Panasonic

No. SX-DSV02309

TECHNICAL REFERENCE

– Functional Specification –

MODEL

Product Name: AC Servo Driver

Part Number: MINAS-A5NL Series
(RTEX communication type/Linear type)

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Revisions

Date	Page	Rev.	Description	Signed
Sep. 15, 2011	–	1.0	NEWLY ISSUED	-
Oct. 20, 2011	18, 19	1.1	Added the description in the Section “2-5 Basic network setting”	-
	51		Error corrected in Pr9.12: 40 to 30, 80 to 60	
	54		Error corrected in the description and figure of the how to set relative phase: 300° to 60°	
	91, 93, 144		Error corrected in the scope of Pr6.10: 511 to 255	
	98		Added the description of “Note 2” of Prs5.25, 26	
	104, 106		Added the description for non-stop condition: “Auto-setting CS/scale direction”	
	147		Added the description to the effect that the setting should coincide with the upper equipment for Prs7.20 to 22	
	148		Added the description about the response for Prs7.29 to 34 when the setting value is zero	
Nov.18,2011	1	1.2	Added the description of “*”(Check the software version)	-
	5		Added the description of “(a-contact)” after SI6,SI7,SI5	
	21		Added the description in Function of Pr7.01	
	108		Added the description of “For example” before「if the frequency ・・・」	
	112		Added the description in Measures of Err16.1.	
	119		Added the description in Measures of Err86.2.	
	147		Added the description in Function/Contents of Pr7.01	
	148		Added the description in Function/Contents of Pr7.23(bit10-13)	
	151		Added the description in Title and Function/Contents of Pr8.00	
	151		Added the description in Title of Pr8.05	
	151		Added the description in Title of Pr8.15	
	152		Changed the description of parameter name (Pr9.01/Pr9.04)	
	56		Corrected the figure of magnetic pole position estimation.	
	57		Correction of cautions.	
	58		Added the means which prevent vibration after pole position estimate.	
	58		Added the description of “Pr7.40 and Pr7.43”	
	114		Correction the description in causes of Err33.5 “(SO4)”->”(SO2)”	
Mar.30,2012	All	1.3	Changed company name.	-
	69,78		Changed the description of parameter name.(Pr6.10,Pr1.15)	
	93		Added the description of parameter of Pr5.08,Pr5.09	

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

Revisions

Date	Page	Rev.	Description	Signed
Mar.30,2012			(Continuation)	
	82,95		Changed the description of parameter name.(Pr1.15,Pr1.20,Pr1.24)	
	2		Added the description of The scale corresponding to others	
	132		Changed the description of return timing diagram from a safety state	
	17		Added the description of Explanatory note	
	34,79		Added the description of Notes	
Apr.1,2013	All	2.0	Changed company name.	-
	1		Software upgrade Ver8.01 -> Ver8.02	
			The table of changes is added. (This mark 2.0 is added to a description change part.)	
	3,19,20,32,65, 73,75-83,96,109, 110,132,152,153, 159,160,162		1) Block Diagram of 2 Degrees of Freedom Mode(Standard type)	
	5,6,12,14,126		2)"b-contact" setting of the input signal (HOME, POT, NOT, EXT1, EXT2, EXT3) used as a home position reference trigger and a latch trigger	
	5,6		3)The falling edge (HOME, POT, NOT) used as a home position reference trigger	
	132		4)Profile homing command extension Type_Code = 34h : Profile homing 4 Type_Code = 35h : Profile homing 5	
	154,165,166		5)Parameter command extension Type_Code = 020h : Parameter initial value read-out Type_Code = 030h : The number read-out of the parameters in a classification Type_Code = 040h : Parameter attribute read-out	
	-		6) PANATERM connection axis check representational function	
	34,35,155,163,165, 170		7)Pr7.24” RTEX function extended setup 3” extension bit2:Setting condition to output the positioning complete signal during servo-off bit3: Setting condition for In_Position(positioning complete signal) of RTEX communication bit4: Setting condition for Servo_Active (servo-on state signal) of RTEX communication	
	35,70,79,80,102, 104,158		8)Pr6.10” Function extended setup” extension. bit9:For manufacturer use	
	118,119		Added the description of setting Pr5.13” Over-speed level setup” and Pr6.15” 2nd over-speed level setup” under alarm sequence	
	19,20,36,162		Added the description of pulse regeneration function.	

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Contents

1. Introduction

This document describes the functions of the linear motor supported servo amplifier MINAS-A5NL series (read MINAS-A5N as MINAS-A5NL, below) equipped with the RTEX communication function.

<Software version>

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

△2.0 Ver.8.02 or later

*Please check the software version by setup support software PANATERM.

