14	Main power off warning detection time	ms	0–2000	2	Specifies a time to wait until a main power off warning is detected when main power shut-off continues. RTEX communication status AC_OFF becomes 1 when main power off is detected. 0–9, 2000: Warning detection is disabled. 10–1999: Unit is [1 ms] Note: Set this parameter so that Pr.7.14 becomes smaller than Pr.5.09 in order for the warning detection is performed before shut-down detection. If the voltage between P and N of the main power convertor is decreased to below a specified value before the warning is detected because the setting value is long, the main power low voltage error (Err13.0) occurs before the warning.	C	All	7-3 RTEX

7-(To be continued)

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	15	Positioning adjacent range	Command unit	0–1073741823	4	The NEAR of the RTEX communication status becomes 1 when the difference between the internal target position and command position is smaller than a specified value during profile position control (PP).	A	Position, full-closed (PP)	RTEX
	16	Torque saturation error protection frequency	time	0–30000	2	If torque saturated is continued during a preset frequency, Err 16.1 “Torque saturation protection” will be activated. If the setup value is 0, this function is disabled and an alarm will not be activated. This parameter is enabled when the value set for Pr6.57 is 0 *To use this setting value in a version corresponding to function extended edition 2 or earlier, please specify the setting value to 6 or larger.	B	Position, velocity, full-closed	6-4
	20	RTEX communication cycle setup	—	-1–12	2	Set up the RTEX communication cycle. -1: Setup by Pr7.91 is enabled. 3: 0.5 [ms] 6: 1.0 [ms] Other settings are used by the manufacturer so that the user is not allowed to set this parameter. ・Set up the RTEX communication cycle properly according to the specifications of the host device. If the parameter is not proper, the operation is not be guaranteed.	R	All	2-5 RTEX
	21	RTEX command updating cycle setup	—	1–2	2	Setup the ratio of RTEX communication cycle and command update cycle. 1: 1 [time] 2: 2 [times] ・Set up the RTEX communication cycle properly according to the specifications of the host device. If the parameter is not proper, the operation is not be guaranteed.	R	All	2-5 RTEX
	22	RTEX function extended setup 1	—	-32768 –32767	2	bit0: Set up RTEX communication data size 0: 16-byte mode, 1: 32-byte mode bit1: Specifies synchronization mode among multiple axes using TMG_CNT. 0: Semi synchronization among axes 1: Full synchronization among axes. bit2: For manufacturer’s use. Permanently set at 0. bit3: unused. Permanently set at 0. bit4: External scale position information monitoring function under semi-closed control setting: 0 : Invalid 1 : Valid * Under full-closed control, external scale position information can be monitored regardless of the setting of this bit. bit5: Command pulse saturation function selection 0: Invalid 1: Valid bit6: Return to origin operation velocity restriction function activation 0: Invalid, 1 : Valid bit7-10: Not used. Permanently set at 0. bit11-13: For manufacturer’s use. Permanently set at 0. bit14-15: Not used. Permanently set at 0. ・Set up the RTEX communication cycle properly according to the specifications of the host device. If the parameter is not proper, the operation is not be guaranteed.	R	All	2-5 4-8 RTEX

(To be continued)

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	23	RTEX function extended setup 2	—	-32768 –32767	2	bit 0: Parameter writing through RTEX communication: 0: Enable 1: Disable bit 1: Alarm code sub number setup 0: Fixed to 0 1: Sub number enabled bit 2: RTEX status response condition setting while sequence upon inputting of over-travel inhibition is disabled (Pr 5.04 = 1). 0: Status enabled 1: Fixed to 0 bit 3: RTEX status bit arrangement setup of POT/NOT 0: POT is bit 1, NOT is bit 0 1: NOT is bit 1, POT is bit 0 bit 4: Set up [COM] LED display mode 0: Mode 1 1: Mode 2 bit 5: Non-cyclic command start mode setting 0: When standard command is changed. 1: When command code and command parameter are changed. bit 6: Set up POT/NOT RTEX status logic 0: No inversion 1: Inversion bit 7: PSL/NSL RTEX status logic setting 0: Without reversing 1: With reversing bit8: RTEX status selection between In_Progress and AC_OFF 0: In_Progress, 1: AC_OFF * It is connected to the setting of bit15. bit9: Selects whethbit9: Selects whether to return a command error in over-travel inhibit direction when a command is received after a deceleration stop caused by over-travel inhibit input. 0: Command error is not returned. 1: Command error is returned. bit10-13: unused Always set to 0. bit14: Command positional deviation [Command unit] output setting 0: Internal command position (after filter) [Command unit] − Actual position[Command unit] 1: Internal command position (before filter) [Command unit] − Actual position [Command unit] bit15:Extension of RTEX status selection for the setting value of In_Progress/AC_OFF/Pr7.112 0:Complying with the setting (In_Progress/AC_OFF) of Pr7.23 bit8 1:The signal designated by Pr7.112 is output.	B	All	4-2-4 5-2-19 6-3-1 6-10 RTEX

(To be continued)

