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Technical Reference

- Functional Specification -

Product Name : AC Servo Driver

Product Series Name : MINAS-A6NL series

Product Model Number : RTEX communication, Linear/DD type/VCM

Motion Control Business Unit, Industrial Device Business Division
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Revisions

Date	Page	Rev.	Description	Signed
July. 10, 2017		1.0	NEWLY ISSUED	-
May. 28, 2018			・Software upgrade CPU1 Ver1.22 → Ver1.23 CPU2 Ver1.22 → Ver1.23	
	P1,P8,P10,P18, P23,P37,P46, P51,P137, P155～P162,P164, P165,P174,P175, P211,P220,P221	2.0	1) Function addition “Retreat operation function”	-
	P4,P51,P94, P99,P176		2) Function addition “Torque control under two-degrees-of-freedom control”	
	P137,P203		3) Function change “Extension of Pr5.09 (Main power supply off detection period) setup range”	
	P169,P176		4) Function change “Alarm change at return to origin command cancellation”	
	Overall		• Corrected all incorrect entries.	
Oct.26,2018	P1,P3	3.0	・Software upgrade CPU1 Ver1.23 → Ver1.24 CPU2 Ver1.23 → Ver1.24	-
	P3,P185,P194, P221		1) Function addition “Function extension of return to origin command”	
	P3,P9,P79		2) Function addition “Function extension of pole position recovery method”	
	P5		3) Addition Added an explanation about G frame and H frame.	
	P10～P13		4) Addition Moved the description about the main differences from MINAS-A5N series in the basic functional specification edition from this document.	
	Overall		• Corrected all incorrect entries.	
June 7,2019	P1,P3	4.0	・Software upgrade CPU1 Ver1.24 → Ver1.25 CPU2 Ver1.24 → Ver1.25	-
	P12,P161～P169, P171,P172,P181, P182,P218,P219, P229		1) Function change “Expansion of evacuation operation function”	
	P155,P156,P209, P219,P228		2) Function change “Expansion of position compare function”	
	Overall		• Corrected all incorrect entries. • Company name changed.	
July 16,2019	Overall	5.0	• Corrected all incorrect entries.	-
Jan 8,2020	P1,P3	6.0	・Software upgrade CPU1 Ver1.25 → Ver1.26 CPU2 Ver1.25 → Ver1.26	-
	P2,P9,P10,P19, P62～P67,P70,P72, P76,P77,P80,P81, P140,P181,P233		1) Function addition “Support of voice coil motor (VCM) ”	
	Overall		• Corrected all incorrect entries.	
Mar.27.2020	P5	6.1	• Corrected all incorrect entries.	-

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

Revisions

Date	Page	Rev.	Description	Signed
May 17,2021	P1,P3,P10-P13	7.0	Software upgrade CPU1 Ver1.26 → Ver1.27 CPU2 Ver1.26 → Ver1.27	-
	P4,P5,P27,P34, P35,P38,P40,P60, P146,P158,P166, P176,P181,P205, P211P212,P213, P221,P223,P224		1) Function addition “V frame supported”	
	Overall		• Corrected all incorrect entries. • Company name changed. • Reference specification name changed.	
Apr. 1, 2022	-	7.1	• Changed the company name • Changed the front cover format	-
Aug. 1, 2023	P1,P3,P10-13	8.0	Software upgrade CPU1 Ver1.27 -> Ver1.28 CPU2 Ver1.27 -> Ver1.28	-
	P3,P190,P192		1) Function change “Excessive position deviation warning”	
	P232,P235		• Addition Added Pr7.41 bit5, Pr7.114 (used by the manufacturer).	
	P220,P222		• Addition Added Pr5.96, Pr5.97, Pr6.25, Pr6.26 (used by the manufacturer).	
	P220,P226,P228		• Addition Added Pr5.102, Pr6.97 bit6, Pr7.18 (used by the manufacturer).	
	P221,P226		• Addition Added Pr6.03, Pr6.97 bit24-26 (used by the manufacturer).	
	P208		• Addition Added Pr0.21 (used by the manufacturer).	
	P176,P188		• Addition Added Err98.5	
	Overall		• Corrected all incorrect entries.	

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

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1. Introduction

This document describes the functions of the servo driver MINAS-A6NL series.

<MINAS-A6NL series Functional comparison>

○:Usable ×:Not usable

Function \ Product		[A6NL] Linear/DD/VCM drive (Standard type) Product number ending with: L	[A6NM] Linear/DD/VCM drive (Multi-function type) Product number ending with: M
		CPU1:Ver1.28 CPU2:Ver1.28	CPU1:Ver1.28 CPU2:Ver1.28
Control mode	Position control(CP)	○	○
	Position control(PP)	○	○
	Velocity control(CV)	○	○
	Torque control(CT)	○	○
Function	Two-degree-of-freedom control (Position)	○	○
	Two-degree-of-freedom control (Velocity)	○	○
	Safety function	×	○
	Vibration control	○	○
	Model type damping filter	○	○
	Feed forward function	○	○
	Load change suppression control	○	○
	Third gain switching function	○	○
	Friction torque compensation	○	○
	Quadrant projection suppressionfunction	○	○
	Torque limit switching function	○	○
	Motor movable range setting function	○	○
	Torque saturation protection function	○	○
	Slow stop function	○	○
	Deterioration diagnosis warning function	○	○
	Position compare output function	○	○
	Latch mode with stop function	×	×
	Retreat operation function	○	○

- [A6NM] : All functions described in this reference can be used.
- [A6NL] : There are some functions that cannot be used.
  Where applicable, these items are indicated with “Cannot be used in [A6NL]” in the descriptions contained in this reference for your confirmation.

<Supported motor types>

This series can drive a linear motor, a DD(direct drive) motor or a VCM(voice coil motor).

Motor type	Linear motor/VCM(Voice coil motor)	DD (Direct drive) motor
Division in this reference	Linear type/VCM type	Rotary type
Related terms	Mass (Unit: kg)	Inertia (Unit: kgm^2)
	Thrust (Unit: N)	Torque (Unit: Nm)
	mm/s	r/min
	Operation	Rotation

On this document, the description of terms are based on “Rotary type.”
In the case of using “Linear type” or “VCM type,” please replace terms as the above table.

<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 Ver1.21
CPU2 Ver1.21</td><td>First edition</td><td>6.0.1.5
or later</td></tr>
<tr><td>CPU1 Ver1.22
CPU2 Ver1.22</td><td>Function extended edition 1
<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-DSV03212
6-4-1</td></tr><tr><td>2) Expansion of the range for actual position setting/ command position setting</td><td>SX-DSV03212
6-5, 6-5-3</td></tr></table></td><td>6.0.1.6
or later</td></tr>
<tr><td>CPU1 Ver1.23
CPU2 Ver1.23</td><td>Function extended edition 2
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Retreat operation function</td><td>This document
1, 1-5, 2-1, 2-4-1, 2-4-2, 4-2, 4-3, 4-4, 6-3-3,6-7, 7-1, 7-2, 9-1
SX-DSV03212
1-1, 2-6, 4-2, 4-2-3, 4-3, 4-3-3, 4-3-4, 6-9-5, 6-10-2, 7-6-3, 8-1-5</td></tr><tr><td>2) Torque control under two-degrees-of-freedom control</td><td>This document
1, 4-4, 5-1-3, 5-2-3, 7-2
SX-DSV03212
1-1, 8-1-11</td></tr><tr><td>3) Extension of Pr5.09 (Main power supply off detection period) setup range</td><td>This document
6-3-3, 9-1
SX-DSV03212
1-1</td></tr><tr><td>4) Alarm change at return to origin command cancellation</td><td>This document
7-2
SX-DSV03212
6-5-1, 8-1, 8-1-12</td></tr></table></td><td>6.0.1.11
or later</td></tr>
</table>

<table>
<tr><th>Software version</th><th>Contents of function change</th><th>Available PANATERM</th></tr>
<tr><td>CPU1 Ver1.24
CPU2 Ver1.24</td><td>Function extended edition 3
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Function extension of return to origin command
(It supports return to origin in absolute mode.)</td><td>This document
7-2, 7-5, 9-1-8
SX-DSV03212
6-5-1, 6-5-3, 6-8-1, 7-2-1, 7-2-2, 7-2-3-1, 7-2-3-2, 7-2-3-3, 7-5-7, 7-5-8, 7-5-9, 7-5-10, 7-5-11</td></tr><tr><td>2) Function extension of pole position recovery method
(It copies the estimation result of pole position.)</td><td>This document
4-7-3-3</td></tr></table></td><td>6.0.1.13
or later</td></tr>
<tr><td>CPU1 Ver1.25
CPU2 Ver1.25</td><td>Function extended edition 4
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Extension of evacuation operation specification</td><td>This document
1-7,6-7,7-1,7-2,9-1-7,9-1-9
SX-DSV03212
2-6,8-1-5</td></tr><tr><td>2) Position compare output function expansion</td><td>This document
6-5
SX-DSV03212
4-3,4-3-3</td></tr></table></td><td>6.0.1.17
or later</td></tr>
<tr><td>CPU1 Ver1.26
CPU2 Ver1.26</td><td>Function extended edition 5
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Support of voice coil motor(VCM)</td><td>This document
1,1-6,1-7,2-2,4-7,4-7-1,4-7-1-3, 6-2,4-7-2,4-7-3,4-7-4,7-2,9-1-10
SX-DSV03212
1</td></tr></table></td><td>6.0.1.19
or later</td></tr>
<tr><td>CPU1 Ver1.27
CPU2 Ver1.27</td><td>Function extended edition 6
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Expansion of V frame supported</td><td>This document
1-1,2-4-2,3-1,3-2-1,3-2-2, 3-4,4-5,6-3-3,6-5,6-7,7-1, 9-1-1,9-1-5,9-1-6,9-1-7, 9-1-8
SX-DSV03212
2-4,2-6,8-1-2,8-3</td></tr></table></td><td>6.0.3.0
or later</td></tr>
<tr><td>CPU1 Ver1.28
CPU2 Ver1.28</td><td>Function extended edition 10
<table><tr><th>Additional capability</th><th>Reference</th></tr><tr><td>1) Excessive position deviation warning</td><td>This document
7-3,9-1-6,9-1-7
SX-DSV03078
6-6-5</td></tr></table></td><td>6.0.9.0
or later</td></tr>
</table>

* A new software version is downward compatible with a old software version.
Parameters used in a old software version can be used in a new software version, as is.
The parameter settings added to 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-DSV03516:	Standard specifications (A6NL Series, other than V frame)
SX-DSV03224:	Standard specifications (A6NL Series, V frame) (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-DSV03212:	Technical reference –RTEX Communication Specification –

<IMPORTANT>

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(2) Motor Business Unit, Panasonic Industry Co., Ltd. reserves the right to make modifications and improvements to its products and/or documentation, including specifications and software, without prior notice.
(3) The MINAS-A6NL 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-A6NL series, please note that it is necessary to re-adjust the parameters.
Refer to the Standard specifications for the default settings of MINAS-A6NL series.
(4) 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 1 and earlier versions.
(5) For differences from the MINAS-A5NL/A6N series, see 1-1 “Major differences from MINAS-A5NL/A6N series” of the technical document RTEX Communication Specification.
(6) Although the MINAS-A6NL series is trying to operate compatible with the previous series(MINAS-A5NL series etc.), it may not be fully compatible operation.
In the case of replacing the previous series to the MINAS-A6NL seriess, be sure to evaluate.

1-1 Basic Specification

Item		Description
Control method		Other than V frame : IGBT PWM method, sinusoidal drive V frame : MOSFET PWM method, sinusoidal drive
Control mode		Position control: Profile position control [PP], Cyclic position control [CP] Velocity control: Cyclic velocity control [CV] Torque control: Cyclic torque control [CT] - Switch PP/CP/CV/CT mode according to the RTEX communication command.
Feedback scale feedback		A/B phase, origin signal differential input type Serial communications type (Incremental specification, Absolute linear specification, and Absolute rotary specification) *1
Pole detection signal		CS signals (CS1, CS2, CS3) or pole position estimation (CS signal unnecessary) - Changeable with a parameter
Control signal	Input	Each 8 input can be assigned by the parameter.
	Output	Other than V frame : Each 3 output can be assigned by the parameter. V frame : Assignment possible at 2 points (function assignment by parameter), alarm signal output 1 point.
Analogue signal	Output	2 outputs for analog monitors 1 and 2 Cannot be used with [V frame].
Pulse signal	Output	Feedback scale pulse is output to the line driver with the A/B phase signal.
Communi-cation	Realtime express (Abbr. RTEX)	Communication for transmission of a real-time operation command, the parameter setting, or the status monitoring.
	USB	Connect to computers (setup support software PANATERM) for parameter setting or status monitoring.
Safety terminal		Terminal to support safety function. *2
Front panel		1. 7-segment LED (double digits) *3 2. Network status LED (LINK, COM) 3. Rotary switch for node address setting 4. Analog monitor output (Analog monitors 1 and 2) *3 5. ALM LED and SRVON LED *4
Regeneration		A,B,G and H frames: Without built-in regenerative resistor (use external resistor) C to F frames: Built-in regenerative resistor (External regenerative resistor is also available) V frame: No built-in regenerative resistor (external addition not possible)
Dynamic brake		For information on the built-in type, refer to the Standard specifications.

*1: Please contact us for a corresponding part number.
*2: Available for [A6NM] only. It cannot be used in [A6NL].
*3: Cannot be used with [V frame].
*4: Can be used only with [V frame].

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.
	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

1-3 Function (speed 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.
	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

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
	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

1-5 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 scale, home position return must be completed.
	Protective function	Overvoltage, undervoltage, overspeed, overload, overheat, overcurrent, 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 1 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

1-6 Combined motor specification (for reference)

Motor	Linear type/ VCM type	Rotary type
Magnetic pole	Pitch: 1 to 300 mm *4 *8	Number of pole pairs per revolution: 1 to 64 *4
Max/rated current ratio	0 to 500%	
M/F ratio (J/T ratio)	M/F ratio: 0.0005 to 0.3 [kg/N]	J/T ratio: 0.000005 to 0.003 [kgm^2/Nm]
Electrical time constant (for reference) *1	Career 6 kHz: 1 ms or more, 8 kHz: 0.8ms or more, 12 kHz: 0.5 ms or more	
Acceptable speed	Electric angle frequency: Up to 500 Hz *8	

Feedback scale	Linear type/ VCM type	Rotary type
Resolution	0.001 to 10 [μm/pulse] *4	10000 to 2^{29} [pulse/r] *4 *7
Maximum length	Up to resolution × (2^{30}-1)	-
Scale type	・A/B phase, differential origin signal input type ・Serial communication type (Incremental specification and Absolute linear specification)	・A/B phase, differential origin signal input type ・Serial communication type (Incremental specification and Absolute rotary specification)
Acceptable scale speed *2	・A/B phase, differential origin signal input type: Up to 4M[pulse/s] *6 ・Serial communication type: Up to 4000M[pulse/s] *5	・A/B phase, differential origin signal input type: Up to 4M[pulse/s] *6 ・Serial communication type: Up to 1000M[pulse/s]

*1 These figures are for reference only. Decide whether to apply the data by evaluating actual combination. (Noise, motor heating, etc.)

*2 This an available speed on the driver. For information on the supported speed on the scale side, refer to the scale specifications separately.

*3 For more information on various specifications, also refer to "4-7 Linear motor/feedback scale setting".

*4 The number of pulses should be 2048 or more per magnetic pole pitch (per electric angle cycle).

*5 In case of velocity control mode or torque control mode, it is up to 2100M [pulse/s].

*6 For information on acceptable scale speed over 4 Mpps, contact us.

*7 Regarding resolution of the serial communication type (absolute rotary specification), if it exceeds 2^{24}[pulse/r], only 2^n (2^{25}, 2^{26}, etc.) [pulse/r] are supported.

*8 VCM is not supported.

1-7 Main differences from the MINAS-A5NL/A6N series

There are mainly the following differences in specifications when comparing the MINAS-A6NL series with the MINAS-A5NL/A6N series.

< SX-DSV03182 : Technical reference (Functional Specifications) >

Chapter	Function	Description	A5NL specification (Linear/DD drive)	A6NF specification	A6NL specification (Linear/DD/VCM drive)
			Ver8.02	[A6NF] (Multi-function type) CPU1:Ver1.28, CPU2:Ver1.28	[A6NM] (Multi-function type) [A6NL] (Standard type) CPU1:Ver1.28, CPU2:Ver1.28
2-1	Input signal funciton	Dynamic brake (DB) switching input “DB-SEL”	Not supported	Supported	
2-2	Output signal funciton	Position comparison output “CMP-OUT”	Not supported	Supported	
		Deterioration diagnosis velocity output “V-DIAG”	Not supported	Supported	
2-4-2	Assignment of output signal	Estimated pole position output (CS-CMP) Setup value	12h	Not supported	16h
3-2	7-segment LED	Overload load rate	Not supported	Supported	
		Pole position estimated accuracy (Pr7.00=8)	When the pole position is not yet estimated: ‘ 0’	Not supported	When the pole position is not yet estimated: ‘b4’
3-4	Monitor signal output function	Analog monitor signal	17 kinds	25 kinds	21 kinds * For details, refer to 3-4.
		Updating cycle	500us	125us	
		Output selecting the unit for command position deviation	Not supported (Command position fixing after filtering)	Supported (Switching the after filtering and the before filtering by Pr7.23 bit14)	
4-2-2	Electronic gear function	Valid range of electric gear specification	1/1000 to 1000	1/1000 to 8000	1/1000 to 8000
		Pr0.09: Setup range	1 to 1073741824	0 to 1073741824	0 to 1073741824 (When value is 0, means 1/1)
4-2-4	Positioning complete output (INP/INP2) function	Position setup unit select	Not supported (Feedback scale unit fixed)	Supported (Switching the command unit and the encoder (feedback scale) unit by Pr5.20)	
4-2-5	Pulse regeneration function	Restriction when a serial communication type feedback scale is used	When the communication cycle is 0.0833 [ms], it will be automatically invalid.	When the communication cycle is 0.0625 [ms], it will be automatically invalid.	
4-7	Linear motor/feedback scale setting	Pr9.01 (Rotary type) (Number of scale pulses per rotation) Valid setup range	10000 to 16777216 * Max. 24bit	Not supported	10000 to 536870912 * Max. 29bit
		Feedback scale Serial communication type (absolute rotary specification)	Not supported	Not supported	Supported (Pr3.23=6)
		Supported speeds for feedback scale	Up to 400Mpps	Not supported	Linear type: Up to 4000Mpps Rotary type: Up to 1000Mpps
		VCM	Not supported	Not supported	Supported(Pr9.00=3)
4-7-3-3	Pole position recovery method	It copies the estimation result of pole position.	Not supported	Not supported	Supported
5-2-5	Notch filter	Maximum quantity used	4 filters available	5 filters available	
5-2-6	Damping Control	Maximum quantity used	Maximum of 2 (Restricted to 1 during two-degree-of-freedom control)	Maximum of 3 (Restricted to 2 during full-closed control) (Restricted to 2 during two-degree-of-freedom control)	Maximum of 3 (Restricted to 2 during two-degree-of-freedom control)
5-2-7	Model-type damping filter	Reducing the vibration by using the model type damping filter to remove the vibration frequency from the position command	Not supported	Supported	
--	Disturbance observer function	Estimating the motor speed using the load model to increase the accuracy of speed detection and to realize both quicker responses and the reduction of shaking at the time of stopping	Supported	Not supported	
5-2-9	Load variation suppression function	Reducing the motor speed variation caused by disturbance torque and load variation to stabilize the operation	Not supported	Supported	
5-2-13	Quadrant projection suppression function	Reducing the quadrant projection that occurs at the time of circular interpolation of two axes or more	Not supported	Supported	

(To be continued)

< SX-DSV03182 : Technical reference (Functional Specifications) >

Chapter	Function	Description	A5NL specification (Linear/DD drive)	A6NF specification	A6NL specification (Linear/DD/VCM drive)
			Ver8.02	[A6NF] (Multi-function type) CPU1:Ver1.28, CPU2:Ver1.28	[A6NM] (Multi-function type) [A6NL] (Standard type) CPU1:Ver1.28, CPU2:Ver1.28
5-2-14 5-2-15	Two-degree-of-freedom control mode	Factory default setting value of two-degree-of-freedom control	Two-degree-of-freedom control disabled (Factory default value: 0)	Two-degree-of-freedom control enabled (Factory default value: 1)	
		Control modes that “Standard type” is available on.	Position control	Position control, Velocity control	Position control, Velocity control, Torque control * * Operation will be similar to that when two-degrees-of-freedom is disabled.
		Control modes that “Synchronization type” is available on.	Not supported	Position control,	Not supported
6-2	Motor working range setup function	Extended function of the protection of the motor working range setting (Expansion of effective range for detection)	Not supported	Supported	
6-3-3	Sequence at main power OFF	Dynamic brake operation by a dynamic brake (DB) switching input after stopping	Not supported	Supported	
		Lower limit value for setting range in Pr5.09 “Main power supply off detection period”	70ms	70ms	20ms
6-3-7	Slow stop function	Function of smoothly stopping the motor at emergency stopping	Not supported	Supported	
6-4	Torque saturation protection function	Method of specifying the condition for setting the protection function on	Specifying by 0.1666 ms × count	Specifying by 0.25 ms × count or in ms units	
6-5	Position comparison output function	Outputting a pulse signal as a general output or from the encoder output pin when the actual position passes the parameter setting position	Not supported	Supported	
--	Single-turn absolute function	Using the absolute encoder as an absolute system only for single-turn absolute position data without connecting the battery power.	Not supported	Supported (Error don’t occur even if the motor position exceeds the single-turn data of the scale.)	Absolute rotary scale is supported (Error don’t occur even if the motor position exceeds the single-turn data of the scale.)
--	Continuous rotating absolute encoder function	Setting any upper limit value for absolute encoder multi-turn data.	Not supported	Supported	Not supported
6-6	Deterioration diagnosis warning function	Checking the motor and the connected devices for any property changes to output deterioration diagnosis warnings	Not supported	Supported	
6-7	Retreat operation function	The function to execute retreat operation by the speed and amount of travel specified in parameters when the condition is satisfied	Not supported	Supported	
7-1 7-2	Protective function	Err30.0 “Safety input protection”	Supported	Not supported	
		Err31.0-Err31.2 “Safety function error protection 1-2”	Not supported	Supported	[A6NM] Supported [A6NL] Not supported
		Err36.2 “EEPROM parameter error protection”	Supported	Not supported	
		Err50.2 “External scale communication data error protection”	Not supported	Supported	
		Er70.0 “Phase U current detector error protection”	Not supported	Supported	
		Err70.1 “Phase W current detector error protection”	Not supported	Supported	
		Err72.0 “Thermal relay error protection”	Not supported	Supported	
		Err80.3 “PLL incomplete error protection”	Not supported	Supported	

(To be continued)

< SX-DSV03182 : Technical reference (Functional Specifications) >

Chapter	Function	Description	A5NL specification (Linear/DD drive)	A6NF specification	A6NL specification (Linear/DD/VCM drive)
			Ver8.02	[A6NF] (Multi-function type) CPU1:Ver1.28, CPU2:Ver1.28	[A6NM] (Multi-function type) [A6NL] (Standard type) CPU1:Ver1.28, CPU2:Ver1.28
7-1 7-2	Protective function	Err91.3 “RTEX command error protection 2”	Not supported	Supported	
		Err94.3 “Home position return error protection2”	Not supported	Supported	
		Err96.2-Err96.7 “Control unit error protection 1-6”	Not supported	Supported	
		Err93.3 “Feedback scale connection error protection” Attribute	Not remained on the alarm history	Remained on the alarm history	
		Err16.1 “Torque saturation error protection” Occurrence factor	Torque saturated has continued for the period set to Pr 9.35 “Torque saturation error protection frequency”	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”.	Torque saturated has continued for the period set to Pr 9.35 “Torque saturation error protection frequency” or Pr6.57 “Torque saturation error protection detection time”.
		Err27.6 “Operation commands contention protection” Occurrence factor	FFT operated only by the driver: RTEX communication was established during trial run.	• 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.	
		Err34.0 “Software limit protection” Occurrence factor	Not supported	Add the following occurrence factors Detection of Err34.0 if Pr6.97 “function expansion setup 3” bit2 = 1, even in the range where detection of Err34.0 is disabled. * For details, refer to 6-2.	
		Err83.0 “RTEX continues communication error protection 1” Occurrence factor	An error (CRC error) with reading data received by a local node continued for a specified period.	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”.	
		Err83.1 “RTEX continues communication error protection 2” Occurrence factor	An error with the reading data received by a local node continued for a specified period.	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”.	
		Err84.0 “RTEX communication timeout error protection” Occurrence factor	No communication data was received and no signal to start receive interrupt handling was received from MNM1221 (RTEX communication control ASIC) for a specified period.	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”.	
		Err86.0 “RTEX cyclic data error protection 1” Occurrence factor	A problem with the data (C/R and MAC-ID) in the cyclic command area, or a problem with the Sub_Chk in 32-byte mode continued for a specified period.	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”.	
		Err86.1 “RTEX cyclic data error protection 2” Occurrence factor	A problem with cyclic command code continued for a specified period.	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”.	
		Err85.0 Retracting operation completion (I/O)	Not supported	Supported	
		Err85.1 Retracting operation completion (communication)	Not supported	Supported	
		Err85.2 Retracting operation error	Not supported	Supported	
		Err87.1 Retracting operation completion (I/O)	Not supported	Supported	
		Err87.2 Retracting operation completion (communication)	Not supported	Supported	
		Err87.3 Retracting operation error	Not supported	Supported	
		Err98.5 Hardware self-diagnosis abnormality protection 1	Not supported	Supported	

(To be continued)

Chapter	Function	Description	A5NL specification (Linear/DD drive)	A6NF specification	A6NL specification (Linear/DD/VCM drive)
			Ver8.02	[A6NF] (Multi-function type) CPU1:Ver1.28, CPU2:Ver1.28	[A6NM] (Multi-function type) [A6NL] (Standard type) CPU1:Ver1.28, CPU2:Ver1.28
7-3	Alarm function	WngAAh “Excessive position deviation warning”	Not supported	Supported	
		WngACh “Deterioration diagnosis warning”	Not supported	Supported	
		WngD2h “PANATERM command execution warning”	Not supported	Supported	
8-1	Safe torque off (STO) function	Description	A5NL Safety function supported specific model	[A6NF] (Multi-function type)	[A6NM] (Multi-function type)
		Performance level	SIL2	SIL3	
		Safety integrity level	Pld (Category 3)	Ple (Category 3)	
		The state when STO function is activated.	Alarm state Occurrence of Err30.0	Safety state(Alarm does not occur.) Front panal display is “St”.	
		Restoration method	Restoration with alarm clear after cancellation of STO command	Restoration with STO command cancellation after turning OFF the servo command	

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Chapter	Function	Description	A5NL specification (Linear/DD drive)	A6NF specification	A6NL specification (Linear/DD/VCM drive)
			Ver8.02	[A6NF] (Multi-function type) CPU1:Ver1.28, CPU2:Ver1.28	[A6NM] (Multi-function type) [A6NL] (Standard type) CPU1:Ver1.28, CPU2:Ver1.28
6	Fit gain	Explore the best gain settings automatically.	Not supported	Supported	Only linear is supported
6	Z phase search	Move to Z phase position automatically.	Not supported	Supported	Not supported

<SX-DSV03212：Technical reference (RTEX Communication Specification) >

Refer to the technical reference RTEX Communication Specification Edition (SX-DSV030212), Section 1-1.

2. Interface Specification

2-1 I/O connector input signal

Title of signal	Symbol	Connector pin No. *2)	Contents	Related control mode *1)			RTEX communications monitor
				Position	Velocity	Torque	
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	
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 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)	Connector pin No.	Contents	Related control mode *1)			RTEX communications monitor *2)
				Position	Velocity	Torque	
Servo-Alarm output	ALM+	3 (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.	○			○
	ALM– (Alarm)	4 (S03–)					
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+	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.	○			—
	BRK-OFF–	1 (S01–)					
Positioning complete	INP (In_Position)	*	• Outputs the positioning complete signal/positioning complete signal. • Turns on the output transistor when positioning is completed. • Bit7 of Pr6.10 = 1: When Pr9.20 = 2 (Pole position estimation) and the pole position was not estimated, the Positioning complete output is turned OFF forcibly. Bit7 of Pr6.10 = 0: Regardless of the pole position was estimated or not, the signal is output according to whether there are the position deviation and command. • 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.	—	○	○	—

Title of signal	Symbol *2)	Connector pin No.	Contents	Related control mode *1)			RTEX communications monitor *2)
				Position	Velocity	Torque	
Positioning complete 2	INP2	*	• Outputs the positioning complete signal/positioning complete signal 2. • Turns on the output transistor upon positioning completion 2. • Bit7 of Pr6.10 = 1: When Pr9.20 = 2 (Pole position estimation) and the pole position was not estimated, the Positioning complete output is turned OFF forcibly. Bit7 of Pr6.10 = 0: Regardless of the pole position was estimated or not, the signal is output according to whether there are the position deviation and command. • 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).	○	—	—	—
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 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.	○			–

Title of signal	Symbol *2)	Connector pin No.	Contents	Related control mode *1)			RTEX communications monitor *2)
				Position	Velocity	Torque	
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.	○			–
Estimated pole position output	CS-CMP (CS_Complete)	*	• When the pole position was estimated, the output transistor is turned ON. • In the case of setting the VCM type, transistor turned ON after power-up. • For information on the output transistor, refer to Note *7.	○			○

*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.

*7) The timing when the Estimated pole position output (CS-CMP, CS_Complete) is turned ON may vary according to the conditions below:

Pr9.20 “Pole detection method”	Pr7.41 “RTEX function extension setup 5” bit0	Timing when Estimated pole position output turns ON
0 (undefined)	– (not dependent)	Does not turn ON
1 (CS signal)	0	After the initialization is completed during the control power-on (compatible with MINAS-A5L)
	1	After the first change edge of CS signal is detected (compatible with MINAS-A4NL)
2 (Pole position estimation)	– (not dependent)	After the pole position is estimated successfully (does not turn ON on abort)
3 (Pole position recovery)	– (not dependent)	After the pole position is recovered successfully (does not turn ON on abort)

Safety precautions:

Please ensure safety on the equipment side.

2-3 I/O connector other signal

2-3-1 Feedback scale output signal / Position comparison output signal

Title of signal	Symbol	Conne-ctor pin No.	Contents	Control mode			RTEX commu-nications monitor
				Position	Velocity	Torque	
A-phase output / Position comparison output 1	OA+ / OCMP1+	17	• Outputs frequency-divided feedback 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	
Frame ground	FG	shell	• This output is connected to the earth terminal inside of the driver.				
To be used by the manufacturer.	—	14, 15, 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 Standard specification are different from values shown below, the settings described in Standard specification are valid standard default values.

Pin name	Pin No.	Applicable parameter	Default setting ( ): decimal notation	Default setup					
				Position 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 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, 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.**

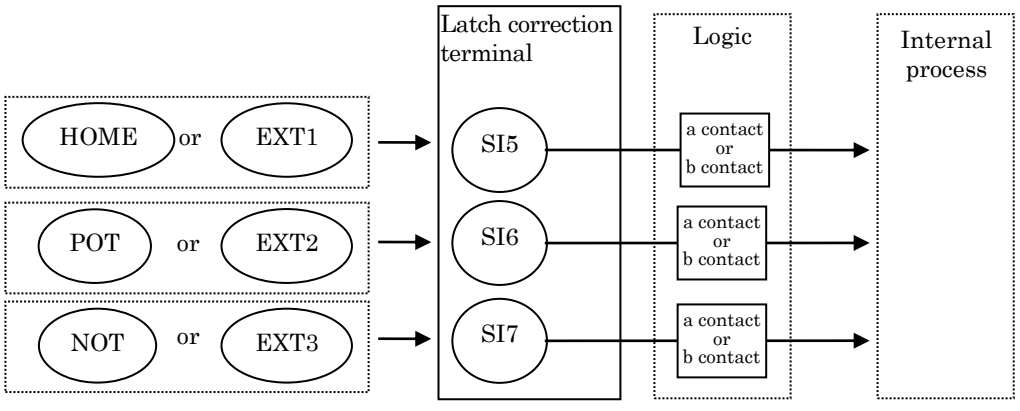
  [Conditions for the control mode to be forced to switch inside the driver]
  - ・When frequency characteristic is analyzed by Setup support software.
    (Position loop characteristics is position control, the speed closed loop characteristic and torque speed (vertical) are speed control, torque speed (normal) is torque control.)
  - ・During test run operation of Setup support software PANATERM (The mode will be forced to switch to position control.)
  - ・During pole position estimation.
  - ・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 Standard specification are different from values shown below, the settings described in Standard specification become valid standard default values.

Pin name	Pin No.	Applicable parameter	Default setting ( ): decimal notation	Default Setup		
				Position 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

・For V frame, SO3 is fixed to ALM. Please do not change Pr4.12 from the shipment value setting.

(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 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. ※Please do not change the shipment value setting with V frame.

*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 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
Estimated pole position output	CS-CMP	CS_Complete	16h

*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 speed 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.)
- During pole position estimation.
- 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 "Section 2-5", RTEX Communication Specification.

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].

< Restriction when the communication cycle is 0.0625 [ms] >
If a serial communication type feedback scale is used, the pulse regeneration will be automatically invalid.</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-A6NL 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-A5NL 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%.

(1) 16 byte mode

○: Compatible -: 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																	○	○	○	○	○	○	○	○

(2) 32 byte mode

○: Compatible -: 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 parameters

Class	No.	At-trib-ute	Title	Range	Unit	Description
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.
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. < Restriction when the communication cycle is 62500 [ns] (0.0625 [ms]) > If a serial communication type feedback scale is used, the pulse regeneration will be automatically invalid.

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:

・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.

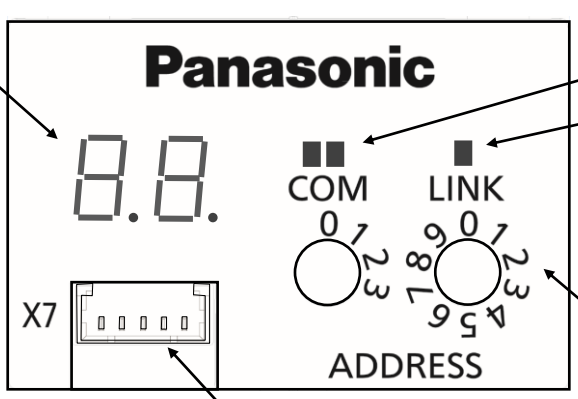
According to the setting above, it is possible to change to the CP/CV/CT control mode. Change to the CP/CV/CT control mode by designating a command code.

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

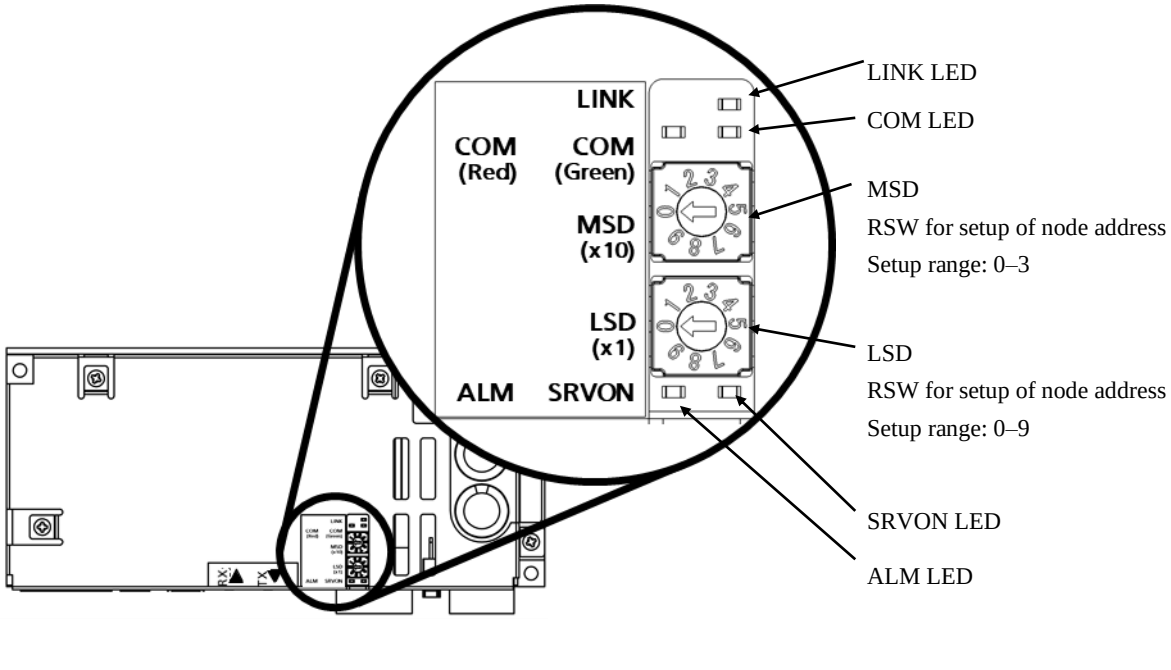
3-1 Appearance of front panel

Other than V frame



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

V frame



3-2 7 Segment LED, ALM and SRVON LED

3-2-1 7 Segment LED

Cannot be used with [V frame].

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.

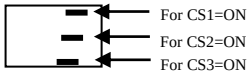
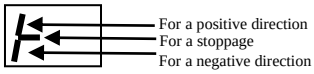
■ Relevant parameters

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).

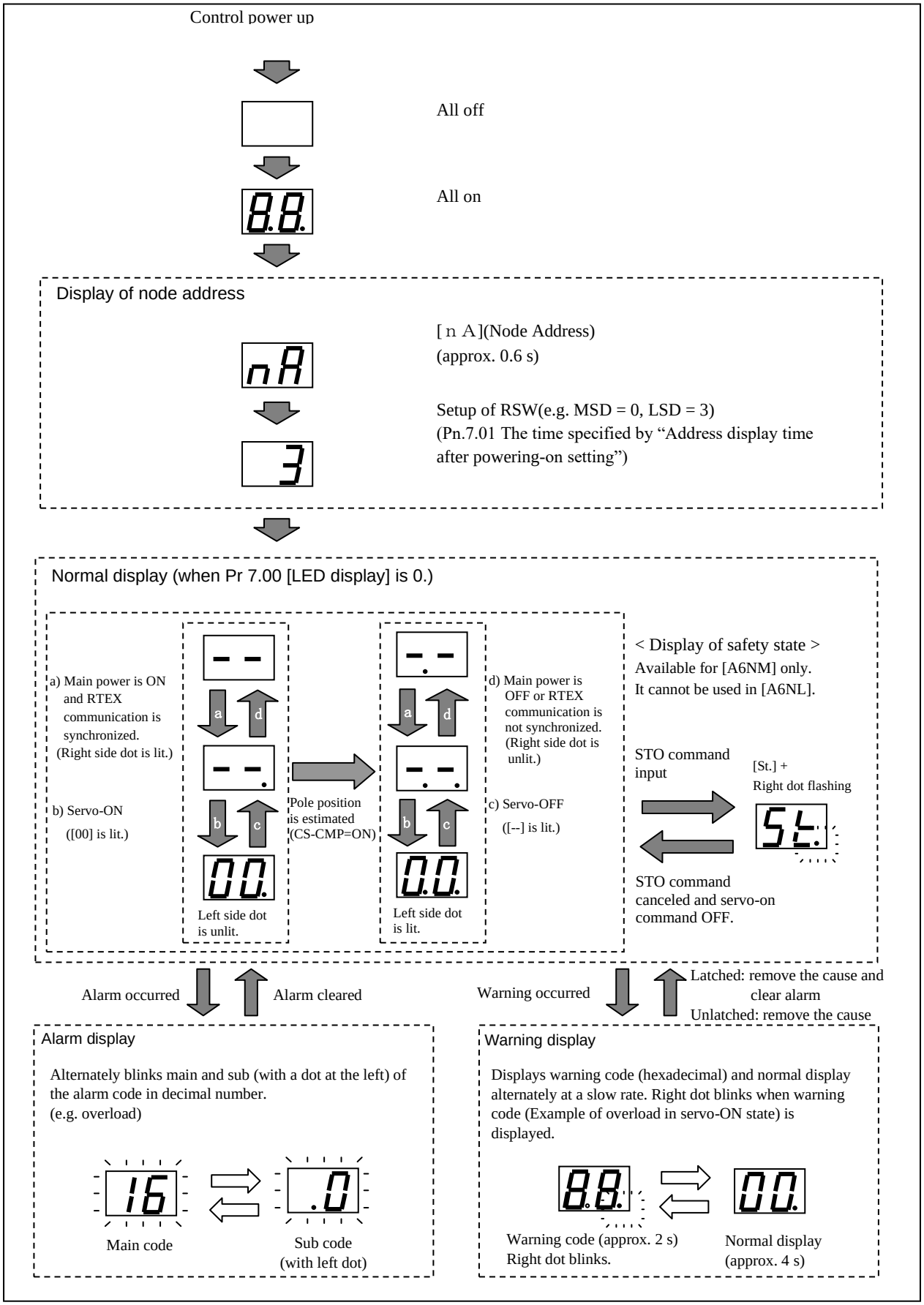
*1) For parameter attribute, refer to Section 9-1.

Pr 7.00	Information on display	Remarks
0	Normal display	[-]: servo OFF, [00]: servo ON
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.
6	Feedback 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	Feedback scale Z phase counter	When incremental feedback scale is used, the reading of feedback scale Z-phase counter value is indicated by 0 to F [hex]. * This will not to rely on the value of Pr3.26 “Feedback scale & CS reversal” and will indicate the value read from the scale as it is. This function in valid only in the case of serial incremental feedback scale, and “nA” (not Available) will be displayed in A/B/Z phase or absolute scale.
8	Pole position estimated accuracy	The estimated accuracy is shown as 0 to B4 [hex] (electric angle: 0 to 180 [degree]) when estimating a pole position. Example: When the display is ‘ A’: It means that the pole position estimated accuracy is up to ±10 [degree] in electric angle. ▪ The smaller this numeric value is, the better the accuracy is. ▪ This accuracy is an estimated accuracy based on the pole position estimation method and will not guarantee a real accuracy. Use it only for reference. ▪ When the pole position is not yet estimated, ‘b4’ is shown. ▪ When estimating the pole position, ‘b4’ is shown. ▪ When an error occurs in estimating the pole position, ‘b4’ is shown. ▪ If Pr9.20 “Pole detection method” ≠ 2 (other than pole position estimation), ‘ 0’ is shown.

(To be continued)

Pr 7.00	Information on display	Remarks
9	CS signal, operation direction	If Pr9.20 “Pole detection method” = 1 (CS signal), the CS signal status is shown at the right and the operation direction is shown at the left. ・ CS signal status CS1, 2, 3 are shown from the top downward, ‘–’ is shown for ON, and nothing is shown for OFF. Note that the CS signal is shown with Pr3.26 (signal (original signal) before the inversion process).  ・ Operation direction The upper left LED lights up when running (speed is 30 mm/s or more) in a positive direction. The lower left LED lights up when running (speed is -30 mm/s or less) in a negative direction. The center LED lights up when it stops (otherwise).  When other than Pr9.20 = 1, ‘nA’ is shown.
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.