<References>

SX-DSV02308: Reference specifications (Specification of hardware)

SX-DSV02310: Technical document (Specification of real-time Express communication)

<IMPORTANT>

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(2) Motor Business Division, Appliances Company, Panasonic Corp. reserves the right to make modifications and improvements to its products and/or documentation, including specifications and software, without prior notice.

(3) In general, these specifications adopt the names/units based on the linear type.
The table below lists the correlation with rotary type, so read the difference as such.
However, the signal symbols, etc. (TLC and Torque_Limited, for example) are for rotary type, read them as a linear type.

Linear type	Rotary type
Mass	Inertia
Thrust	Torque
mm/s	r/min

1-1 Basic Specification

Item		Description
Control method		IGBT PWM method, sinusoidal drive
Control mode		Position control: Profile position control (PP), Cyclic position control (CP) Velocity control: Cyclic velocity control (CV) Thrust control: Cyclic thrust control (CT) ▪ Change PP/CP/CV/CT above with the RTEX communication commands
Feedback scale		• A/B/Z phase signal differential input • Compatible with absolute ST770A, ST770AL, AT573A manufactured by Mitutoyo Corporation • And incremental SR75, SR85, absolute SR77, SR87 manufactured by Magnescale Corporation (Compatible with Panasonic-type serial), etc. (For other supported feedback scales, contact us.) ▪ For more information, refer to the Sections 1 – 3.
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	Each 3 output can be assigned by the parameter.
Analogue signal	Output	2 outputs for analog monitors 1 and 2
Pulse signal	Output	Feedback scale pulse is output to the line driver with the A/B phase signal
Communication	Realtime express (Abbr. RTEX)	Communication for transmission of a real-time operation command, the parameter setting, or the status monitoring.
	USB	USB interface to connect to computers (PANATERM) for parameter setting or status monitoring.
Safety terminal		Terminal to provide functional safety [Cannot be applied to standard models of A5N series (compatible only with special version).]
Front panel		1. 7-segment LED (double digits) 2. Network status LED (LINK, COM) 3. Rotary switch for node address setting 4. Analog monitor output (Analog monitors 1 and 2)
Regeneration		Size A , B, G, and H: Without built-in regenerative resistor (use external resistor) Size C–F: Built-in regenerative resistor (External regenerative resistor is also available)
Dynamic brake		For information on the built-in type, refer to the Reference specifications SX-DSV02308.

1-2 Function

Item			Description
Position control	Digital input		CW drive inhibit, CCW drive inhibit, latch signal, near home position, etc.
	Digital output		Positioning completion etc.
	Position command input	Input mode	Command type by RTEX command
		Electronic gear ration setting	Applicable scaling ratio: 1/1000–1000 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.
		Smoothing Filter	1st order filter or FIR filter selectable for command input
	Instantaneous velocity observer		Available
	Anti-vibration Control		Available
	Block Diagram of 2 Degrees of Freedom Mode(Standard type)		Available
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 mm/s Acceleration and deceleration can be set separately. S-curve acceleration/deceleration is also available.
	Instantaneous velocity observer		Available
	Block Diagram of 2 Degrees of Freedom Mode(Standard type)		unavailable
Thrust control	Control input		Positive direction drive inhibit, negative direction drive inhibit, latch signal, etc.
	Control output		At speed etc.
	Thrust command input	Input mode	Command type by RTEX command
	Speed limit function		Speed limit can be set by parameter or RTEX.
	Block Diagram of 2 Degrees of Freedom Mode(Standard type)		unavailable
Common	Auto-tuning		Identifies the load mass real-time and automatically sets up the gain that meets the stiffness setting when the motor is running with upper and internal operation commands.
	Protective function		Overvoltage, undervoltage, overspeed, overload, overheat, overcurrent, positional overdeviaition, EEPROM failure, etc.
	Alarm data trace back		Tracing back of alarm data is available

1-3 Scope

The table below lists the scope of the motor/feedback scale used in combination with this servo amplifier:

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

Feedback scale	Linear type	Rotary type
Resolution	0.01–10 [μm/pulse] *4	10000–2^{24} [pulse/r] *4
Maximum length	Up to resolution × (2^30-1)	—
Scale type	A/B phase, differential origin signal input	
	Serial communication type ・ Manufactured by Mitutoyo AT573A, ST770A, ST770AL (Panasonic serial supported) ・ Manufactured by Magnescale SR75, SR77, SR85, SR87 (Panasonic serial supported) etc. *5	Note: For information on the serial communication type, contact us separately.
Acceptable scale speed *2	A/B phase type: Up to 4 Mpps *6 Serial communication type: Up to 400 Mpps (however, up to 105 Mpps for rotary type)	

*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 amplifier. 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 Basic linear motor/feedback scale setting”.
*4 The number of pulses should be 2048 or more per magnetic pole pitch (per electric angle cycle).
*5 For other supported feedback scales, contact us.
*6 For information on acceptable scale speed over 4 Mpps, contact us.