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	24	RTEX function extended setup 3	—	-32768 –32767	2	bit0: Specifies output status of EX-OUT1 during communication shut-down after RTEX communication is established. 0: Held 1: Initialized (Output when EX-OUT1 is 0.) bit1: Specifies output status of EX-OUT2 during communication shut-down after RTEX communication is established. 0: Held 1: Initialized (Output when EX-OUT2 is 0.) bit2: For manufacturer's use Permanently set at 0 bit3: Setting condition for In_Position (positioning complete signal) of RTEX communication 0: Unit is set up by Pr5.20. 1: Command unit bit4: Setting condition for Servo_Active (servo-on state signal) of RTEX Communication 0: Same as before 1: Turns on in command receivable state after servo ON. bit5 The correction function for detection delay of latch position. 0:The correction time of both the latch signal rising edge detection and the latch signal falling edge detection is set by Pr7.09 1:The correction time of the latch signal rising edge detection is set by Pr7.09, the correction time of the latch signal falling edge detection is set by Pr7.92. bit7：Select the state of the internal value of TFF from RTEX communication (Fall prevention in Servo-ON) 0: Clear 1: Hold the internal value * The internal value is cleared at the timing of Servo-OFF, deceleration to stop due to over-travel inhibit input, stop and in safety state * When this setting value is set to 1, set TFF to a value smaller than Pr5.11 “Torque setup for emergency stop”. bit8-10: For manufacturer's use Permanently set at 0 bit11-15: Not used Permanently set at 0	C	All	2-2, 4-2-4, RTEX
	25	RTEX speed unit setup	—	0–1	2	Set up the unit of speed data used in RTEX communication. Set up the unit both for both command data such as command speed and for response data such as actual speed. 0: r/min 1: Command unit/s	C	All	RTEX

(To be continued)

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	26	RTEX continuous error warning setup	No. of times	0–32767	2	Generates WngC0h (RTEX continuous communication error warning) when the No. of continuous errors reaches the setting of this parameter. When the setting value is 0, this function is disabled and no warning is issued.	A	All	7-3, RTEX
	27	RTEX accumulated error warning setup	No. of times	0–32767	2	Generates WngC1h (RTEX accumulated communication error warning) when the No. of accumulated errors reaches the setting of this parameter. When the setting value is 0, this function is disabled and no warning is generated.	A	All	7-3, RTEX
	28	RTEX_Update_Counter error warning setup	No. of times	0–32767	2	If Update_Counter is accumulated exceeding the setting value of this parameter and correct update fails, WngC2h (RTEX_Update_ Counter error warning) is issued. When the setting value is 0 or 1, this function is disabled and no warning is generated.	A	All	7-3, RTEX
	29	RTEX monitor select 1	—	0–32767	2	Select the monitor type of Response_data 1. Please set up Type_Code (8 bits) of a RTEX monitor command. If the setup value is 0, the actual position (APOS) is monitored.	A	All	RTEX
	30	RTEX monitor select 2	—	0–32767	2	Select the monitor type of Response_data 2 when non-cyclic command = 0h. Please set up Type_Code (8 bits) of a RTEX monitor command. If the setup value is 0, the actual speed (ASPD) is monitored.	A	All	RTEX
	31	RTEX monitor select 3	—	0–32767	2	Select the monitor type of Response_data 3 when non-cyclic command = 0h. Please set up Type_Code (8 bits) of a RTEX monitor command. If the setup value is 0, torque (TRQ) is monitored.	A	All	RTEX
	32	RTEX monitor select 4	—	0–32767	2	Selects a monitor type of Sub_Response _Data1 in 32-byte mode when sub command is 0h. Please set up Type_Code (8 bits) of a RTEX monitor command. If the setup value is 0, 0 is returned.	A	All	RTEX
	33	RTEX monitor select 5	—	0–32767	2	Selects a monitor type of Sub_Response _Data2 in 32-byte mode. Please set up Type_Code (8 bits) of a RTEX monitor command. If the setup value is 0, 0 is returned.	A	All	RTEX
	34	RTEX monitor select 6	—	0–32767	2	Selects a monitor type of Sub_Response _Data3 in 32-byte mode. Please set up Type_Code (8 bits) of a RTEX monitor command. If the setup value is 0, 0 is returned.	A	All	RTEX
	35	RTEX command setting 1	—	0–2	2	Specifies the Command_Data3 of non-cyclic command. However, this setting is invalid for non-cyclic command using Command_Data3 area. 0: Invalid 1: Velocity feedforward [Command unit/s] or [r/min] 2: Torque feedforward [0.1%]	C	All	RTEX
	36	RTEX command setting 2	—	0–2	2	Specifies Sub_Command_Data2 of sub command. 0: Invalid 1: Velocity feedforward [Command unit/s] or [r/min] 2: Torque feedforward [0.1%]	C	All	RTEX
	37	RTEX command setting 3	—	0–2	2	Specifies Sub_Command_Data3 of sub command. 0: Invalid 1: Velocity feedforward [Command unit/s] or [r/min] 2: Torque feedforward [0.1%]	C	All	RTEX

(To be continued)