3-2-2 ALM LED and SRVON LED

V frame, ALM LED and SRVON LED are equipped for simple status check.

Display	Description	Display color	Status	Description
ALM	Alarm LED	Red	Lit	Alarm occurred
			Not lit	Normal
SRVON	Servo on LED	Green	Lit	Motor servo ON status
			Not lit	Motor servo OFF status

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	*If the evacuation operation is performed only with Err84.0 "RTEX communication timeout error protection" (Pr6.85 "Evacuation operation condition setup" bit 7-4 = 1), because Err84.0 does not occur, flashing in red does not occur. It is not supported by function extended version 3 and earlier versions.				
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.

3-4 Monitor signal output function

Cannot be used with [V frame].

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.

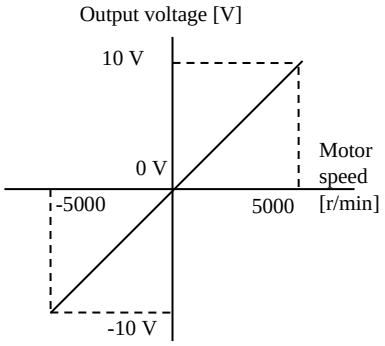
■Relevant parameters

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)

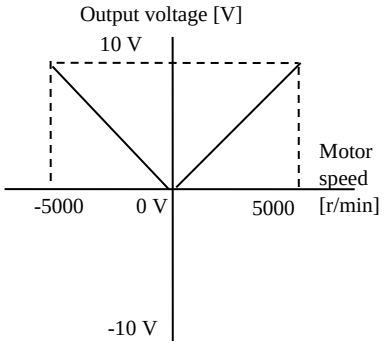
*1) For parameter attribute, refer to Section 9-1.

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

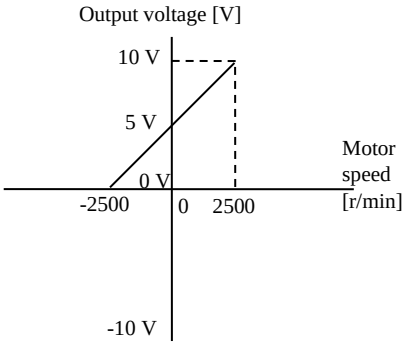
Pr 4.21 = 0, signed data output (output range –10 to 10 V)



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)



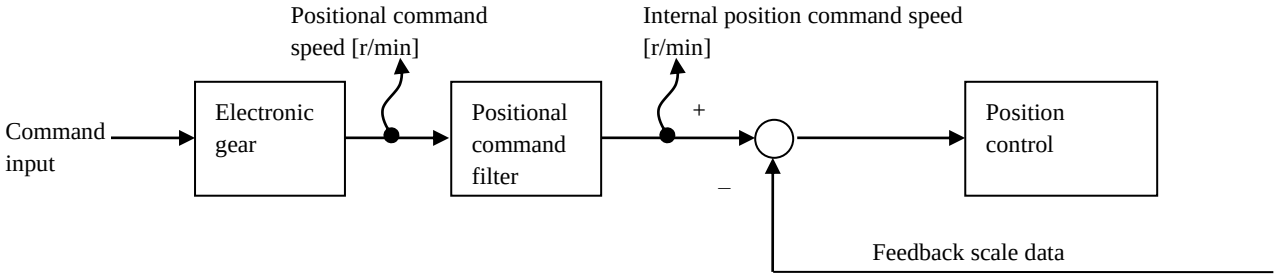
• When monitor type is motor speed, and conversion gain is 500 (1 V = 500 r/min).

(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.

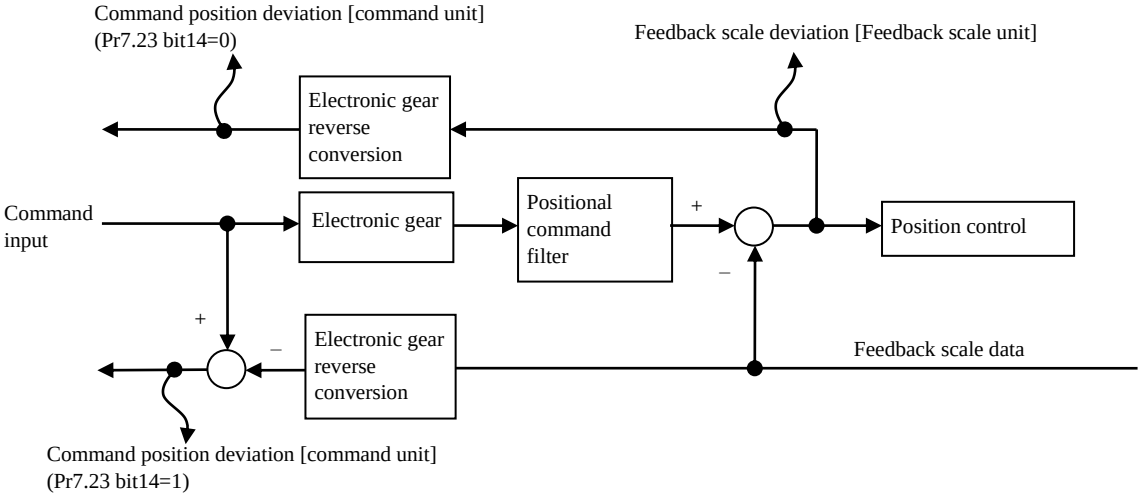
Pr 4.16/Pr 4.18	Type of monitor	Unit	Output gain for setting Pr 4.17/Pr 4.19 = 0
0	Motor velocity	r/min	500
1	Positional command velocity *2	r/min	500
2	Internal positional command velocity *2	r/min	500
3	Velocity control command	r/min	500
4	Torque command	%	33
5	Command positional deviation *3	pulse (Command unit)	3000
6	Feedback scale deviation *3	pulse (Feedback scale unit)	3000
7	Reserved	—	—
8	Reserved	—	—
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	Reserved	—	—
20	Driver temperature	°C	10
21	Reserved	—	—
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 “Operating direction setup.”

*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-A6NL 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 Operation direction setup

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

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	00	C	Operation direction setup	0–1	—	Setup the relationship between the direction of command and direction of feedback scale count. 0: The command direction is positive but the feedback scale count direction is negative. 1: The command and feedback scale count directions are positive.

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

・ Set the Pr0.00 “Operation direction” under the procedures below:

[Step 1]

First of all, set Pr3.26 “Feedback scale & CS reversal”.
For information on how to set up, refer to 4-7-1-4 Direction setting of feedback scale.
After the setup, write data in EEPROM and turn on the power supply again.

[Step 2]

Set Pr0.00=1, write data in EEPROM, and turn off and on the power supply again.
(Because Pr0.00=1 by default, this step is unnecessary for the default setting.)

[Step 3]

When the servo is turned off (motor power supply off), move the motor in a positive direction.
Here, check the feedback scale count direction. If the direction is negative, set Pr0.00=0. If the direction is positive, set Pr0.00=1.
After the setting, write data in EEPROM, and turn off and on the power supply again.
The feedback scale count direction can be checked with the changing direction of “Sum of scale pulse” in the PANATERM's monitor screen.

The positive/negative direction in these specifications is the direction configured here. As an example, the table below lists the relationship with the positive/negative drive inhibit input.

Pr0.00	Command direction	Feedback scale direction *1	Positive drive inhibit input	Negative drive inhibit input
0	Positive	Negative	Valid	–
0	Negative	Positive	–	Valid
1	Positive	Positive	Valid	–
1	Negative	Negative	–	Valid

*1) The feedback scale direction in this table is the direction checked before setting Pr0.00 (Pr0.00=1) in the step 3 above. The command direction coincides with the feedback scale direction by setting Pr0.00 properly.

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.

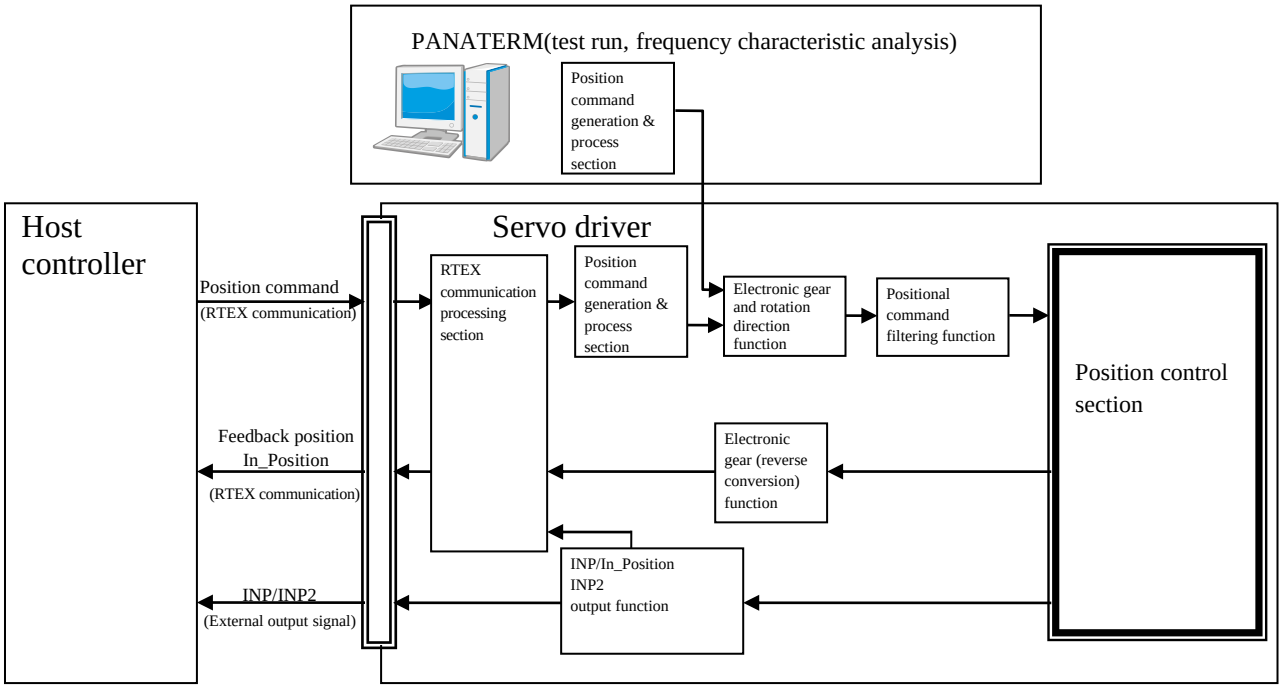
4-2 Position control

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 by position control, the speed closed loop characteristic and torque speed (vertical) characteristic are by velocity control, torque speed (normal) characteristic is by torque control.)
- Test run of the setup support software (Forcibly position control mode).
- 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.)



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

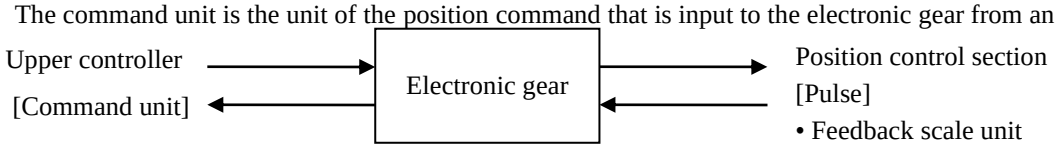
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	09	C	Numerator of electronic gear	0–1073741824	—	Set the numerator of electronic gear ratio *2)
0	10	C	Denominator of electronic gear	1–1073741824	—	Set the denominator of electronic gear ratio *2)

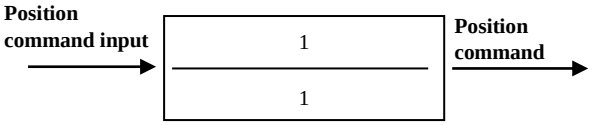
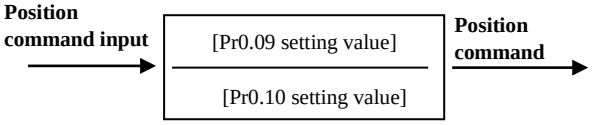
*1) For parameter attribute, refer to Section 9-1.

*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.



Pr0.09	Pr0.10	Electronic gear process
0	— (No effect)	 • If Pr0.09 is 0, the processing indicated in the above diagram will be carried out with both the numerator and denominator as 1.
1–1073741824	1–1073741824	

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”.

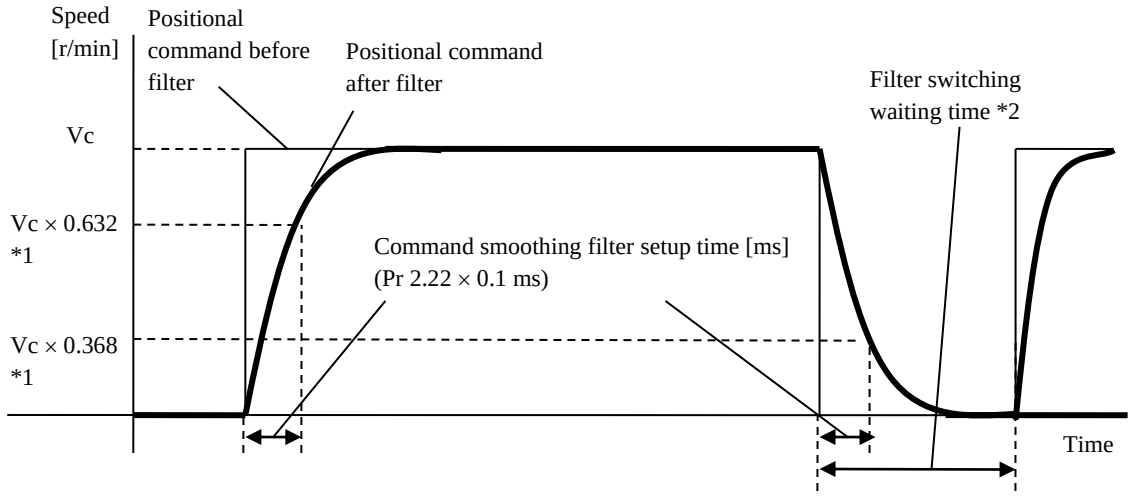
■ Relevant parameters

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 5-2-14 "Two-degree-of-freedom control mode (With position control)" and 5-2-15 "Two-degree-of-freedom control mode (With velocity 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 5-2-14 and 5-2-15.

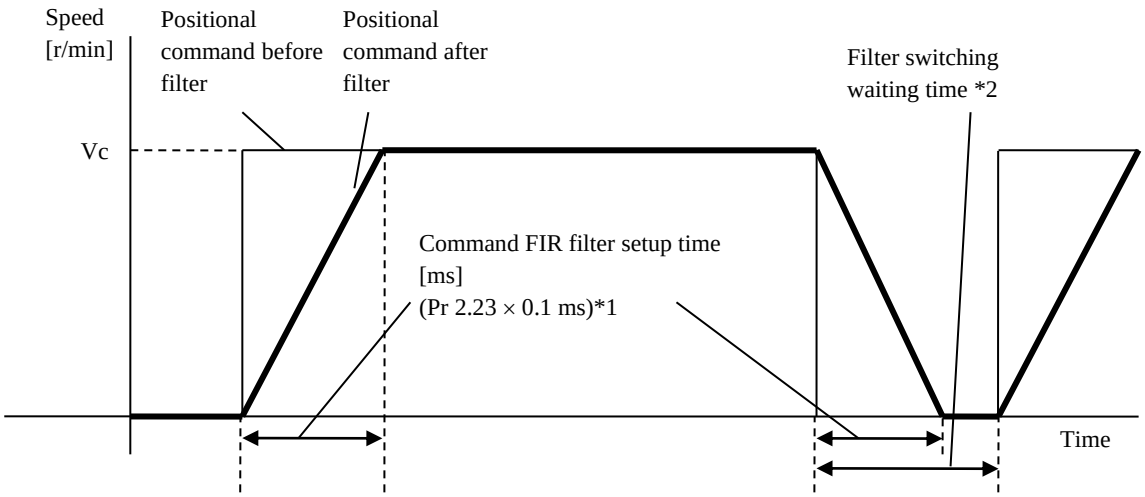


*1 Actual filter time constant (setup value × 0.1 ms) has the maximum absolute error of 0.4 ms for a time constant below 100 ms and the maximum relative error of 0.2% for a time constant 20 ms or more.

*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.

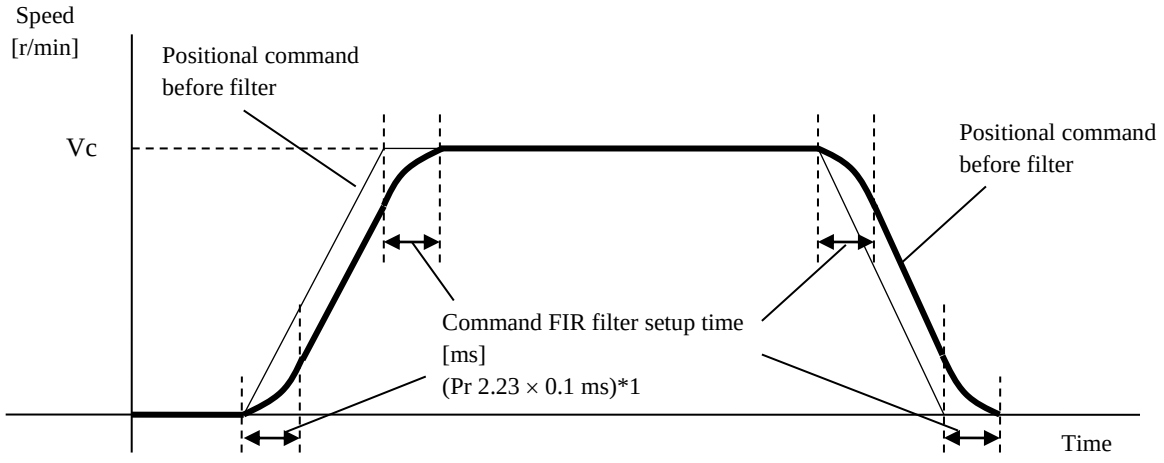


*1 The actual average travel time (setup value × 0.1 ms) has the maximum absolute error of 0.2 ms for a time constant below 10 ms and the maximum relative error of 1.6% for a time constant 10 ms or more.

*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 feedback scale unit by using Pr 5.20. “Position setup unit select”. Note that when the feedback 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. 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 feedback scale unit by using Pr 5.20. “Position setup unit select”. Note that when the feedback 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	—	Selects the setting unit for the positioning completion range and excessive position deviation warning setting. 0: Command unit, 1: Feedback 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.
6	10	B	Function expansion setup	-32768 –32767	—	bit7: INP output limit 0: Invalid 1: Valid In case of valid, if Pr9.20 “Pole detection method” = 2 (Pole position estimation), Positioning complete (INP) and Positioning complete 2 (INP2) are **turned OFF forcibly** until the pole position estimation is finished.
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 and B phase logic can be set up by using parameters.
Z phase signal is not compatible with pulse regeneration.

< Restriction when the communication cycle is 0.0625 [ms] >
If a serial communication type feedback scale is used, the pulse regeneration will be automatically invalid.

■ Relevant parameters

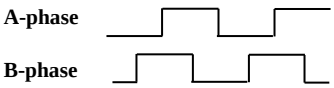
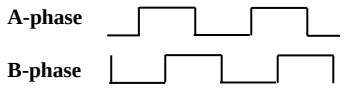
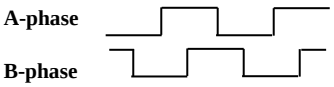
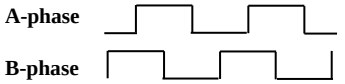
Class	No.	At-trib-ute *1)	Parameter	Range	Unit	Function
0	11	R	Pulse output numerator	1–262144	pulse/r	The division ratio can be set by using Pr0.11 as a division numerator and Pr5.03 as a division denominator. Therefore, if the pulse count is multiplied by 4 in the upper side: Pulse output resolution per distance = (Pr0.11 value / Pr5.03 value) × Feedback scale resolution per distance
5	3	R	Pulse output denominator	0–262144	-	
0	12	R	Pulse output logic reversal	0–3	-	You can set up the B-phase logic and the output source of the pulse output. With this parameter, you can reverse the phase relation between the A-phase pulse and the B-phase pulse by reversing the B-phase logic.
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: Feedback scale output signal 1: Position comparison output signal
5	33	C	Regenerative pulse output limit	0–1	-	Enable/disable detection of Err28.0 Pulse regenerative limit protection. 0: Invalid 1: Valid
6	22	R	A/B-phase feedback scale pulse output method	0–1	-	Select the pulse regeneration method of A, B and Z parallel feedback scale. 0: Directly output the signals from A, B and Z parallel feedback scales. 1: Output A and B phase signals recovered from A, B and Z parallel feedback scales. Z-phase is output directly.

*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”.

Pr 0.11	Pr 5.03	Command division/multiplication operation
1–2097152	0	Feedback scale pulse [pulse] → 1/1 → Output pulse [pulse] • When Pr.5.03 = 0, division ratio is 1:1.
1–2097152	1–8388608	Feedback scale pulse [pulse] → [Pr.0.11 setting value] / [Pr.5.03 setting value] → Output pulse [pulse] • The resolution of output pulse does not become more than the resolution of feedback scale pulse. Please use under the setting that satisfies “Set value for Pr0.11 ≤ Set value for Pr5.03.”

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

Pr0.12	B-phase logic	Output source	At operation to positive direction	At operation to negative direction
0, 2	Non-inversion	Feedback scale		
1, 3	Inversion	Feedback scale		

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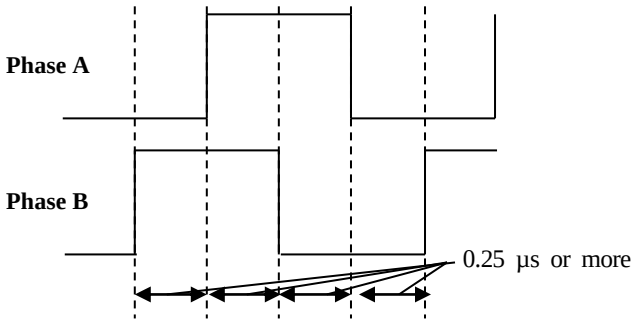
■ Command on pulse regeneration function

• 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).

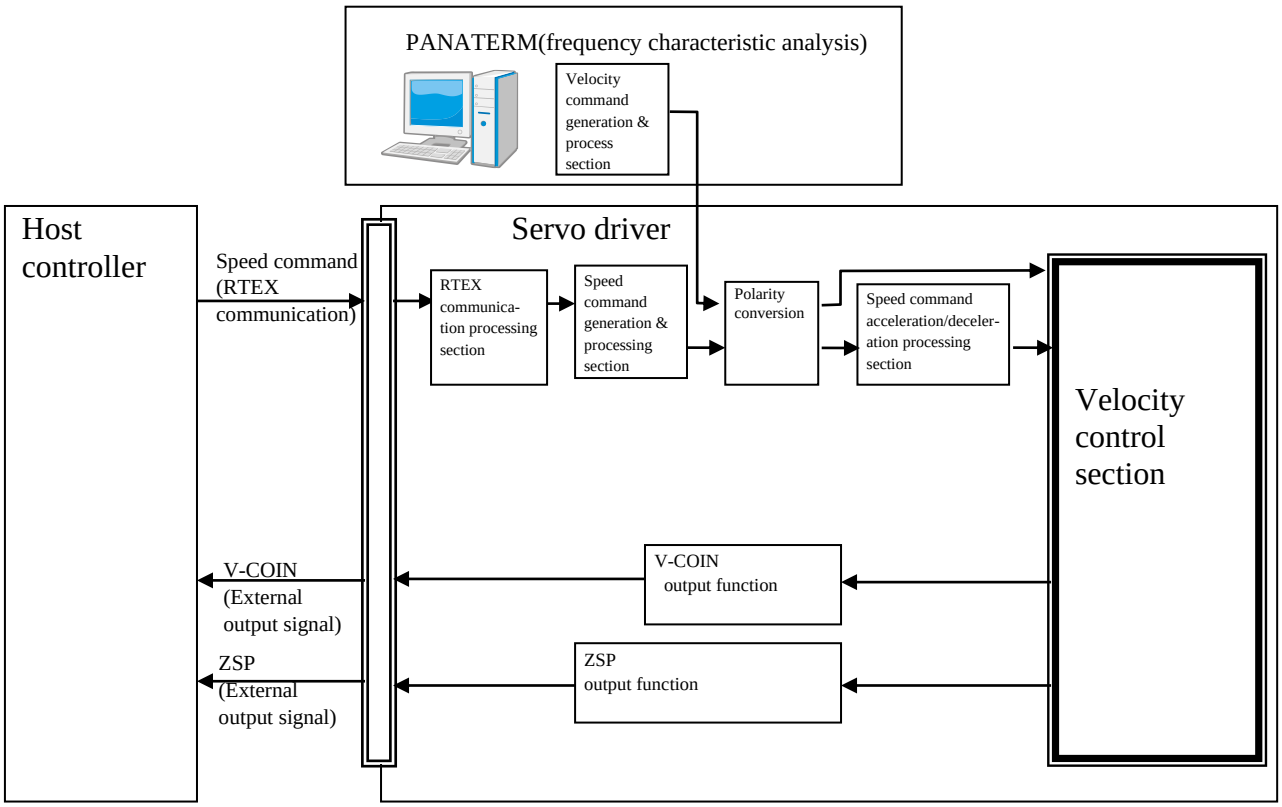
4-3 Velocity Control

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 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 by position control, the speed closed loop characteristic and torque speed (vertical) characteristic are by velocity control, torque speed (normal) characteristic is by torque control.)
- Test run of the setup support software (Forcibly position control mode).
- 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.)



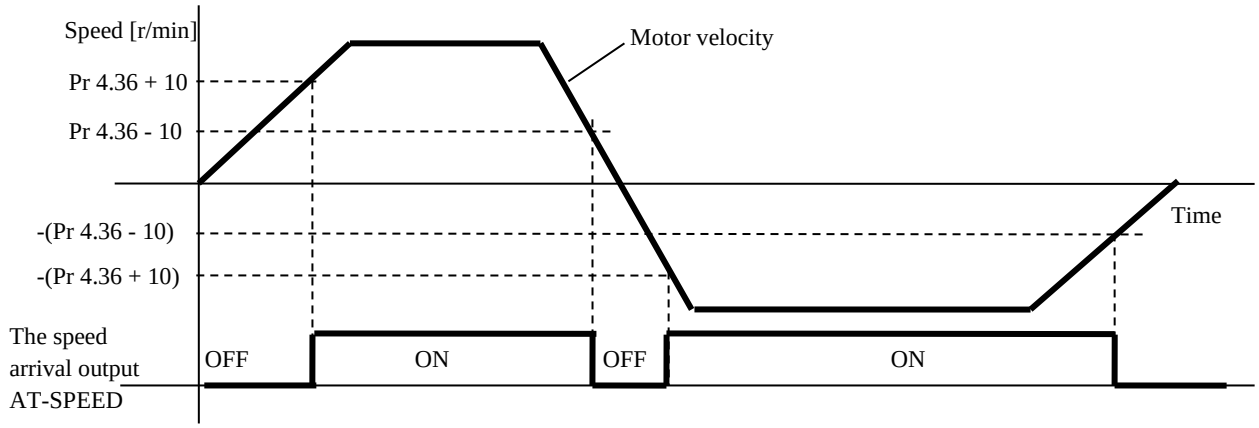
4-3-1 Attained speed output (AT-SPEED)

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.



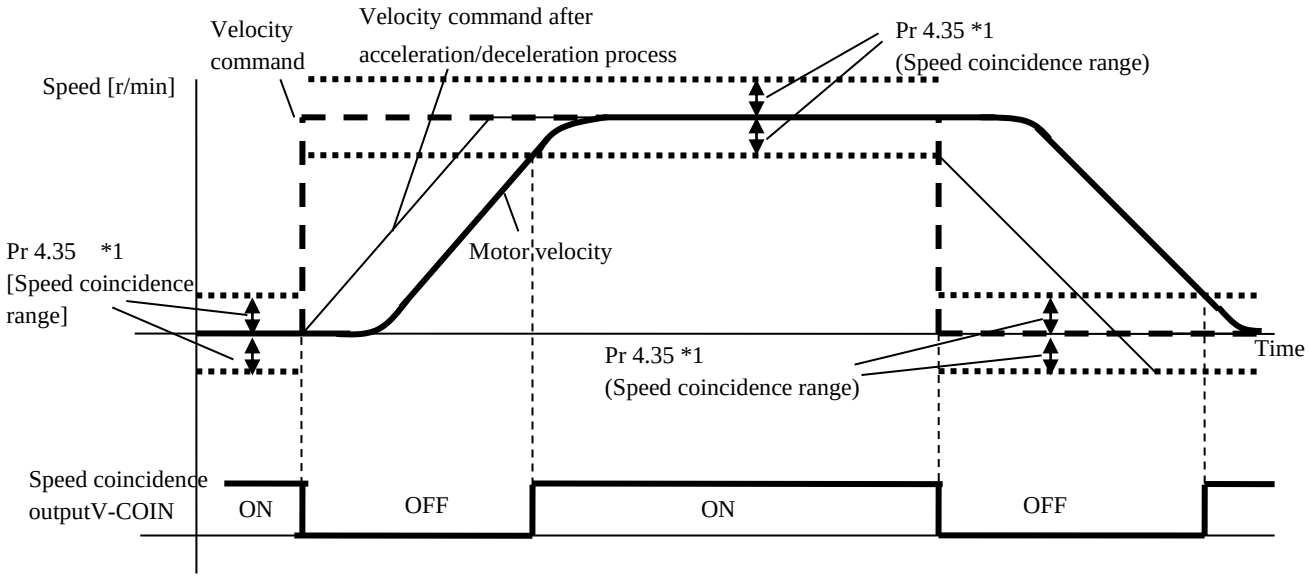
4-3-2 Speed coincidence output (V-COIN)

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

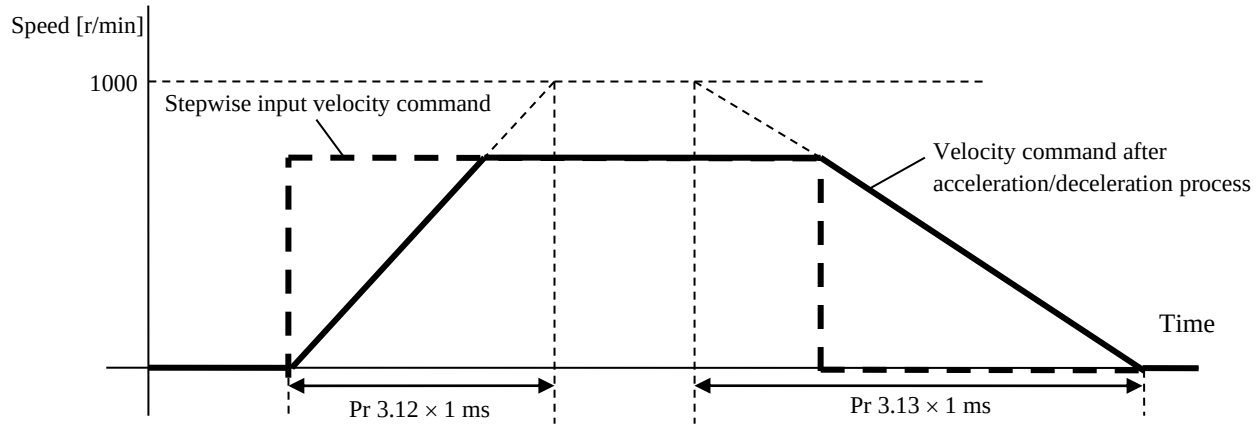
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	12	B	Acceleration time setup	0–10000	ms/ (1000 r/min)	Set up acceleration processing time in response to the velocity command input.
3	13	B	Deceleration time setup	0–10000	ms/ (1000 r/min)	Set up deceleration processing time in response to the velocity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

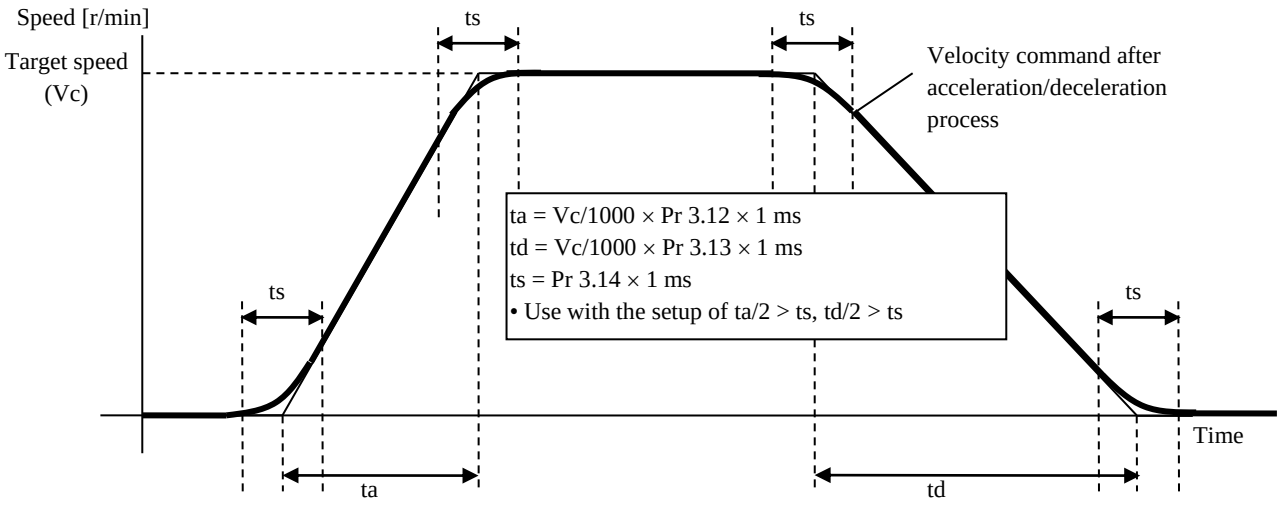
Note: When the position loop is external to the driver, do not use the acceleration/deceleration time setting. Set these values to 0.

• 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”.

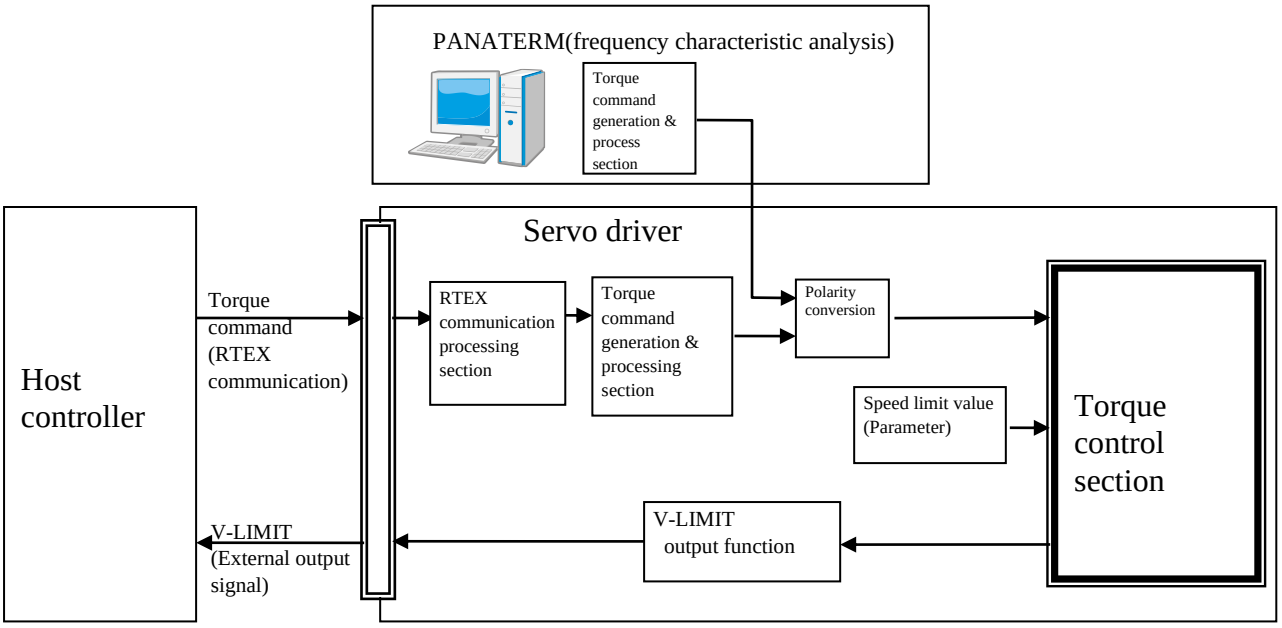
The control mode is switched forcibly inside the driver depending on its operating status irrespective of the command from the host controller.

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

- When frequency characteristic is analized by Setup support software.
  (Position loop characteristics is by position control, the speed closed loop characteristic and torque speed (vertical) characteristic are by velocity control, torque speed (normal) characteristic is by torque control.)
- Test run of the setup support software (Forcibly position control mode).
- 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.)

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 Pr9.10 “Maximum overspeed 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 Pr9.10 “Maximum overspeed level”, whichever smaller.</td></tr>
</table>

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

4-5 Setting regenerative resistor

Cannot be used with [V frame].

The table describes setup of regenerative resistor.
For details of regenerative resistor specification, refer to Standard 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.) ※Please do not change the shipment value setting with V frame.
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) ※Please do not change the shipment value setting with V frame.

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

4-6 Absolute setup

4-6-1 Feedback scale

With the absolute type of feedback scale, an absolute system that does not require return to origin action after power-up, can be configured.

■ Relevant parameters

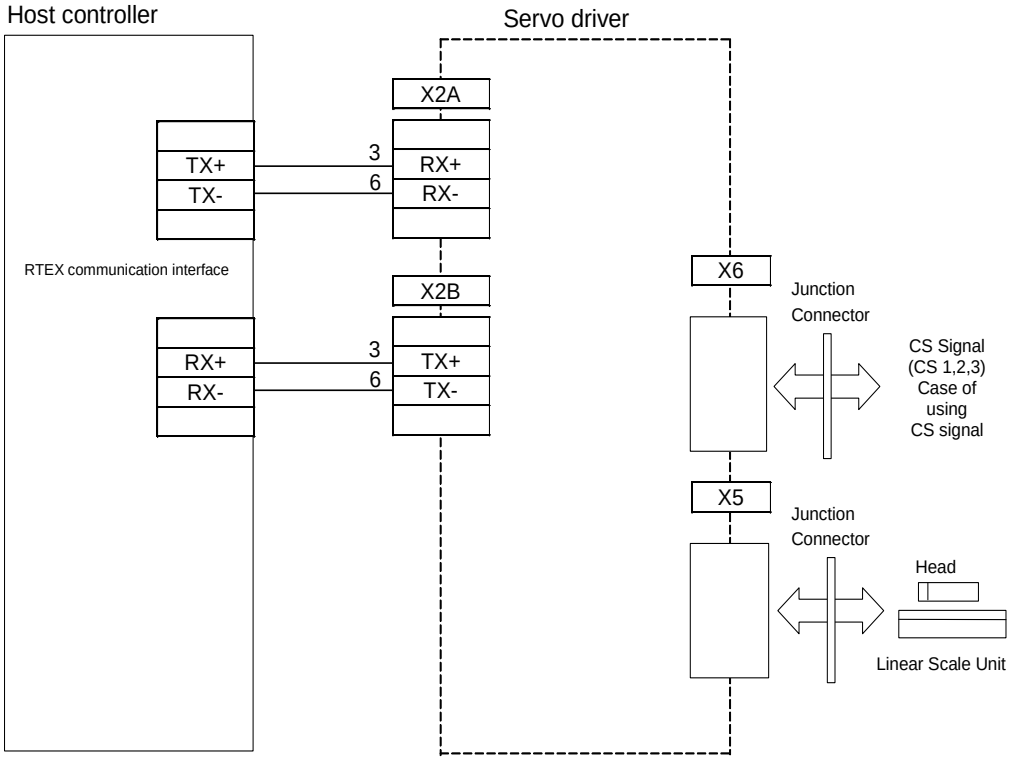
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	23	R	Feedback scale selection	0–2	—	Set the feedback scale type. 0: A/B phase output type 1: serial communication type (increment specification) 2: serial communication type (absolute linear specification) 3: For manufacturer use 4: For manufacturer use 5: For manufacturer use 6: serial communication type (absolute rotary specification)

*1) For information on the parameter attribute, refer to the section 9-1.

4-6-1-1 Feedback 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.



4-7 Linear motor/feedback scale setting

The MINAS-A6NL series requires you to set up the linear motor/feedback scale to be connected.

Follow the procedures below to set up the linear motor/feedback scale.

■Procedures

1. Set up linear motor/feedback scale parameter			
(1) Linear motor (motor type, mass, rated torque, etc.) Feedback scale (resolution, etc.)	Linear type		4-7-1-1
	Rotary type		4-7-1-2
	VCM		4-7-1-3
(2) Feedback scale	A/B phase output type		4-7-1-4
	Serial communication type (increment specification)		
	Serial communication type (absolute linear specification)		
	Serial communication type (absolute rotary specification)		
(3) Pole position estimation	CS signal		4-7-3-1
	Pole position estimation		4-7-3-2
	Pole position recovery		4-7-3-3

2. Set up current gain				
(A) Theoretical value calculation based on parameters	4-7-2	(B) Use automatic setting tool	4-7-4	

3. Set up feedback scale/CS signal direction				
(A) Manual setting	Scale	4-7-1-5	(B) Use automatic setting tool	4-7-4
	CS signal	4-7-3-1		

■ Points to note

- When the power is turned on at factory defaults, Err60.0 “Motor setting error protection” occurs. This is because the linear motor/feedback scale is not yet set up.
- When the installation condition is changed, such as when a linear motor or feedback scale is exchanged, follow the procedures above to configure the setting again.

4-7-1 Parameter setting according to linear motor/feedback scale specification

Set up various parameters by referring to the specifications of the linear motor to be connected.
Three motor types are supported: “Linear type,” “Rotary type” and “VCM type”.

The same parameter number has different meaning between “Linear type,” “Rotary type” and “VCM type”.
For more information, refer to the parameter tables in Sections 4-7-1-1, 4-7-1-2, 4-7-1-3.

■ Points to note

- For Pr9.06 (Rated effective motor current), if a value exceeding the rated motor current is set, the current obtained when the thrust command is 100% will not take effect as the rated motor current. Therefore, Err16.0 (Overload protection) does not function normally, resulting in the risk of motor burnout.

- For Pr9.07 (Maximum instantaneous motor current), if a value exceeding the maximum instantaneous motor current is set, the current obtained when the maximum thrust command is given will not take effect as the motor maximum current. Therefore, Err16.1 (Thrust saturation error protection) does not function normally, resulting in the risk of motor burnout.