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	38	RTEX_Update_Counter error protection setup	No. of times	0–32767	2	If the Update_Counter exceeds the setup value for this parameter and is not updated correctly, Err 86.2 “RTEX_Update_Counter error protection” will be activated. If the setup value is 0 or 1, this function will be disabled and an alarm will not be activated.	A	All	RTEX
	39	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	40	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	41	RTEX function extended setup 5	—	-32768-32767	2	bit0: For manufacturer’s use Permanently set at 0 bit1-6: Not used Permanently set at 0 bit7: Run inhibit input detection setting when returning to origin of Z phase 0: Invalid 1: Valid bit8-10: For manufacturer’s use Permanently set at 0 bit11-15: Not used Permanently set at 0	R	All	7-5
	43	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	52	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	78	Signal reading setting for latch trigger with stop function	—	0–3	2	The number of readings from latch trigger signal input until internal logic confirmation by amplifier with Latch mode with stop function is selected. 0:0.1875ms (3 readings) 1:0.0625ms (1 reading) 2:0.125ms (2 readings) 3:0.1875ms (3 readings)	C	Position, full-closed (CP)	6-9
	87	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	91	RTEX communication cycle expansion setting	ns	0–2000000	4	Set the RTEX communication cycle at the time of Pr7.20=-1. Only 62500, 125000, 250000, 500000, 1000000 or 2000000 can be set. If other value is set, Err93.5 “parameter setting error protection 4” occurs.	R	All	2-5 RTEX
	92	Correction time of latch delay 2	25ns	-2000–2000	2	Set the correction time for delay of the latch trigger signal detection. This parameter can be switched by Pr7.24 bit5. bit5 is 0: This parameter is disable. bit5 is 1: The correction time is reflected in the latch signal falling edge detection. *Signal state of edge detection means the following The rising edge detection means the photocoupler is turned ON. The falling edge detection means the photocoupler is turned OFF.	B	All	RTEX
	93	Home position return limit speed	r/min	0–20000	2	Set the limit speed for home position return operation. If a value smaller than the internal minimum speed is set, the internal minimum speed is applied as limit speed. If a value greater than the motor maximum speed is set, the motor maximum speed is applied as limit speed. (Note) The value is converted into command unit/s during internal computation. The converted value is limited within the following range. 0000001h to 7FFFFFFFh (1 to 2147483647) If 0 is set for this parameter, 1 is internally set for control.	C	All	RTEX

(To be continued)

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	95	Number of RTEX continuous communication error protection 1 detections	No. of times	0–17	2	Set the number of RTEX continuous communication error protection 1 detections. If a continuous CRC error occurs exceeding the number of times set for this parameter, Err83.0 “RTEX continuous communication error protection 1” occurs. If 0 or 1 is set for this parameter, 2 is internally set.	R	All	2-5 RTEX
	96	Number of RTEX continuous communication error protection 2 detections	No. of times	0–17	2	Set the number of RTEX continuous communication error protection 2 detections. If an interrupt omission, CRC error, MAC-ID error, C/R error or cyclic data error occurs exceeding the number of times set for this parameter, Err83.1 “RTEX continuous communication error protection 2” occurs. If 0 or 1 is set for this parameter, 2 is internally set.	R	All	2-5 RTEX
	97	Number of RTEX communication timeout error protection detections	No. of times	0–17	2	Set the number of times for RTEX communication timeout error protection detection. If 0 or 1 is set for this parameter, 2 is internally set.	R	All	2-5 RTEX
	98	Number of RTEX cyclic data error protection 1/2 detections	No. of times	0–17	2	Set the number of times for RTEX cyclic data error protection 1/2 detection. If a continuous cyclic error occurs exceeding the number of times set for this parameter, Err86.0 or Err86.1 “RTEX cyclic data error protection 1 or 2” occurs. If 0 or 1 is set for this parameter, 2 is internally set.	R	All	2-5 RTEX
	99	RTEX function extended setup 6	—	-32768-32767	2	bit0: Activation of operation command (test run, FFT, etc.) execution by USB communication (PANATERM) when TEX communication established: 0: Invalid, 1: Valid bit1- 2: For manufacturer use Permanently set at 0 bit3: Command pulse aggregate value [command units] output setting 0: Before filter, 1: After filter bit 4-6: For manufacturer use Permanently set at 0 bit7: RTEX monitor command regenerative load factor unit switching 0: [%] 1: [0.1%] bit8-15: For manufacturer use Permanently set at 0	B	All	—
	100	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	108	RTEX communication synchronization setup	—	0–7	2	0: Extended setup * Err96.4 is detected when a delay occurs in transmission/reception processing by the amplifier due to unstable transmission timing from the host device and so forth. If delay cannot be tolerated, please use this setting. 1-6: For manufacturer’s use 7: Normal setting	R	All	—
	109	For manufacturer’s use	—	—	2	Permanently set at 0	—	—	—
	110	RTEX function extended setup 7	—	-2147483648 – 2147483647	4	Setting of various functions is performed by the unit of 1 bit. bit0-15:Used by the manufacturer. bit16:Judgment of reaching the external scale at the virtual full-closed control mode 0:Judged by upper controller 1:Judged by amplifier bit17-31:Used by the manufacturer.	B	Full-closed	5-2-19
	111	Trigger signal allocation setting of latch mode with stop function	—	0–64	2	Select the output signal to be used as the trigger signal in latch mode with stop function. 0:Ineffective 1-5:Used by the manufacturer. 6:Output during torque limitation (TLC) 7-64:Used by the manufacturer.	C	Position, full-closed (CP)	6-9
	112	Selection of RTEX communication status flag	—	0–1	2	Select the signal returned with the status flag (Byte2 bit1) of RTEX response in the case of Pr7.23 bit15=1 0:RET_status (the status during execution of escape operation) is returned.	B	All	5-2-19 6-10 RTEX

Class 8: Special setting 3

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
8	00	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	01	Profile linear acceleration constant	10000 Command unit /s^2	1–429496	4	Set up the acceleration under profile position control (PP) and retreat operation. Be sure to set before starting operation.	B	All	6-10 RTEX
	02	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	03	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	04	Profile linear deceleration constant	10000 Command unit /s^2	1–429496	4	Set up the deceleration under profile position control (PP) and retreat operation. Be sure to set before starting operation.	B	All	6-10 RTEX
	05	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	10	Amount of travel after profile position latch detection	Command unit	-1073741823 –1073741823	4	Specifies the amount of travel during profile position latch positioning after a latch trigger signal input position is detected.	B	Position, full-closed (PP)	RTEX
	12	Profile return to home position mode setup	—	0–1	2	Specifies a direction in which latch trigger signal is detected during profile home position return. 0: Positive direction 1: Negative direction * For profile homing 2 or 4, select 0 setting. Setting to 1 also causes homing in positive direction.	B	Position, full-closed (PP)	RTEX
	13	Profile home position return velocity 1	Command unit/s or r/min	0– 2147483647	4	Specifies a velocity for high-speed operation during profile home position return. Unit is specified with Pr7.25 "RTEX speed unit setup". Maximum velocity is internally limited using the motor maximum speed. * When velocity setting is in r/min, it is converted to command unit/s through internal computation and the equivalent value is limited within the range as shown below: 00000001h to 7FFFFFFFh (1 to 2147483647) If setting value is 0, control is performed with an assumption that the setting value is 1.	B	Position, full-closed (PP)	RTEX
	14	Profile home position return velocity 2	Command unit/s or r/min	0– 2147483647	4	Specifies a velocity for low-speed operation during profile home position return. Specify a minimum speed to decrease detection error. Unit is specified with Pr7.25 "RTEX speed unit setup". Maximum velocity is internally limited using the motor maximum speed. * When velocity setting is in r/min, it is converted to command unit/s through internal computation and the equivalent value is limited within the range as shown below: 00000001h to 7FFFFFFFh (1 to 2147483647) If setting value is 0, control is performed with an assumption that the setting value is 1.	B	Position, full-closed (PP)	RTEX
	15	For manufacturer's use	—	—	4	Permanently set at 0.	—	—	—
	17	Relative displacement of escape operation	Command unit	-2147483648 – 2147483647	4	Set the displacement at retreat operation. Err85.0 or Err87.1 will occur when retreat operation is not executed and the amount of travel after electronic gear is 0. Be sure to set before start-up of operation.	B	All	6-10

(To be continued)

Class 8: Special setting 3

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
	18	Speed of escape operation	Command unit/s or r/min	0– 2147483647	4	Set the speed at escape operation Set the unit with Pr7.25 (RTEX speed unit setting). The maximum value is limited with the max. motor speed by internal processing. * When setting by the unit of r/min, the unit is converted to the unit for command/s at internal computing, and the converted value is limited within the following range. 00000001h-7FFFFFFFh (1-2147483647) Be sure to set before start-up of operation.	B	All	6-10
	19	For manufacturer's use	—	—	0	Permanently set at 0.	—	—	—

Class 9: For manufacturer's use

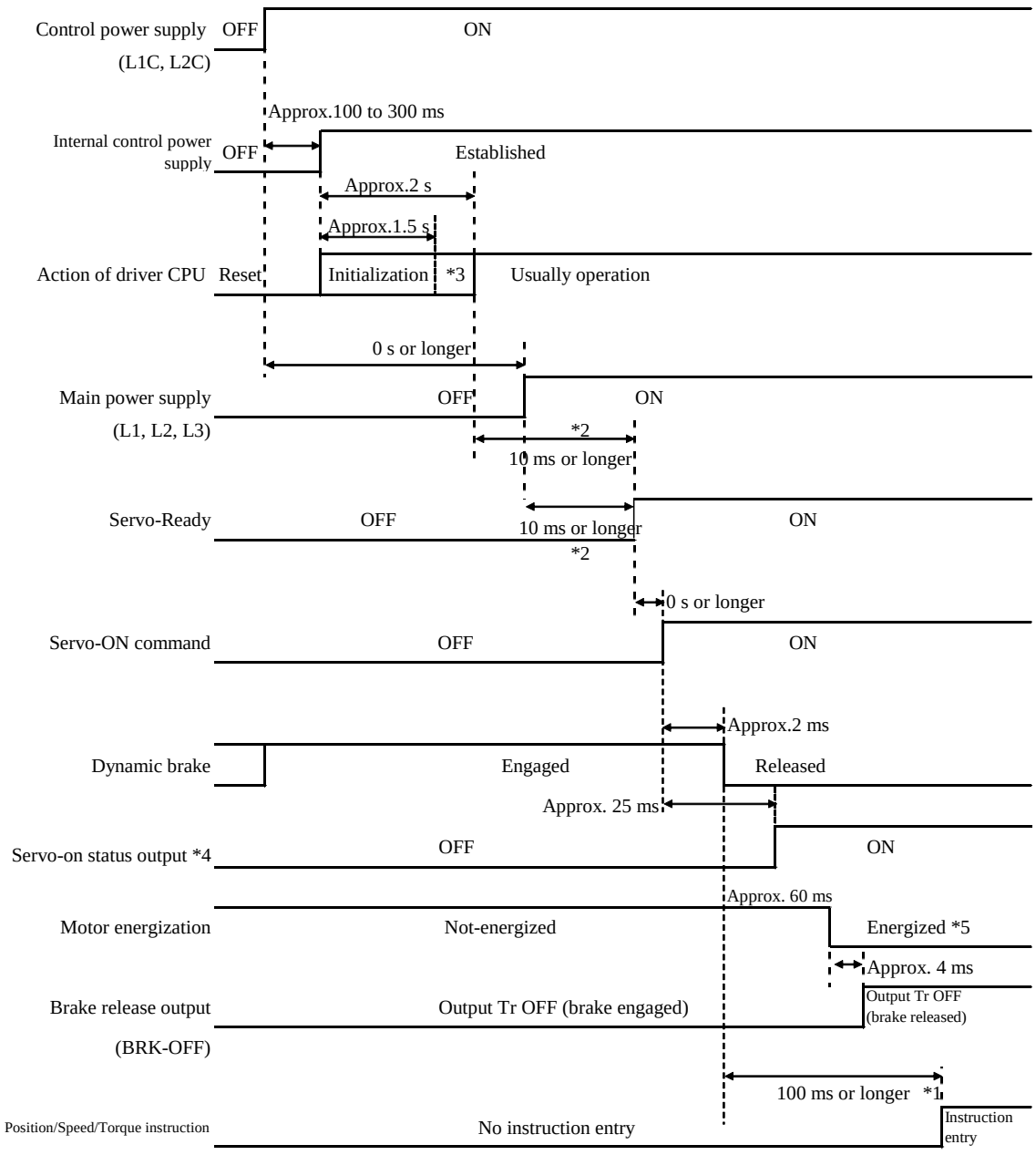
Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
9	00	For manufacturer's use	-	-	2	Permanently set at 1.	-	-	-
	01	For manufacturer's use	-	-	4	Permanently set at 0.	-	-	-
	02	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	03	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	04	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	05	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	06	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	07	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	08	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	09	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	10	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	11	For manufacturer's use	-	-	2	Permanently set at 1.	-	-	-
	12	For manufacturer's use	-	-	2	Permanently set at 80.	-	-	-
	13	For manufacturer's use	-	-	2	Permanently set at 50.	-	-	-
	14	For manufacturer's use	-	-	2	Permanently set at 10.	-	-	-
	17	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	18	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	19	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	20	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	21	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	22	For manufacturer's use	-	-	2	Permanently set at 200.	-	-	-
	23	For manufacturer's use	-	-	2	Permanently set at 50.	-	-	-
	24	For manufacturer's use	-	-	2	Permanently set at 100.	-	-	-
	25	For manufacturer's use	-	-	2	Permanently set at 40.	-	-	-
	26	For manufacturer's use	-	-	2	Permanently set at 40.	-	-	-
	27	For manufacturer's use	-	-	2	Permanently set at 1000.	-	-	-
	28	For manufacturer's use	-	-	2	Permanently set at 1.	-	-	-
	29	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	30	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	31	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	32	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	33	For manufacturer's use	-	-	2	Permanently set at 100.	-	-	-
	34	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	35	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	48	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	49	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	50	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-