4-7-1-1 Linear type motor

■ Relevant parameters: Linear type

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	00	R	Motor type	0 to 3	—	Select the type of the motor to be connected. 1: linear type, 2: rotary type, 3: VCM type If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	01	R	Feedback scale resolution	0 to 536870912	nm	Set the feedback scale resolution. The valid range is 1 to 1000000. If out of range, Err60.0 “Motor setting error protection” occurs.
9	04	R	Motor movable part mass	0 to 32767	0.01kg	Set the movable part mass of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	05	R	Motor rated thrust	0 to 32767	0.1N	Set the rated thrust of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	06	R	Motor rated effective current	0 to 32767	0.1 Arms	Set the rated current of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, if it exceeds allowable rated current of the driver, Err60.1 “Motor combination error 1” occurs.
9	07	R	Motor maximum instantaneous current	0 to 32767	0.1A	Set the maximum instantaneous current of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, if it exceeds maximum allowable instantaneous current of the driver, Err60.1 “Motor combination error 1” occurs.
9	10	R	Maximum overspeed level	0 to 20000	mm/s	Set the maximum overspeed of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	11	R	Carrier frequency	0 to 3	—	Select the carrier frequency. 0: 6kHz, 1: 12kHz, 2: 8kHz, 3: For manufacturer use * The factory default of carrier frequency may vary according to frame size of the driver. * If the setting value is changed from the shipment value, a derating is necessary. For more information, refer to the Standard specifications.

(To be continued)

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	02	R	Magnetic pole pitch	0 to 32767	0.01 mm	Set the magnetic pole pitch. This setting value is valid only for Pr9.00 “Motor type selection” = 1 (linear type). This is not compatible with Pr9.30 “Number of pulses per magnetic pole”. To set the magnetic pole with this parameter, set Pr9.30 “Number of pulses per magnetic pole” to zero. Err60.0 “Motor setting error protection” occurs in the cases below: · Pr9.00=1 (linear type) and Pr9.02=0 and Pr9.30<512 · Pr9.00=1 (linear type) and Pr9.02≠0 and Pr9.30≠0
9	30	R	Number of pulses per magnetic pole	0 to 327670000	pulse	Set the magnetic pole for the linear motor with the number of pulses. This value is valid only for Pr9.00 “Motor type selection” = 1 (linear type). Setting value = 512 or more: The value is the number of pulses per magnetic pole. ▪ The setting value becomes effective from 512. But, set it to not less than 2048 as much as possible. Setting value = pole pitch [mm] ÷ scale resolution [um] × 1000 This is not compatible with Pr9.02 “Magnetic pole pitch”. To set the magnetic pole with this parameter, set Pr9.02 “Magnetic pole pitch” to zero. Err60.0 “Motor setting error protection” occurs in the cases below: · Pr9.00=1 (linear type) and Pr9.02=0 and Pr9.30<512 · Pr9.00=1 (linear type) and Pr9.02≠0 and Pr9.30≠0 Note: In general, use Pr9.02 “Magnetic pole pitch” for setting the magnetic pole. If this is the case, make sure to set this parameter to zero. Use this parameter only if Pr9.02 is exceptionally unavailable.

*1) For information on the parameter attribute, refer to the section 9-1.

4-7-1-2 Rotary type motor

■ Relevant parameters: Rotary type

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	00	R	Motor type	0 to 3	—	Select the type of the motor to be connected. 1: linear type, 2: rotary type, 3: VCM type If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	01	R	Number of scale pulses per revolution	0 to 536870912	pulse	Set the number of pulses of the feedback scale per revolution. The valid range is 10000 to 536870912. If out of range, Err60.0 “Motor setting error protection” occurs. Also, this value changes the supported speed [r/min]. If the number of pulses per second exceeds 1091 M[pulse/s] based on the Pr9.10 “Maximum overspeed level” value and this setting value, Err60.1 occurs. Example: Pr9.01=33554432 (25bit): Supported speed [r/min] = 60 × 1091000000 / 33554432 = 1950.86 So, if Pr9.10 is not less than 1951, Err60.1 occurs. Note: When using the serial communication type (absolute rotary specification) (Pr 3.23 = 6), be sure to set the value according to the scale specification. Otherwise, even if the ratio between the setting values of Pr9.01 and Pr9.03 is appropriate, normal control can not be performed. Regarding resolution of the serial communication type (absolute rotary specification), if it exceeds 2^{24}[pulse/r], only 2^{n} (2^{25}, 2^{26}, etc.) [pulse/r] are supported.
9	03	R	Number of pole pairs per revolution	0 to 255	Number of pole pairs	Set the number of pole pairs of the motor per revolution. If Pr9.00=2 (rotary type) and the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	04	R	Motor inertia	0 to 32767	0.00001 kgm^2	Set the inertia of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	05	R	Motor rated torque	0 to 32767	0.1Nm	Set the rated torque of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	06	R	Motor rated effective current	0 to 32767	0.1 Arms	Set the rated current of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, if it exceeds allowable rated current of the driver, Err60.1 “Motor combination error 1” occurs.
9	07	R	Motor maximum instantaneous current	0 to 32767	0.1A	Set the maximum instantaneous current of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, if it exceeds maximum allowable instantaneous current of the driver, Err60.1 “Motor combination error 1” occurs.
9	10	R	Maximum overspeed level	0 to 20000	r/min	Set the maximum overspeed of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, this value changes the supported speed [r/min]. If the number of pulses per second exceeds 1091 M[pulse/s] based on the Pr9.01 “Number of scale pulses per revolution” value and this setting value, Err60.1 occurs.
9	11	R	Carrier frequency	0 to 3	—	Select the carrier frequency. 0: 6kHz, 1: 12kHz, 2: 8kHz, 3: For manufacturer use * The factory default of carrier frequency may vary according to frame size of the driver. * If the setting value is changed from the shipment value, a derating is necessary. For more information, refer to the Standard specifications.

*1) For information on the parameter attribute, refer to the section 9-1.

4-7-1-3 VCM type

■ Relevant parameters: Linear type

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	00	R	Motor type	0 to 3	—	Select the type of the motor to be connected. 1: linear type, 2: rotary type, 3: VCM type If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	01	R	Feedback scale resolution	0 to 536870912	nm	Set the feedback scale resolution. The valid range is 1 to 1000000. If out of range, Err60.0 “Motor setting error protection” occurs.
9	04	R	Motor movable part mass	0 to 32767	0.01kg	Set the movable part mass of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	05	R	Motor rated thrust	0 to 32767	0.1N	Set the rated thrust of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	06	R	Motor rated effective current	0 to 32767	0.1A	Set the rated current of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, if it exceeds allowable rated current of the driver, Err60.1 “Motor combination error 1” occurs.
9	07	R	Motor maximum instantaneous current	0 to 32767	0.1A	Set the maximum instantaneous current of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs. Also, if it exceeds maximum allowable instantaneous current of the driver, Err60.1 “Motor combination error 1” occurs.
9	10	R	Maximum overspeed level	0 to 20000	mm/s	Set the maximum overspeed of the motor. If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	11	R	Carrier frequency	0 to 2	—	Select the carrier frequency. 0: 6kHz, 1: 12kHz, 2: 8kHz, 3: For manufacturer use * The factory default of carrier frequency may vary according to frame size of the driver. * If the setting value is changed from the shipment value, a derating is necessary. For more information, refer to the Standard specifications.

*1) For information on the parameter attribute, refer to the section 9-1.

4-7-1-4 Feedback scale type setting

Select the type of the feedback scale to be used.

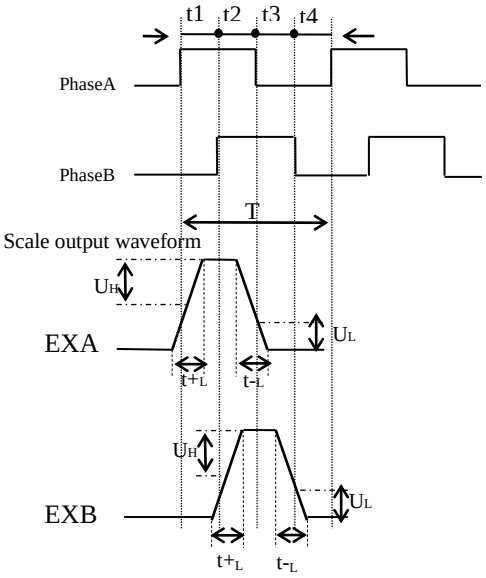
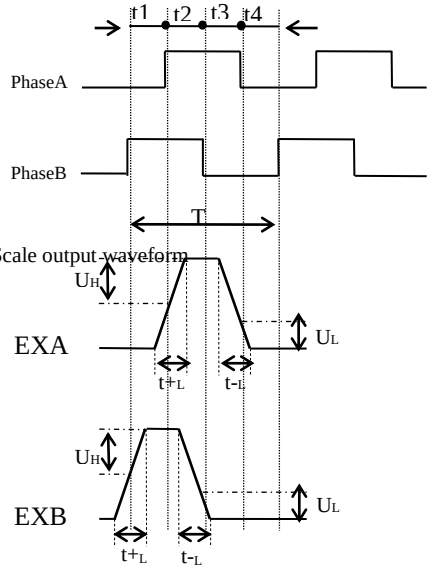
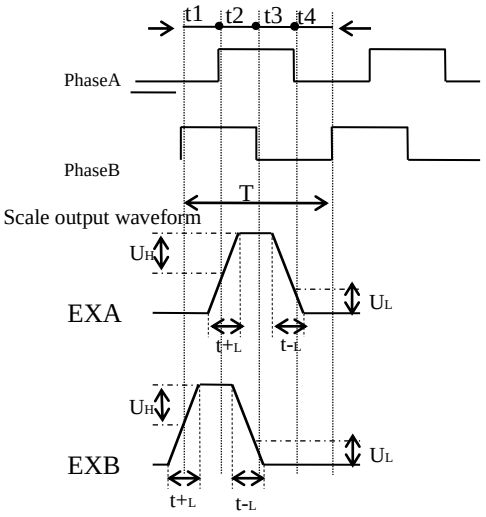
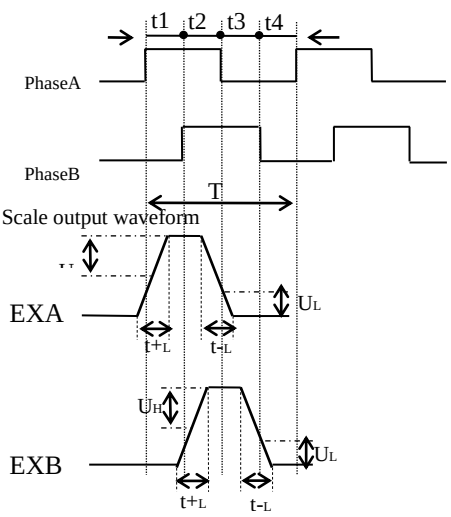
■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
3	23	R	Feedback scale selection	0 to 6	—	Set the feedback scale type. 0: A/B phase output type 1: Serial communication type (increment specification) *4 2: Serial communication type (absolute linear specification) *4 3: For manufacturer use 4: For manufacturer use 5: For manufacturer use 6: Serial communication type (absolute rotary specification) *3 *4 In the case where the type of the connected feedback scale does not agree with the setting, the following error may occur depending on the situation. Err50.0 “Feedback scale wiring error protection” Errs55.0 to 2 “A/B/Z phase wiring error protection” Err93.3 “Feedback scale connection error”

*1) For information on the parameter attribute, refer to the section 9-1.

Pr3.23	Feedback scale type	Acceptable speed *2
0	A/B phase output type *1	Up to 4 M[pulse/s] (multiplied by 4)
1	Serial communication type (increment specification) *4	Linear type: Up to 4000 M[pulse/s] VCM type: Up to 4000 M[pulse/s] Rotary type: Up to 1000 M[pulse/s]
2	Serial communication type (absolute linear specification) *4	Up to 4000 M[pulse/s]
6	Serial communication type (absolute rotary specification) *3 *4	Up to 1000 M[pulse/s]

*1 The table below lists the count direction of feedback scale for the A/B phase output type in the internal driver process.

Pr3.26	Negative direction (count down)	Positive direction (count up)
0, 2 : Not reversed	A phase moves more than B phase by 90° t1 t2 t3 t4> 0.25µs T > 1.0µs Amplifier receiving waveform 	B phase moves more than A phase by 90° t1 t2 t3 t4> 0.25µs T > 1.0µs Amplifier receiving waveform 
1, 3 : reversed	B phase moves more than A phase by 90° t1 t2 t3 t4> 0.25µs T > 1.0µs Amplifier receiving waveform 	A phase moves more than B phase by 90° t1 t2 t3 t4> 0.25µs T > 1.0µs Amplifier receiving waveform 

*2 The acceptable speed represents the feedback speed [pulse/s] of the feedback scale to be processed by driver.
For the supported range in the scale side, refer to the scale specifications.
For example, when using the feedback scale at 1 nm resolution in the serial communication type, the speed is up to 4 m/s. Also, to use the serial communication type at 8 m/s speed, select 2 nm or more for the feedback scale resolution.

*3 Only in case of setting the rotary type, the setting of Pr3.23 = 6 is enabled.

*4 The incremental scale is usable with Pr3.23 = 1 for both linear and rotary types. The absolute scale will cause Err 93.3 “Feedback scale connection error” unless the setting is appropriate for the linear or rotary type.

4-7-1-5 Manual direction setting of feedback scale

■ Relevant parameters

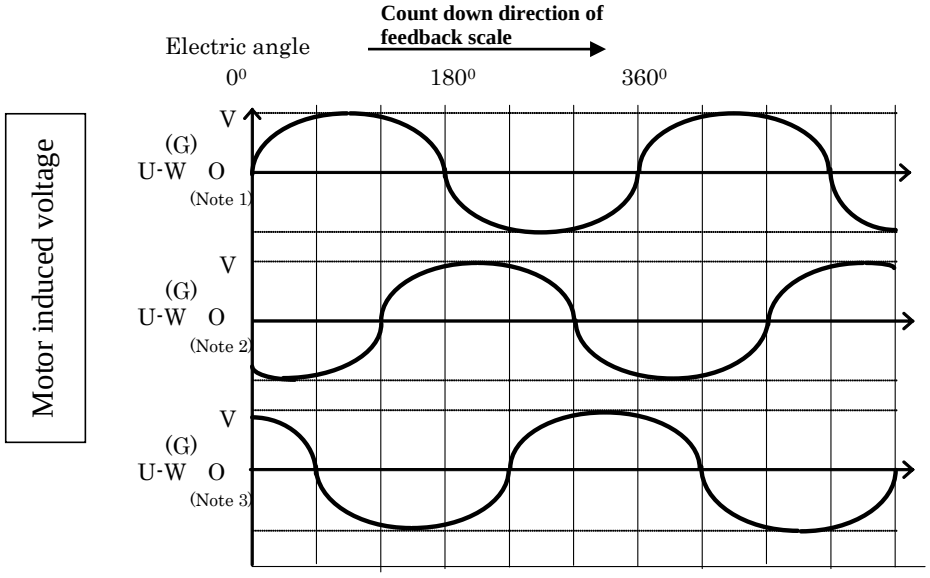
Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
3	26	R	Feedback scale and CS direction inversion	0 to 3	—	Set the reversal of the feedback counter and CS signal direction of the feedback scale. [Scale] [CS signal] 0: not reversed not reversed 1: reversed not reversed 2: not reversed reversed 3: reversed reversed The logic setting of CS signal is valid only when the CS signal is selected (Pr9.20 = 1). For VCM, the logic setting of the CS signal is disabled.

*1) For information on the parameter attribute, refer to the section 9-1.

Note: Before checking the count direction, make sure to set Pr0.00 “Operation direction” to 1 and write the data in EEPROM and turn OFF and ON the power supply.

・Other than VCM

Set up these parameters so that the relationship between the feedback scale count direction and motor's inductive voltage phase order meets the diagram below. Check the count direction of the feedback scale by using the PANATERM (sum of scale pluses) while removing the motor cables and moving the movable part by hand.



Note 1: It is a waveform generated when checking the induced voltage in the terminal U by connecting the terminal W with GND.

Note 2: It is a waveform generated when checking the induced voltage in the terminal V by connecting the terminal U with GND.

Note 3: It is a waveform generated when checking the induced voltage in the terminal W by connecting the terminal V with GND.

・For VCM

When using VCM, connect the U and W terminals of the amplifier, and never connect the V terminal.

4-7-2 Current gain setting

There are two ways to set the current gain: theoretical value calculation (when the motor phase inductance and resistance are known) with parameters and automatic setting with a tool.
This section describes how to calculate the theoretical value with parameters.
For information on the automatic setting with a tool, refer to “Section 4-7-4”.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	08	R	Phase inductance	0 to 32767	0.01mH	Set the phase inductance of the motor. If Pr9.12 “Automatic current response adjustment” ≠ 0 and this value is zero, Err60.0 “Motor setting error protection” occurs.
9	09	R	Phase resistance	0 to 32767	0.01Ω	Set the phase resistance of the motor. If Pr9.12 “Automatic current response adjustment” ≠ 0 and this value is zero, Err60.0 “Motor setting error protection” occurs.
9	12	R	Automatic current response adjustment	0 to 100	%	When this value ≠ 0, calculate the theoretical values of Pr9.13 and Pr9.14 from Pr9.08 and Pr9.09. Set the standard for current responsivity when calculating Pr9.13 “Proportional current gain” and Pr9.14 “Integral current gain”. The bigger the setting value is, the higher the current response is. But, because it can cause unusual behaviors including oscillation, set an appropriate value according to the operational state. Roughly speaking, if Pr9.11 = 0 (carrier 6 kHz), set 30. If Pr9.11 = 1 (carrier 12 kHz), set 60. If the setting value is zero, the theoretical values of Pr9.13 and Pr9.14 is not calculated. Otherwise, set Pr9.13 and Pr9.14 manually or automatically with a tool. * When Pr9.00 “Motor type selection” = 3 (VCM type), this setting value is invalid.
9	13	R	Proportional current gain	0 to 32767	—	Set a proportional current gain. In general, use the theoretical value as is calculated using Pr9.12.
9	14	R	Integral current gain	0 to 32767	—	Set an integral current gain. In general, use the theoretical value as is calculated using Pr9.12.
9	48	B	Voltage feed forward gain 1	0 to 32767	—	Set a voltage feed forward gain 1. The higher the setting, the higher the current response to the change in torque command becomes. However, since it may cause oscillation or any other faulty operation, select an appropriate value according to the operating conditions. There is no compatibility with the automatic setting by the use of Pr9.12.
9	49	B	Voltage feed forward gain 2	0 to 32767	—	Set a voltage feed forward gain 2. The higher the setting, the higher the current response to torque command. However, since it may cause oscillation or any other faulty operation, select an appropriate value according to the operating conditions. There is no compatibility with the automatic setting by the use of Pr9.12.

*1) For information on the parameter attribute, refer to the section 9-1.
*2) The value is calculated at power-on.

■Points to note

- Our servo amplifiers are made specifically for the connection with a motor that uses Y connection.
  If a motor for Δ connection is used, calculate the settings of Pr9.08 (Motor phase inductance) and Pr9.09 (Motor phase resistance) from the formula shown below.

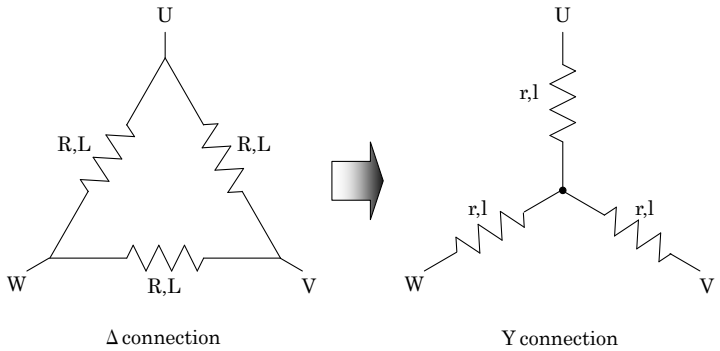
$$l = \frac{1}{3}L \qquad r = \frac{1}{3}R$$

L : Inductance between lines in Δ connection

R : Resistance between lines in Δ connection

l : Phase inductance in Y connection

r : Phase resistance in Y connection



Δ connection　　Y connection

- If the setting of Pr9.12 (Automatic current response adjustment) is other than 0, the theoretical values of Pr9.13 (Proportional current gain) and Pr9.14 (Integral current gain) are calculated from the settings of Pr9.08, Pr9.09, and Pr9.12. Therefore, note that if a wrong setting is entered for Pr9.08 and/or Pr9.09, correct theoretical values cannot be obtained and current response will be affected.

4-7-3 Pole position detection method setting

There are three ways to detect the motor's pole position: CS signal-using method (CS signal), automatic estimation method of pole position without using CS signal (Pole position estimation), and stored position-using method (Pole position recovery).
In the case of VCM type, pole detection is not performed.

4-7-3-1 CS signal method

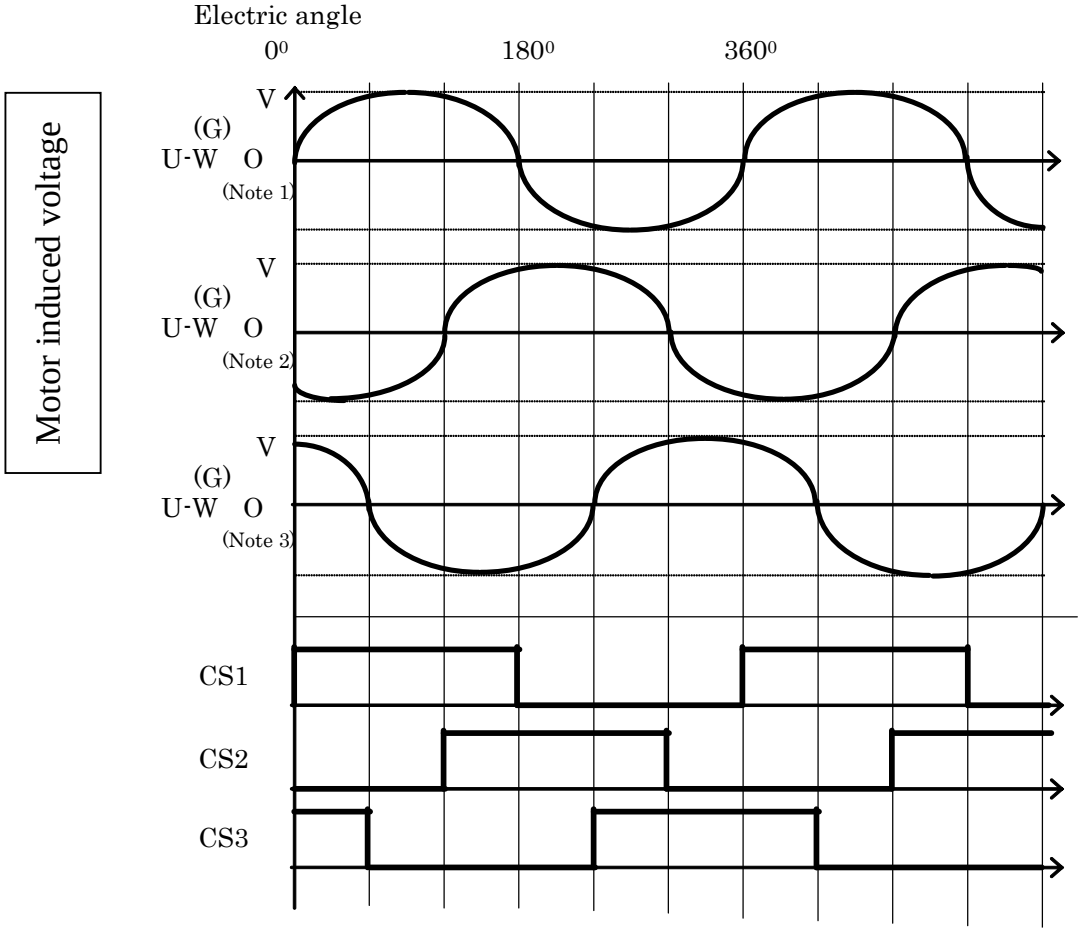
Detect a pole position by using the CS signals (CS1, CS2, CS3).
This section describes how to manually set the direction and phase of CS signal.
For information on the automatic setting with a tool, refer to the “Section 4-7-4”.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	20	R	Pole detection method	0 to 3	—	Set how to detect a pole position. 1: CS signal 2 Pole position estimation 3: Pole position recovery If the setting value is zero, Err60.0 “Motor setting error protection” occurs. If the setting value is other than zero and Pr9.00 “Motor type selection” = 3 (VCM type), this setting value is invalid.
9	21	R	CS phase	0 to 360	Electric angle (°)	Set the relative phase between the motor's induced voltage and CS signal. This setting is valid only when CS signal is selected (Pr9.20 = 1).
3	26	R	Feedback scale & CS reversal	0 to 3	—	Set the reversal of the feedback counter and CS signal direction of the feedback scale. [Scale] [CS signal] 0: not reversed not reversed 1: reversed not reversed 2: not reversed reversed 3: reversed reversed The logic setting of CS signal is valid only when the CS signal is selected (Pr9.20 = 1). For VCM, the logic setting of the CS signal is disabled.

*1) For information on the parameter attribute, refer to the section 9-1.

Connect the terminals so that the relationship between the motor's induced voltage and CS1, 2, 3 signals can meet the figure below.
Note that Pr9.21 “CS phase” enables to correct a relative phase. (See subsequent page)
Also, Pr3.26 enables to set the CS signal direction. (See the CS signal direction described later)

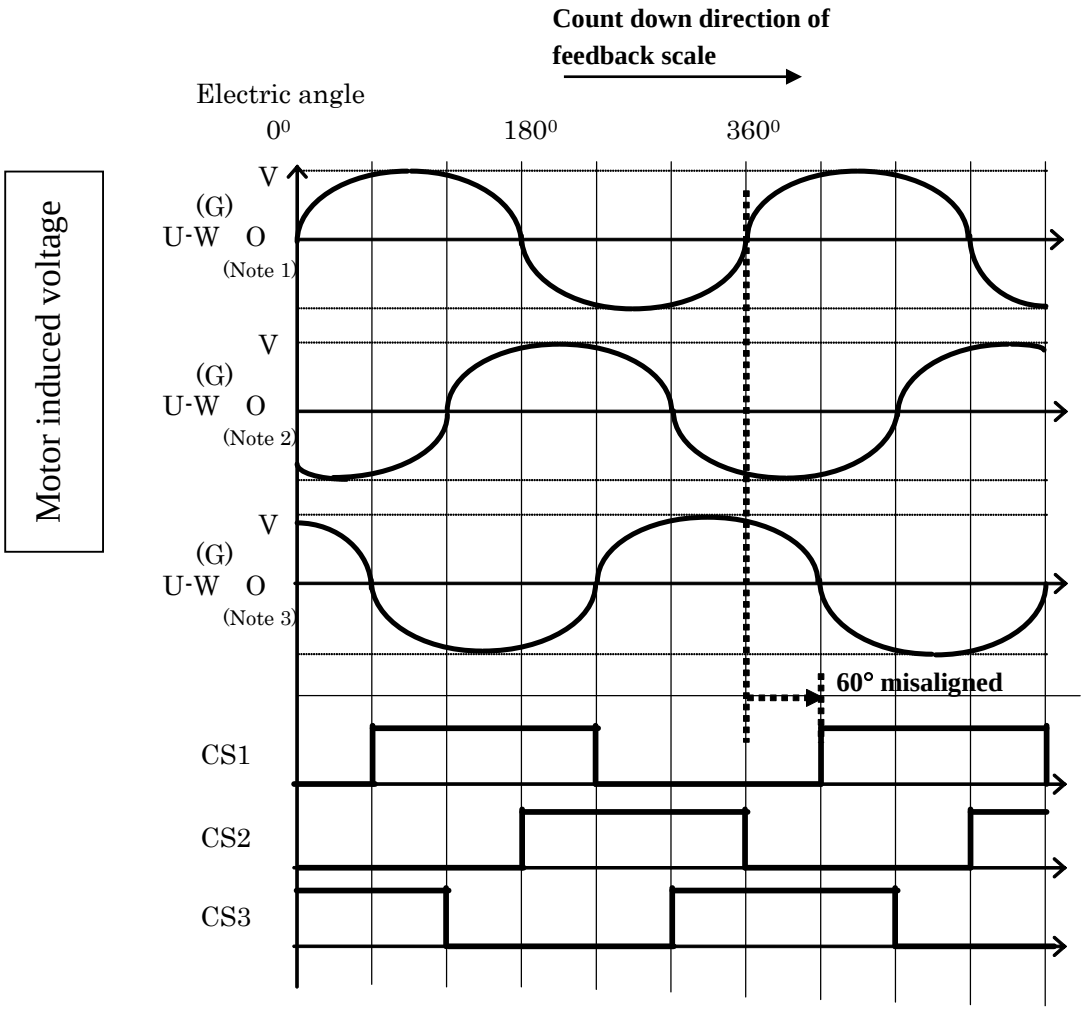


Note 1: It is a waveform generated when checking the induced voltage in the terminal U by connecting the terminal W with GND.
Note 2: It is a waveform generated when checking the induced voltage in the terminal V by connecting the terminal U with GND.
Note 3: It is a waveform generated when checking the induced voltage in the terminal W by connecting the terminal V with GND.

・How to set relative phase using Pr9.21 “CS phase”

If it is difficult to connect the terminals in the same way as shown in previous page, Pr9.21 “CS phase” enables to compensate the relative phase with the software.

For example, if the relationship between the induced voltage and CS signal is the same as shown in the figure below in the count down direction of the feedback scale, the rising edge misalignment is 60° between the induced voltage of the terminals U-W and the CS1 signal. So, set Pr9.21 to ‘60’.

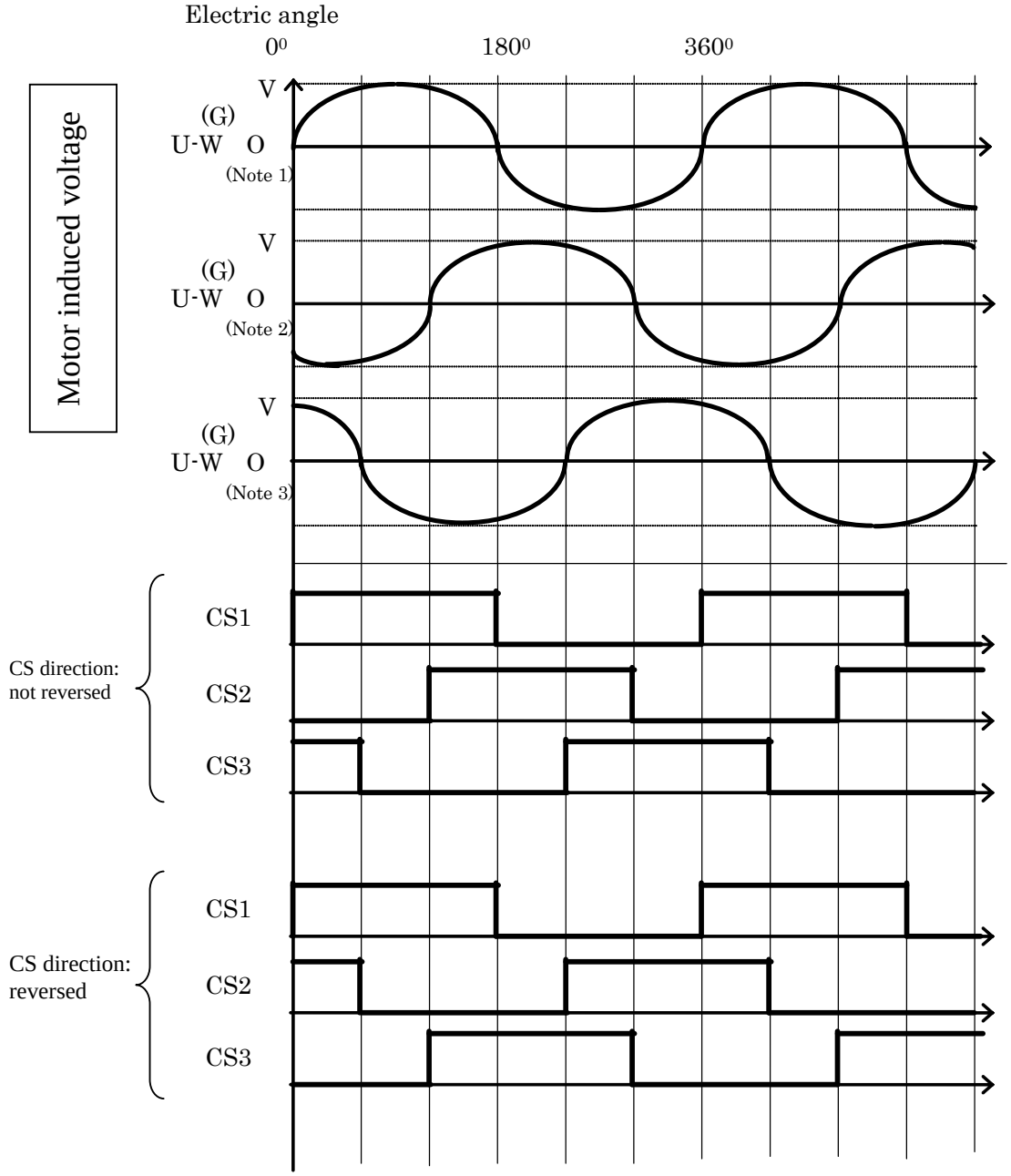


Note 1: It is a waveform generated when checking the induced voltage in the terminal U by connecting the terminal W with GND.

Note 2: It is a waveform generated when checking the induced voltage in the terminal V by connecting the terminal U with GND.

Note 3: It is a waveform generated when checking the induced voltage in the terminal W by connecting the terminal V with GND.

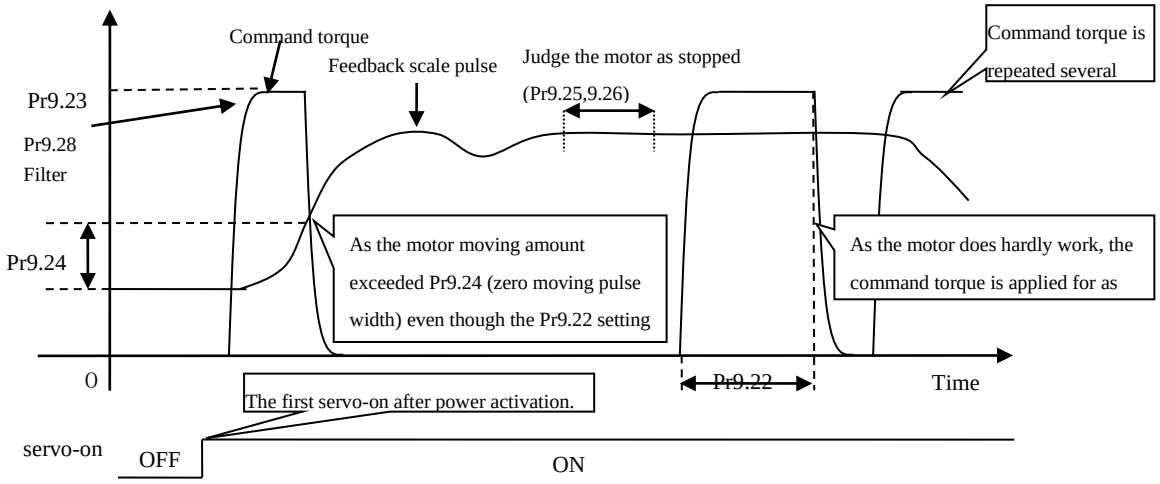
・How to set the CS signal direction by using Pr3.26 “Feedback scale & CS reversal”
There are two types of wiring patterns among CS1, CS2, and CS3 as shown in the figure below. In the figure above, the wiring among CS1, CS2, and CS3 is correct for the induced voltage, so set the CS signal direction to “not reversed” using Pr3.26.
On the contrary, in the figure below, the wiring between CS2 and CS3 is the reverse of the figure above, so set the CS signal direction to “reversed” by using Pr3.26.
The “reversed” CS direction exchanges CS2 and CS3 on the inside of the servo driver, so the motor works properly.



Note 1: It is a waveform generated when checking the induced voltage in the terminal U by connecting the terminal W with GND.
Note 2: It is a waveform generated when checking the induced voltage in the terminal V by connecting the terminal U with GND.
Note 3: It is a waveform generated when checking the induced voltage in the terminal W by connecting the terminal V with GND.

4-7-3-2 Pole position estimation method

The pole position is automatically estimated at the first servo-on after power-on (including soft-reset mode with a reset command in the RTEX communication) without using the CS signal. The pole position estimated is valid until the power supply is reset. After the power reset, the pole position is automatically estimated again at the first servo-on.



■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	20	R	Pole detection method	0 to 3	—	Set how to detect a pole position. 1: CS signal 2: Pole position estimation 3: Pole position recovery If the setting value is zero, Err60.0 “Motor setting error protection” occurs. If the setting value is other than zero and Pr9.00 “Motor type selection” = 3 (VCM type), this setting value is invalid.
9	22	B	Torque command time for estimating pole position	0 to 200	ms	・ Set the time to apply a command when estimating pole position. ・ When the moving pulse count of the motor goes over Pr9.24 setting value, the torque command stops even if the time does not expire. ・ If the setting value is small, the motor will not work adequately, resulting in a bad estimation accuracy or pole position estimation error. ・ This setting is valid only when the pole position estimation is selected (Pr9.20=2).
9	23	B	Command torque for estimating pole position	0 to 300	%	・ Set the torque per command when estimating pole position. ・ If the setting value is small, the motor will not work adequately, resulting in a bad estimation accuracy or pole position estimation error. ・ This setting is valid only when the pole position estimation is selected (Pr9.20=2). Note: The actual command torque is limited by the maximum allowable torque of the motor.

(To be continued)

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	24	B	Zero moving pulse width for estimating pole position	0 to 32767	pulse	・ Set the pulse width for judging as a zero moving in the pole position estimation. ・ When the motor moving pulse is less than this setting value regardless of the torque application under the Pr9.22 and Pr9.23 conditions, it is judged as a zero travel. ・ The travel amount can be reduced in the pole position estimation by reducing the setting value, but the estimated accuracy may be poor. Roughly speaking, set the number of pulses corresponding to the electric angle. ・ This setting is valid only when the pole position estimation is selected (Pr9.20=2).
9	25	B	Stop pulse count for estimating pole position	0 to 32767	pulse	・ Set the condition for judging the motor as stopped in the pole position estimation. ・ When the motor moving pulse count is not more than Pr9.25 for Pr9.26 [ms] at 2 ms interval, the motor is judged as stopped and next torque command is applied. ・ This setting is valid only when the pole position estimation is selected (Pr9.20=2).
9	26	B	Stop time for estimating pole position	0 to 32767	ms	
9	27	B	Stop time limit for estimating pole position	0 to 32767	ms	・ Set the time limit for judging the motor as stopped in the pole position estimation. ・ If the motor is not judged as stopped even if this setting time expires, Err61.1 Pole position estimation error 2 occurs. ・ This setting is valid only when the pole position estimation is selected (Pr9.20=2).
9	28	B	Torque command filter for estimating pole position	0 to 2500	0.01ms	・ Set the time constant of the filter for the torque command in the pole position estimation. If the setting value is zero, the filter will be invalid and only a step command will be available. ・ This setting is valid only while estimating the pole position when the pole position estimation is selected (Pr9.20=2).

*1) For information on the parameter attribute, refer to the section 9-1.

■ Points to note

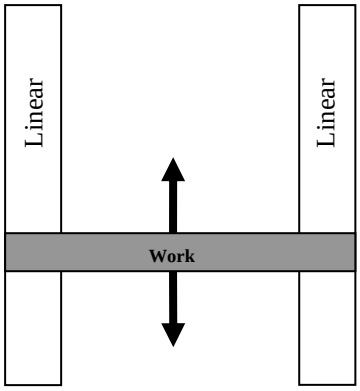
- This function is done at the first servo-on after power-on. The motor works when estimating the pole position, the operation commands are generated on the inside of the servo driver regardless of the operation commands (including control mode) from upper equipment, so fully take care so as not to collide with the end of the unit.
- This function may not work as expected when the vertical axis, uneven load, or friction is large.
- The setting values for Prs9.22 to 9.27 are valid set during the startup of the pole position estimation. The change is ignored while estimating the pole position.
- For the estimated accuracy when estimating the pole position, check the segment 7 LED (Pr7.00=8) in the front panel or PANATERM's status monitor. The smaller this numeric value is, the better the accuracy is. This accuracy is an estimated accuracy based on the pole position estimation method and will not warrant a real accuracy. Use it only for reference.
- When multiple axes lock the same work as shown in the figure below:

Do not run the pole position estimation (at the first servo-on after power-on) in the multiple axes at the same time.

As synchronous operation is not available while estimating the pole position, the pole position estimation cannot be finished properly because the axes may suffer an impact from other axis, the estimation result finished might have a large error, or **the unit may be damaged.**

Be sure that the axes excluded from the pole position estimation cannot give any impact on the axis to be estimated.

In this configuration, we recommend you to use the CS signal method (4-7-3-1) or Pole position recovery (4-7-3-3).
To use the pole position recovery method, apply the pole position estimation to each linear motor alone.



・ In the case of CP control, since the operation instruction from a host device becomes effective to the timing which magnetic pole position estimate completed, when the difference of the stop position at the time of the completion of magnetic pole position presumption and an instruction position is large, it moves to an instruction position suddenly, vibration may occur.
Therefore, it is necessary to take the following measures as processing of a host device or a system.
(measure1) Using CMD-POS_Invalid bit to make command position invalid during magnetic pole position estimation.
(measure2) Making command position follow during magnetic pole position estimation.
A setup of Pr7.40 bit0 by the amplifier side, 0 is set up in the measure 1. 1 is set up in the measure 2.
When the specification of a host device is unknown, please check whether it is improved by setting Pr7.40 bit0 to 1.
*For details, refer to Technical Reference RTEX Communication Specification ”Section 7-1-2”.

■ Relevant parameter

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
7	40	C	RTEX function extension setup 4	-32768 –32767	—	bit0: Set up a condition for turning ON the Servo_Active bit for the RTEX status when magnet pole position estimation is valid (Pr 9.20 = 2). 0: Not dependent on magnet pole position estimation 1: Forcedly OFF during Magnet pole position estimation
7	43	B	Magnet pole position estimation completion output setup	0-8	—	Set up the pit arrangement for outputting magnet pole position estimation completion output (CS_Complete) to byte 3 for the RTEX status. This setting will override the setting of Pr7.40 bit1. 0: Not allotted 1: Byte 3, bit0 (NOT/POT) 2: Byte 3, bit1 (POT/NOT) 3: Byte 3, bit2 (HOME) 4: Byte 3, bit3 (SI-MON1/EXT1/CS1) 5: Byte 3, bit4 (SI-MON2/EXT2/RET/CS2) 6: Byte 3, bit5 (SI-MON3/EXT3/STOP/CS3) 7: Byte 3, bit6 (SI-MON4/EX-SON) 8: Byte 3, bit7 (SI-MON5/EXT-STOP) * Information in () refers to a signal name before allotment.

*1) For information on the parameter attribute, refer to the section 9-1.

4-7-3-3 Pole position recovery method

Once a pole position is estimated with the pole position estimation method (4-7-3-2), the pole position can be stored and the motor can be controlled by using the pole position even after the power reset.
This recovery method can be supported only when the feedback scale of absolute type is used.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
9	20	R	Pole detection method	0 to 3	—	Set how to detect a pole position. 1: CS signal 2: Pole position estimation 3: Pole position recovery If the setting value is zero, Err60.0 “Motor setting error protection” occurs. If the setting value is other than zero and Pr9.00 “Motor type selection” = 3 (VCM type), this setting value is invalid.