Class 15: For manufacturer’s use

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
15	00	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	16	For manufacturer’s use	—	—	2	Permanently set at 2.	—	—	—
	17	For manufacturer’s use	—	—	2	Permanently set at 4.	—	—	—
	30	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	31	For manufacturer’s use	—	—	2	Permanently set at 5.	—	—	—
	33	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	34	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	35	For manufacturer’s use	—	—	2	Permanently set at 1.	—	—	—

9-2 Timing Chart

9-2-1 Servo-on signal accept timing on power-up



- The above chart shows the timing from AC power-ON to command input.
- Input the servo-On command, position/velocity/torque commands according to the above timing chart.

*1. It is shown that an instruction input receptionist is not ready in this section.
Please input instructions after the completion of preparation.

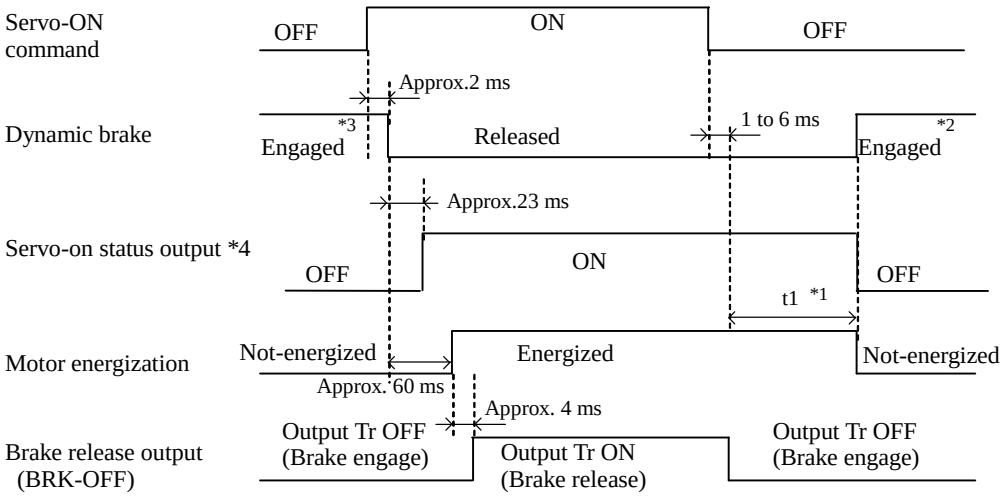
*2. The servo ready is turned on when all the following conditions are satisfied: “Initialization of microcomputer is completed”, “Main power supply is established”, “No alarm is issued”, and “Synchronization (phase matching) between RTEX communication and servo is completed and RTEX communication is established”.

*3. After Internal control power supply, protective functions are active from approx. 1.5 sec after the start of initializing microcomputer. Please set the signals, especially for protective function, for example over-travel inhibit input (POT, NOT) or external scale input, so as to decide their logic until this term. The lapse time can be changed with Pr 6.18 “Power-up wait time”.

*4. Note that the servo-on status output signal is to let you know of the receipt of servo-on command and is not an output to let you know that command input is possible.

9-2-2 Servo-ON/OFF action while the motor is at stall (servo-lock)

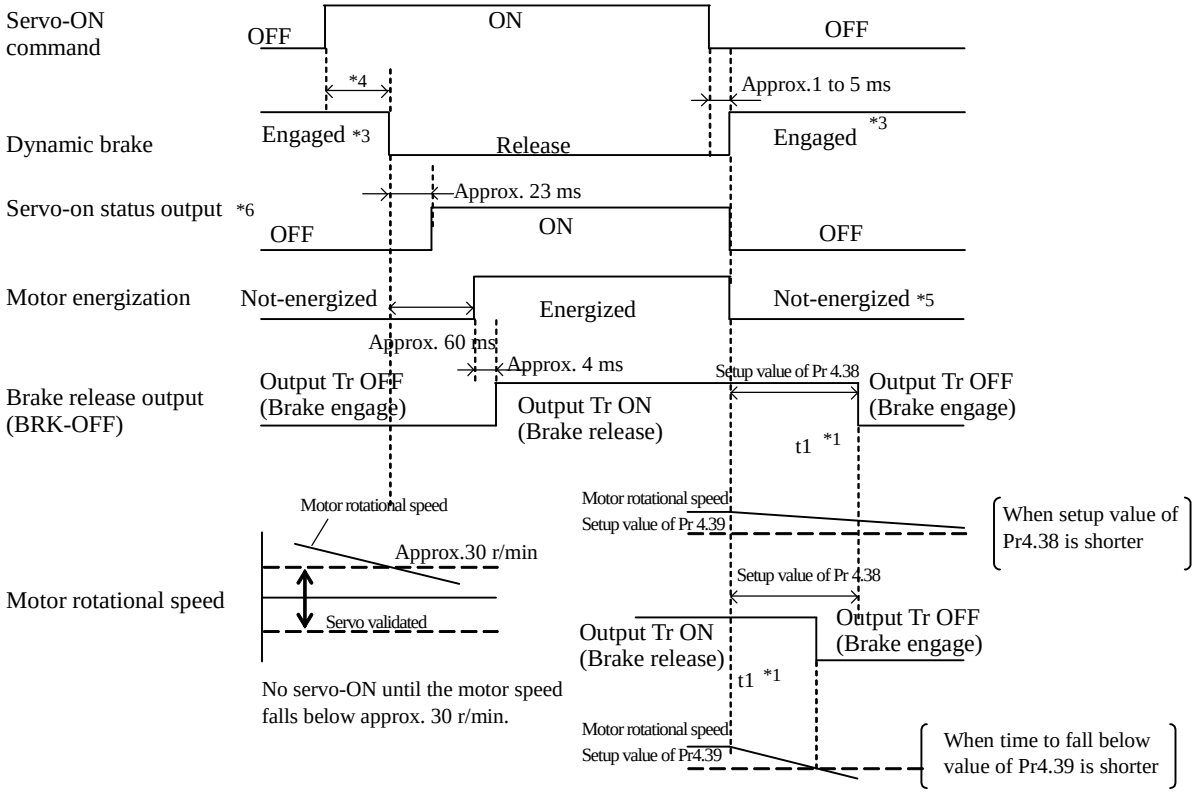
(To turn on/off the servo during normal operation, first stop the motor.)



*1. t1 depends on the setup value of Pr 4.37"Mechanical brake action at stalling setup".
*2. The operation of dynamic brake during servo off depends on the setup value of Pr 5.06 "Sequence at Servo-off".
*3. Servo-ON will not be activated until the motor speed falls below approx. 30 r/min.
*4. Note that the servo-on status output signal is to let you know of the receipt of servo-on command and is not an output to let you know that command input is possible.

9-2-3 Servo-ON/OFF action while the motor is in motion

(Timing at emergency stop or trip. Do not repeat this sequence.)



*1. t1 will be a shorter time of either the setup value of Pr 4.38 “Mechanical brake action at running setup” or elapsing time for the motor speed to fall below Pr 4.39 “Brake release speed setup”.

*2. Even when the servo-ON command is turned on again while the motor is decelerating, transition to servo-ON is not performed until the motor stops.