*1) For information on the parameter attribute, refer to the section 9-1.

■Procedures 1 (normal operation)

(1) Restart the control power supply after setting to Pr9.20=2 and writing it into EEPROM.
(2) Execute magnet pole position estimation (refer to 4-7-3-2).
(3) Restart the control power supply after changing to Pr9.20=3 and writing it into EEPROM.

* After this process, the magnet pole position estimation result from execution in (2) is restored at control power supply restart

■Procedures 2 (at amplifier replacement)

It is possible to restore the magnet pole estimation result for a different amplifier by following the procedures below to execute setup.

(1) Connect with the amplifier to be the source of magnet pole position estimation result copying via PANATERM, and save the parameter information for the source amplifier.
(2) Connect with the amplifier to copy the magnet pole position estimation result via PANATERM.
(3) Select “Copy magnet pole position estimation result” from “Other” menu on PANATERM.
(4) Select “Load” to load the parameter information saved in (1).
(5) Select “Execute” and write the magnet pole position estimation result into the subject amplifier.
(6) Restart the control power supply after setting to Pr9.20=3 and writing it into EEPROM.

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

■ Points to note

・ The estimation result of the pole position is stored in the driver. When the combination of the driver and linear motor is changed (exchange of driver, linear motor, or feedback scale), the pole position may change, thereby disabling you to control the motor properly.
In this case, because the driver cannot recognize the change, an alarm will not occur.
When one of components above is exchanged at least, set Pr9.20=2 once. Then, estimate the poles position again and set Pr9.20=3.

・ Procedures 2 is for the case when the linear motor and the feedback scale are not exchanged but the amplifier alone is exchanged. When exchanging the linear motor and the feedback scale, because the pole position changes, an incorrect estimation result of pole position will be written in the amplifier and **it inhibits normal motor control.** When changing the motor, **estimate the pole position again before use.**

・ When this method is selected while the pole position is not estimated at all or while the estimation result of the pole position is cleared, Err61.2 “Magnetic pole position estimation error 3” occurs.

・ The estimation result of the pole position is cleared when the detection method of pole position is not specified (Pr9.20=0).
However, EEPROM relevant alarms (Errs36.0 - 2, Errs37.0 - 2) are not cleared. Also, any alarm is not cleared when Err11.0 “Control power undervoltage protection” occurred.

・ When this method is selected while using the feedback scale of other than absolute type, Err61.2 “Pole position estimation error 3” occurs.

4-7-4 Automatic linear motor setting with tool

The initial parameter (current gain, feedback scale direction, CS direction) for the combination with a linear motor can be automatically set by using the automatic setting tool (MotorAutoSetup).

■ Parameter changed by the automatic linear motor setting

The automatic linear motor setting updates the parameters below:

Class	No.	At-trib-ute *1)	Title	Setting range	Unit	Function
3	26	R	Feedback scale & CS reversal	0 to 3	—	Set the reversal of the feedback counter and CS signal direction of the feedback scale. [Scale] [CS signal] 0: not reversed not reversed 1: reversed not reversed 2: not reversed reversed 3: reversed reversed The logic setting of CS signal is valid only when the CS signal is selected (Pr9.20 = 1). For VCM, the logic setting of the CS signal is disabled.
9	13	B	Proportional current gain	0 to 32767	—	Set a proportional current gain.
9	14	B	Integral current gain	0 to 32767	—	Set an integral current gain.
9	21	R	CS phase	0 to 360	Electric angle (°)	Set the relative phase between the motor's induced voltage and CS signal. This setting is valid only when CS signal is selected (Pr9.20 = 1).

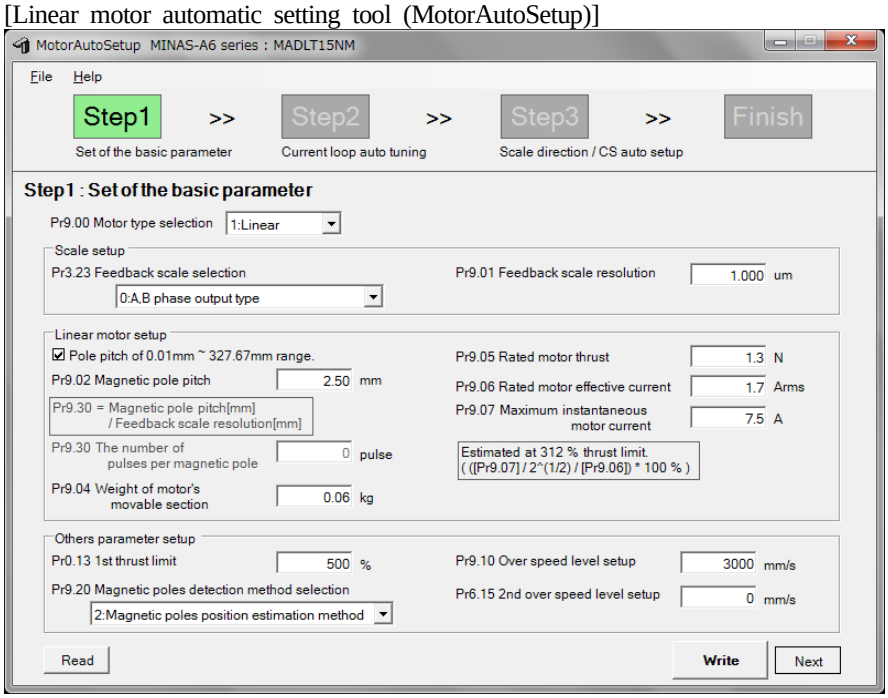
*1) For information on the parameter attribute, refer to the section 9-1.

- To set Pr9.13 “Proportional current gain” and Pr9.14 “Integral current gain” by using the automatic linear motor setting, set Pr9.12 “Automatic current response adjustment” to zero.

■ How to automatically set linear motor

For automatically setting a linear motor, the automatic setting tool (MotorAutoSetup) is required. (For information on the automatic setting tool, contact us.)

[Linear motor automatic setting tool (MotorAutoSetup)]



When the automatic setting starts, the linear motor works in order to automatically set up the linear motor after the servo-on. After the automatic setting is finished, the servo is automatically turned OFF.

<u>After the automatic setting, make sure to reset the power supply of the servo driver finally.</u>

(For information on how to use the linear motor automatic setting tool, refer to the tool's procedure manual.)

■ Points to note

・The version of the tool compatible with A6NL series is 2.0.0.1 or later.
In the case of VCM type, the automatic setting tool (MotorAutoSetup series is 2.0.0.3 or later) is not available.

・In the linear motor automatic setting, the motor may move up to two cycles of electric angle.
Secure the movable range in advance before the automatic setting.

・This function may not work as expected when the vertical axis, uneven load, or friction is large.
Also, the tool may not work properly when a load is mounted. If this is the case, run the tool with the linear motor alone by unmounting the load.

・The tool may not work properly when the basic setting is not correct for the linear motor and scale. Set the data properly by referring to "4-7-1 Parameter setting according to linear motor/feedback scale specification" in advance.

・If the network is established with the upper controller while automatically setting the linear motor, Err60.3 "Linear motor automatic setting error protection" occurs and the tool is killed.

・If Pr9.20 "Pole detection method" = 2 (Pole position estimation), when the linear motor is automatically set while the pole position estimation was finished, the pole position estimation becomes unfinished. The pole position will be estimated on next servo-on.

・If the torque command is overshot while automatically setting the linear motor, Err60.3 "Linear motor automatic setting error protection" occurs and the tool is killed.

・When the external servo-on signal is allocated for input signal allocation, turn ON the external servo-on signal. If the external servo-on signal remains OFF, the servo cannot turn ON and the automatic setting cannot start.
Also, if the external servo-on signal is turned OFF during the automatic setting, the servo turns OFF and the tool is killed.

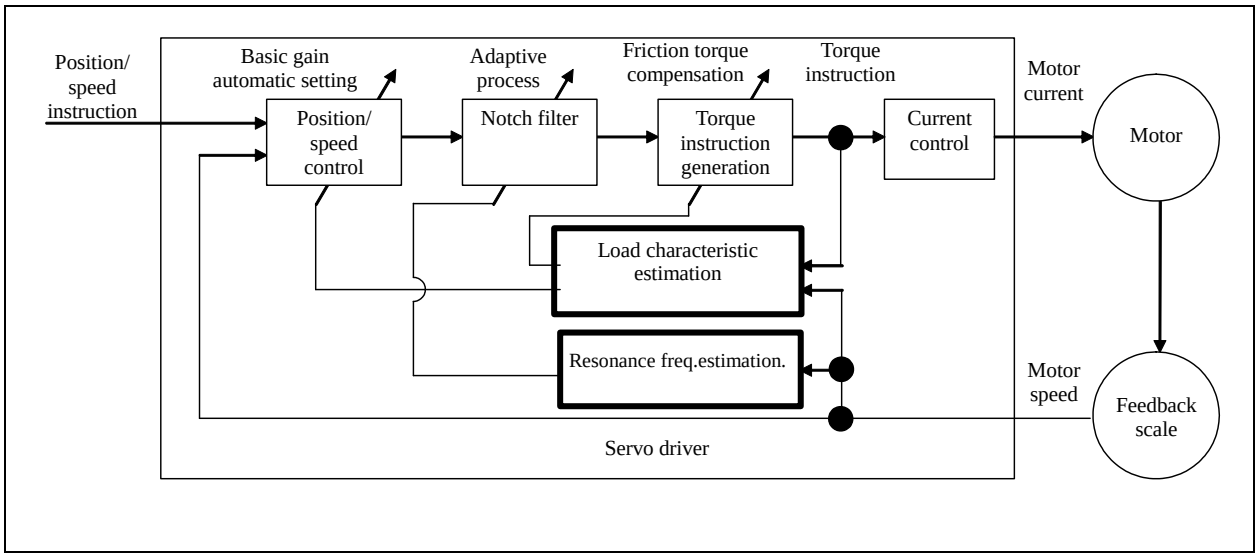
・Pr9.48 "Voltage feed forward gain 1" and Pr9.49 "Voltage feed forward gain 2" are not compatible with the automatic setup of the current gain. Any execution of the automatic setup will result in a setting of zero (0).

・After the automatic setting is finished, make sure to reset the power supply of the servo driver and establish the network with the upper controller. If it is tried to establish network with the upper controller without resetting the power supply of the servo driver, Err60.3 "Linear motor automatic setting error protection" occurs.

5. Gain tuning/vibration suppressing function

5-1 Automatic adjusting function

The figure below shows outline of automatic adjusting function of MINAS-A6NL 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.

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. • The mass ratio is not estimated and the thrust compensation value is not updated while estimating the pole position.

2) Points to note

- 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.
Others	• The feedback scale resolution is low. (1 μm/pulse or more) • The estimation accuracy of magnetic pole position estimation is low.

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 use

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. • Adaptive operation will not be executed during magnetic pole position estimation.

2) Points to note

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].
Others	• The feedback scale resolution is low. (1 μm/pulse or more) • The feedback scale resolution is high. (0.01 μm/pulse or less)

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: Maker uses.

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

Note: Two-degree-of-freedom control mode has the standard type and synchronization type. However only standard type is available on MINAS-A6NL series.

1) Applicable range

This function is enabled under the following conditions:

	Conditions for real-time auto tuning
Control mode	Position Control or Velocity 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) Points to note

- 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.
Others	• The feedback scale resolution is low. (1 µm/pulse or more) • The estimation accuracy of magnetic pole position estimation is low.

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>For manufacturer’s use</td><td>Don’t use this setting.</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.

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) How to use

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.

[5] 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.

5-2 Manual adjusting function

As explained previously, MINAS-A6NL 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) Gain switching function (5-2-4)
5) Notch filter (5-2-5)
6) Damping control (5-2-6)
7) Model type damping filter (5-2-7)
8) Feed forward function (5-2-8)
9) Load variation suppression function (5-2-9)
10) 3rd gain switching function (5-2-10)
11) Friction torque compensation (5-2-11)
12) Two-stage torque filter (5-2-12)
13) Quadrant projection suppression function (5-2-13)
14) Two-degree-of-freedom control mode (with position control) (5-2-14)
15) Two-degree-of-freedom control mode (with velocity control) (5-2-15)

5-2-1 Block diagram of position control mode

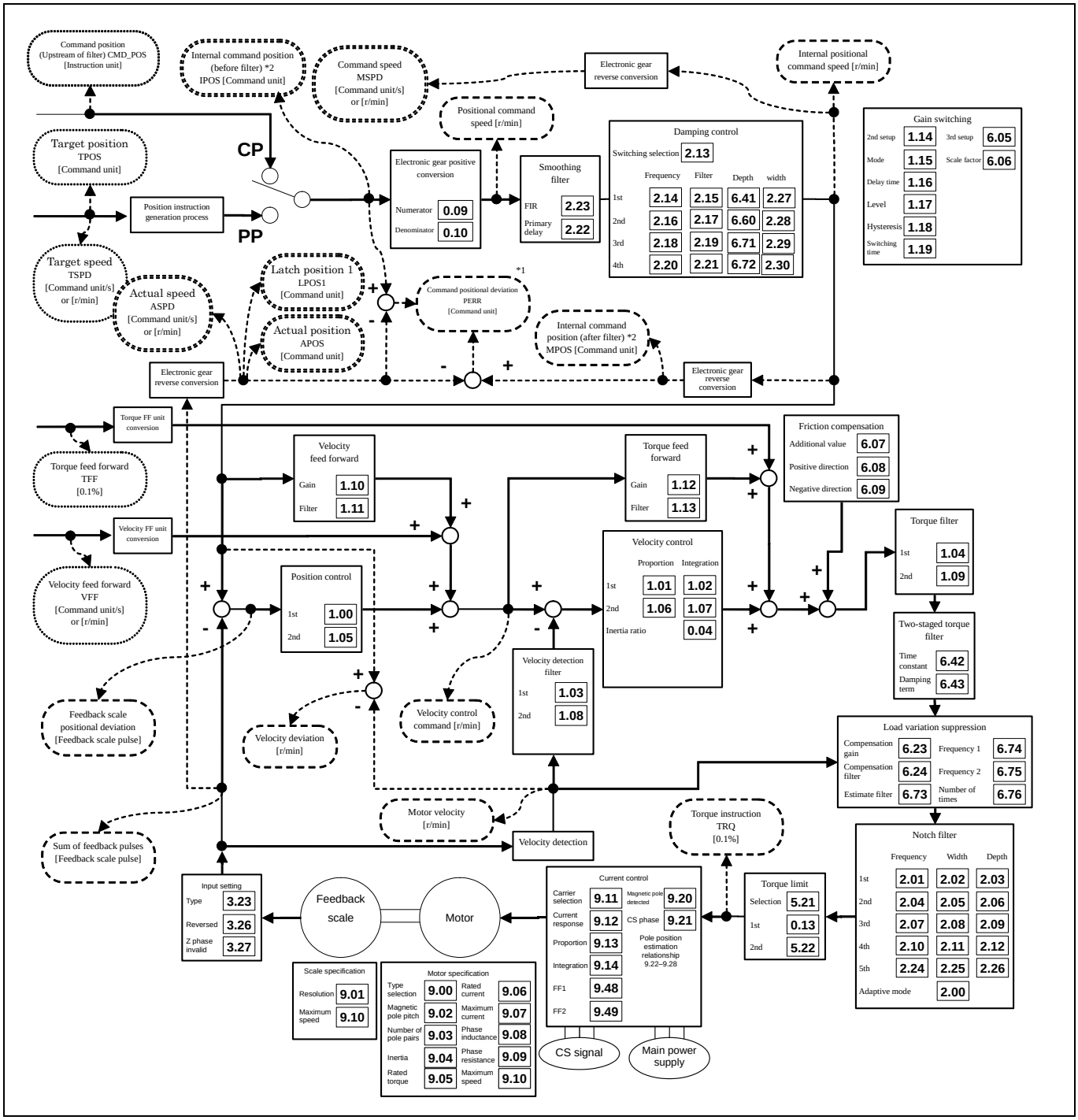
The diagram below shows position control block of MINAS-A6NL series.

- 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 Command position on PANATERM changes depending on the Command pulse aggregate value output setting (bit3) of Pr7.99 "RTEX function extended setup 6".

*3 When performing test run function or frequency characteristic analysis (position loop characteristic) from the PANATERM, the driver switches to position control internally.

5-2-2 Block diagram of velocity control mode

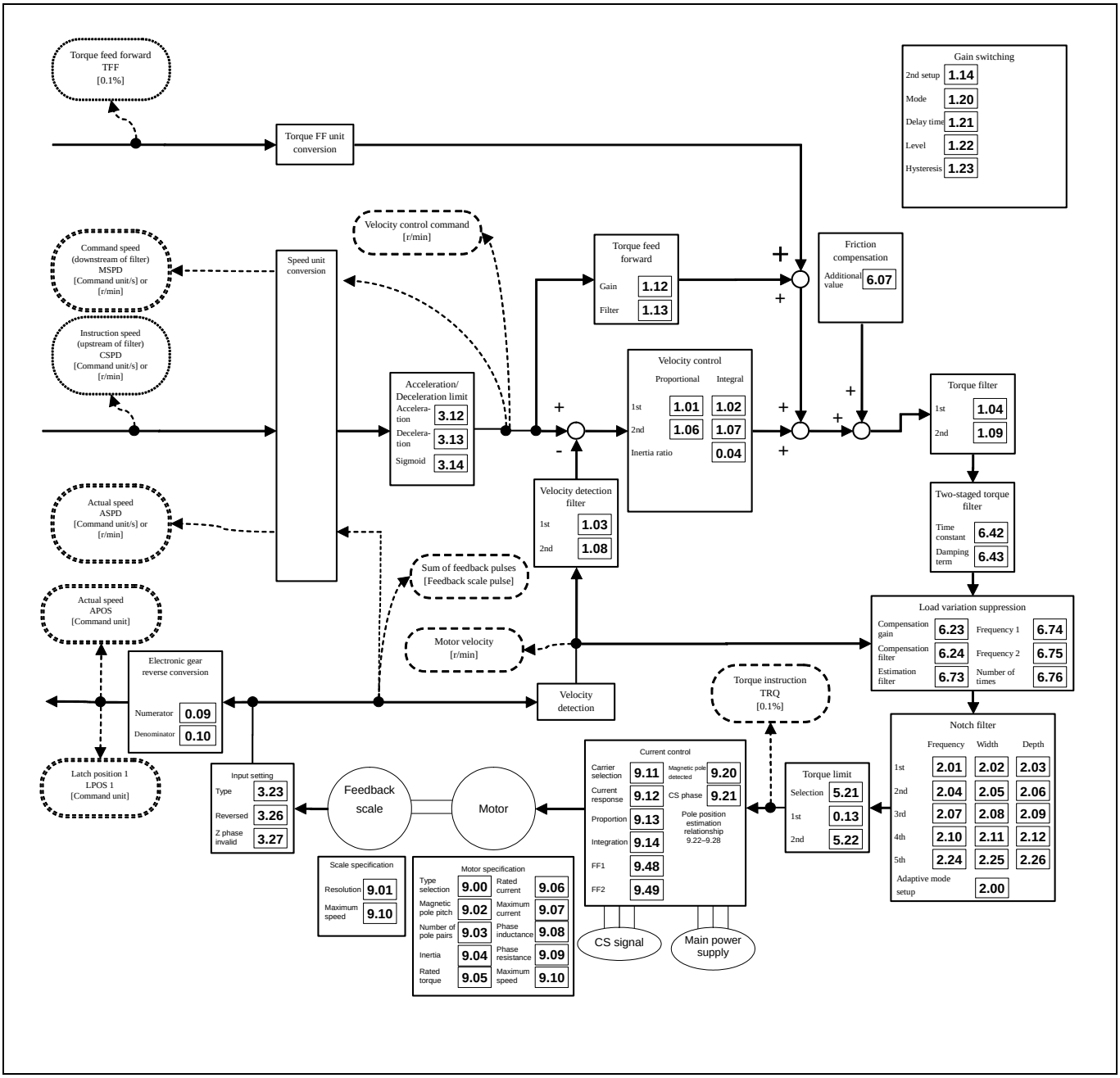
The diagram below shows velocity control block of MINAS-A6NL series.

• Cyclic velocity control mode (CV)

RTEX command data

RTEX monitor data

PANATERM/RTEX monitor data



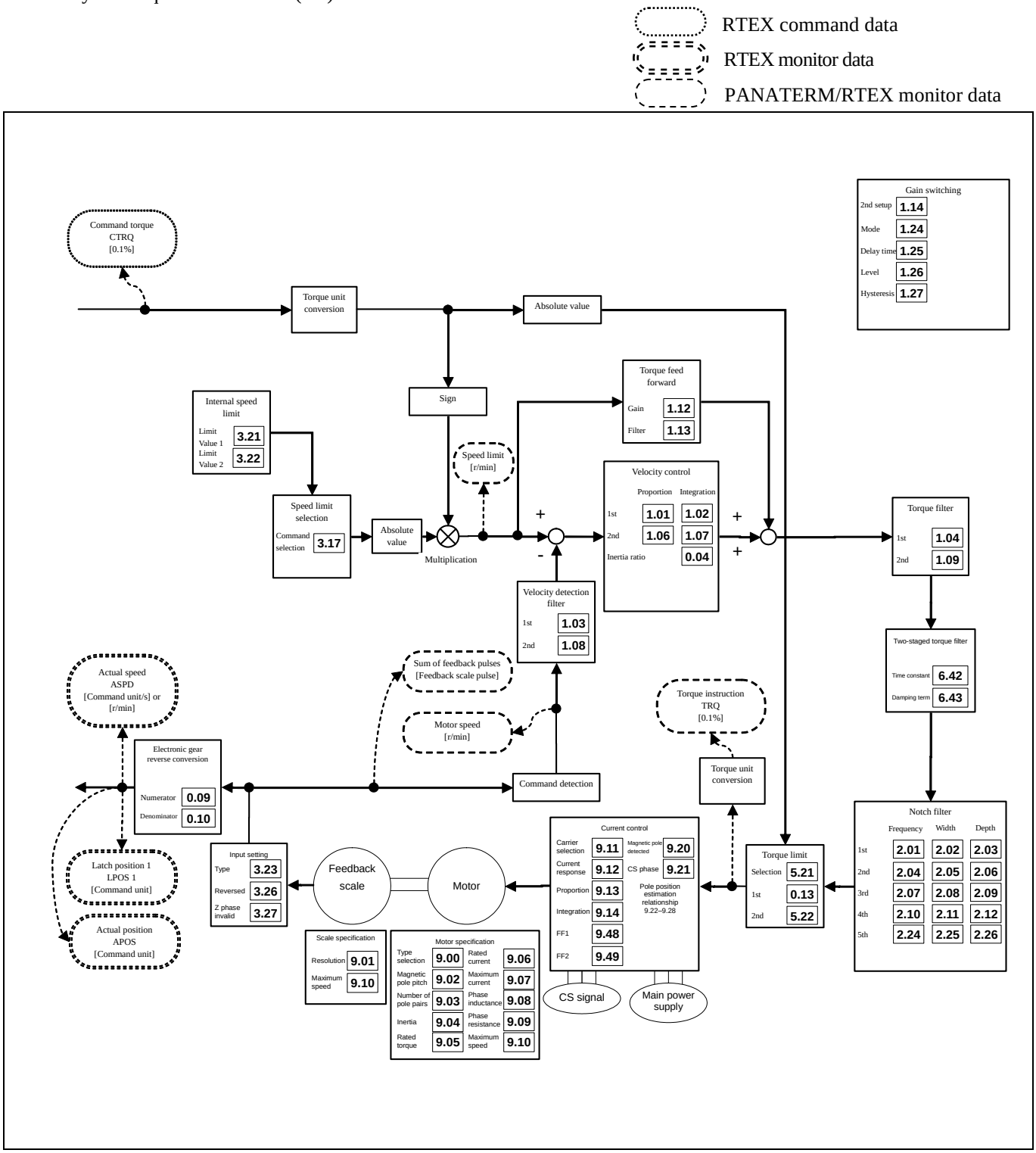
Block diagram of velocity control

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

5-2-3 Block diagram of torque control mode

The diagram below shows the torque control block of MINAS-A6NL 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 2 and earlier versions.

5-2-4 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 (level–hysteresis) (%) or below 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 (level–hysteresis) (10 r/min/s) or below 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 and velocity 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 (level- hysteresis) (r/min) or below previously during delay time with the 2nd gain.
6	Position deviation is large	• Valid for position control. • 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 (level–hysteresis) (pulse) or below previously over delay time with the 2nd gain. * Unit of level and hysteresis (pulse) is set as the feedback scale resolution.

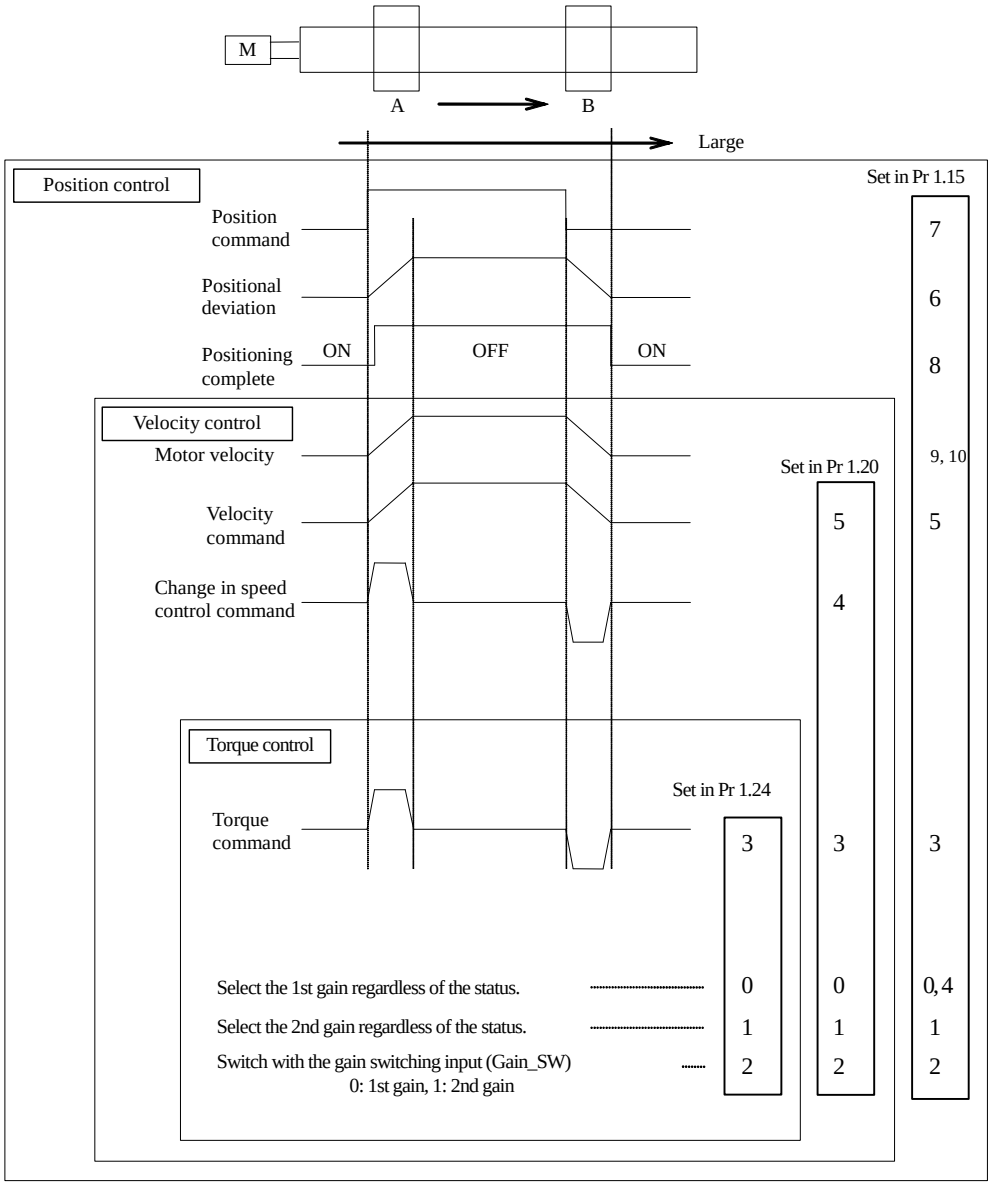
(To be continued)

Setup value (Pr1.15)	Switching condition	Gain switching condition
7	Position command exists	• Valid for position control. • 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 control. • 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 control. • 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 (level -hysteresis) (r/min) or below previously during delay time with the 2nd gain.
10	Position command exists + Actual speed	• Valid for position control. • 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 (level–hysteresis) (r/min) or below previously with the 2nd gain.

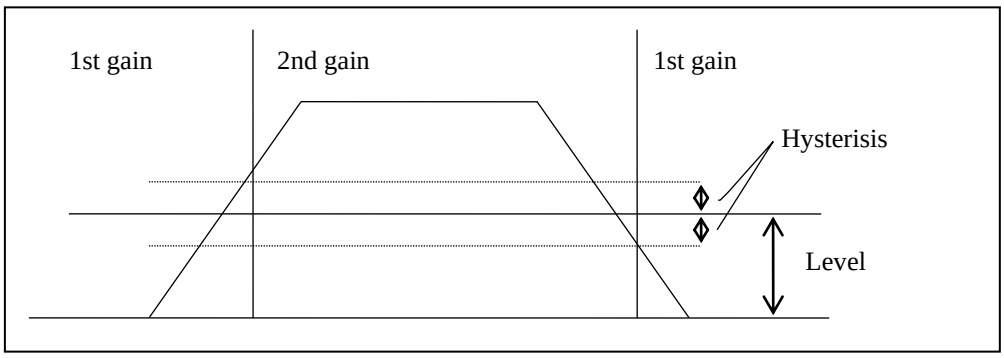
3) How to set

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”

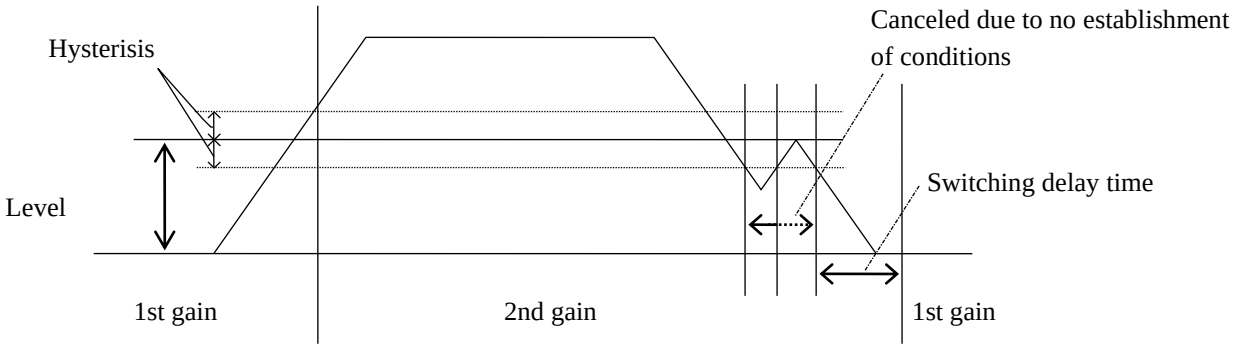


2) Set up the switching level and Hysteresis depending on the switching conditions.



3) Set up the switching delay time.

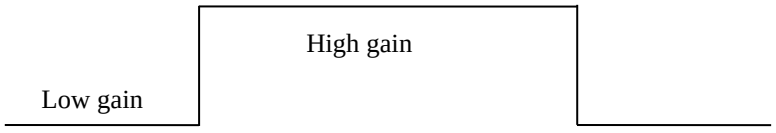
Set up the time delay for switching from 2nd gain to 1st gain.
Switching conditions have to be established continuously during the switching delay time for the switching from the 2nd to the 1st.



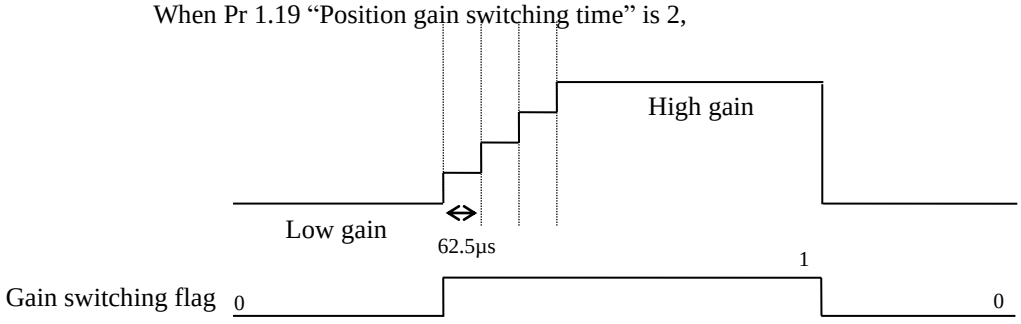
4) Set up the switching time of position gain.

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,



5-2-5 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-A6NL 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.

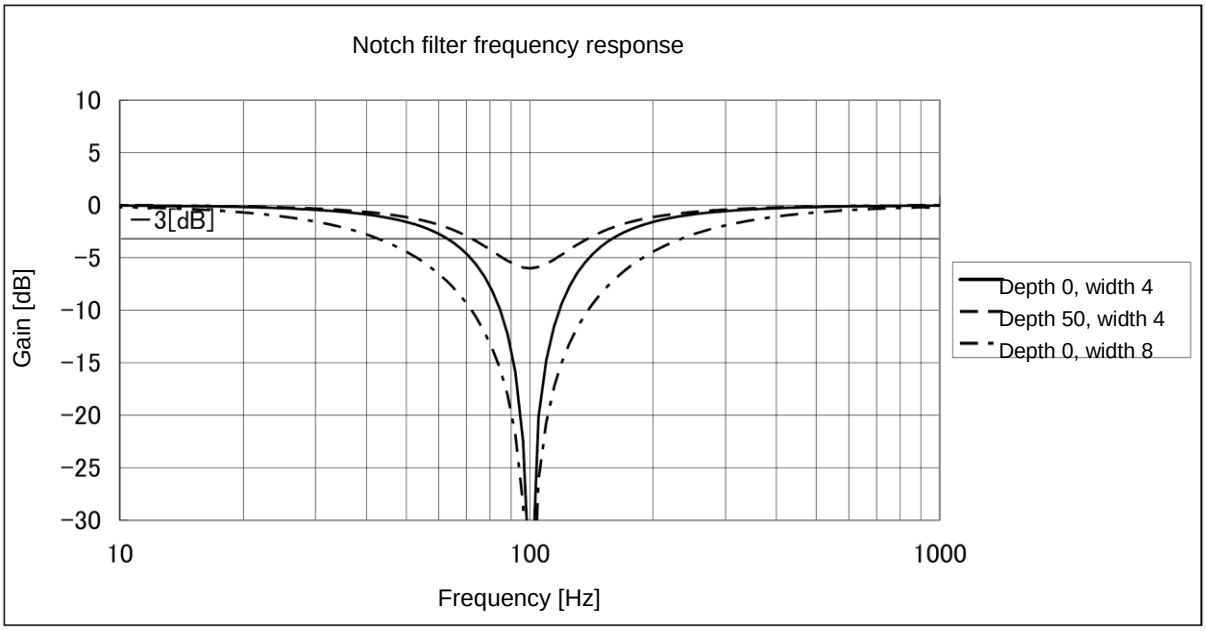
3) Notch width and depth

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.

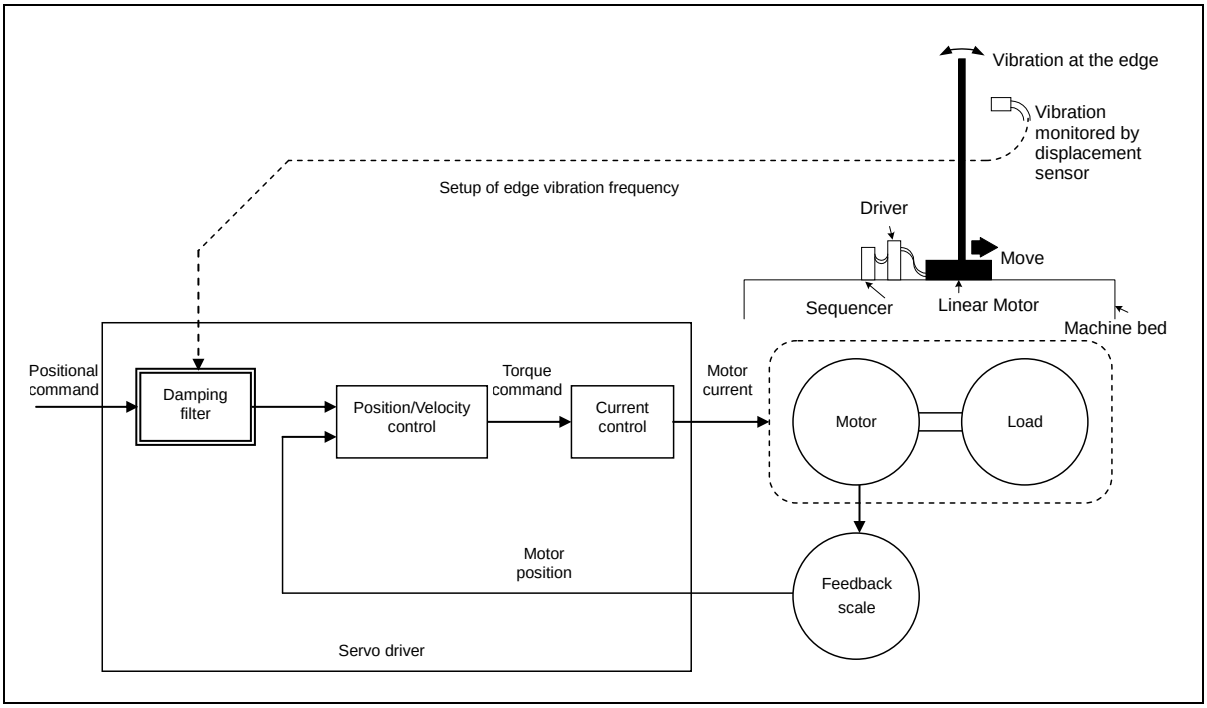
Notch width	Band width/center frequency
0	0.25
1	0.30
2	0.35
3	0.42
4	0.50
5	0.59
6	0.71
7	0.84
8	1.00
9	1.19
10	1.41
11	1.68
12	2.00
13	2.38
14	2.83
15	3.36
16	4.00
17	4.76
18	5.66
19	6.73
20	8.00

Notch depth	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



5-2-6 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.

2) Points to note

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>
</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.

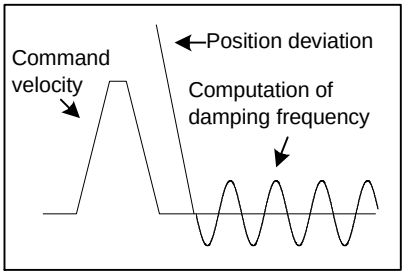
*1) For parameter attribute, refer to Section 9-1.

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.

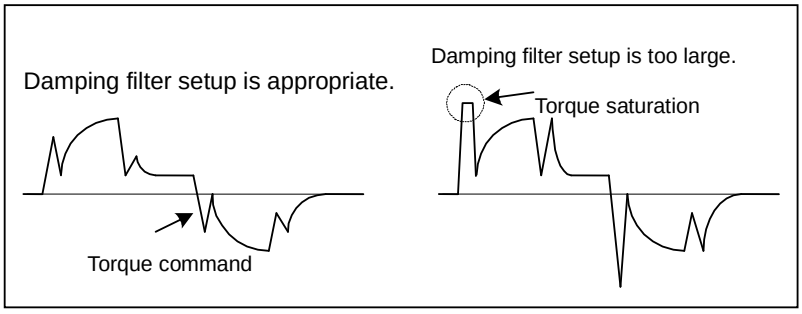
If suitable measuring device is not available, measure the frequency according to the residual vibration of the position deviation waveform measured by the vibration frequency monitor of the setup support software PANATERM or a waveform graphic function.



(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.

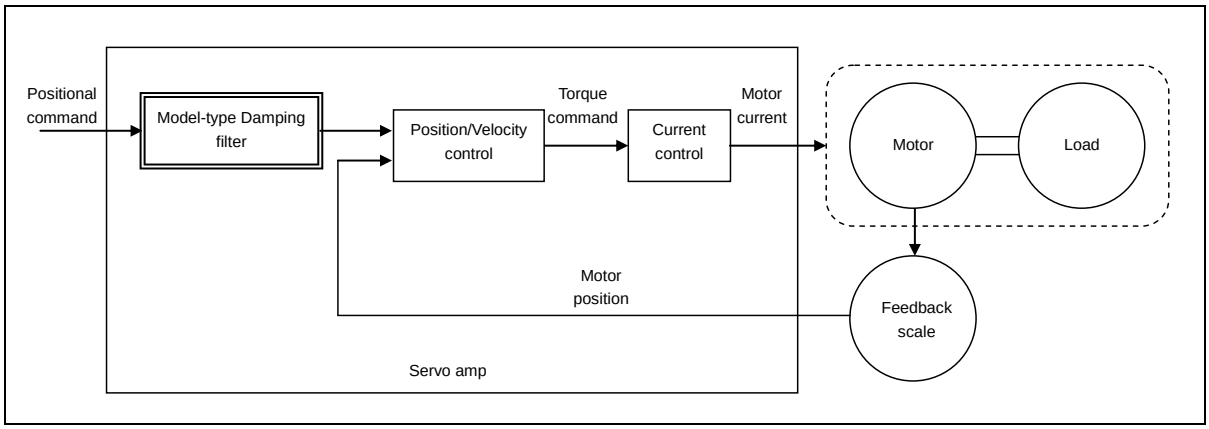


(3) Setup of damping depth (Pr 6.41, Pr 6.60, Pr 6.71, Pr 6.72)
Setup of damping width (Pr 2.27, Pr 2.28, Pr 2.29, Pr 2.30)

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.

5-2-7 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) Points to note

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>
</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]

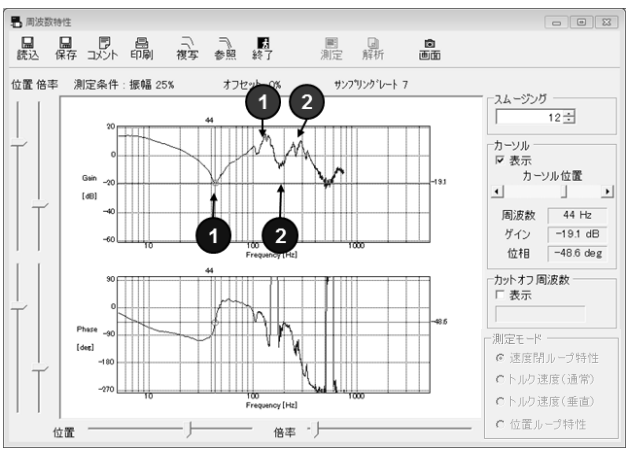
[2] The resonance attenuation ratio and anti-resonance attenuation ratio should have initial values of around 50 (0.050).

[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

5-2-8 Feed forward function

When position control 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).

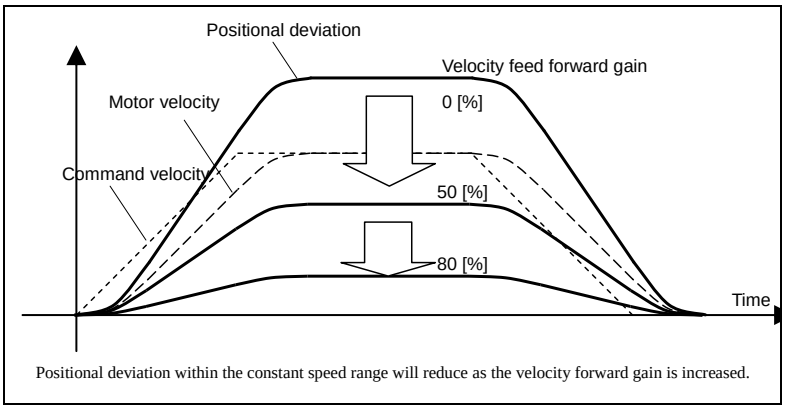
1) Relevant parameters
For MINAS-A6NL series, the velocity feed forward and torque feed forward can be used.

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. * It becomes invalid in two-degree-of-freedom control mode.
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.

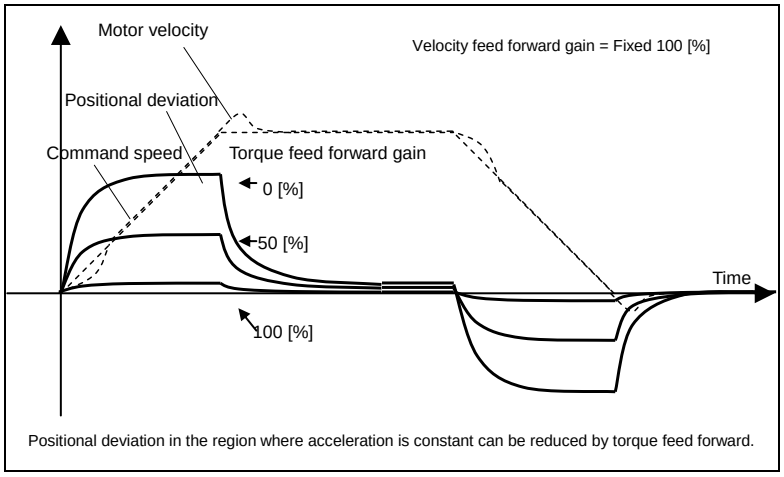
Positional deviation [unit of command] = command velocity [unit of command/s] /
positional loop gain [1/s] × (100–velocity feed forward gain [%]) / 100



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.

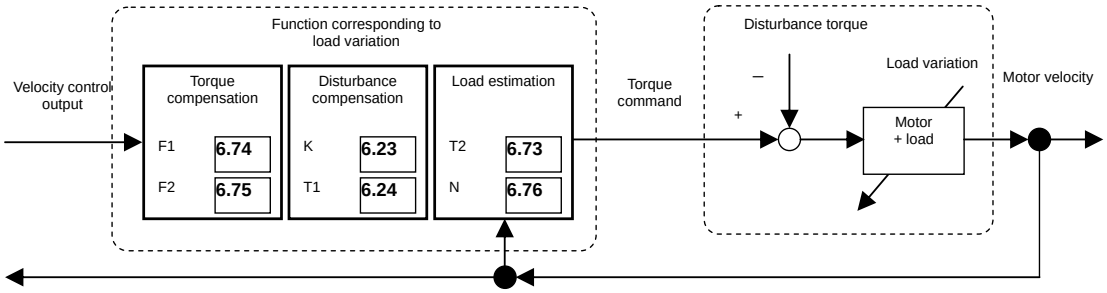
3) Usage example of torque feed forward
To use the torque feed forward, correctly set the inertia ratio. Use the value that was determined at the start of the real time auto tuning, or set the inertia ratio that can be calculated from the machine specification to Pr 0.04 “Inertia ratio”.
The torque feed 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.

5-2-9 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 or Velocity 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

□ 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.
Other	• The feedback scale resolution is low. (1 μm/pulse or more)

(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 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 feedback scale 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] Confirm the maximum and minimum values in Pr. 0.04 "Inertia ratio."

Possible methods for doing this are as follows.

1) Make theoretical calculation based on the system design information
2) Operate the system within the range not significantly varying the inertia ratio while changing the system's posture/condition, and read out the acceleration/deceleration torque and motor acceleration. Then, make calculation from the equation: Total inertia = torque / acceleration
3) While operating within the range not significantly varying the inertia ratio, check the inertia estimation value with Pr. 0.02 = 5 (load characteristic measuring mode) of real-time auto tuning.
4) If no information can be obtained, use 0% as minimum value and the motor's permissible load inertia as maximum value.

* For an articulated robot, make measurement while moving it to the posture where the load inertia becomes maximum/minimum for each joint.
* For pick & place equipment, make measurement with maximum payload and no load.

[2] Make gain adjustment under the following conditions.

With the load variation suppression function disabled (Pr. 6.10 bit1=0) and in the posture/condition where Pr. 0.04 "Inertia ratio" becomes minimum, make gain adjustment by specifying the maximum value in Pr. 0.04 "Inertia ratio."

* Make adjustment so that Pr. 1.01 "1st velocity loop gain"(Kvp) becomes as high as possible.
* Please note that in applications where a large and steep load inertia variation is generated, the real-time auto tuning function and adaptive filter may not be able to correctly estimate load, which may result in oscillation and vibration.

[3] Turn off the servo and then specify initial values in the following parameters.

Pr. 0.02 "Real-time auto tuning mode setting" = 0 (disabled)
Change Pr. 0.04 "Inertia ratio" to the minimum value in [1].
Pr. 1.00 "1st position loop gain" = Pr. 1.01 "1st velocity loop gain"
Pr. 1.02 "1st velocity integration time constant" = 1000.0 ms (disabled)
Pr. 6.23 "Load variation compensation gain" = 100%
Pr. 6.24 "Load variation compensation filter" = Time constant converted value of velocity loop gain (Kvp)
(Ex: where the rigidity is 16, Kvp=50.0 Hz, then Pr. 6.24 =1/(Kvp*2π) = 3.18 ms)
Pr. 6.73 "Load estimation filter" = 0.10 ms
Pr. 6.76 "Load estimation count" = 4

[4] Change the following parameter setting according to the variation ratio α of the total inertia.

Pr. 6.74 "Torque compensation frequency 1" = frequency converted value Hz in Pr. 6.24
(Ex.: If Pr. 6.24 = 3.18 ms = 0.00318 s, then the frequency converted value = 1/ (Pr. 6.24[s]*2π) = 50.0 Hz)
Pr. 6.75 "Torque compensation frequency 2" = frequency converted value Hz/α in Pr. 6.24

* The variation ratio α of the total inertia is the ratio of the maximum and minimum (>1) values of the aggregated inertia of the motor and load. The value in Pr. 0.04 "Inertia ratio," which can be calculated by real-time auto tuning, does not include the inertia portion of the motor, and thus the following calculation should be made to compute the total inertia to obtain the variation ratio α.

  Variation ratio α = ((maximum value in Pr. 0.04) + 100%) / ((minimum value in Pr. 0.04) + 100%)

[5] Set bit1 to 1 in Pr. 6.10 "Function expansion setting" to enable the load variation suppression function.

* 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, turn off the servo and then increase the value of Pr. 6.24 in Step [3] to a value about twice as large. Then reset Pr. 6.74 and Pr. 6.75 in Step [4] to enable it. If the oscillation or abnormal sound still persists, return to Step [1] and decrease the velocity loop gain by about 50% to 75% before repeating the subsequent steps.

[6] Specify a small value as possible in Pr. 6.24 "Load variation compensation filter."

In addition to changing Pr. 6.24, carry out Step [4] to increase Pr. 6.74 and Pr. 6.75.
Specifying a smaller value within the range that does not produce any significant abnormal sound or torque command variation will improve the stability against load variation. Try various operations including the posture and condition where the load inertia becomes maximum or minimum to check the motor operation.

* When an abnormal sound at high frequency (1 kHz or above) is generated, increase the value in Pr. 6.76 "Load estimation count."

5-2-10 3rd gain switching function

In addition to the normal gain switching function described on 5-2-4, 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.
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.

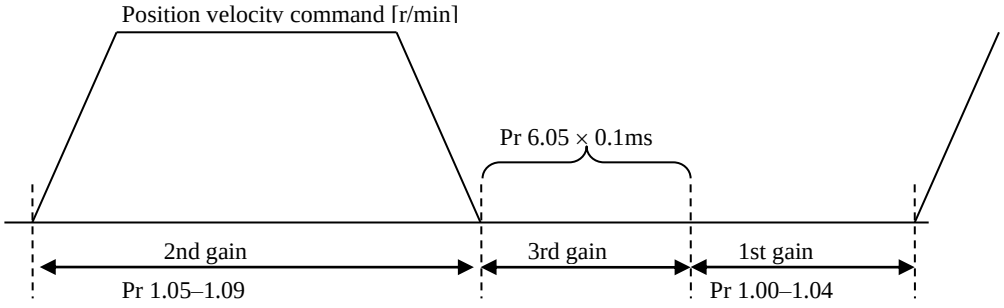
(3) How to use

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.
- 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.

5-2-11 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

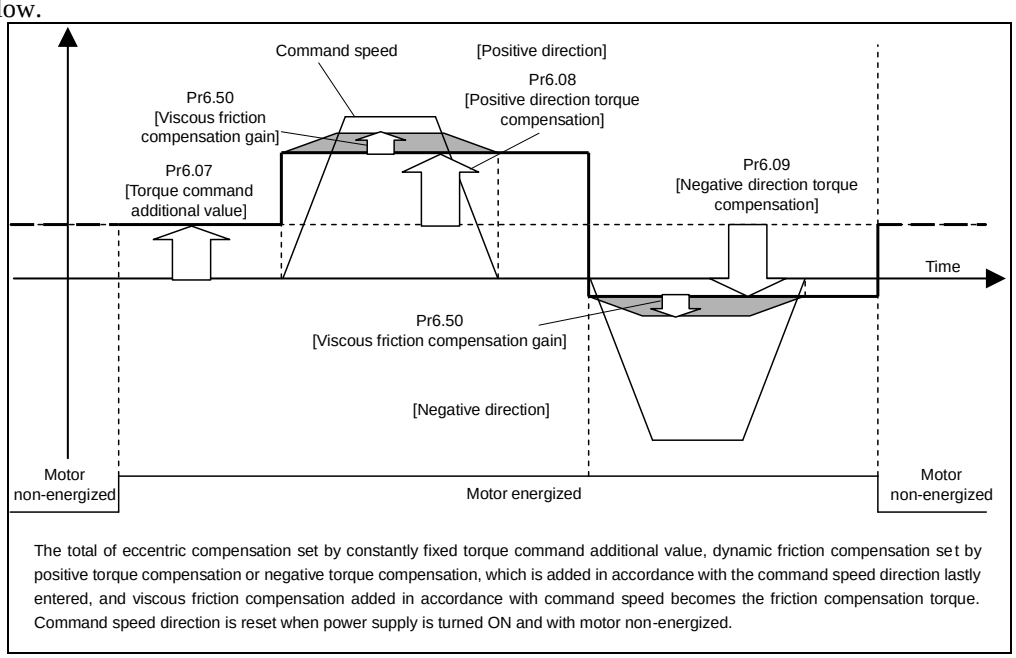
Combine the following 3 parameters to setup appropriate friction torque compensation.

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 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 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.

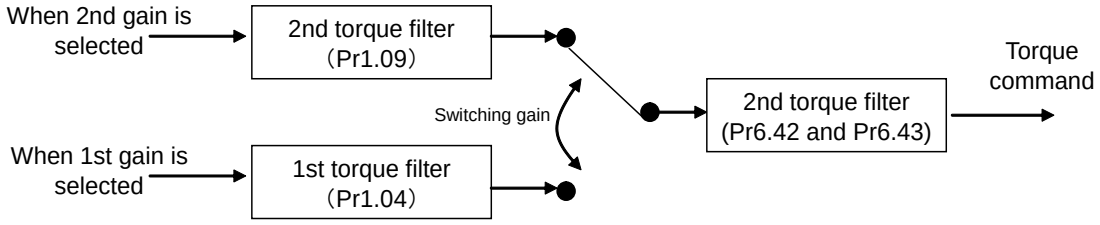
- Pr 6.07 “Torque command additional value” reduces variations in positioning operation (performance is affected by direction of movement). These variations occur when constant offset torque resulting from weight on vertical axis is applied to the motor.
- Certain loads such as belt driven shaft requires 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 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.

5-2-12 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) Applicable 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	• In servo-ON state • Elements, such as deviation counter clear command input inhibition and torque limit, other than control parameter are set properly, and motor is running without any problem.

(2) Points to note

- 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) How to use

In the event that the high-pass vibration is unable to be removed by conventional first and second torque filters, set the two-stage torque filter. With Pr6.43 "Two-stage torque filter 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 5.

5-2-13 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) Applicable range

☐ 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.
Others	・To be in Servo-On state. ・Elements other than control parameters, such as prohibition of deviation counter clear command input and torque limit, etc. are set appropriately, in a state where there are no obstructions in normal motor revolutions.

(2) Points to note

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

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

(3) Relevant 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 5-2-9, 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.

5-2-14 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.

(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
Other	• The servo is ON. • Elements other than control parameters such as torque limit are set properly, and there is no obstacle to normal motor operation.

(2) Relevant 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).
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 For manufacturer’s use Fix to 0. * The least significant bit is bit0.
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 feedback scale 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 feedback scale 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.

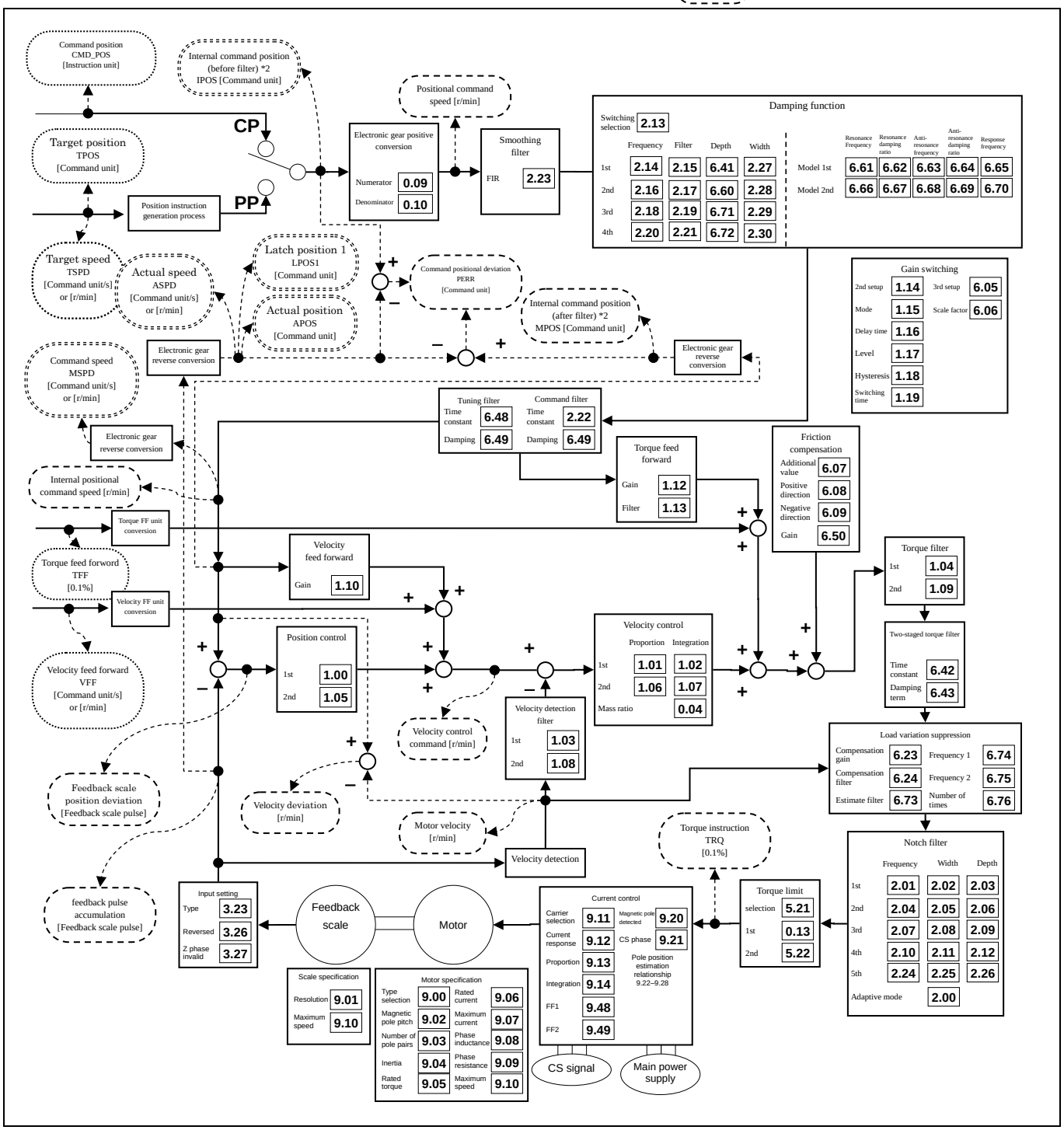
*2) Switching of “Adjustment filter,Command response filter and adjustment filter damping term setting” is performed on the rising edge of the command when the number of command pulses (before positional command filter) per command pulse detection frequency (0.125 ms) changes from 0 to a value other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

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

(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 positional deviation [command unit] can be changed by bit14 for Pr7.23 “RTEX function extended setup 2”.

*2 Command position on PANATERM changes depending on the Command pulse aggregate value output setting (bit3) of Pr7.99 "RTEX function extended setup 6".

*3 When performing test run function or frequency characteristic analysis (position loop characteristic) from the PANATERM, the driver switches to position control internally.

5-2-15 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.

(1) Applicable range

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

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

(2) Relevant 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.

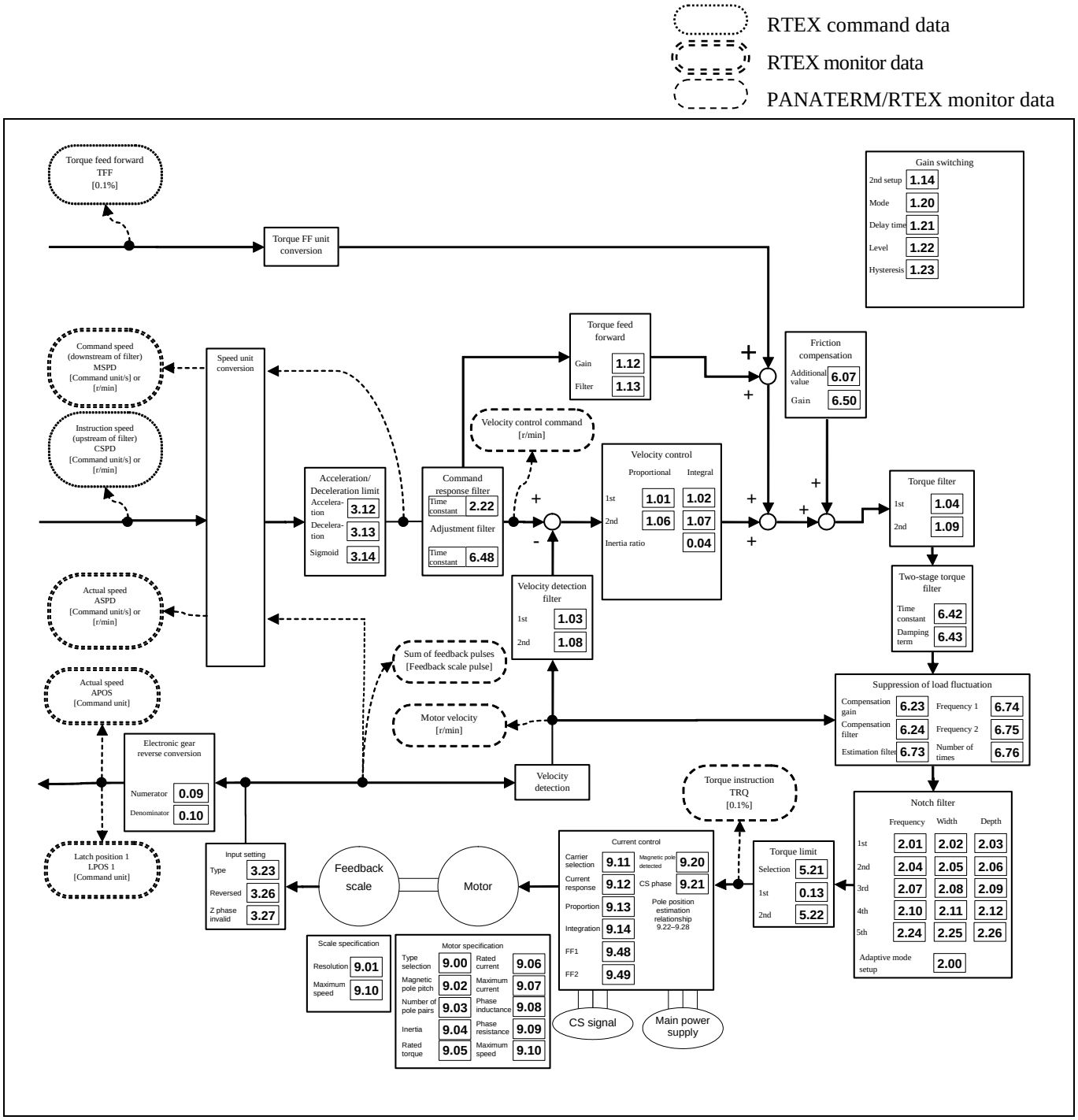
Thereafter, adjust the related parameters by real-time auto-tuning (see 5-1-3). Only when further improvement is required, manually finely adjust the following parameters while confirming responses.

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 For manufacturer’s use Fix to 0. *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 speed 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 analysis (Speed close loop characteristic, Torque speed(Vertical)) from the PANATERM, the driver switches to velocity control internally.

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) During torque controlling or performing Frequency characteristic analysis (Torque speed(normal)) from the PANATERM, the switching function is disabled and only Pr. 0.13 “1st torque limit” is enabled.

(2) 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>0</td><td>13</td><td>B</td><td>1st torque limit</td><td>0–500</td><td>%</td><td>You can set up the 1st limit value of the motor output torque.</td></tr>
<tr><td>5</td><td>21</td><td>B</td><td>Selection of torque limit</td><td>0–4</td><td>—</td><td>You can set up the torque limiting method.
<table>
<tr><th rowspan="2">Setup value</th><th colspan="2">TL_SW = 0</th><th colspan="2">TL_SW = 1</th></tr>
<tr><th>Negative direction</th><th>Positive direction</th><th>Negative direction</th><th>Positive direction</th></tr>
<tr><td>1</td><td colspan="4">Pr 0.13</td></tr>
<tr><td>2</td><td>Pr 5.22</td><td>Pr 0.13</td><td>Pr 5.22</td><td>Pr 0.13</td></tr>
<tr><td>3</td><td colspan="2">Pr 0.13</td><td colspan="2">Pr 5.22</td></tr>
<tr><td>4</td><td>Pr 5.22</td><td>Pr 0.13</td><td>Pr 5.26</td><td>Pr 5.25</td></tr>
</table>
*If 0 is set for this parameter, 1 is internally set.</td></tr>
<tr><td>5</td><td>22</td><td>B</td><td>2nd torque limit</td><td>0–500</td><td>%</td><td>You can set up the 2nd limit value of the motor output torque.</td></tr>
<tr><td>5</td><td>23</td><td>B</td><td>Torque limit switching setup 1</td><td>0–4000</td><td>ms/100 %</td><td>Set the rate of change (gradient) from value 1 to value 2 during torque limit change.</td></tr>
<tr><td>5</td><td>24</td><td>B</td><td>Torque limit switching setup 2</td><td>0–4000</td><td>ms/100 %</td><td>Set the rate of change (gradient) from value 2 to value 1 during torque limit change.</td></tr>
<tr><td>5</td><td>25</td><td>B</td><td>Positive direction torque limit</td><td>0–500</td><td>%</td><td>Set up positive direction torque limit upon receiving torque limit switching.</td></tr>
<tr><td>5</td><td>26</td><td>B</td><td>Negative direction torque limit</td><td>0–500</td><td>%</td><td>Set up negative direction torque limit upon receiving torque limit switching.</td></tr>
</table>

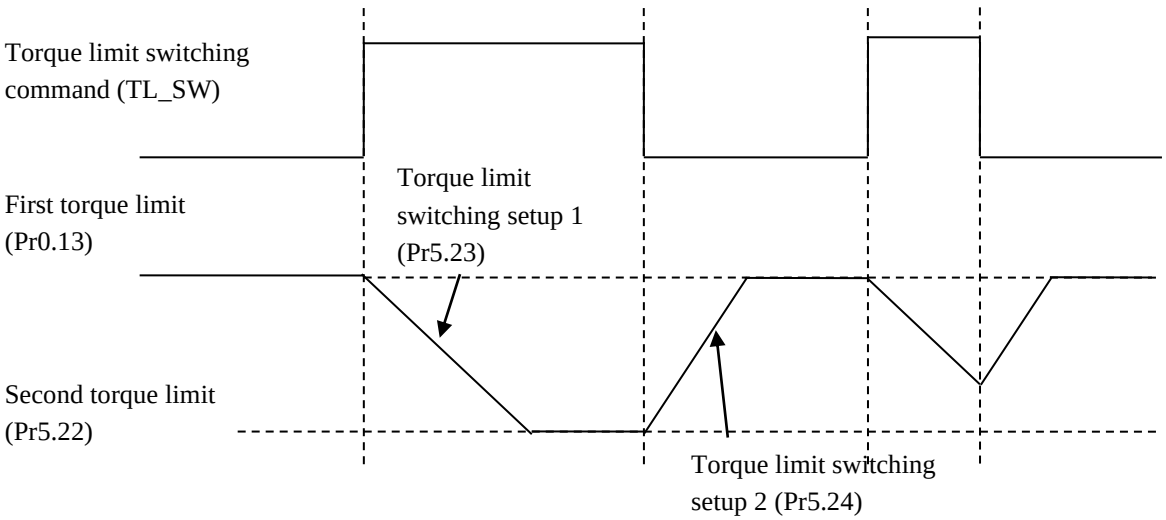
*1) For parameter attribute, refer to Section 9-1.

(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 first torque limit (Pr0.13) and the second 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.
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

- <u>This function is not a protection against the abnormal position command.</u>
- 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 ([Feedback scale pulse] unit) managed internally in the amplifier, exceeds -2^{31} to $2^{31}-1$, 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
- 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 operation using setup support software (PANATERM).
  - －A state in which pole position estimation isn't completed under Pr9.20=2(Pole position estimation method).
  - －During automatic linear motor setting by the automatic setting tool (MotorAutoSetup).
  - －Pr5.14 = 0
  - －When Pr5.14 satisfies the following formula (when the value of Pr5.14 converted into feedback scale pulse units exceeds 2^{31}). *1

Motor type is linear type (Pr9.00=1)	Pr5.14 > (2^{31} -1) * Pr9.01 / (Pr9.02 * 1000) or Pr5.14 > (2^{31} -1) * 10 / Pr9.30
Motor type is rotary type (Pr9.00=2)	Pr5.14 > (2^{31} -1) * Pr9.03 * 10 / Pr9.01
Motor type is VCM type (Pr9.00=3)	Pr5.14 > (2^{31} -1) * Pr9.01 / 1000000

  - －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

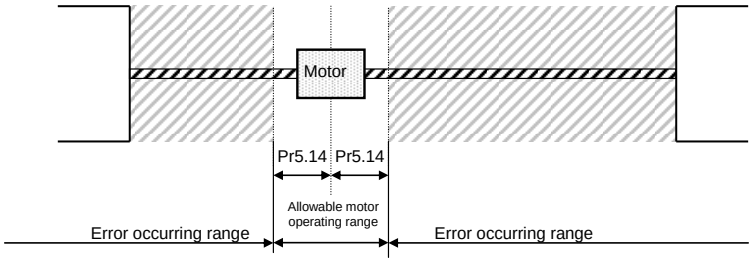
(3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	14	A	Motor working range setup	0–1000	0.1 magnetic pole pitch	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

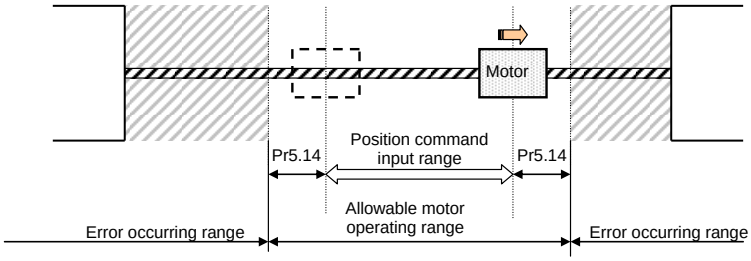
*1) For parameter attribute, refer to Section 9-1.

(4) Example of movement

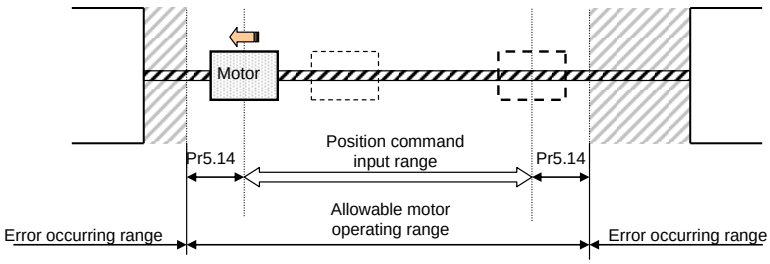
(1) When no position command is entered (Servo-ON status)
The motor movable range will be the travel range which is set at both sides of the motor with Pr5.14 since no position command is entered. When the load enters to the Err34.0 occurrence range (oblique line range), software limit protection will 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. Regardless of operating condition, torque in over-travel inhibition direction is 0. *3) 1: Sequence upon inputting of over-travel inhibition are disabled, having no effect on operation. *4) 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 a technical document , RTEX communication.

*3) During magnet pole position estimation, and automatic linear motor setup, Err 38.0 “Over-travel inhibit input protection 1” is caused by the input of either of POT and NOT.

*4) Under the condition that POT is allocated to SI6 or NOT is allocated to SI7, Err 38.2 “Over-travel inhibit input protection 3” is caused if Pr5.04 “Over-travel inhibit input setup” is set other than 1(disabled).

(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, feedback scale deviation 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”.

*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. ※Please do not change the shipment value setting with V frame.
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. ※Please do not change the shipment value setting with V frame.
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.

*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” bit0= 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.

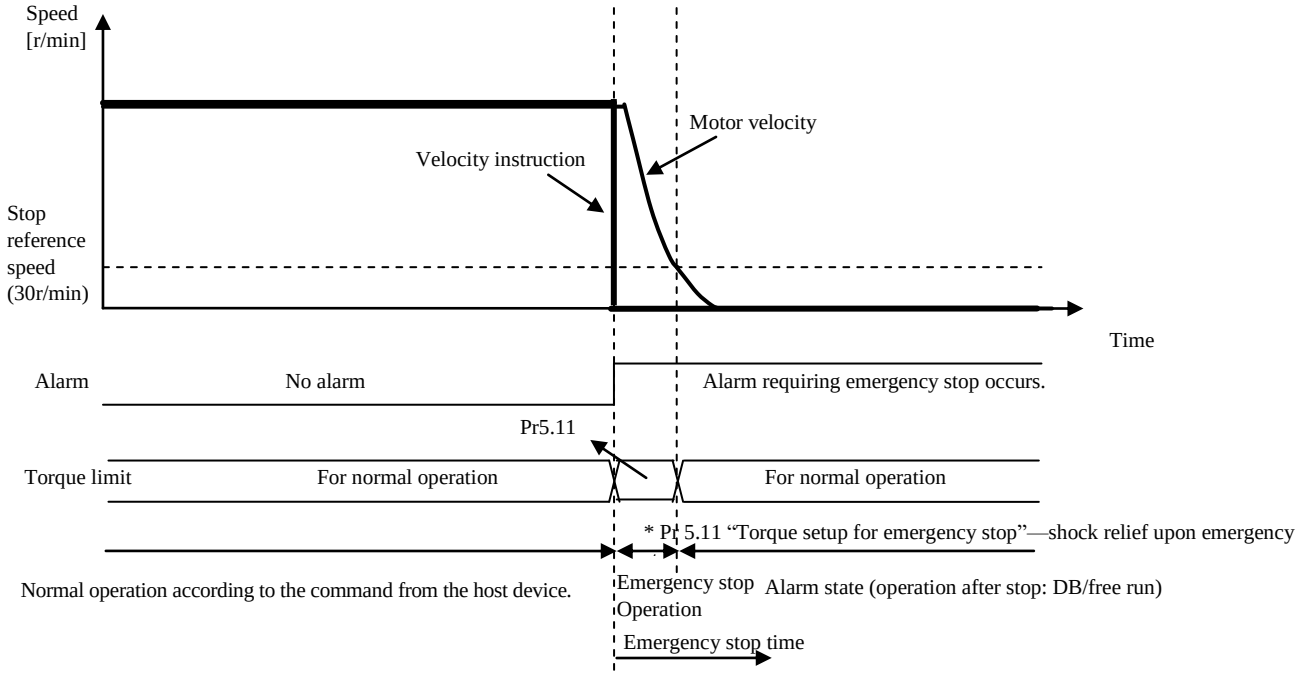
(1) Relevant parameters

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	Set up the detection level of Err.26.0 “Over-speed protection”. If setup value is 0, Err 26.0 will be activated with a setup value for Pr 9.10 “Maximum over-speed level”. If the setup value exceeds Pr 9.10, it will be saturated with Pr 9.10.
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	Set up the detection level of Err.26.1 “2nd overspeed protection”. If setup value is 0, Err 26.1 will be activated with a setup value for Pr 9.10 “Maximum over-speed level”. If the setup value exceeds Pr 9.10, it will be saturated with Pr 9.10.
9	10	R	Maximum over-speed level	0–20000	r/min	Set up the maximum over-speed for the motor. If setup value is 0, Err 60.0 “Motor setting error protection” will be activated.

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

(2) Description

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



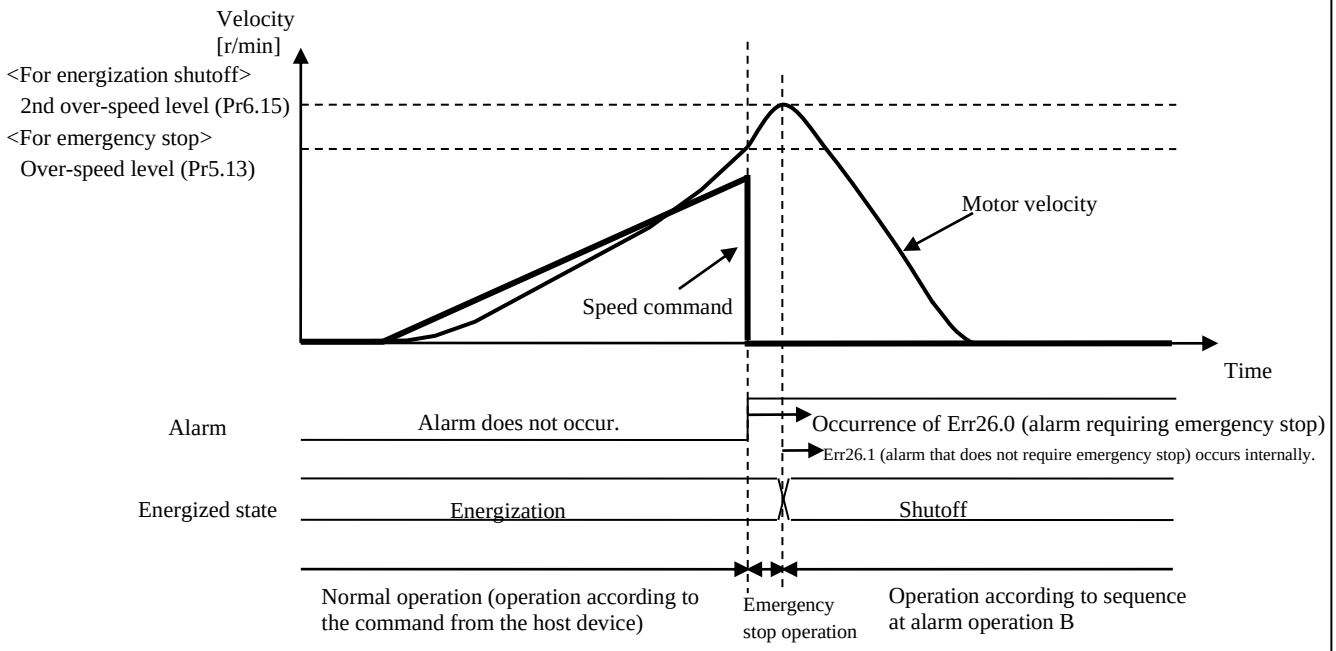
After occurrence of an alarm requiring emergency stop: when the speed has not dropped down to 30 r/min after the elapse of time set by Pr 6.14 “Emergency stop time at alarm”, the system generates the alarm. The system also enters the alarm state if an alarm that does not require emergency stop occurs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

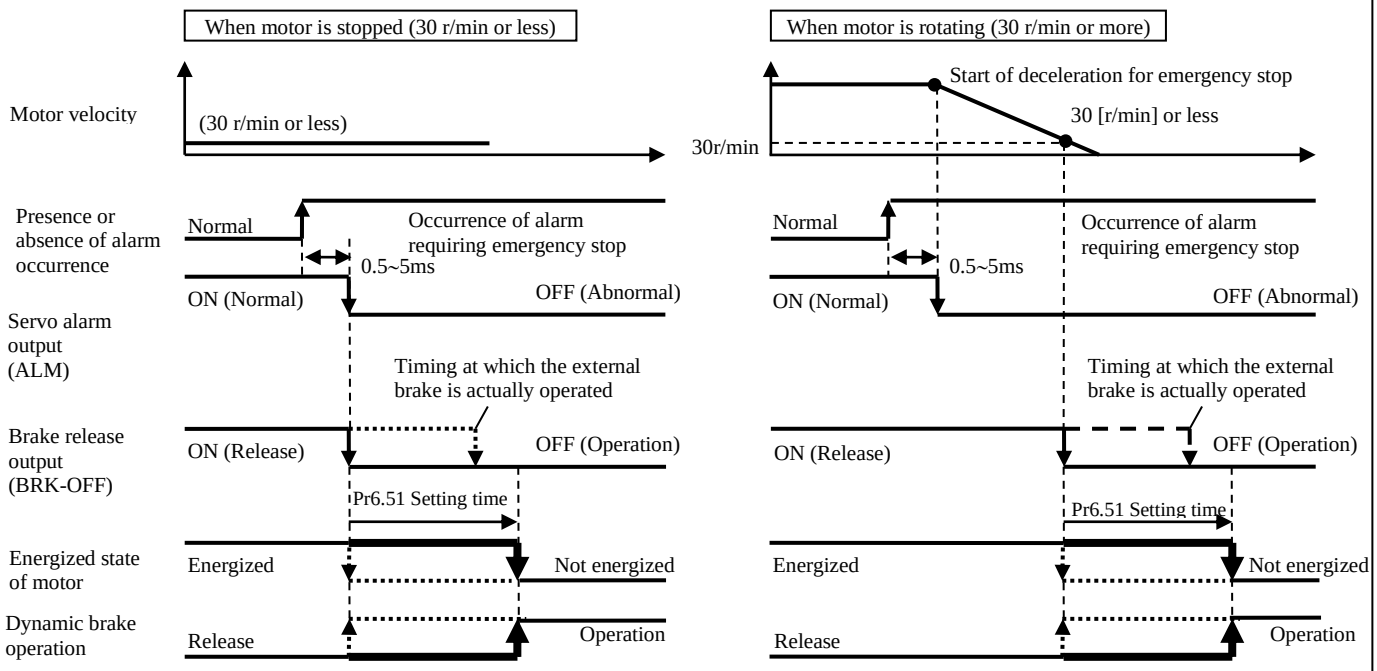
(1) Relevant parameters

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 to stop smoothly with the servo still remaining ON, and control being valid, when drive prohibited input, servo-OFF, main power OFF or immediate stop supporting alarm is detected under immediate stop setting.

(1) Applicable range

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

	Condition for activation of slow stop function
Control mode	・All control modes *1)
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 emergency stop, the control mode is forcibly set to position control.

(2) Relevant parameters

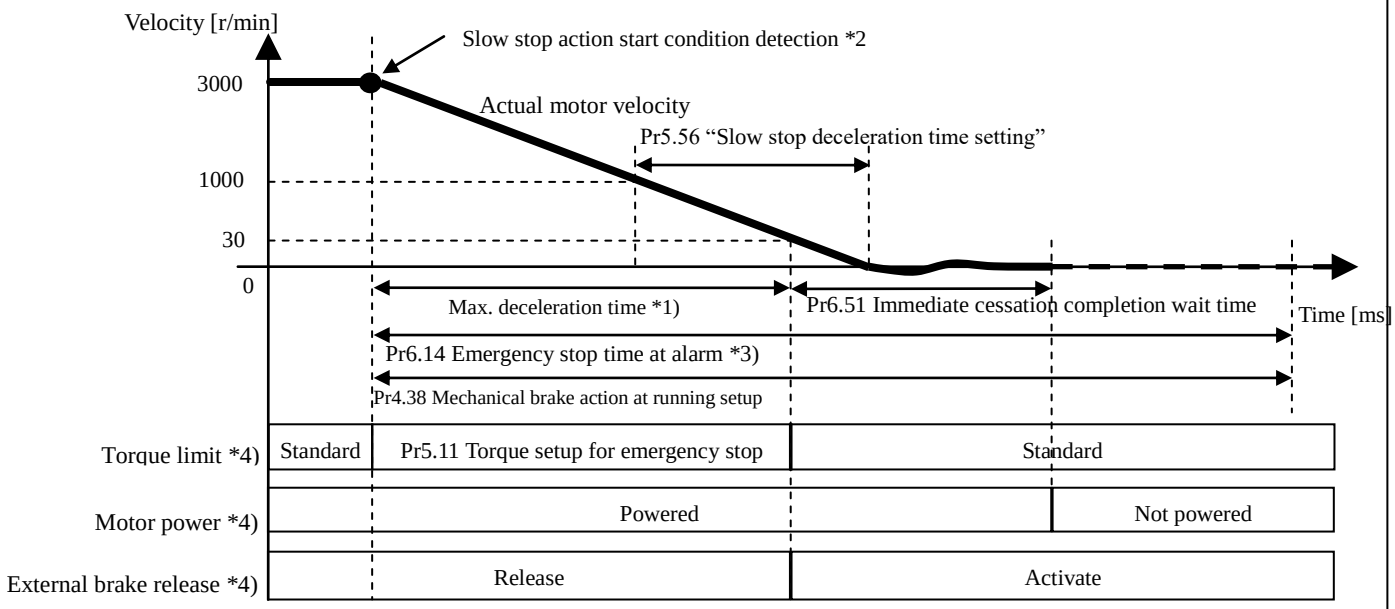
Class	No.	Attri-bute *1)	Parameter name	Set range	Units	Functions
5	05	C	Sequence at over-travel inhibit	0–2	—	When Pr 5.04 “Over-travel inhibit input setup” = 0, specify the status during deceleration and stop after application of the over-travel inhibition (POT, NOT). * Set up emergency stop to enable 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	-	bit10 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 the parameter attributes, 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.