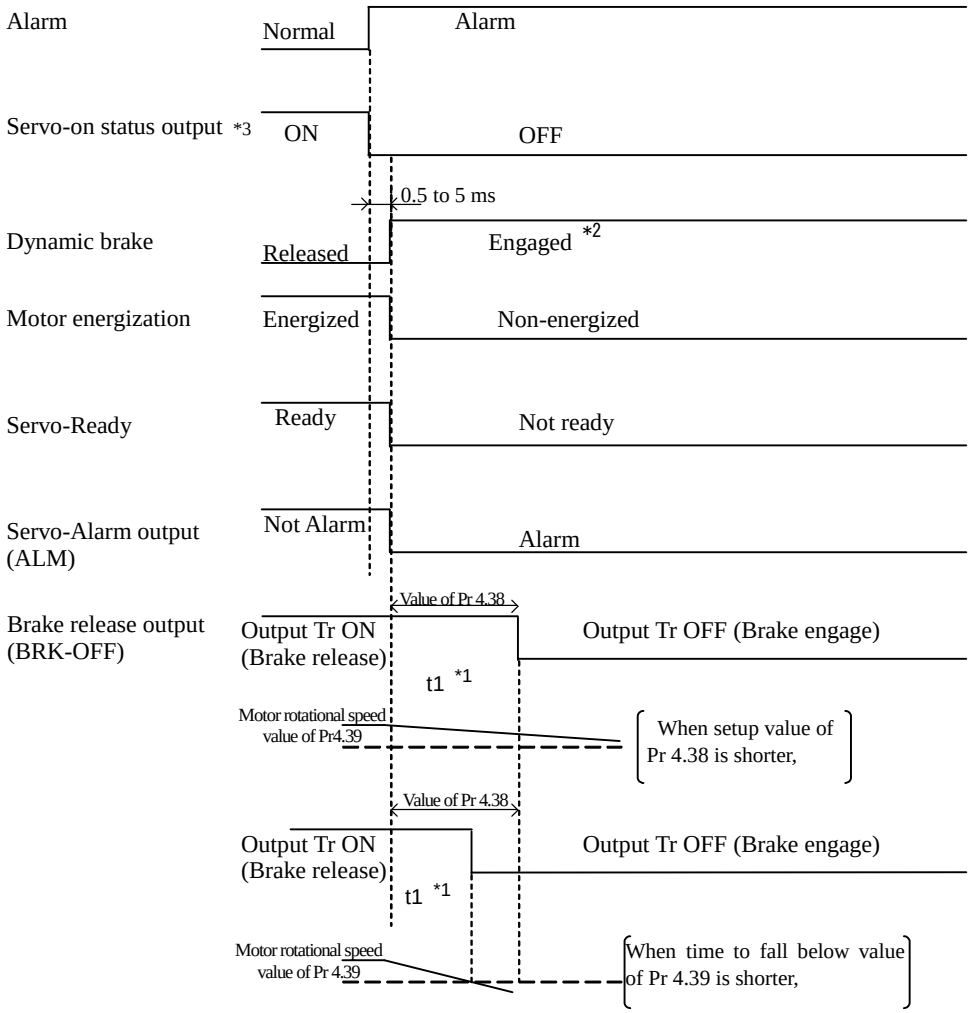
*3. For the action of dynamic brake at alarm occurrence, refer to an explanation of Pr 5.06, “Sequence at Servo-off” as well.

*4. Servo-ON will not be activated until the motor speed falls below approx. 30 r/min.

*5. For the motor energization during deceleration at Servo-OFF depends on the setup value of Pr .5.06, “Sequence at Servo-off”.

*6. Note that the servo-on status output signal is to let you know of the receipt of servo-on command and is not an output to let you know that command input is possible.

9-2-4 When an error (alarm) has occurred (at Servo-ON command) (DB deceleration, free run deceleration operation)



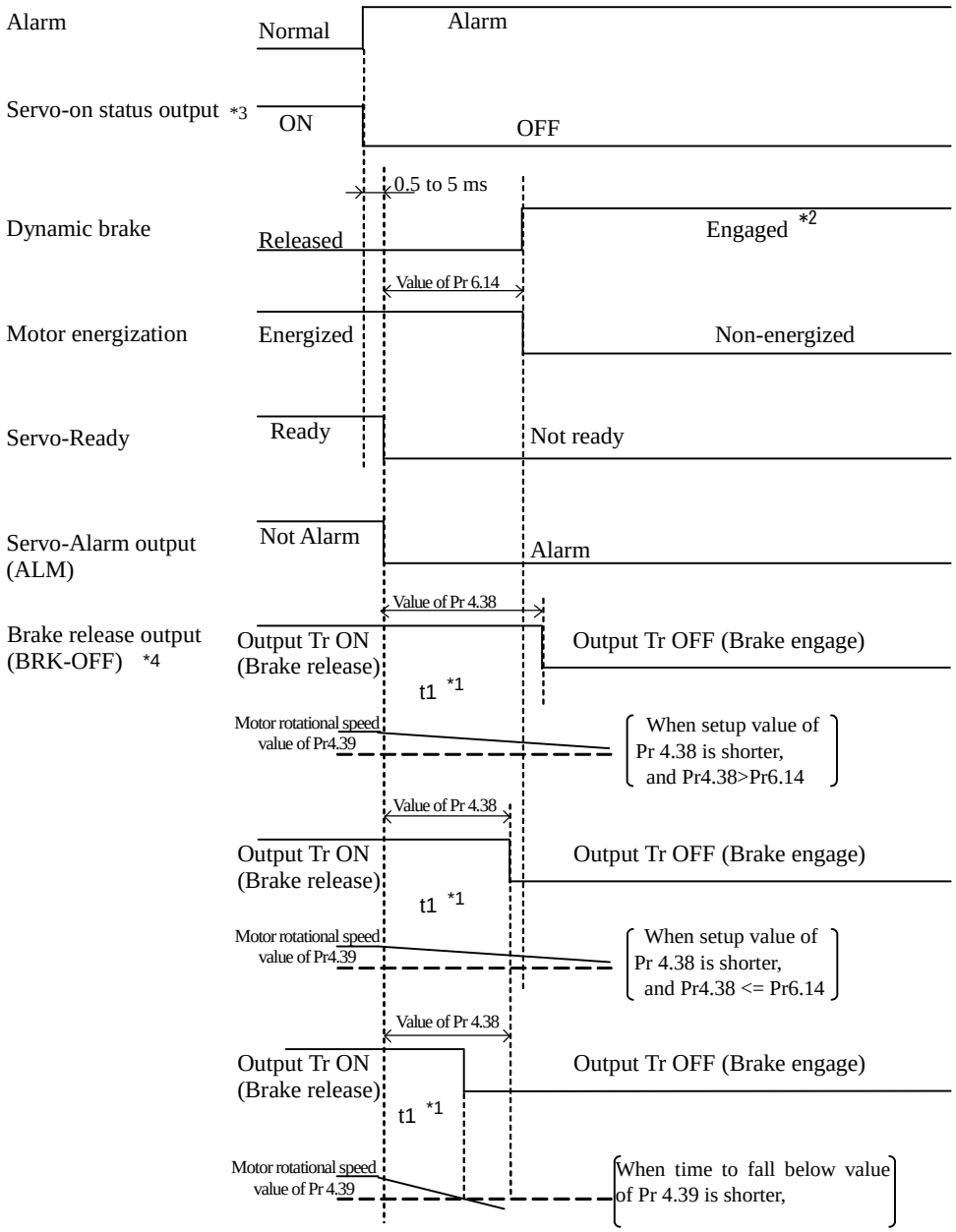
・The timings in the above diagram vary depending on the settings of sequence operations.