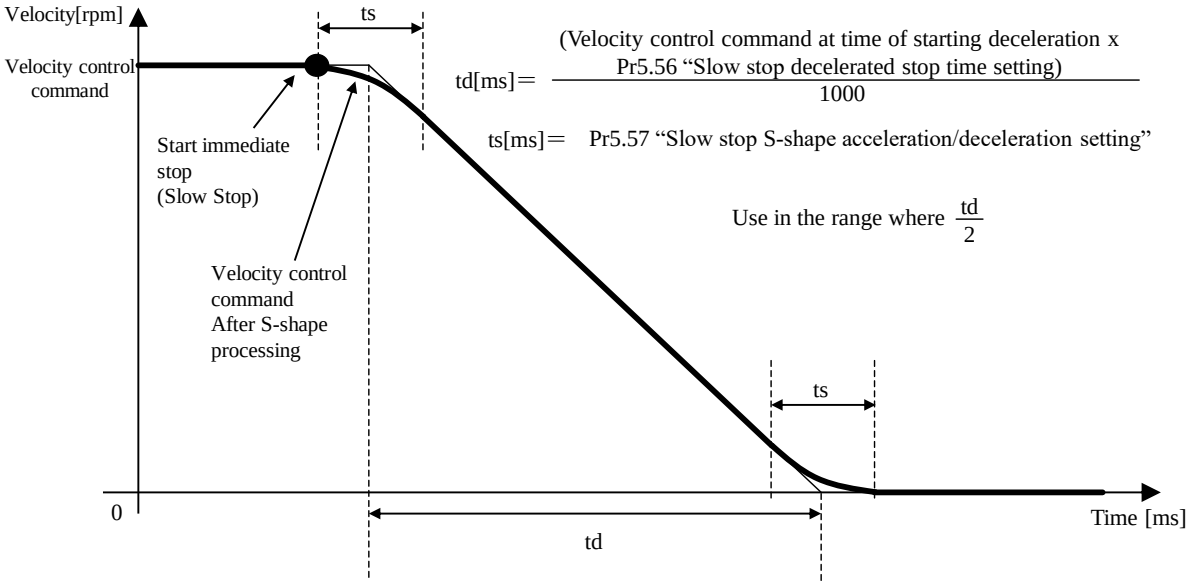
*3) Please set Pr6.14 "Emergency stop time at alarm" to a value that is sufficiently long in length than the completion of slow stop operation. The stop judgment under slow stop operation is based on actual velocity. Therefore, the time required for the actual deceleration may take longer than the maximum 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.



*) 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)

[Motor type: Linear type] (Pr9.00=1)

Linear decelerating time [s]

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

Linear deceleration brake distance [mm]

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

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

[Motor type: Rotary type] (Pr9.00=2)

Linear decelerating time [s]

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

Linear deceleration brake distance [revolution]

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

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

2) For S-shape deceleration (Pr5.57 ≠ 0)

[Motor type: Linear type] (Pr9.00=1)

S-shape deceleration braking distance [mm]

$$= \text{Linear deceleration brake distance [mm]} + \frac{\text{(Velocity control command at time of starting deceleration [mm/s])} \times \text{Pr5.57 [ms]}}{1000 \times 2}$$

[Motor type: Rotary type] (Pr9.00=2)

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

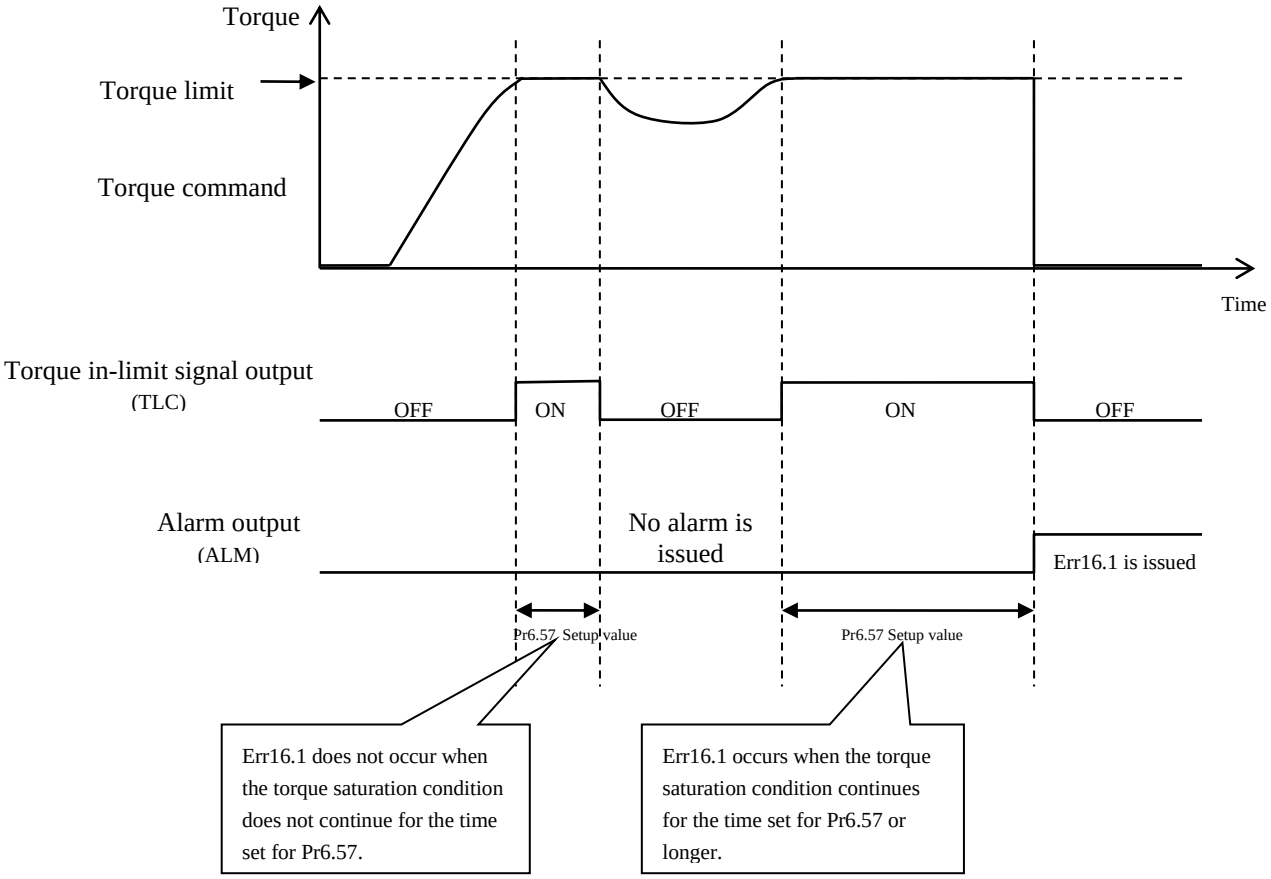
If torque saturated has continued for a fixed period, an alarm can be activated.

(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 Pr9.35 is enabled.
7	03	A	Output setup during torque limit	0–1	–	Sets the judgment condition for output during torque limit in the torque control mode. 0: ON with torque limit including torque command value 1: ON with torque limit excluding torque command value
9	35	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.

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

- Set both Pr6.57 and Pr9.35 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-A5NL series.
  In the case of the same setting, the time until Err16.1 occurs, A6NL is longer than A5NL.
- The torque saturation is determined based on the currently effective torque limit.
  For details about torque limit, please see Section 6-1.
- Error detection is executed even when the servo is off while this function is enable
- During torque control, when Pr.7.03 is 0, the signal output during torque limit (TLC) is always ON.
  To check the torque limit during torque control, set Pr7.03 to 1.



6-5 Position comparison output function

This function enables a general-purpose output or a position compare 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	Feedback scale (Communication)	Available
	Feedback 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
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) Points to note

Position compare output accuracy may deteriorate depending on feedback speed [pulse/s], or the relationship between feedback scale resolution and motor speed.

(4) Relevant parameters

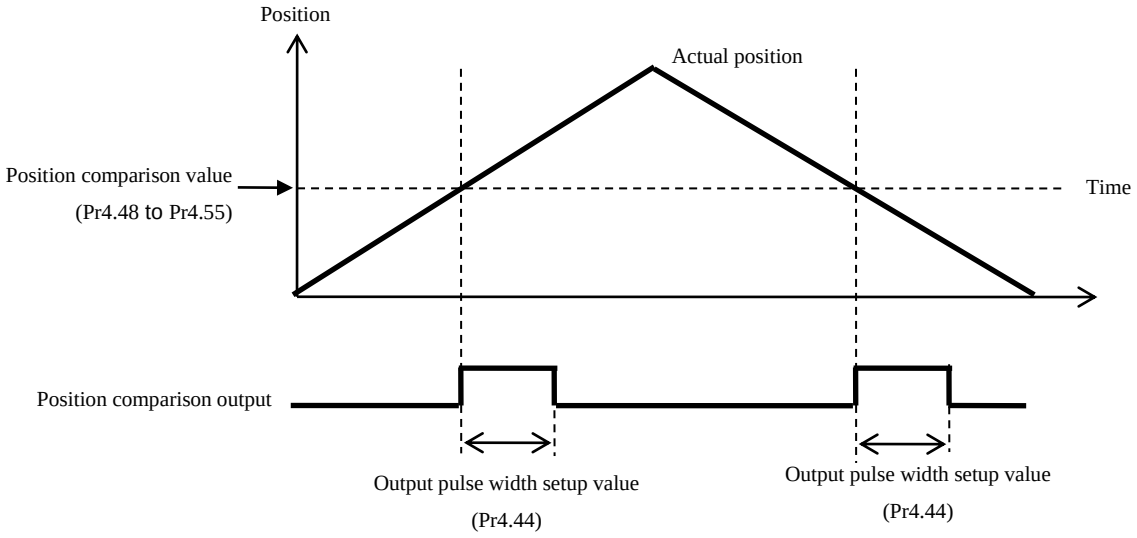
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	44	R	Position comparison output pulse width setting	0–32767	0.1 ms	Set the pulse width of position comparison output. No pulse is output when 0 is set.
4	45	R	Position comparison output polarity selection	0–7	—	Set the polarity of position comparison 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. ※Do not use SO3 with V frame.
4	47	R	Pulse output selection	0–1	—	Select the signal to be output from the feedback scale output terminal or position comparison output terminal. *3) 0: Feedback scale output signal (OA, OB) 1: Position comparison output signal (OCMP1 to 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	B	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.) ※Do not use SO3 with V frame.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	97	B	Function expansion setup 3	-2147483648 –2147483647	—	bit 10: Position compare output function selection 0: Valid, 1: Invalid
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	112	B	Selection of RTEX communication status flag	0～2	-	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. 1: For manufacturer's use 2: CMP_OUT_Status(Position compare output function valid state) is returned. 0: Invalid, 1: Valid

*1) For parameter attributes, see Section 9-1.
*2) When general-purpose outputs (SO1 to SO3) are used as position comparison outputs (CMP-OUT), 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 feedback scale output signals are used as position comparison outputs (OCMP1 to 3), set Pr4.47 to "1".

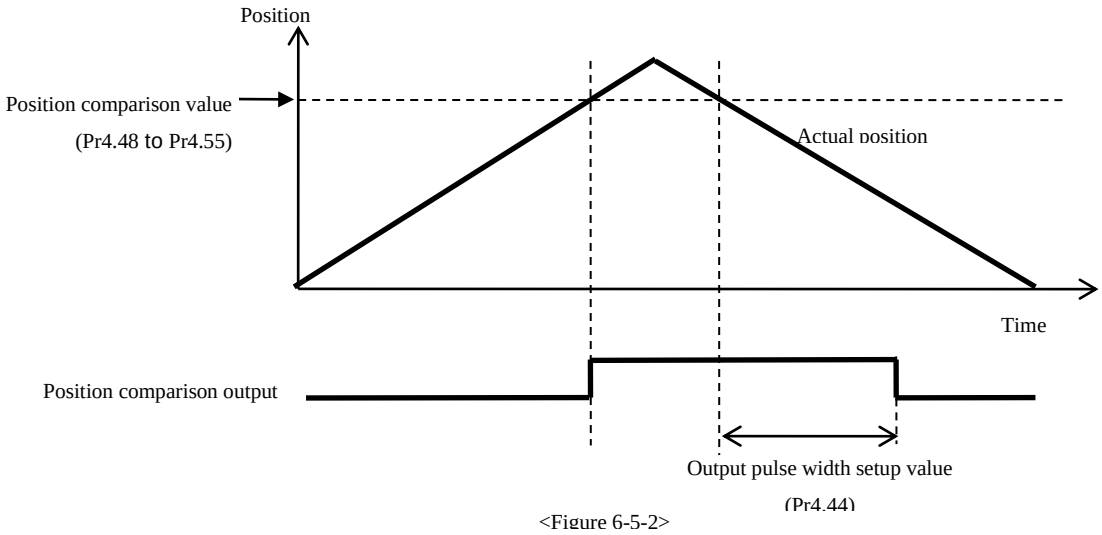
(5) Operation

・When the actual position of the feedback scale 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).



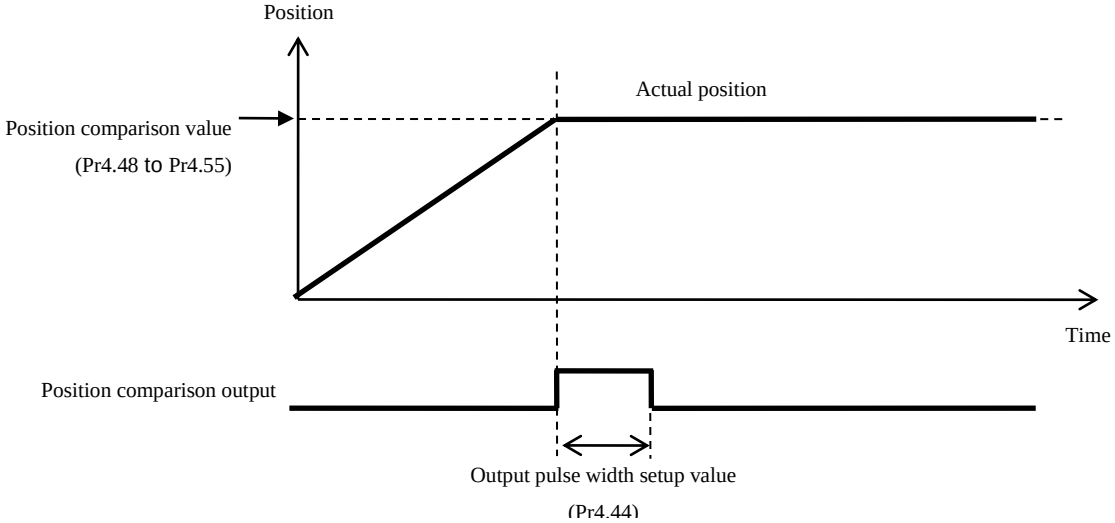
<Figure 6-5-1>

・A pulse is output when the position comparison value is passed and the relationship in size changes, irrespective of the passing direction of the feedback scale position.
・Multiple position comparison values can be set up on one position comparison output.
・If, during pulse output, feedback 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 feedback scale 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 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) Relevant 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 estimation speed) = 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.
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 attributes, see Section 9-1.

(3) Points to note

- 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)
- Various types of information from degradation diagnosis can be confirmed by the monitor command of RTEX communication. For details, see the RTEX communication specification edition (Section 4-2) of the technical materials.

(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.

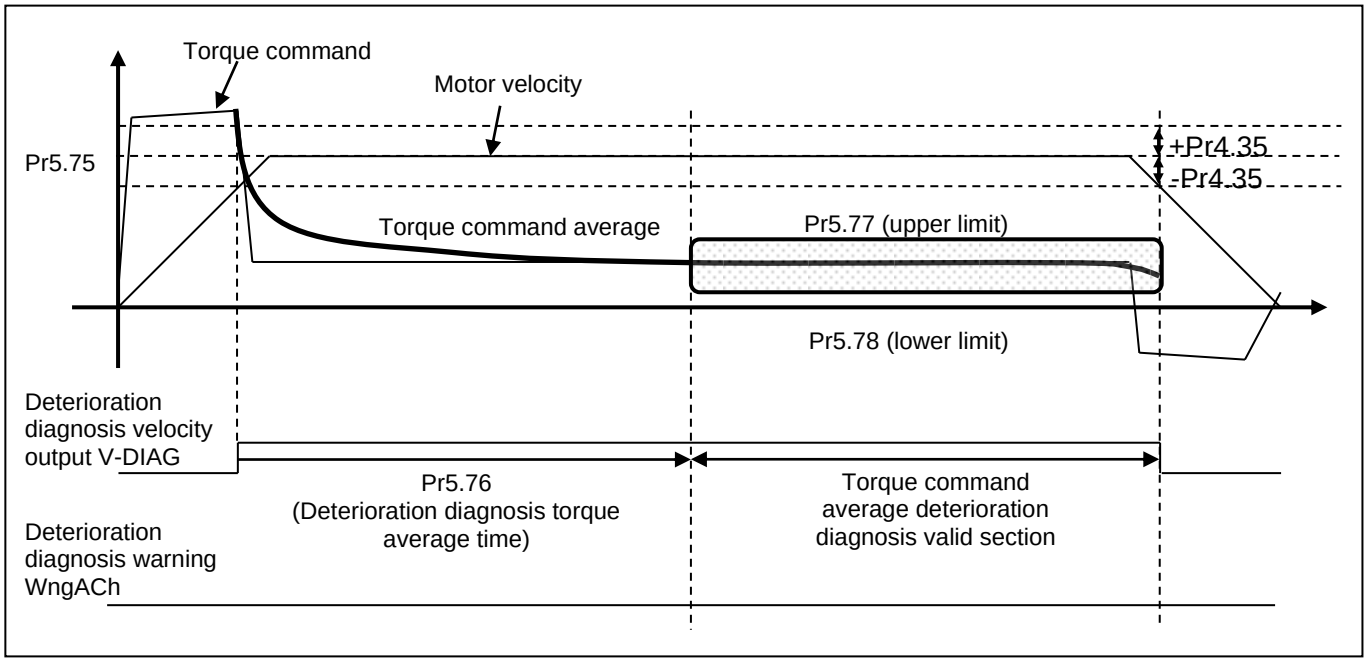
	(4-1-1)	(4-1-2)	(4-1-3)	(4-1-4)
	Inertia ratio	Unbalanced load	Dynamic friction	Viscous friction
Upper limit value	Pr5.67	Pr5.69	Pr5.71	Pr5.73
Lower limit value	Pr5.68	Pr5.70	Pr5.72	Pr5.74

* 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.

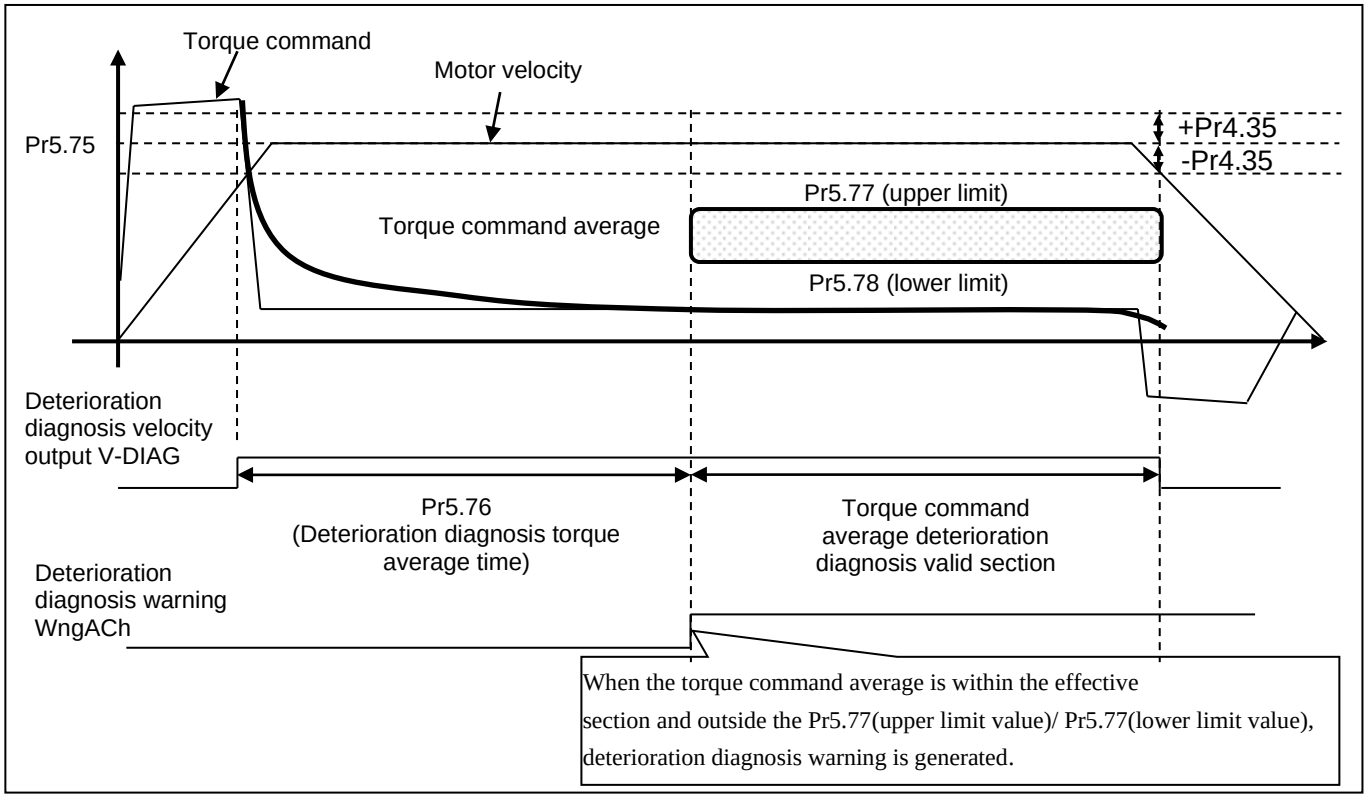
(4-2) Deterioration diagnosis warning for constant velocity torque command average value

- 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



6-7 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 2 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) Points to note

・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, Err85.1 *1), Err85.2, Err87.1, Err87.2 *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).

・At the time of execution of evacuation operation due to communication timeout, the communication re-establishment state of RTEX does not occur until the evacuation operation has been executed (after occurrence of Err85.1/Err87.2).*1)
*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

(3) Relevant parameters

<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>5</td><td>08</td><td>B</td><td>LV trip selection at mai n power off</td><td>0～3</td><td>—</td><td>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.</td></tr>
<tr><td>5</td><td>09</td><td>C</td><td>Detection time of main power off</td><td>20～2000 *2)</td><td>ms</td><td>Set up the main power alarm detection time.
When 2000 is set, main power off detection is disabled.</td></tr>
<tr><td>6</td><td>85</td><td>C</td><td>Condition setting for escape operation</td><td>-32768～ 32767</td><td>-</td><td>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 *5)
4-15:Err85.2 or Err87.3 is generated due to setting failure. *6)
bit7 - 4: Start-up condition for retreat operation (communication)
0: Disable evacuation operation by Err84.0 (RTEX communication timeout error protection) or Err84.5 (RTEX communication cycle error protection) (conventional Err84.0 operation)
1: Execution of evacuation operation under the conditions of occurrence of Err84.0 (RTEX communication timeout error protection)
2: Execution of evacuation operation under the conditions of occurrence of Err84.0 (RTEX communication timeout error protection) or Err84.5 (RTEX communication cycle error protection)
3-15:Err85.2 or Err87.3 is generated due to setting failure. *6)
<table>
<tr><th colspan="3">Binary number</th><th>Decimal number</th><th colspan="2">Start-up condition for re treat operation (communication)</th></tr>
<tr><th>bit7-6</th><th>bit5</th><th>bit4</th><th></th><th>Err84.5</th><th>Err84.0</th></tr>
<tr><td>00</td><td>0</td><td>0</td><td>0</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td>00</td><td>0</td><td>1</td><td>1</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>00</td><td>1</td><td>0</td><td>2</td><td>Valid</td><td>Valid</td></tr>
<tr><td>Value other than 00</td><td>—</td><td>—</td><td>3–15</td><td>Invalid</td><td>Invalid</td></tr>
</table>
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.</td></tr>
</table>

(To be continued)

Class	No.	Attri-bute *1)	Title	Range	Unit	Function
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: Err85.1/Err87.2 (Completion of retreat operation (communication)) 0:Clearing is impossible, 1:Clearing is possible. 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
7	112	B	Selection of RTEX communication status flag	0～2	-	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. 1: For manufacturer's use 2:CMP_OUT_Status(Position compare output function valid state) is returned. 0: Invalid, 1: Valid
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/Err85.1*8) or Err87.1/Err87.2*8) 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.
Please do not use this setting value with V frame.

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

*8) It is not supported in versions corresponding to function extended edition 3 or earlier.

(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.
84	0	RTEX communication timeout error protection *3)	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”. However, when Pr6.85 "Evacuation operation condition setup" bit 7-4 = 1, Err84.0 does not occur, and after completion of the evacuation operation, Err85.1 or Err87.2 occurs.	• 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.
84	5	RTEX communication cycle error protection *3)	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) *2)	The retracting operation by I/O is successfully completed.	• 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	1	Retracting operation completion (communication)*1)*3)	The retracting operation by communication is successfully completed.	
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 2 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) *2)	The retracting operation by I/O is successfully completed.	• 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 completion (communication)*1)*3)	The retracting operation by communication is successfully completed.	
	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, Err85.1*3) and Err85.2 will occur (A5N compatible specification),
and when bit15=1, Err87.1, Err87.2 *3) and Err87.3 will occur (A6B compatible specification).

*2) This is not supported by software versions earlier than function extended version 1.

*3) This is not supported by software versions earlier than function extended version 3.

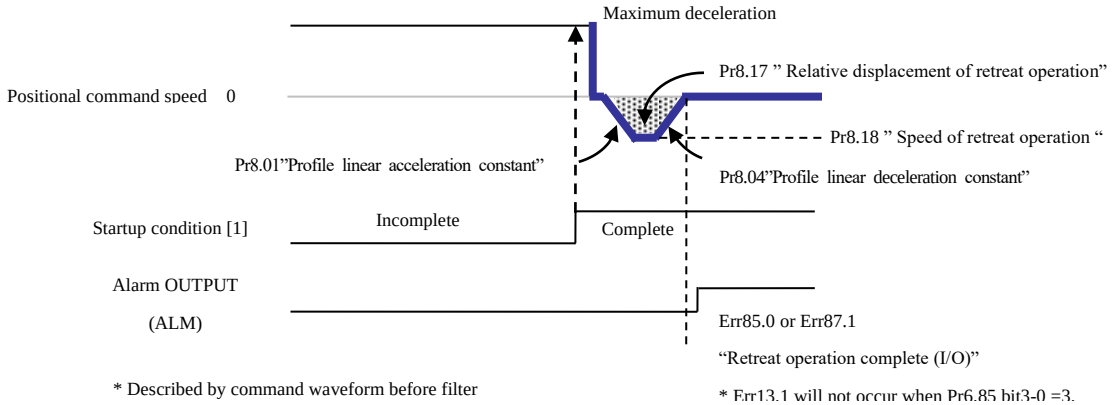
(5) Retreat operation details

(5-1) Retreat operation startup condition

Retreat operation is started when Condition [1] or [2]*1) is satisfied.

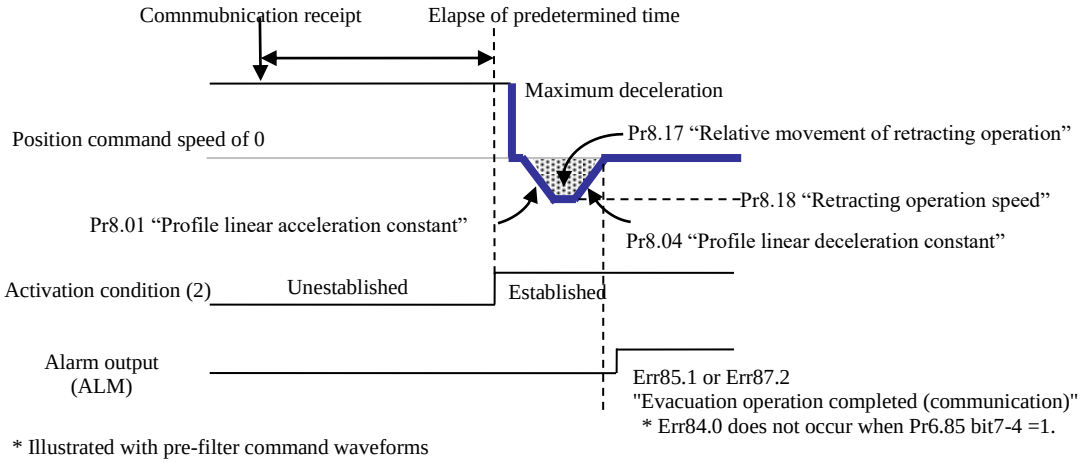
Condition [1]

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.



Condition [2] *1)

When Pr6.85 bit 7-4 = 1 and RTEX communication timeout error has been detected
When Pr6.85 bit 7-4 = 2 and either RTEX communication timeout error or RTEX communication cycle error has been detected



*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

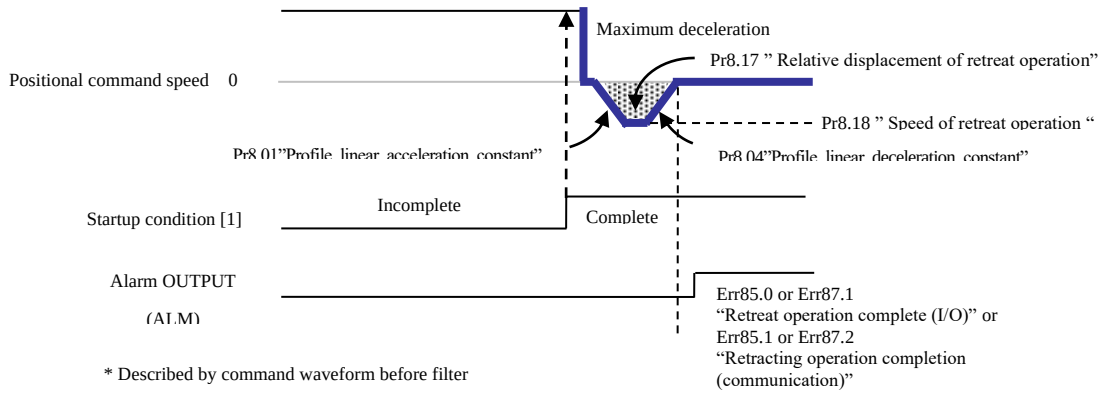
(5-2) External brake control at completion of retreat operation

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 or Err85.1/Err87.2 *1) occurs at completion of retreat operation.
For details, refer to "6-3-6 Fall prevention function in the event of alarms."

*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

(5-3) Retreat operation startup during motor operation

When retreat operation startup Condition [1] or [2] *1) is satisfied during operation, it will stop at maximum deceleration and execute retreat operation.



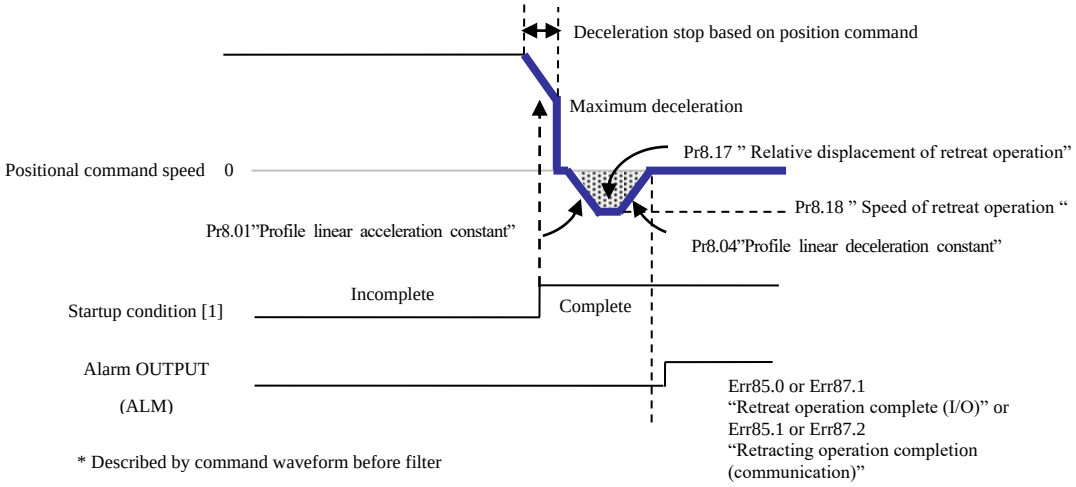
*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

(5-4) Retreat operation startup during motor deceleration

When retreat operation startup Condition [1] or [2]*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] or [2]*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.

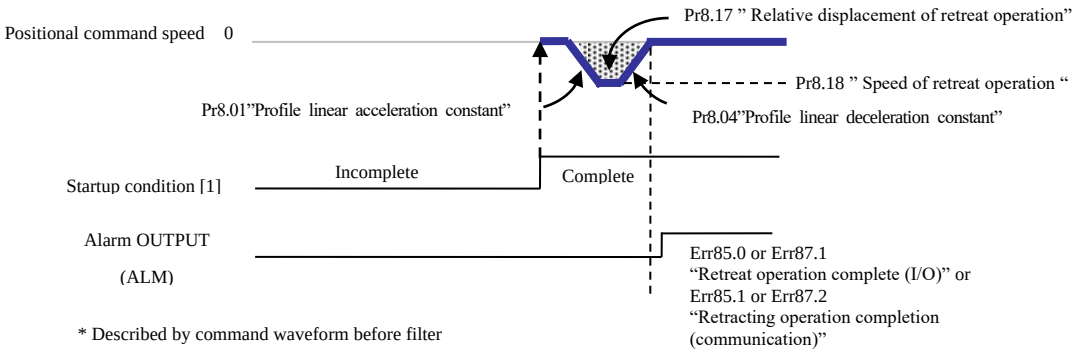
Retreat operation will not be executed, but Err85.2 or Err87.3 will be generated with position command sto pping and deceleration starting according to the deceleration sequence in case of alarm, if retreat operation startup Condition [1] or [2]*1) is satisfied during servo off, main power off (except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



*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

(5-5) Retreat operation from motor stop state

Retreat operation will be executed when retreat operation startup Condition [1] or [2]*1) is satisfied while it is stopped.



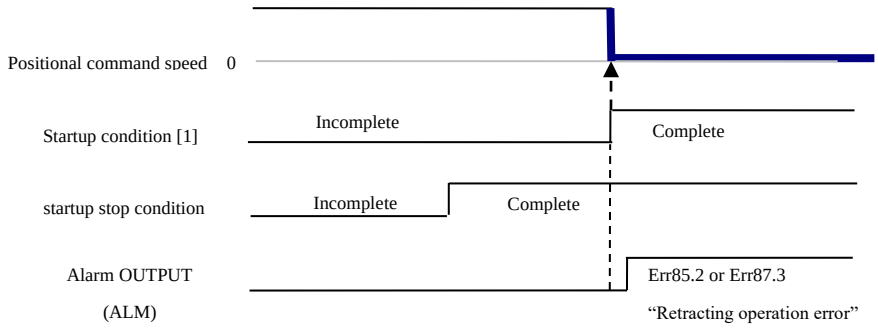
*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

(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] or [2] *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

*1) It is not supported in versions corresponding to function extended edition 3 or earlier.

(5-7) Retreat operation execution abort condition

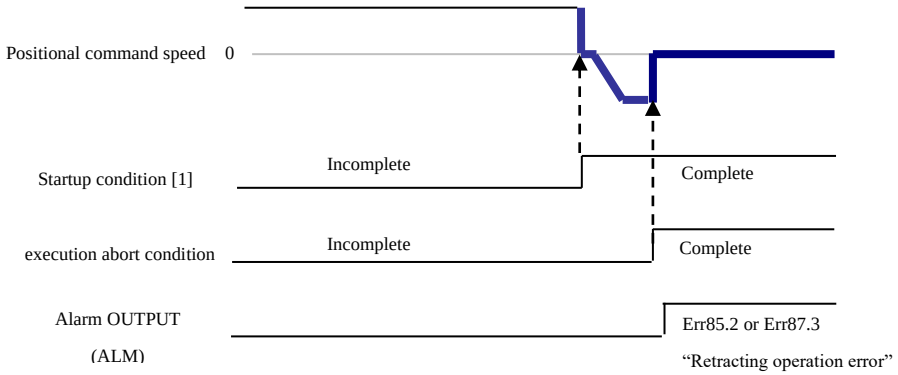
If one of the following execution abort conditions is satisfied during retreat operation, execution of the retreat operation will be aborted, and Err85.2 or Err87.3 will occur with the position command stopping, depending on the execution abort condition and following the alarm operation sequence.

* 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.

However, V frame is not equipped with a 7-segment LED.

Error No.		Alarm	Attribute		
Main	Sub		History	Can be cleared	Emergency stop *5
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	○		○
16	0	Over-load protection	○	○*1	
	1	Torque saturation error protection	○	○	
18	0	Over-regeneration load protection	○		○
	1	Over-regeneration Tr error protection	○		
24	0	Position deviation excess protection	○	○	○
	1	Speed deviation excess protection	○	○	○
26	0	Over-speed protection	○	○	○
	1	2nd over-speed protection	○	○	
27	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	○	○	
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	○		
50	0	Feedback scale connection error protection	○		
	1	Feedback scale communication error protection	○		
	2	Feedback scale communication data error protection	○		
51	0	Feedback scale ST error protection 0	○		
	1	Feedback scale ST error protection 1	○		
	2	Feedback scale ST error protection 2	○		
	3	Feedback scale ST error protection 3	○		
	4	Feedback scale ST error protection 4	○		
	5	Feedback scale ST error protection 5	○		

(To be continued)

Error No		Alarm	Attribute		
Main	Sub		History	Can be cleared	Emergency stop *5
55	0	Phase A connection error protection	○		
	1	Phase B connection error protection	○		
	2	Phase Z connection error protection	○		
	3	CS signal wiring error protection	○		
	4	A/B phase open error protection	○		
60	0	Motor setting error protection			
	1	Motor combination error 1 protection			
	2	Motor combination error 2 protection			
	3	Linear motor automatic setting error protection	○	○	
61	0	Magnet pole position estimation error 1 protection	○	○	
	1	Magnet pole position estimation error 2 protection	○	○	
	2	Magnet pole position estimation error 3 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) *6	○	*7	○
	1	Retracting operation completion (communication) *6	○	*7	○
	2	Retracting operation error *6	○	*7	○
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) *6	○	*7	○
	2	Retracting operation completion (communication) *6	○	*7	○
	3	Retracting operation error *6	○	*7	○
90	2	Multi-axis synchronization establishment error protection	○		
91	1	RTEX command error protection	○	○	
92	1	Feedback scale date recovery error protection	○		
93	0	Parameter setting error protection 1	○		
	3	Feedback scale connection error protection	○		
	5	Parameter setting error protection 4	○		
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 *5
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	○		
	5	Hardware self-diagnosis abnormality protection 1			
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 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.

*3: 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.

*4: If the servo driver internal control circuit malfunctions due to excessive noise etc., the display will show as follows:

Immediately turn OFF power.

*5: 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.

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

*7: 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
bit1: Err85.1/Err87.2 (retreat operation completion (communication)) 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. ※For V frame, the voltage between lines P2 and N2 is measured.
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. ※For V frame, the voltage between lines P1 and N1 is measured.
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 “LV trip selection at main power off” bit0 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 retreat 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 Standard 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. ※For V frame, the voltage between lines P1 and N1 is measured.
	1	Main power supply undervoltage protection (AC)		
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 E and F frames)	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 driver and motor. Set up longer acceleration/ deceleration time. Lower 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) Pr5.12 “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 feedback scale 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 9.35 “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			
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 torque has not saturated in torque monitor. Make a gain adjustment. Set up maximum value to Pr 0.13 and Pr 5.22. Make a feedback scale 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).
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 feedback scale 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	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.	• 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.
	7	Position information initialization error protection	• During validation mode of attribute C parameter of reset command of RTEX communication, servo was turned ON. • Cancellation of the homing command was executed from the host device during homing command (Type_Code: 11h to 1Dh,21h,22h) between home position detection and completion of return to home position. Note: It is not supported in versions corresponding to function extended edition 1 only.	• 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 “Numerator of pulse output division” 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 feedback 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 with absolute scale, after executing the attribute C parameter enabling mode, when PANATERM operation (trial run or frequency characteristic analysis) is completed, or when pin assignment is made by PANATERM.	• Confirm the operating range of absolute feedback 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 $\pm2^{30}$ (1073741824).	• Check that the motor runs as per the position command pulses. • Check that the output torque has not saturated in torque monitor. • Make a gain adjustment. • Set up maximum value to torque limit setting. • Make a wiring connection of the feedback scale 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 the products to the dealer or manufacturer.
	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.	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.)
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. With Pr 5.04 = 0, and either of the positive and negative over-travel inhibit input has turned ON during the execution of magnet pole position estimation. With Pr 5.04 = 0, and either of the positive and negative over-travel inhibit input has turned ON during automatic linear motor setup.	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.
	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).

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
50	0	Feedback scale connection error protection	Communication between the feedback 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 feedback scale according to the correct connection. Correct the miswiring of the connector pins.
	1	Feedback scale communication error protection	Communication error has occurred in data from the feedback scale. Data error mainly due to noise. Feedback 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 feedback scale…Be notified particularly in case of longer feedback scale cable. • Separate if the motor wire and the feedback scale cable are bound together. • Connect the shield to FG …Refer to the connection diagram of feedback scale in the Standard specification.
	2	Feedback scale communication data error protection	The data from the feedback scale was not a communication error, but the contents of the data became an error. Data error mainly caused by noise. Feedback scale connecting cable was connected, but communication data became an error.	
51	0	Feedback scale ST error protection 0	The feedback scale error code (ALMC) has become 1 from bit 0. Check the feedback scale specification.	Remove the causes of the error, and then clear the feedback scale error from the front panel. And then, shut off the power to reset.
	1	Feedback scale ST error protection 1	The feedback scale error code (ALMC) has become 1 from bit 1. Check the feedback scale specification.	
	2	Feedback scale ST error protection 2	The feedback scale error code (ALMC) has become 1 from bit 2. Check the feedback scale specification.	
	3	Feedback scale ST error protection 3	The feedback scale error code (ALMC) has become 1 from bit 3. Check the feedback scale specification.	
	4	Feedback scale ST error protection 4	The feedback scale error code (ALMC) has become 1 from bit 4. Check the feedback scale specification.	
	5	Feedback scale ST error protection 5	The feedback scale error code (ALMC) has become 1 from bit 5. Check the feedback scale specification.	
55	0	A-phase wiring error protection	A-phase wiring in the feedback scale is defective, e.g. disconnected.	Check A-phase wiring in the feedback scale.
	1	B-phase wiring error protection	B-phase wiring in the feedback scale is defective, e.g. disconnected.	Check B-phase wiring in the feedback scale.
	2	Z-phase wiring error protection	Z-phase wiring in the feedback scale is defective, e.g. disconnected.	Check Z-phase wiring in the feedback scale.
	3	CS signal logic error protection	There is an error in CS signal logic. (All of CS signals 1, 2, and 3 are high or low)	Check the CS signal wiring connection.
	4	AB-phase missing error protection	There are extremely few AB-phase pulses between CS signal changes.	Check the CS signal, A-phase, and B-phase wiring connections.

(To be continued)

Error No.		Protective function	Causes	Measures
Main	Sub			
60	0	Motor setting error protection	• Pr 9.00 “Motor type selection” = 0 has been set. • A setup value out of the range has been set as a setup value for Pr 9.01 “Feedback scale resolution/number of scale pulse per rotation”. • When setting Pr 9.00 = 1(Linear type), Pr 9.02 “Magnet pole pitch” and Pr 9.30 “Number of pulses per magnet pole” has been set at the same time. • When setting Pr 9.00 = 1 “Linear type”, a value out of the range has been set as a setup value for Pr 9.30 “Number of pulses per magnet pole”. • When setting Pr 9.00 = 2 (Rotary type), Pr 9.03 “Pole logarithm per rotation” = 0 has been set. • When setting Pr 9.08 “Motor phase inductance” = 0, Pr 9.12 “Automatic current response adjustment” ≠ 0 has been set. • When setting Pr 9.09 “Motor phase resistance”, Pr 9.12 ≠ 0 has been set. • Number 0 has been set to each of Pr 9.04 to Pr 9.07, Pr 9.10, and Pr 9.20. • When setting Pr 9.00 = 1 (Linear type) or 3 (VCM type), Pr 3.23 “Feedback scale type selection” = 6 has been set.	• Check the setup value for Pr 9.00 “Motor type selection” • Check the setup value for Pr 9.01 “Feedback scale resolution/number of scale pulse per rotation”. • Check the setup value for each of Pr 9.00 “Motor type selection”, Pr 9.02 “Magnet pole pitch”), and Pr 9.30 “Number of pulses per magnet pole”. • Check the setup value for each of Pr 9.00 “Motor type selection“ and Pr 9.30 “Number of pulses per magnet pole”. • Check the setup value for each of Pr 9.00 “Motor type selection“ and Pr .9.03 “Pole logarithm per rotation”. • Check the setup value for each of Pr 9.08 “Motor phase inductance” and Pr 9.12 “Automatic current response adjustment”. • Check the setup value for each of Pr 9.09 “Motor phase resistance” and Pr 9.12 “Automatic current response adjustment”. • Check the setup value for each of Pr 9.04 to Pr 9.07, Pr 9.10, and Pr 9.20. • Check the setup value for each of Pr 9.00 “Motor type selection“ and Pr 3.23 “Feedback scale type selection”. Under linear type setting, an absolute rotary scale can’t be used.
	1	Motor combination error 1 protection	• The setup value for Pr 9.06 “Rated effective motor current” is above the allowable rated current for the driver. • The setup value for Pr 9.07 “Maximum instantaneous motor current” is above the allowable maximum current for the driver. • When setting Pr 9.00 = 2 (Rotary type), feedback speed that correspond with overspeed level [r/min] exceed 1091M [pulse/s].	• Check the setup value for Pr 9.06 “Rated effective motor current” (Setting unit: 0.1 Arms). • Check the setup value for Pr 9.07 “Maximum instantaneous motor current” (Setting unit: 0.1 A). • If the above setup value is not problematic, the frame size of the driver needs to be enlarged. • Check the setup value for each of Pr 9.01 “Number of scale pulse per rotation” and Pr 9.10 “Overspeed level” in order for feedback speed not to exceed 1091M [pulse/s].
	2	Motor combination error 2 protection	• The rated motor current is too small as against the rated driver current. • A ratio of an inertia (J) to the rated torque (T) is too large. (The J-T ratio is too large) • The automatically adjusted current-proportional integral gain is too large • The percentage of the maximum current to the rated motor current is larger than 500%.	• Check the setup value for Pr 9.06 “Rated effective motor current” (Setting unit: 0.1 Arms). If the above setup value is not problematic, the frame size of the driver needs to be reduced. • Check the setup value for each of Pr 9.05 “Rated motor torque” (Setting unit: 0.1 Nm) and Pr 9.04 “Motor inertia” (Setting unit: 0.00001 kgm^2). • Check the setup value for each of Pr 9.06 “Rated effective motor current”(Setting unit: 0.1 Arms), Pr 9.08 “Motor phase inductance” (Setting unit: 0.01 mH), and Pr 9.09 “Motor phase resistance”(Setting unit: 0.01 Ω) • Check the setup value for each of Pr 9.07 “Maximum instantaneous motor current” (Setting unit: 0.1 A) and Pr 9.06 “Rated effective motor current” (Setting unit: 0.1 Arms).
	3	Linear motor automatic setting error protection	• RTEX communication has been established during automatic linear motor setup (during automatic scale direction/CS setting and during automatic current gain adjustment) • After automatic linear motor setting, RTEX communication has been established with the power supply not turned ON again. • A feedback current value has been overshot respective to the thrust command during automatic linear motor setting.	• Make sure that no RTEX communication will be established during automatic linear motor setting (during automatic scale direction/CS setting and during automatic current gain adjustment) • After automatic linear motor setting, establish communication with the host device after the power supply is turned ON. • If there is current overshooting present, make adjustments such as by reducing the current gain.

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
61	0	Magnet pole position estimation error 1 protection	Magnet pole position estimation has not been finished correctly. • Wrong feedback scale direction setting • Shortage of thrust command/command time at the time of magnet pole position estimation • Use of the vertical axis • An unbalanced load and a large friction	• Check the direction of the feedback scale • Adjust Pr .9.22 “Thrust command time for magnet pole position estimation” and Pr 9.23 “Command thrust for magnet pole position estimation”. • The magnet pole position estimation function cannot be used for the vertical axis and an axis with an unbalanced load and a large friction.
	1	Magnet pole position estimation error 2 protection	The motor has not stopped after the elapse of the time set using Pr 9.27 “Motor stop control time for magnet pole position estimation”.	• Increase the setup value for Pr 9.27 • Check for unbalanced loads in the setup environment. (Does the motor operate even when with thrust command = 0?)
	2	Magnet pole position estimation error 3 protection	• A value of 3 has been set to Pr 9.20 (Magnet pole detection scheme selection) with magnet pole position estimation never executed. • A value of 3 has been set to Pr 9.20 when a feedback scale that is not of the absolute type is in use.	• Temporarily use Pr 9.20 = 2 and perform magnet pole position estimation once. Then use Pr 9.20 = 3, and this error will not be activated. • Check that the feedback scale is of the absolute type.
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. • Check the parameter settings again. Return the products to the dealer or manufacturer.
	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”. However, when Pr6.85 "Evacuation operation condition setup" bit 7-4 = 1, Err84.0 does not occur, and after completion of the evacuation operation, Err85.1 or Err87.2 occurs. note: It is not supported in versions corresponding to function extended edition 3 or earlier.	• 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 2 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.
	1	Retracting operation completion (communication) *1)	The retracting operation by communication is successfully completed. Note: It is not supported in versions corresponding to function extended edition 3 or earlier.	
	2	Retracting operation error *1)	When execution of retreat operation is impossible • In the case where setting of Pr6.85 “Condition setting for retreat operation” is abnormal • In the case where retreat 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 retreat operation” bit0-3 is other than 3)/ Servo off/ Alarm generation/ STO input, during retreat 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 retreat 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 retreat operation, due to the Servo off status, etc. Note: It is not supported in versions corresponding to function extended edition 2 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. Main	Error No. Sub	Protective function	Causes	Measures
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 2 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 completion (communication) *1)	The retracting operation by communication is successfully completed. Note: It is not supported in versions corresponding to function extended edition 3 or earlier.	
	3	Retracting operation error *1)	When execution of retreat operation is impossible • In the case where setting of Pr6.85 “Condition setting for retreat operation” is abnormal • In the case where retreat 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 retreat operation” bit0-3 is other than 3)/ Servo off/ Alarm generation/ STO input, during retreat 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 retreat 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 retreat operation, due to the Servo off status, etc. Note: It is not supported in versions corresponding to function extended edition 2 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).

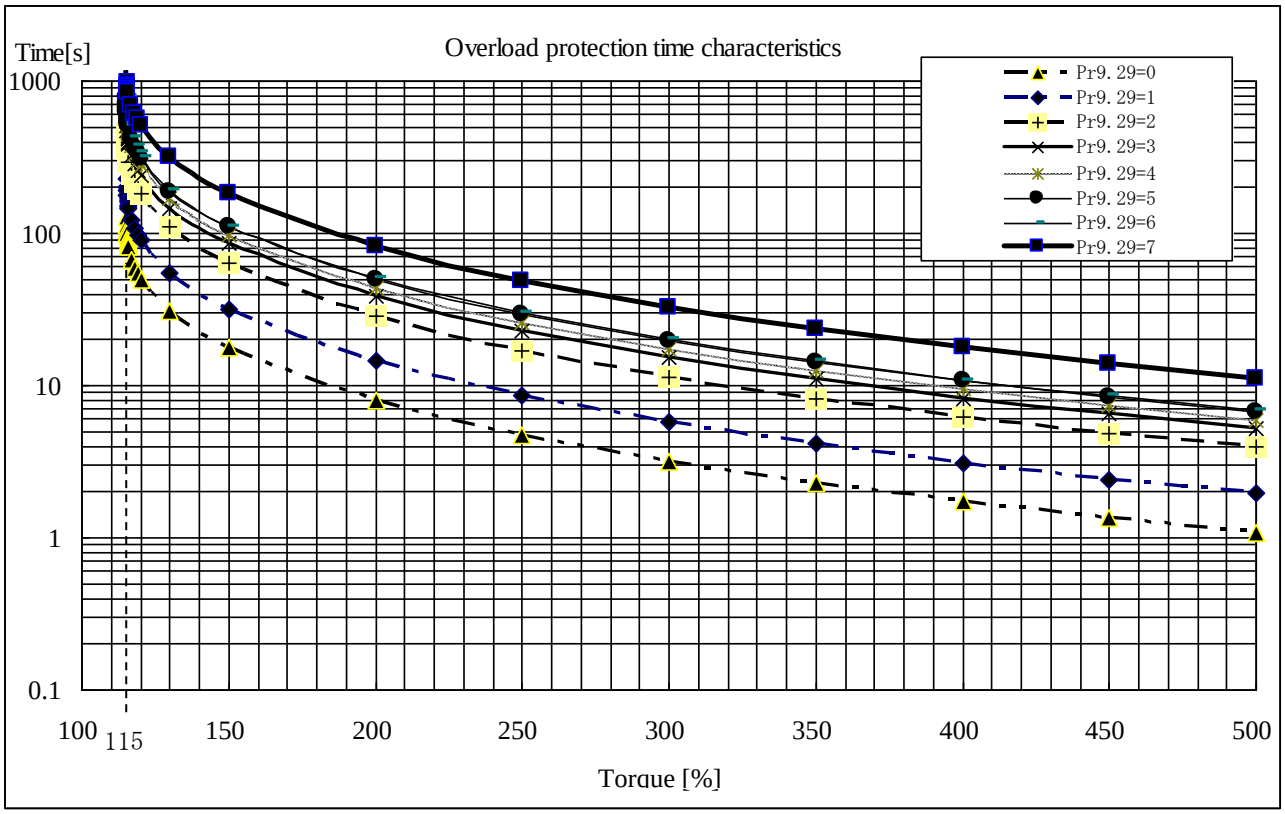
(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
91	1	RTEX command error protection	• Disagreement in the combination of communication cycle, 16/32 byte 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 (4h) was performed at the time of speed control (CV)/ torque control (CT). • During the two-degrees-of-freedom control mode (standard type), the control mode was switched to other than position/speed control. (Note) It is not supported by function extended version 2 and later versions.	• Check the process of upper device for any problem.
	3	RTEX command error protection 2	・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 2 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 2 and earlier versions.	・Check if the return to origin command is cancelled near the origin signal (cancelling after stopping is recommended if possible).
92	1	Feedback scale data recovery error protection	Initialization processing of the internal positional information was not correctly executed when an absolute scale is used.	• Secure feedback scale power supply voltage of 5 VDC±5% (4.75 to 5.25 V). Please take extra care in case the cable connecting the feedback scale is long. • In case the motor line and the feedback scale connecting cable are bundled together, separate them. • Connect shield to FG. …Refer to the connection diagram of feedback scale in the Standard specification.

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
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.
	3	Feedback scale connection error protection	Set value for Pr3.23 “Feedback scale selection” and the connected serial communication type feedback scale type to not match.	• Set Pr3.23 to match the type of the connected feedback 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 ”Section 2-5”, RTEX Communication Specification.
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. ・In return-to-origin operation in absolute mode, there was an error in writing Pr7.13 “Absolute home position offset” to EEPROM. (Note) It is not supported in versions corresponding to function extended edition 2 or earlier.	• 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). ・Execute alarm clear and then execute return-to-origin operation again. If an error still occurs with an error display, there is a possibility of a failure. Discontinue the use and exchange the servo amplifier. ・Return the products to the dealer or manufacturer.
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		
	5	Hardware self-diagnosis abnormality protection 1	The current detector has an abnormality.	• Return the products to the dealer or manufacturer.
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 feedback scale. Return the products to the dealer or manufacturer.

Overload protection time characteristics



■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	29	R	Overload protection timing characteristic setup	0–7	—	0 : Standard specification Select the overload protection above 8 characteristic.

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

Notes: Overload protection does not guarantee error protection due to motor heat buildup, for example.
Before use, be sure to check that there are no problems due to motor heat buildup, for example, in the actual operation environment.

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.

(1) Relevant parameters

Class	No.	At-trib-ute *1)	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.
5	20	C	Position setup unit select	0–1	2	Selects the setting unit for the positioning completion range and excessive position deviation warning setting. 0: Command unit 1: Encoder unit (the 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.
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. Please refer to the table on the next page.
6	39	C	Warning mask setting 2	-32768 –32767	—	
6	105	A	Excessive position deviation warning setting	$0–2^{30}$	Command unit	Set the setting range of excessive position deviation warning. Set value 0 disables detection of warning AA "Excessive position deviation warning." Use the unit specified by Pr 5.20 “Position setup unit select”. Make appropriate settings according to the safety of the device.
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]

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
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
A3	Fan alarm	Fan has stopped for 1 sec.	○	4	Pr 6.38 bit 6
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	Feedback scale error warning	The feedback scale has detected the warning.	○	9	Pr6.38 bit 8
A9	Feedback scale communication warning	The number of successive feedback scale communication errors has exceeded the specified value.	○	10	Pr6.38 bit 14
AA	Excessive position deviation warning	The motor motion does not follow the command whose position deviation pulse exceeds the set value of Pr6.105 "Excessive position deviation warning setting."	○	28	Pr6.39 bit 12
AC	Deterioration diagnosis warning *5)	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”Communication function Extended setup 6” is 1 and 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”. Lifetime detection alarm and so on will be in the latch 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) 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.

*5) 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.
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, 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 feedback scale positional deviation [pulse (feedback 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 by feedback scale position deviation)

* In this case, the position deviation cannot be obtained through calculation formula. Set the value including allowance, by estimating the maximum value of feedback scale 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.

・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 by feedback scale position 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.

Fedback scale position deviation : P1 = Ve / Kp × ((100 - (set value for Pr1.10 / 10)) / 100)

・Ve : Maximum operation frequency [pulse/s] in feedback scale unit
・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, 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.

7-5 About the protection function setting while returning to the origin by using the Z phase

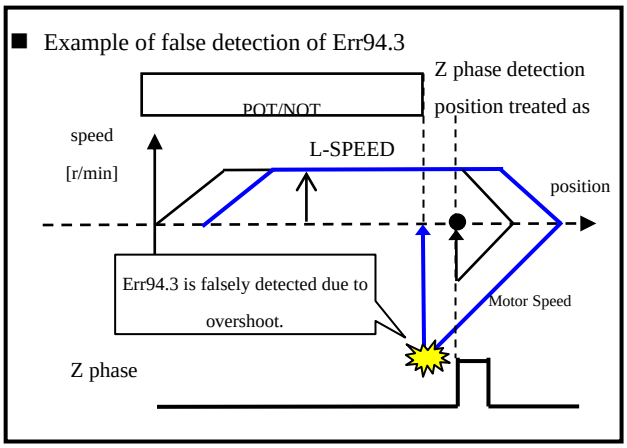
If the following parameters are set, the run inhibit input (POT, NOT) is detected when returning to the Z phase detection position, which is treated as the origin, with the operation for returning to origin by using the Z phase.
If run inhibit input is detected during the return operation, the protection 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

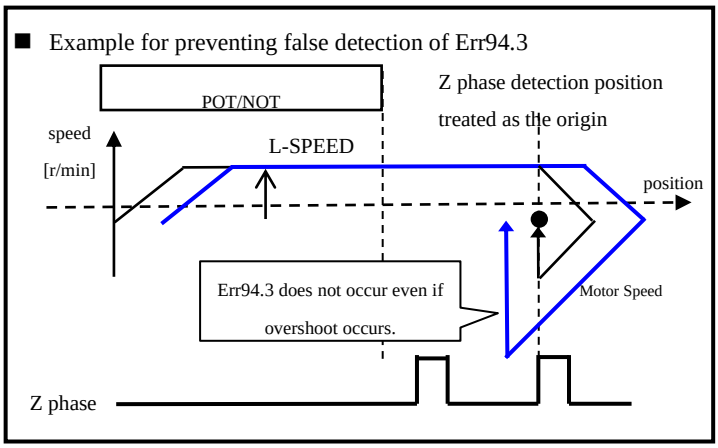
(Caution)

- 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 document RTEX communication specification edition (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. ・In return-to-origin operation in absolute mode, there was an error in writing Pr7.13 "Absolute home position offset" to EEPROM. (Note) It is not supported in versions corresponding to function extended edition 2 or earlier.	・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). ・Execute alarm clear and then execute return-to-origin operation again. If an error still occurs with an error display, there is a possibility of a failure. Discontinue the use and exchange the servo amplifier. ・Return the products to the dealer or manufacturer.

8. Safety function

Available for [A6NM] only. It cannot be used in [A6NL].

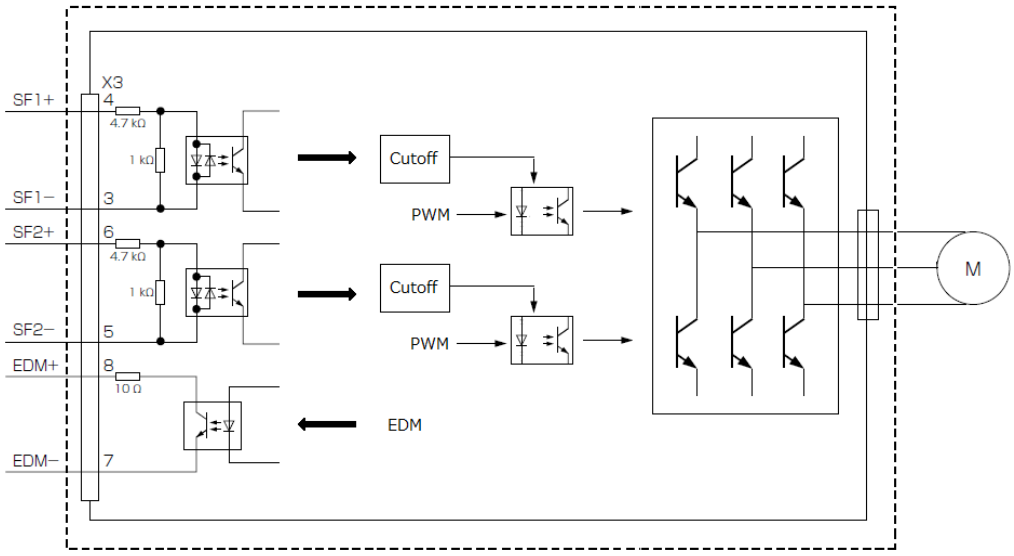
This servo driver has safety function built in.

≪Change point from MINAS-A5NL series≫

	MINAS-A5NL (specific model)	MINAS-A6NL ([A6NM])	
STO operation	Alarm generation Err30.0	No alarm 7-segment LED is "st"	
Method of releasing the STO state	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.
In the STO state, the position deviation is cleared to zero.

8-2 Input/output signal specification

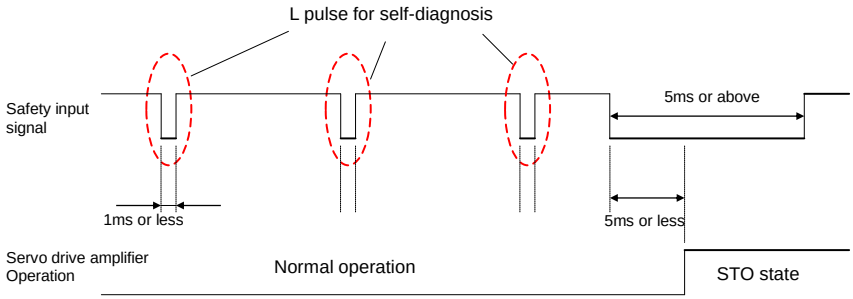
8-2-1 Safety input signal

• Two safety input circuit channels that trigger STO function are provided.

Class	Signal name	Signal	Connector pin number	Content	Control mode		
					Position	Speed	Torque
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
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.

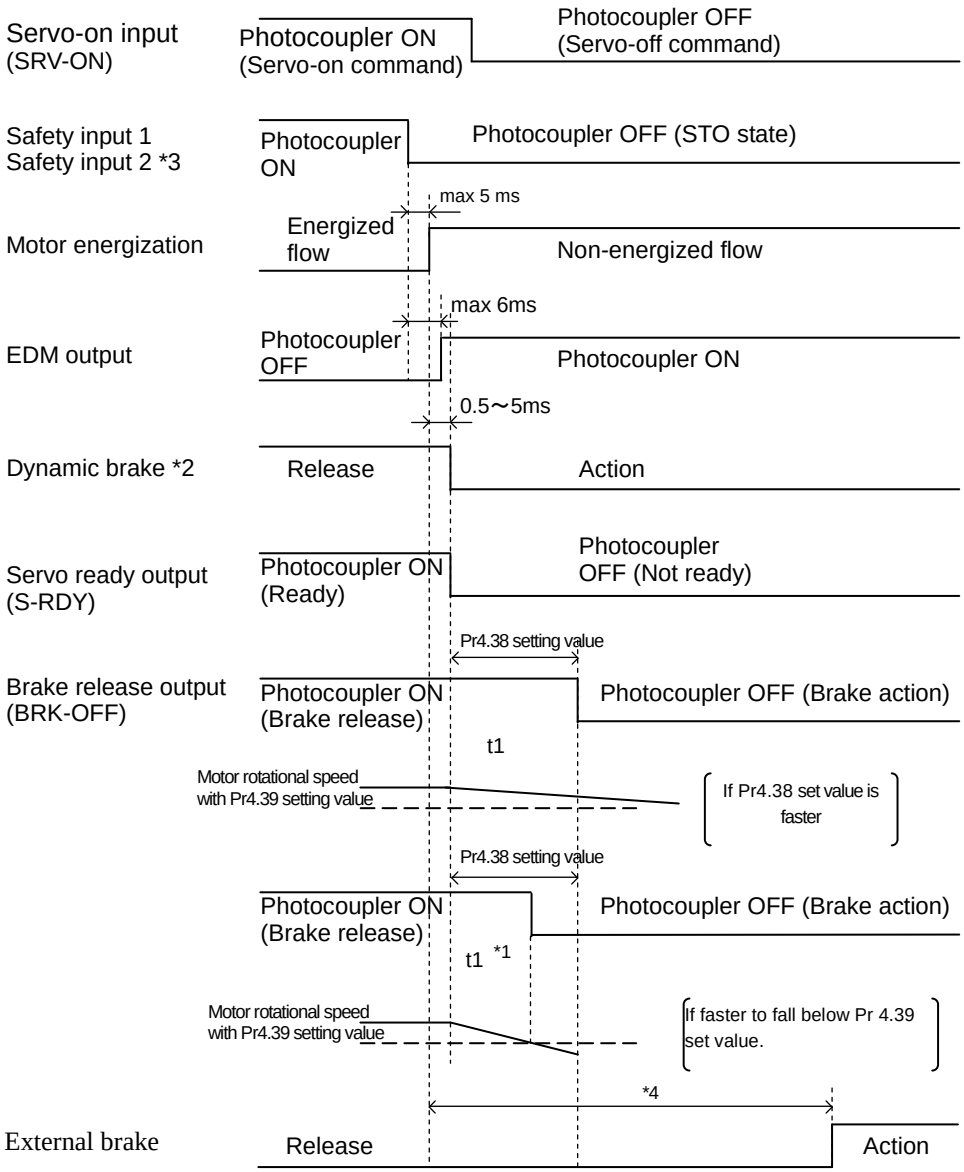
・Maximum delay time from input of safety 1 and 2 signals to output of EDM signal is 6 ms.

・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 3 months , and at the time of safety input.

8-3 Description of functions

8-3-1 Activation to STO state, timing diagram



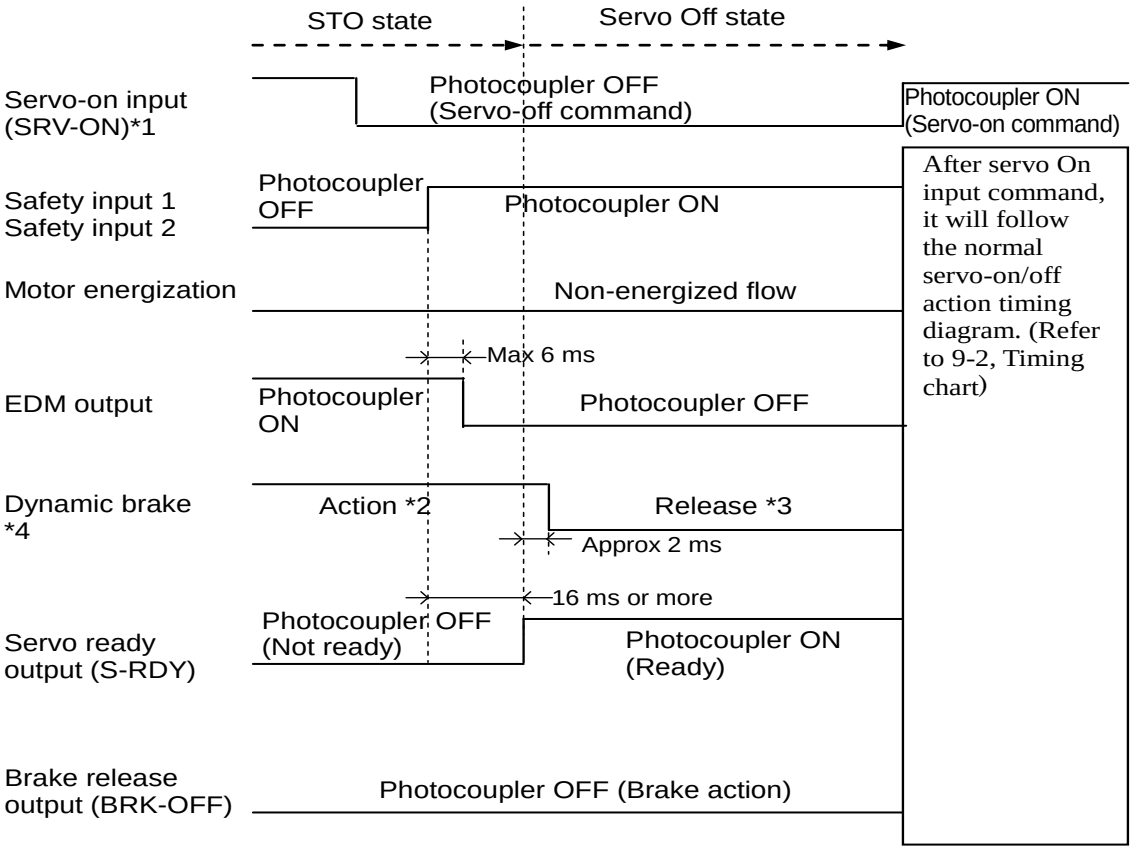
*1. t1 will be a shorter time of either the setup value of Pr4.38 “Mechanical brake action at running setup” or elapsing time for the motor speed to fall below Pr4.39 “Brake release speed setup.”

*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.

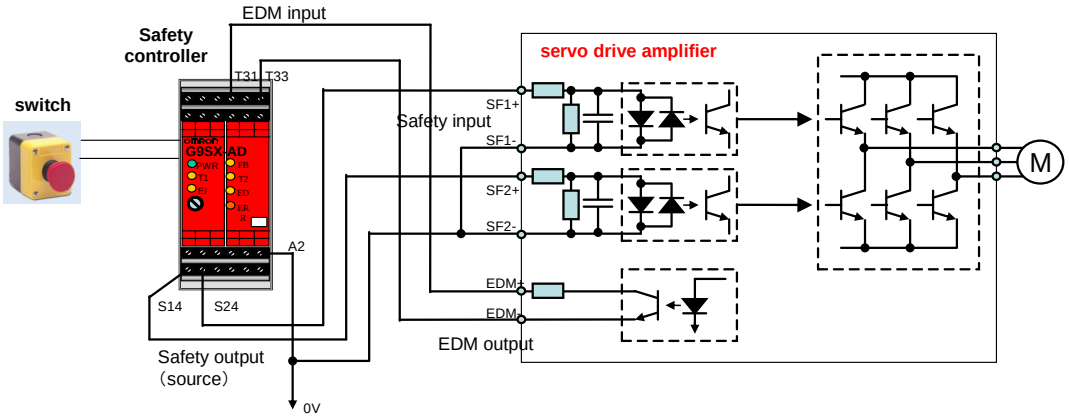
≪MINAS-A5 series≫

① Turn off servo ON input
② Return the photo couplers for safety input 1 and 2 to ON.
③ Release the alarm.

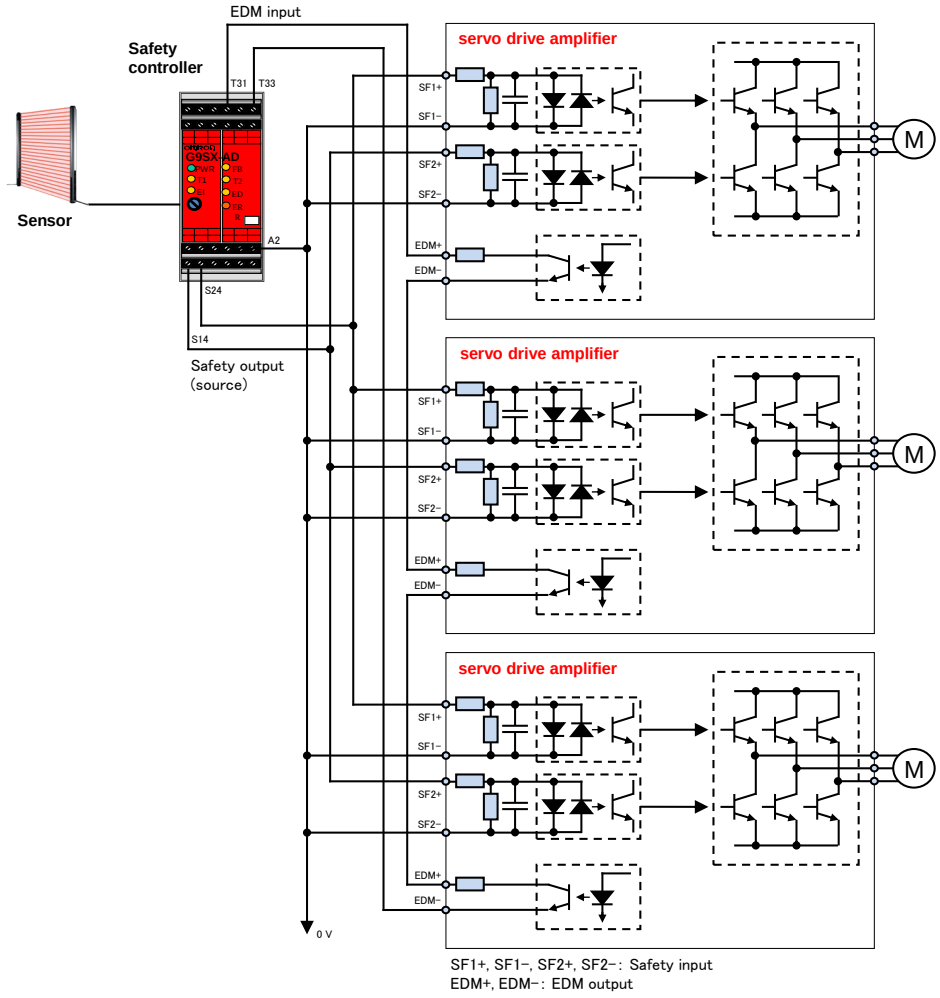
≪MINAS-A6 series≫

① Turn off servo ON input
② Return the photo couplers for safety input 1 and 2 to ON.
* Automatically return to the servo ready state.

8-4-1 Example of connection to safety contoller



8-4-2 Example of connection when using multiple axes



- Capacity requirement per safety output (source) channel: 5×No. of connected axes (mA)
- DC 24 V supply allowable voltage: 24 V±15 %
- Maximum No. of connectable axes: 8 axes

*1. 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

Attribute indicates the condition under which the changed parameter becomes valid.

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.

RO: Read only, and cannot be changed through normal parameter change procedure.

9-1-1 Class 0: Basic setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
0	00	Operating direction setup	—	0–1	2	Setup the relationship between the direction of command and direction of motor operation. 0: Command direction positive = feedback scale negative 1: Command direction positive = feedback scale positive	C	All	4-1
	01	For manufacturer's use	—	—	—	Permanently set at 0.	—	—	—
	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	For manufacturer's use	—	—	—	Permanently set at 0.	—	—	—
	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	Numerator of pulse output division	—	1–2097152	4	Set the numerator of pulse output division.	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. In addition, the actual torque applied is limited with the maximum torque limit for the motor applied. (The parameter value is not limited) Note that the maximum torque limit for the motor applied can be calculated according to the expression given below. Maximum torque limit [%] = 100 × Pr 9.07 / (Pr 9.06 × √2).	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	7-4
	15	For manufacturer's use	—	—	—	Permanently set at 0.	—	—	—
	16	External regenerative resistor setup	—	0–3	2	Set up items related to regenerative resistor. ※Please do not change the shipment value setting with V frame.	C	All	4-5
	17	Load factor of external regenerative resistor selection	—	0–4	2	Select the computation method of loading factor for external regenerative resistor. ※Please do not change the shipment value setting with V frame.	C	All	4-5
	18	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-
	21	For manufacturer's use	-	-	2	Permanently set at 0.	-	-	-

9-1-2 Class 1: 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	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	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	5-2-8
	11	Velocity feed forward filter	0.01 ms	0–6400	2	Set up the time constant of velocity feed forward filter.	B	Position	5-2-8
	12	Torque feed forward gain	0.1%	0–2000	2	Set up the torque feed forward gain.	B	All	5-2-8
	13	Torque feed forward filter	0.01 ms	0–6400	2	Set up the torque feed forward filter.	B	All	5-2-8
	14	2nd gain setup	-	0–1	2	Using the gain select function, set this parameter for the best tuning.	B	All	5-2-4
	15	Mode of position control switching	-	0–10	2	Set up the condition of gain switching for position control.	B	Position	5-2-4
	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	5-2-4
	17	Level of position control switching	-	0–20000	2	Set up the gain switching level.	B	Position	5-2-4
	18	Hysteresis at position control switching	-	0–20000	2	Set up the hysteresis at gain switching.	B	Position	5-2-4
	19	Position gain switching time	0.1 ms	0–10000	2	Set up the position gain switching time upon gain switching.	B	Position	5-2-4
	20	Mode of velocity control switching	-	0–5	2	Set the condition of gain switching for velocity control	B	Velocity	5-2-4
	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	5-2-4
	22	Level of velocity control switching	-	0–20000	2	Set up the gain switching level.	B	Velocity	5-2-4
	23	Hysteresis at velocity control switching	-	0–20000	2	Set up the hysteresis at gain switching.	B	Velocity	5-2-4
	24	Mode of torque control switching	-	0–3	2	Set the condition of gain switching for torque control	B	Torque	5-2-4
	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	5-2-4
	26	Level of torque control switching	-	0–20000	2	Set up the gain switching level.	B	Torque	5-2-4
	27	Hysteresis at torque control switching	-	0–20000	2	Set up the hysteresis at gain switching.	B	Torque	5-2-4

(To be continued)

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.	-	-	-

9-1-3 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	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	5-2-5
	02	1st notchwidth selection	-	0–20	2	Set up the notch width of 1st resonance suppression notch filter.	B	All	5-2-5
	03	1st notch depth selection	-	0–99	2	Set up the notch depth of 1st resonance suppression notch filter.	B	All	5-2-5
	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	5-2-5
	05	2nd notch width selection	-	0–20	2	Set up the notch width of 2nd resonance suppression notch filter.	B	All	5-2-5
	06	2nd notch depth selection	-	0–99	2	Set up the notch depth of 2nd resonance suppression notch filter.	B	All	5-2-5
	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 5-2-5
	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 5-2-5
	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 5-2-5
	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 5-2-5
	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 5-2-5
	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 5-2-5
	13	Selection of damping filter switching	-	0–6	2	Select the filters to be used for damping control.	B	Position	5-2-6 5-2-7
	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	5-2-6
	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	5-2-6
	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	5-2-6
	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	5-2-6
	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	5-2-6
	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	5-2-6
	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	5-2-6
	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	5-2-6

(To be continued)

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 speed 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	4-2-3 5-2-14 5-2-15
	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	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	5-2-5
	25	5th notch width selection	-	0–20	2	Set the notch width for the 5th resonance suppression notch filter.	B	All	5-2-5
	26	5th notch depth selection	-	0–99	2	Set the notch depth for the 5th resonance suppression notch filter.	B	All	5-2-5
	27	1st damping width setting	-	0–1000	2	Fine tune the 1st damping control function.	B	Position	5-2-6
	28	2nd damping width setting	-	0–1000	2	Fine tune the 2nd damping control function.	B	Position	5-2-6
	29	3rd damping width setting	-	0–1000	2	Fine tune the 3rd damping control function.	B	Position	5-2-6
	30	4th damping width setting	-	0–1000	2	Fine tune the 4th damping control function.	B	Position	5-2-6
	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.	-	-	-

9-1-4 Class 3: Velocity/ Torque/ Scale

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 Pr 9.10 "Maximum over-speed 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 Pr 9.10 "Maximum over-speed level".	B	Torque	4-4-1
	23	Feedback scale selection	-	0– 6	2	Selects feedback scale type. 0: AB phase output type 1: Serial communication type (incremental spec.) 2: Serial communication type (absolute linear spec.) 3: For manufacturer's use 4: For manufacturer's use 5: For manufacturer's use 6: Serial communication type (absolute rotary spec.)	R	All	4-6-1 4-7
	24	For manufacturer's use	-	-	-	Permanently set at 0.	-	-	-
	25	For manufacturer's use	-	-	-	Permanently set at 1.	-	-	-
	26	Reversal of direction of feedback scale & CS	-	0 – 3	2	Set the polarity of feedback scale feedback pulse and the CS signal.	R	All	4-7
	27	Feedback scale Z phase disconnection detection disable	-	0 – 1	2	Validate/invalidate Z-phase disconnection detection when using AB phase output type feedback scale. 0: Valid, 1: Invalid	R	All	-
	28	For manufacturer's use	-	-	-	Permanently set at 1.	-	-	-
	29	For manufacturer's use	-	-	-	Permanently set at 0.	-	-	-
	32	For manufacturer's use	-	-	-	Permanently set at 0.	-	-	-

9-1-5 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. ※Please do not change the shipment value setting with V frame.	C	All	2-4-2
	16	Type of analog monitor 1	-	0–28	2	Select the type of monitor for analog monitor 1. ※Please do not change the shipment value setting with V frame.	A	All	3-4
	17	Analog monitor 1 output gain	-	0–214748364	4	Set up the output gain of analog monitor 1. ※Please do not change the shipment value setting with V frame.	A	All	3-4
	18	Type of analog monitor 2	-	0–28	2	Select the type of monitor for analog monitor 2. ※Please do not change the shipment value setting with V frame.	A	All	3-4
	19	Analog monitor 2 output gain	-	0–214748364	4	Set up the output gain of analog monitor 2. ※Please do not change the shipment value setting with V frame.	A	All	3-4
	21	Analog monitor output setup	-	0–2	2	Select output voltage format of the analog monitor. ※Please do not change the shipment value setting with V frame.	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	4-2-4
	32	Positioning complete (In-position) output setup	-	0–10	2	Set up the condition for positioning complete output.	A	Position	4-2-4
	33	INP hold time	ms	0–30000	2	Set up the hold time	A	Position	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	8-2-2
	38	Mechanical brake action at running setup	ms	0–32000	2	Set up mechanical brake operating time at running.	B	All	8-2-3 8-2-4
	39	Brake release speed setup	r/min	30–3000	2	Set up the speed timing of brake output checking during operation.	B	All	8-2-3 8-2-4
	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	4-2-4

(To be continued)

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. ※Do not use SO3 with V frame.	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: Feedback scale 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.	B	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.) ※Do not use SO3 with V frame.	R	All	6-5

9-1-6 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	With uses that the output pulse count per one rotation does not become as an integer, the setting can be performed by setting this value to other than zero, Pr0.11 as division numerator, and Pr5.03 as division denominator. Consequently, the result of pulse count with host side ×4 multiplication processing becomes as follows. Pulse output resolution per one rotation = (Pr0.11 set value / Pr5.03 set value) × Feedback scale resolution	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. ※Please do not change the shipment value setting with V frame.	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. ※Please do not change the shipment valuesetting with V frame.	B	All	—
	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. ※Please do not change the shipment valuesetting with V frame.	C	All	—
	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”. If setup value is 0, Err 26.0 will be activated with a setup value for Pr 9.10 “Maximum over-speed level”. If the setup value exceeds Pr 9.10, it will be saturated with Pr 9.10.	B	All	6-3-5 7-4
	14	Motor working range setup	0.1 magnetic pole pitch	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	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	—