*1. t1 will be a shorter time of either the setup value of Pr 4.38 “Mechanical brake action at running setup” or elapsing time for the motor speed to fall below Pr 4.39 “Brake release speed setup”.

*2. When an alarm is generated, the dynamic brake operates according to Pr 5.10 “Sequence at alarm”.

*3. Note that the servo-on status output signal is to let you know of the receipt of servo-on command and is not an output to let you know that command input is possible.

9-2-5 When an error (alarm) has occurred (at Servo-ON command) (emergency stop)



・The timings in the above diagram vary depending on the settings of sequence operations.

*1. 't1' is the value set for Pr 4.38 "Mechanical brake action at running setup" or the time taken for the motor revolution speed to drop below the time set for Pr 4.39 "Brake release speed setting", whichever comes first.

*2. When an alarm occurs, the dynamic brake operates to the setting of Pr 5.10 "Sequence at alarm".

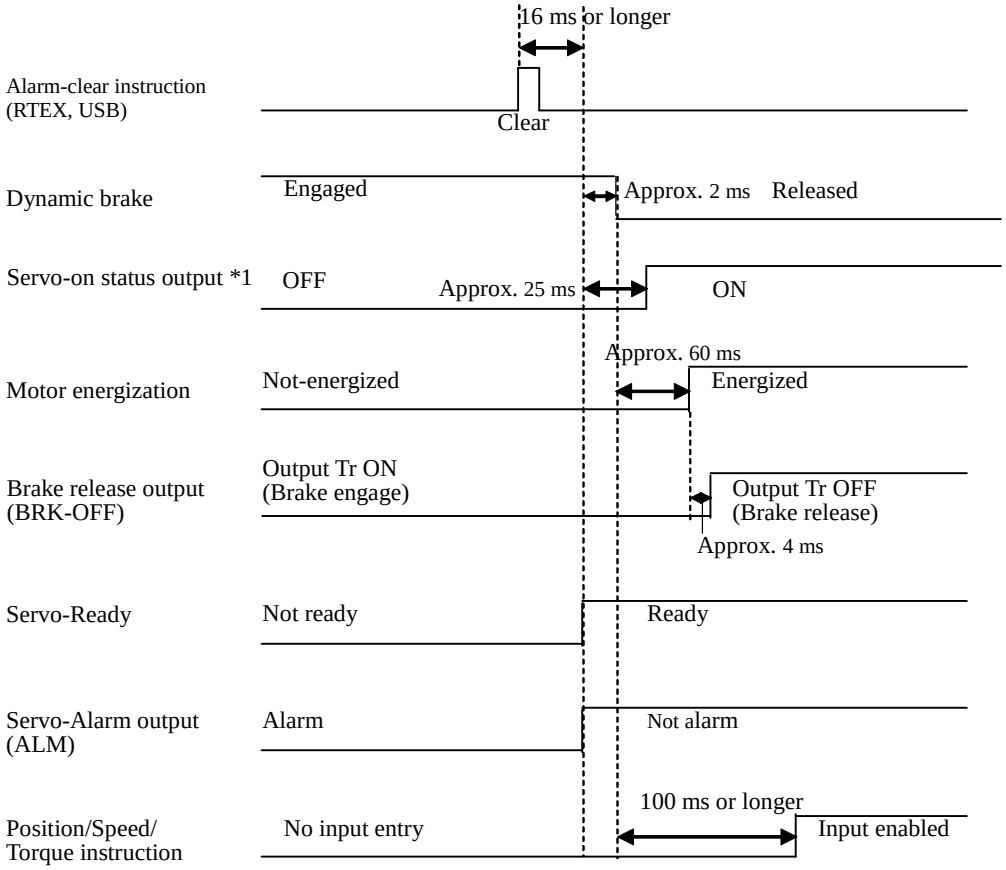
*3. Note that the servo-on status output signal is to let you know of the receipt of servo-on command and is not an output to let you know that command input is possible.

*4. The following setup is recommended: Pr4.38 "Mechanical brake action at running setup" = Pr6.14 "Emergency stop time at alarm"

When Pr4.38 ≤ Pr6.14, the brake operates after the time set for Pr4.38 has elapsed.

When Pr4.38 > Pr6.14, the brake does not operate even after the time set for Pr4.38 has elapsed but operates when the status shifts to no power-on.

9-2-6 When an alarm has been cleared (at Servo-ON command)



*1. Note that the servo-on status output signal is to let you know of the receipt of servo-on command and is not an output to let you know that command input is possible.