*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	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	20	Position setup unit select	—	0–1	2	Selects the setting unit for the positioning completion range and excessive position deviation warning setting. 0: Command unit, 1: Feedback 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	7-3 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	6-1
	22	2nd torque limit	%	0–500	2	You can set up the 2nd limit value of the motor output torque. Note that the maximum torque limit for the motor applied can be calculated according to the expression given below. Maximum torque limit [%] = 100 × Pr 9.07 / (Pr 9.06 × √2).	B	Position, velocity	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	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	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 maximum torque limit for the motor applied can be calculated according to the expression given below. Maximum torque limit [%] = 100 × Pr 9.07 / (Pr 9.06 × √2).	B	Position, velocity	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 maximum torque limit for the motor applied can be calculated according to the expression given below. Maximum torque limit [%] = 100 × Pr 9.07 / (Pr 9.06 × √2).	B	Position, velocity	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	5-2-13
	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	5-2-13
	47	Quadrant glitch compensation delay time	ms	0–1000	2	Set the compensation timing delay time for quadrant glitches.	B	Position	5-2-13

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	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	5-2-13
	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	5-2-13
	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	Positon, 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	Positon, 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	6-6

(To be continued)

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	6-6
	68	Deterioration diagnosis inertia ratio lower limit	%	0– 10000	2		A	All	6-6
	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	6-6
	70	Deterioration diagnosis unbalanced load lower limit	0.1%	-1000 – 1000	2		A	All	6-6
	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	6-6
	72	Deterioration diagnosis dynamic friction lower limit	0.1%	-1000 – 1000	2		A	All	6-6
	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	6-6
	74	Deterioration diagnosis viscous friction lower limit	0.1%/ (10000r /min)	0– 10000	2		A	All	6-6
	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	6-6

(To be continued

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	6-6
	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	6-6
	78	Deterioration diagnosis torque lower limit	0.1%	-1000 – 1000	2		A	All	6-6
	96	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	97	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	102	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—

9-1-7 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	—
	03	For manufacturer’s use	—	—	2	Permanently set at 0.	—	—	—
	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	5-2-10
	06	Position 3rd gain scale factor	%	50–1000	2	Set up the 3rd gain by a multiplying factor of the 1st gain	B	Position	5-2-10
	07	Torque command additional value	%	-100–100	2	Set up the offset torque to be added to the torque command.	B	Position, velocity	5-2-11
	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	5-2-11
	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	5-2-11
	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 INP output limit 0: Invalid 1: Valid 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 For manufacturer's use. Always set to 0. 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 *1 bit15 Slow stop function.. 0: Invalid 1: Valid • bit 0 = LSB *1 When bit14 to 1, it will be bit1 and 2 also 1.	B	All	4-2-4 5-1-1 5-1-3 5-1-4 5-2-10 6-3-6 6-3-7
	11	For manufacturer’s use	-	-	2	Permanently set at 100.	—	-	-
	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
	15	2nd over-speed level setup	r/min	0–20000	2	Set up the detection level of Err.26.1 “2nd overspeed protection”. If setup value is 0, Err 26.0 will be activated with a setup value for Pr 9.10 “Maximum over-speed level”. If the setup value exceeds Pr 9.10, it will be saturated with Pr 9.10.	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 feedback 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 feedback 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	Position	4-2-5

(To be continued)

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	5-2-9
	24	Load change compensation filter	0.01 ms	10–2500	2	Set the filter time constant for a load change.	B	Position, velocity	5-2-9
	25	For manufacturer's use	—	—	2	Do not change from the shipping value setting.	—	—	—
	26	For manufacturer's use	—	—	4	Permanently set at 2.	—	—	—
	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	For manufacturer's use	-	-	2	Permanently set at 0.	—	-	-
	35	For manufacturer's use	-	-	2	Permanently set at 10.	—	-	-
	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	5-2-6
	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	5-2-12
	43	Two-stage torque filter attenuation term	-	0–1000	2	Specifies the attenuation term of the Two-stage torque filter.	B	All	5-2-12

(To be continued)

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 For manufacturer's use Permanently set at 0. bit3 For manufacturer's use Permanently set at 0. 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 Permanently set at 0. * The least significant bit is bit0.	R	All	5-2-13 5-2-14 5-2-15
	48	Adjust filter	0.1 ms	0–2000	2	Set the time constant for the adjust filter in 2 degrees of freedom control.	B	Position, velocity	5-2-14 5-2-15
	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	5-2-14

(To be continued)

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	5-2-11 5-2-14
	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 using this setting value, set a setting value 2 or greater. When 0 is set, the value set for Pr9.35 is enabled.	B	Position, velocity	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	5-2-6
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	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	5-2-7
	71	3rd damping depth	-	0–1000	2	Set the damping depth for the 3rd damping function.	B	Position	5-2-6
	72	4th damping depth	-	0–1000	2	Set the damping depth for the 4th damping function.	B	Position	5-2-6
	73	Load estimation filter	0.01 ms	0–2500	2	Set the filter time constant for load estimation.	B	Position, Velocity	5-2-9
	74	Torque compensation frequency 1	0.1 Hz	0–5000	2	Set the filter frequency 1 for speed control output.	B	Position, Velocity	5-2-9
	75	Torque compensation frequency 2	0.1 Hz	0–5000	2	Set the filter frequency 2 for speed control output.	B	Position, Velocity	5-2-9
	76	Load estimation count	—	0–8	2	Set the number of times regarding load estimation.	B	Position, Velocity	5-2-9

(To be continued)

<table>
<tr><th>Class</th><th>No.</th><th>Title</th><th>Unit</th><th>Range</th><th>Size [byte]</th><th>Function / Contents</th><th>Attribute</th><th>Related control mode</th><th>Reference</th></tr>
<tr><td>6</td><td>85</td><td>Condition setting for retreat operation</td><td>-</td><td>-32768～32767</td><td>2</td><td>
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: Start-up condition for retreat operation (communication)
0: Disable evacuation operation by Err84.0 (RTEX communication timeout error protection) or Err84.5 (RTEX communication cycle error protection) (conventional Err84.0 operation)
1: Execution of evacuation operation under the conditions of occurrence of Err84.0 (RTEX communication timeout error protection)
2: Execution of evacuation operation under the conditions of occurrence of Err84.0 (RTEX communication timeout error protection) or Err84.5 (RTEX communication cycle error protection)
3-15:Err85.2 or Err87.3 is generated due to setting failure. *2)
<table>
<tr><th colspan="3">Binary number</th><th>Decimal number</th><th colspan="2">Start-up condition for re treat operation (communication)</th></tr>
<tr><th>bit7-6</th><th>bit5</th><th>bit4</th><th></th><th>Err84.5</th><th>Err84.0</th></tr>
<tr><td>00</td><td>0</td><td>0</td><td>0</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td>00</td><td>0</td><td>1</td><td>1</td><td>Invalid</td><td>Valid</td></tr>
<tr><td>00</td><td>1</td><td>0</td><td>2</td><td>Valid</td><td>Valid</td></tr>
<tr><td>Value other than 00</td><td>—</td><td>—</td><td>3–15</td><td>Invalid</td><td>Invalid</td></tr>
</table>
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.
Please do not use this setting value with V frame.
*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.
</td><td>C</td><td>All</td><td>6-7</td></tr>
</table>

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	86	Alarm setting for retreat 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: Err85.1/Err87.2 (Completion of retreat operation (communication)) 0:Clearing is impossible, 1:Clearing is possible. 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	6-7
	87	For manufacturer's use	-	-	4	Permanently set at 0.	-	-	-
	88	For manufacturer's use	-	-	4	Permanently set at 0.	-	-	-
	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 bit 3 to 4: Not used. Please set fixed to 0 bit 5: For manufacture use. Please set fixed to 0 bit 6 to 9: For manufacture use. Please set fixed to 0 bit 10: Select position compare output function 0: valid, 1: Invalid bit 11 to 23: Not used. Please set fixed to 0 bit 24 to 26: For manufacture use. Please set fixed to 0 bit 27 to 31: Not used Please set fixed to 0 *bit 0 is the least significant bit.	B	All	5-2-13 6-2 6-6
	98	Function expansion setup 4	-	-2147483648 - 2147483647	4	Sets various function in bit units: bit 0 to 5: For manufacture use. Please set fixed to 0 bit6 to 8: Not used. Please set fixed to 0 bit9: For manufacture use. Please set fixed to 0 bit10 to 31: Not used. Please set fixed to 0 *bit 0 is the least significant bit.	R	All	-
	105	Excessive position deviation warning setting	command unit	$0–2^{30}$	4	Set the setting range of excessive position deviation warning. Set value 0 disables detection of warning AA "Excessive position deviation warning." Use the unit specified by Pr 5.20 "Position setup unit select". Make appropriate settings according to the safety of the device.	A	Position, Full-closed	7–3

9-1-8 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. ※Please do not change the shipment value setting with V frame.	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). ※Please do not change the shipment value setting with V frame.	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 (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 (PP)	RTEX
	12	Negative side software limit value	Command unit	-1073741823 –1073741823	4		A	Position (PP)	RTEX
	13	Absolute home position offset	Command unit	-2147483648～2147483647	4	Set up the offset value on feedback scale position when using absolute feedback scale and mechanical coordinate system position. ・When executing return to origin in absolute mode, the amplifier automatically sets the value internally and this parameter alone is saved to EEPROM. (Note) It is not supported in versions corresponding to function extended edition 2 or earlier.	C	All	RTEX

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	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. ※Please do not change the shipment value setting with V frame.	C	All	RTEX
	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	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	18	For manufacturer's use	—	—	4	Permanently set at 0.	—	—	—
	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: For manufacturer's use. Permanently set at 0. 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	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 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 6-3-1 6-7 RTEX

(To be continued)

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. Note: Pr7.40 “RTEX function extended setup 4” bit0 can be set up simultaneous, refer to it. 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

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	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
	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	2-5, 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	2-5, 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	2-5, 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

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	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
	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	RTEX function extended setup 4	—	-32768–32767	2	bit0: Set up a condition for turning ON the Servo_Active bit for the RTEX status when magnet pole position estimation is valid (Pr 9.20 = 2). Note: Pr7.24 “RTEX function extension setup 3” bit4 can be set up simultaneous, refer to it. 0: Not dependent on magnet pole position estimation 1: Forcedly OFF during Magnet pole position estimation bit1: Switch data to be set to byte 3, bits 3 to 5 for the RTEX status when in CS signal scheme (Pr 9.20 = 1). 0: SI-MON1/EXT1 to SI-MON3/EXT3 1: CS1 to CS3	C	All	4-7 9-2-1 RTEX
	41	RTEX function extended setup 5	—	-32768–32767	2	bit0: Set up a condition for turning ON the magnet pole position estimation completion output (CS-CMP, CS_Complete) when in CS signal scheme (Pr 9.20 = 1). 0: After completion of initialization when the control power supply is turned ON (MINAS-A5L transposition) 1: After first change edge for CS signal (MINAS-A4NL transposition) bit 1 to 4: Not used Permanently set at 0 bit 5: For manufacturer’s use Permanently set at 0 bit 6: Not used Permanently set at 0 bit7: Run inhibit input detection setting when returning to origin of Z phase 0: Invalid 1: Valid bit8-11: For manufacturer’s use Permanently set at 0 bit12-15: Not used Permanently set at 0	R	All	7-5

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	43	Magnet pole position estimation completion output setup	—	0–8	2	Set up the pit arrangement for outputting magnet pole position estimation completion output (CS_Complete) to byte 3 for the RTEX status. This setting will override the setting of Pr7.40 bit1. 0: Not allotted 1: Byte 3, bit0 (NOT/POT) 2: Byte 3, bit1 (POT/NOT) 3: Byte 3, bit2 (HOME) 4: Byte 3, bit3 (SI-MON1/EXT1/CS1) 5: Byte 3, bit4 (SI-MON2/EXT2/RET/CS2) 6: Byte 3, bit5 (SI-MON3/EXT3/STOP/CS3) 7: Byte 3, bit6 (SI-MON4/EX-SON) 8: Byte 3, bit7 (SI-MON5/E-STOP) * Information in () refers to a signal name before allotment.	B	All	4-7 RTEX
	52	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	78	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	80	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	81	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	87	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	88	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	89	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

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	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
	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 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	—	—	—

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	110	RTEX function extended setup 7	—	-2147483648 – 2147483647	4	Setting of various functions is performed by the unit of 1 bit. bit0-3:Used by the manufacturer. bit4: Profile position control mode start condition extension 0: Standard specifications 1: Extended specifications bit5-16:Used by the manufacturer. bit17-31: Not used	—	—	RTEX
	111	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—
	112	Selection of RTEX communication status flag	—	0–2	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 retreat operation) is returned. 1: For manufacturer's use 2:CMP_OUT_Status(Position compare output function valid state) is returned. 0: Invalid, 1: Valid	B	All	6-5 6-7 RTEX
	114	For manufacturer's use	—	—	4	Permanently set at 0.	—	—	—
	119	For manufacturer's use	—	—	2	Permanently set at 0	—	—	—

9-1-9 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	6-7 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	6-7 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 (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 (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 Pr 9.10 "Maximum over-speed level setup". * 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 (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 Pr 9.10 "Maximum over-speed level setup". * 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 (PP)	RTEX
	15	For manufacturer's use	—	—	4	Permanently set at 0.	—	—	—
	17	Relative displacement of retreat operation	Command unit	-2147483647 – 2147483647	4	Set the displacement at retreat operation. Err85.0,Err85.1 ,Err87.1 or Err87.2 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	6-7

(To be continued)

Class 8: Special setting 3

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
8	18	Speed of retreat operation	Command unit/s or r/min	0– 2147483647	4	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.	B	All	6-7
	19	For manufacturer's use	—	—	0	Permanently set at 0.	—	—	—

9-1-10 Class 9: Linear-related

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
9	00	Motor type selection	—	0–3	2	Select the type of a motor that will be connected.	R	All	4-7
	01	Feedback scale resolution	nm	0–536870912	4	[Motor type: Linear] Set up the resolution for the feedback scale.	R	All	4-7
		Number of scale pulses per rotation	pulse			[Motor type: Rotary] Set the number of pulses of the feedback scale per revolution.			
	02	Magnet pole pitch	0.01mm	0–32767	2	[Motor type: Linear] Set up the magnet pole pitch. * For the rotary type or VCM type, no settings are required.	R	All	4-7
	03	Pole logarithm per rotation	Pole logarithm	0–255	2	[Motor type: Rotary] Set up the pole logarithm per motor rotation for the motor. * For the linear type or VCM type, no settings are required.	R	All	4-7
	04	Mass of motor's movable section	0.01kg	0–32767	2	[Motor type: Linear or VCM] Set up the moving portion’s mass of motor.	R	All	4-7
		Motor inertia	0.00001 kgm^2			[Motor type: Rotary] Set up the motor inertia.			
	05	Rated motor thrust	0.1N	0–32767	2	[Motor type: Linear or VCM] Set up the rated thrust for the motor.	R	All	4-7
		Rated motor torque	0.1Nm			[Motor type: Rotary] Set up the rated torque for the motor.			
	06	Rated effective motor current	0.1 Arms	0–32767	2	[Motor type: Linear or Rotary] Set up the rated effective current for the motor.	R	All	4-7
			0.1A			[Motor type: VCM] Set up the rated effective current for the motor.			
	07	Maximum instantaneous motor current	0.1A	0–32767	2	Set up the maximum instantaneous current for the motor.	R	All	4-7
	08	Motor phase inductance	0.01mH	0–32767	2	Set up the phase inductance for the motor.		All	4-7
	09	Motor phase resistance	0.01Ω	0–32767	2	Set up the phase resistance for the motor.	R	All	4-7
	10	Maximum over-speed level	mm/s r/min	0–20000	2	Set up the maximum over-speed for the motor.	R	All	4-7
	11	Carrier frequency selection	—	0–3	2	Select the carrier frequency. 0: 6 kHz 1: 12 kHz 2: 8 kHz 3: For manufacturer’s use.	R	All	4-7
	12	Automatic current response adjustment	%	0–100	2	Set up the criteria for current response for the automatic setup of Pr 9.13 “Proportional current gain” and Pr 9.14 “Integral current gain”.	R	All	4-7
	13	Proportional current gain	—	0–32767	2	Set up the proportional current gain.	B	All	4-7
	14	Integral current gain	—	0–32767	2	Set up the integral current gain.	B	All	4-7
	17	For manufacturer’s use	—	—	—	Always set to 0.	—	—	—
	18	For manufacturer’s use	—	—	—	Always set to 0.	—	—	—
	19	For manufacturer’s use	—	—	—	Always set to 0.	—	—	—

(To be continued)

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
9	20	Magnet pole detection scheme selection	—	0–3	2	Select the detection scheme for magnet pole position.	R	All	4-7
	21	CS phase setup	Electrical angle (°)	0–360	2	Set up the phase difference between the induced voltage of the motor and the CS signal.	R	All	4-7
	22	Magnet pole position estimation thrust command time	ms	0–200	2	Set up the command thrust time for Magnet pole position estimation.	B	All	4-7
	23	Magnet pole position estimation command thrust	%	0–300	2	Set up the command thrust for magnet pole position estimation.	B	All	4-7
	24	Magnet pole position estimation zero travel pulse width setup	pulse	0–32767	2	Set up the zero travel pulse width for magnet pole position estimation.	B	All	4-7
	25	Number of pulses for magnet pole position estimation motor stop judgment	pulse	0–32767	2	Set up the number of pulses for motor stop judgment for magnet pole position estimation.	B	All	4-7
	26	Time for magnet pole position estimation motor stop judgment	ms	0–32767	2	Set up the motor stop judgment time for magnet pole position estimation.	B	All	4-7
	27	Time for magnet pole position estimation motor stop limitation	ms	0–32767	2	Set up the motor stop limitation time for magnet pole position estimation.	B	All	4-7
	28	Magnet pole position estimation thrust command filter	0.01ms	0–2500	2	Set up the time constant for filter respective to the command thrust for magnet pole position estimation.	B	All	4-7
	29	Overload protection timing characteristic selection	—	0–7	2	Setup value 0: According to standard specifications Select the overload protection timing characteristic from eight types of characteristics.	R	All	7-2
	30	Number of pulses per magnet pole	pulse	0–327670000	4	Linear motor information can be set in pulses, which is valid for linear-type settings. This parameter cannot be used at the same time with Pr 9.02 (Magnet pole pitch). Use either of these parameters for setting.	R	All	4-7
	31	For manufacturer's use	—	—	2	Always set to 0.	—	—	—
	32	For manufacturer's use	—	—	2	Always set to 0.	—	—	—
	33	For manufacturer's use	—	—	2	Always set to 100.	—	—	—
	34	For manufacturer's use	—	—	2	Always set to 0.	—	—	—

(To be continued)

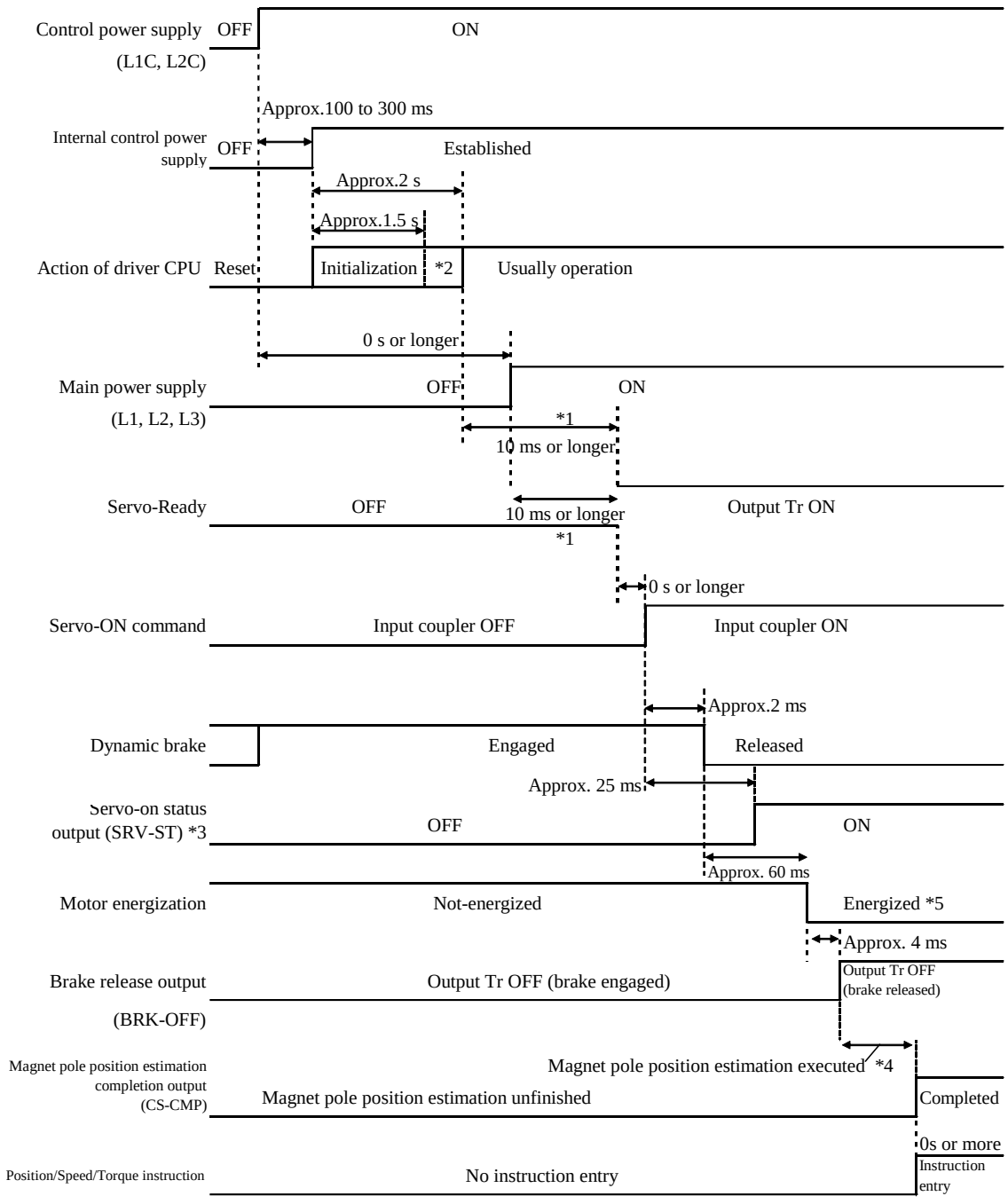
Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
9	35	Thrust saturation error protection frequency	time	0–30000	2	If torque saturated is continued during a preset frequency, Err 16.1 “Torque saturation protection” will be activated. If the setup value 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	B	Position, Velocity	6-4
	48	Voltage feed forward gain 1	—	0–32767	2	Set a Voltage feed forward gain 1. The higher the setting, the higher the current response to the change in torque command becomes. However, since it may cause oscillation or any other faulty operation, select an appropriate value according to the operating conditions. There is no compatibility with the automatic setting by the use of Pr9.12.	B	All	4-7
	49	Voltage feed forward gain 2	—	0–32767	2	Set a Voltage feed forward gain 2. The higher the setting, the higher the current response to torque command. However, since it may cause oscillation or any other faulty operation, select an appropriate value according to the operating conditions. There is no compatibility with the automatic setting by the use of Pr9.12.	B	All	4-7
	50	For manufacturer’s use	—	—	2	Always set to 0.	—	—	—

9-1-11 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

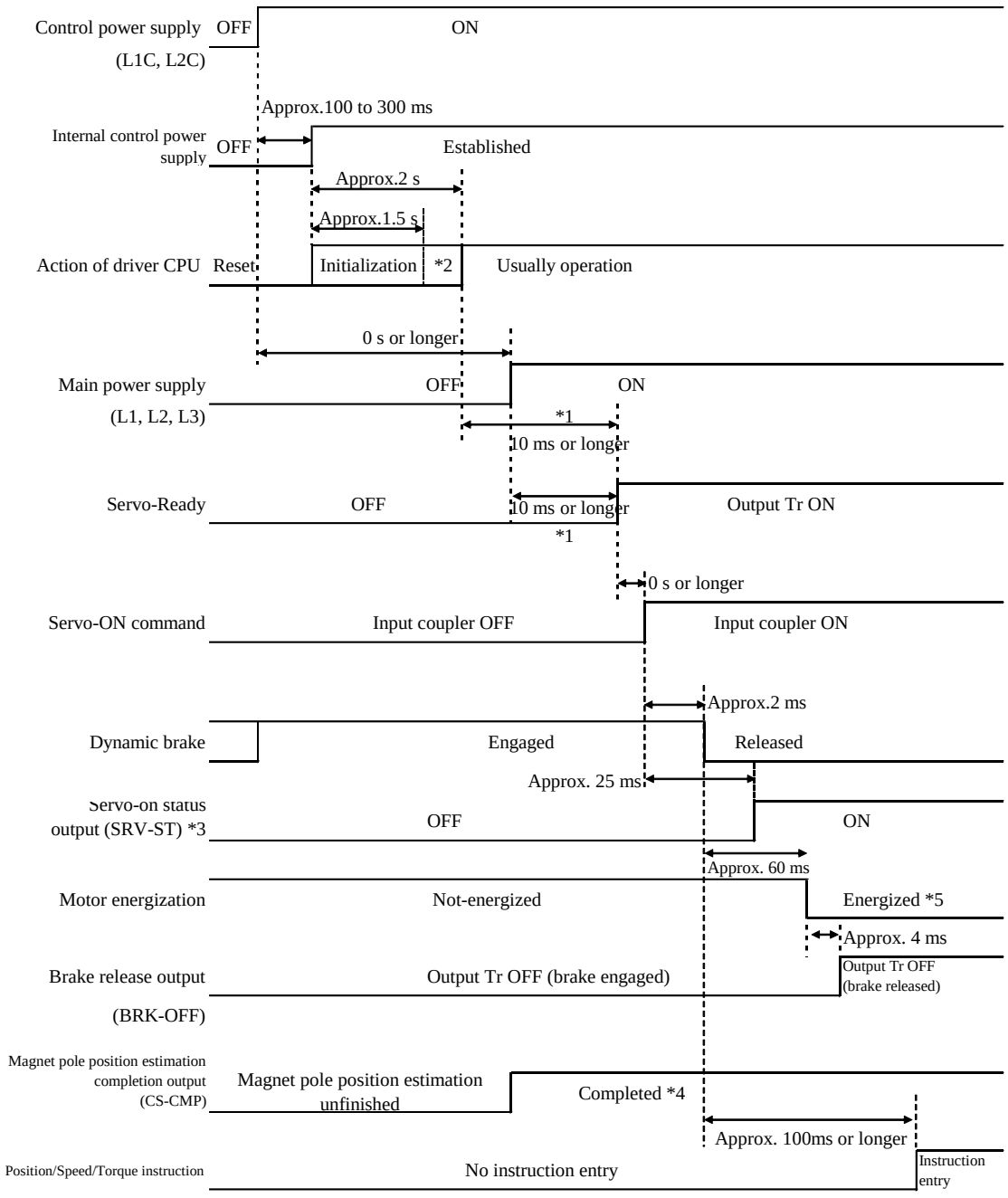
9-2-1 Servo-on signal accept timing on power-up: When magnet pole position estimation is valid (Pr 9.20 = 2)



- 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. 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”.
*2. 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 feedback 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”.
*3. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.
*4. The time of the magnetic pole position estimation depends on the parameter setting etc. Please impress the instruction after confirming the magnetic pole position estimation completed output is turned on. When the magnetic pole position estimation is not normally completed, the magnetic pole position estimation completed output is not turned on.
*5. With Pr 7.40 “RTEX function extension setup 4” bit0 = 1, the Servo_Active flag for the RTEX status is forced to return a servo off (no electricity conducted) until magnet pole position estimation is completed.
And with Pr 7.24 “RTEX function extension setup 3” bit4 = 1, the Servo_Active flag for the RTEX status is forced to return a servo off (no electricity conducted) until charge + offset measurement is completed.

9-2-2 Servo-on signal accept timing on power-up: When magnet pole position estimation is invalid (Pr 9.20 = 0, 1, 3)



- 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. 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”.

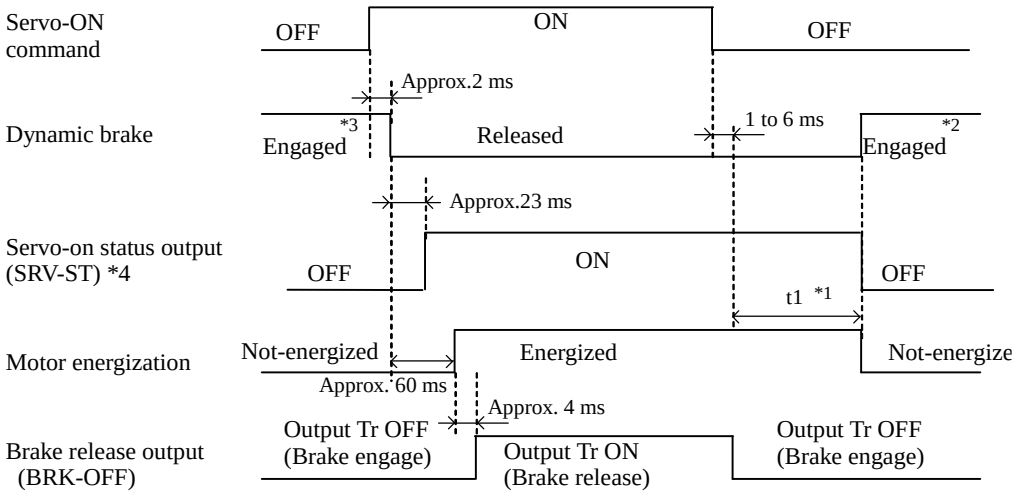
*2. After Internal control power supply, protective functions are active from approx. 1.5 sec after the start of initializing microcomputer. Please set the signals, especially for protective function, for example over-travel inhibit input (POT, NOT) or feedback scale input, so as to decide their logic until this term. The lapse time can be changed with Pr 6.18 “Power-up wait time”.

*3. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

*4. If Err 61.2 “Magnet pole position estimation error 3 protection” is activated or with Pr 9.20 = 0, the magnet pole position estimation completion output will not turn ON. The timing (condition) at which the magnet pole position estimation completion output turns ON depends on the setup value for Pr 9.20 “Magnet pole detection scheme selection” and Pr 7.41 “RTEX function extension setup 5” bit0. For more information, refer to Section 2-2

9-2-3 Servo-ON/OFF action while the motor is at stall (servo-lock)

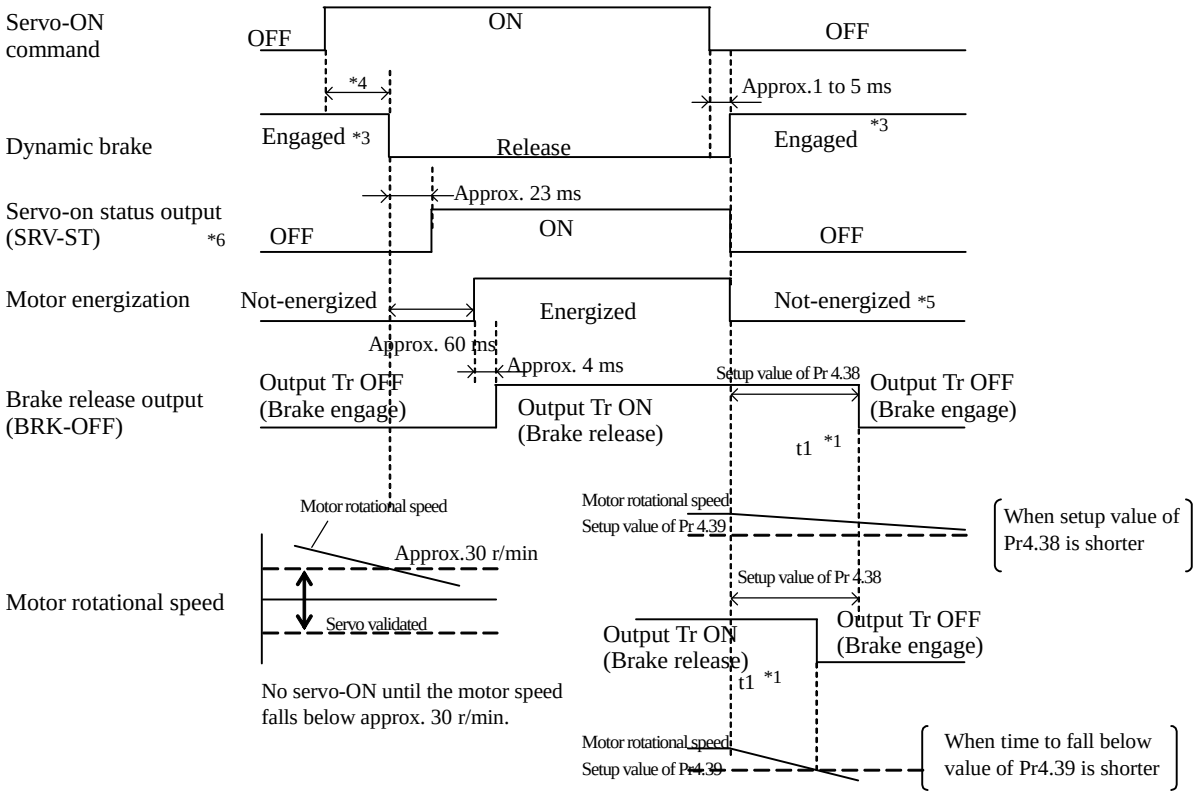
(To turn on/off the servo during normal operation, first stop the motor.)



*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 (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-2-4 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.

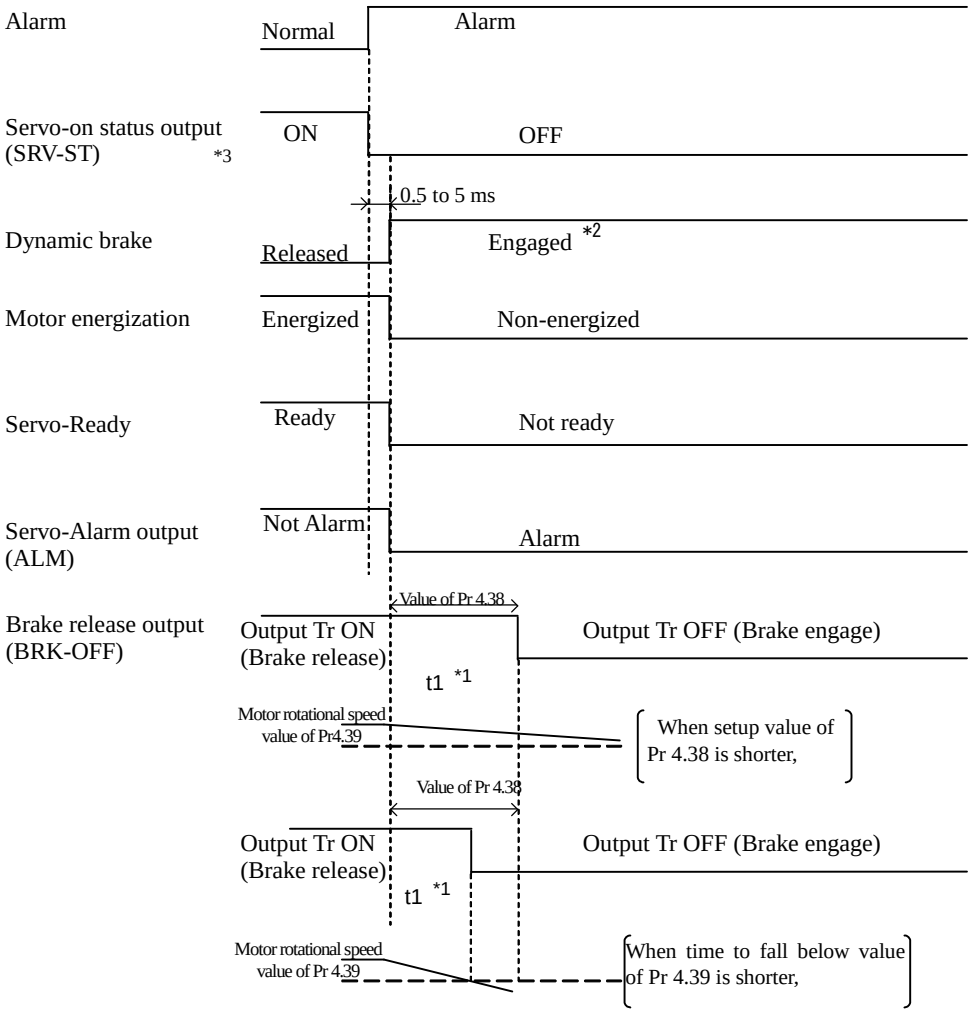
*3. For the action of dynamic brake at alarm occurrence, refer to an explanation of Pr 5.06, “Sequence at Servo-off” as well.

*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 (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-2-5 When an error (alarm) has occurred (at Servo-ON command) (DB deceleration, free run deceleration operation)



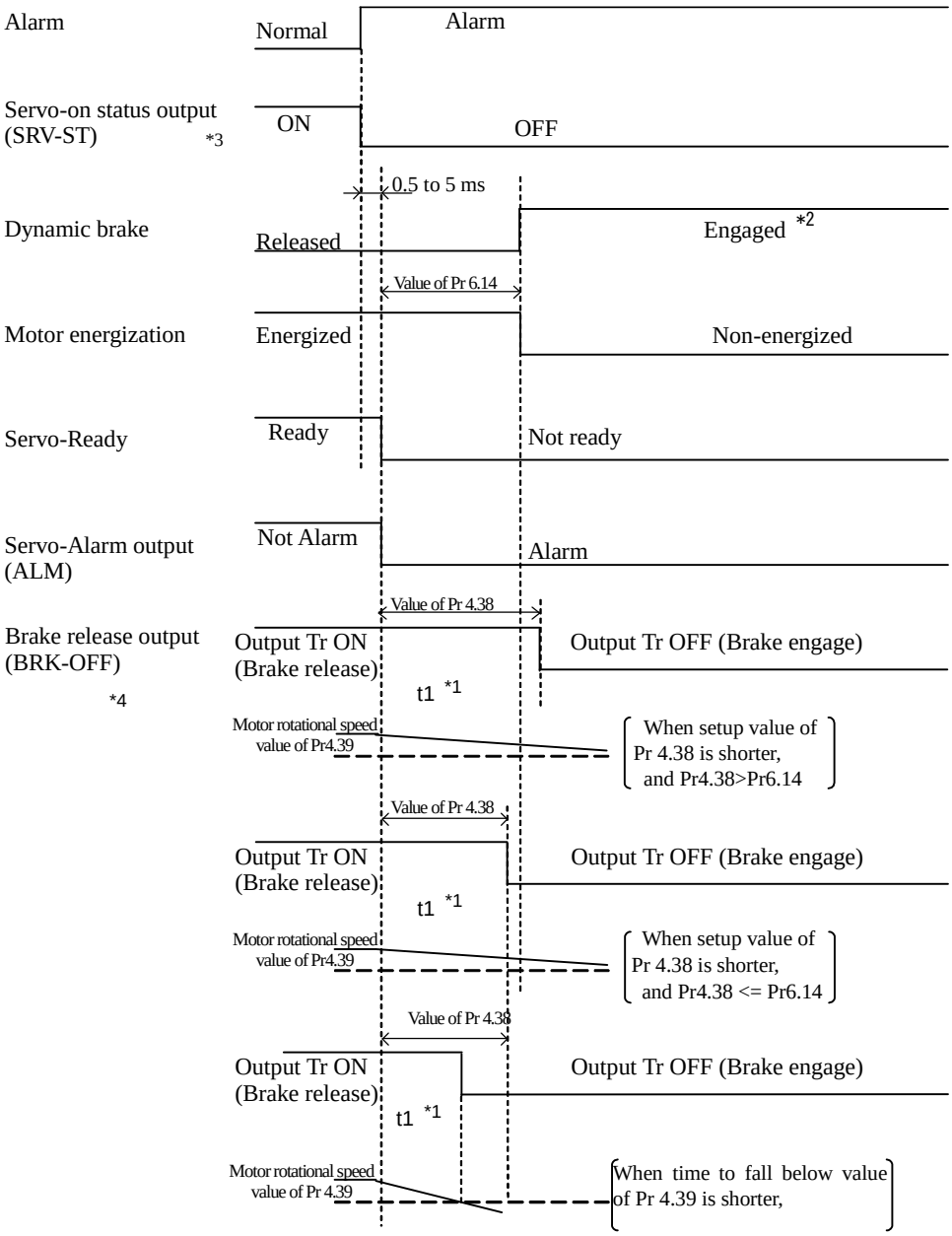
・The timings in the above diagram vary depending on the settings of sequence operations.

*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 (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

9-2-6 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".

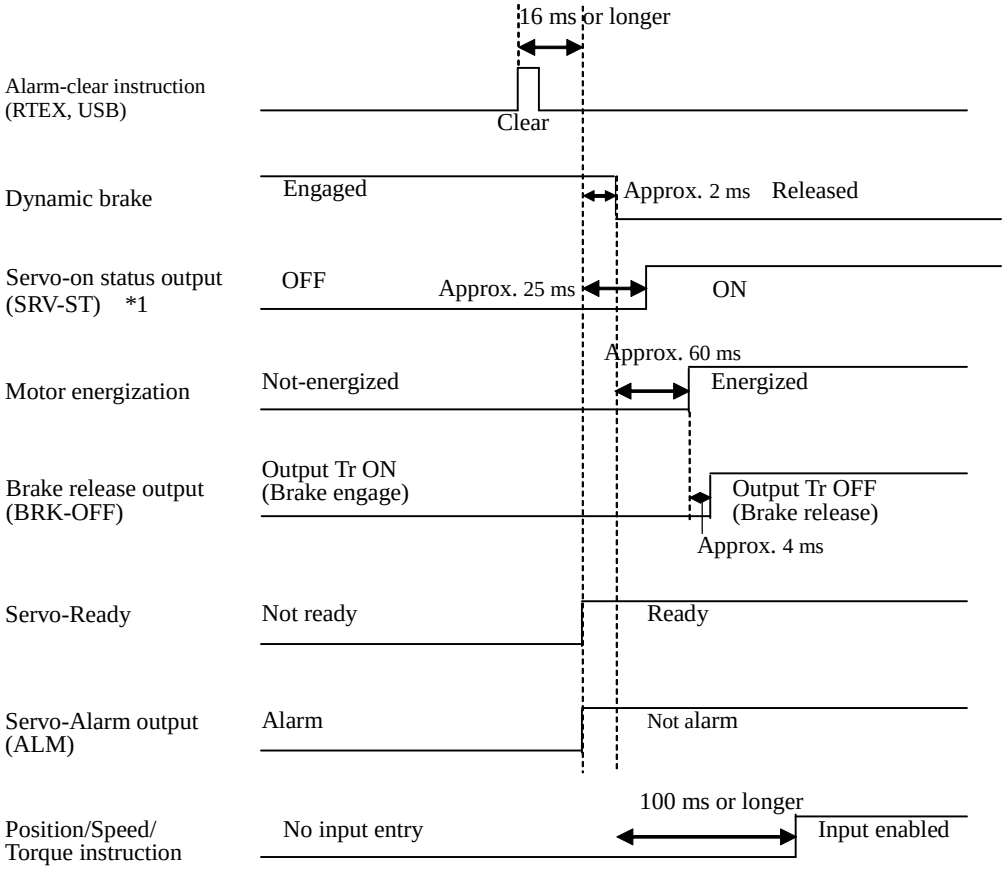
*3. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.

*4. The 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.

9-2-7 When an alarm has been cleared (at Servo-ON command)



*1. Note that the servo-on status output signal (SRV-ST) is to let you know of the receipt of servo-on input and is not an output to let you know that command input is possible.