2. Interface Specification

2-1 I/O connector input signal

Title of signal	Symbol	Connector pin No. *2)	Contents	Related control mode *1)			RTEX communi-cations monitor
				Position	Velocity	Thrust	
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”.	○			○
2.0 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. This input signal can only be assigned to S16, 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.	○			○
2.0 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. This input signal can only be assigned to S16, respectively. This input signal can only be assigned to S17, 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.	○			○
2.0 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	Connector pin No. *2)	Contents	Related control mode *1)			RTEX communi-cations monitor
				Position	Velocity	Thrust	
2.0 External latch input 1	EXT1	*	• An external input signal used as a trigger for position latch and home position return. • This input can only be set to a-contact. Trigger timing is transition from Open (OFF) to Close (ON). • 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.	○			○
2.0 External latch input 2	EXT2	11 (SI6)		○			○
2.0 External latch input 3	EXT3	12 (SI7)		○			○
General purpose monitor input 1	SI-MON 1	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-MON 2	*		△			○
General purpose monitor input 3	SI-MON 3	*		△			○
General purpose monitor input 4	SI-MON 4	13 (SI8)		△			○
General purpose monitor input 5	SI-MON 5	5 (SI1)		△			○

Title of signal	Symbol	Connector pin No. *2)	Contents	Related control mode *1)			RTEX communi-cations monitor
				Position	Velocity	Thrust	
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.	○			○

*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”.

2-2 I/O connector output signal

Title of signal	Symbol *2)	Connector pin No.	Contents	Related control mode *1)			RTEX communi-cations monitor *2)
				Position	Velocity	Thrust	
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. If 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.	—	○	○	—
Thrust in-limit signal output	TLC (Thrust _ Limited)	*	• Outputs the thrust in-limit signal. • Turns on the output transistor when thrust is limited.	○			○
Zero-speed detection output signal	ZSP	*	• Outputs the zero-speed detection signal. • Turns on the output transistor when zero velocity is detected.	○			—
Speed coincidence output	V-COIN	*	• Outputs the speed coincidence signal. • Turns on the output transistor when velocity matches. • For details, refer to 4-3-2.	—	○	○	—
Positioning complete 2	INP2	*	• Outputs the positioning complete signal/positioning complete signal 2. • Turns on the output transistor upon positioning completion 2. • Bit7 of Pr6.10 = 1: When Pr9.20 = 2 (Pole position estimation) and the pole position was not estimated, the Positioning complete 2 output is turned OFF forcibly. If bit7 of Pr6.10 = 0, regardless of the pole position was estimated or not, the signal is output according to the position deviation. • For details, refer to 4-2-4.	○	—	—	—

Title of signal	Symbol *2)	Connector pin No.	Contents	Related control mode *1)			RTEX communi-cations monitor *2)
				Position	Velocity	Thrust	
Alarm output 1	WARN1 (Warning)	*	• Outputs the warning output signal set to Pr 4.40 "Warning output select 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 "Warning output select 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	*	• Outputs the speed limit signal when the thrust is controlled. • 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 30mm/s (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.	○			—
Estimated pole position output	CS-CMP (CS_Complete)	*	• When the pole position was estimated, the output transistor is turned ON. • For information on the output transistor, refer to Note *6.	○			○

*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, SX-DSV02310"Section 6-9-5", RTEX communication.

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 RETX operation output 1/2 when RETEX 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	Title of signal	Pr.7.24 RTEX function enhancement setting 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) 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)

2-3 I/O connector other signal

2-3-1 Feedback scale output signal

Title of signal	Symbol	Connector pin No.	Contents	Control mode			RTEX communi-cations monitor
				Position	Velocity	Thrust	
A-phase output	OA+	17	• Feeds out the divided feedback scale signal or external scale signal (A, B-phase) in differential. (equivalent to RS422) • 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)	○			—
	OA–	18					
B-phase output	OB+	20					
	OB–	19					
Signal ground	GND	16	• Signal ground				

2-3-2 Others

Title of signal	Symbol	Connector pin No.	Contents	Control mode			RTEX communi-cations monitor
				Position	Velocity	Thrust	
Frame ground	FG	shell	• This output is connected to the earth terminal inside of the driver.				
To be used by the manufacturer.	—	14, 15 21, 22 23, 24	• Keep these pins unconnected.				

2-4 I/O signal allocation function

Default I/O signal allocation can be changed.

2-4-1 Input signal allocation

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

(1) Using with the default setting

The table below shows default signal allocation.

Note: Default settings of certain model will differ from those shown below. If the default settings shown in Reference specification SX-DSV02308 are different from values shown below, the settings described in SX-DSV02308 are valid standard default values.

Pin name	Pin No.	Applicable parameter	Default setting ( ): decimal notation	Default setup					
				Position control		Velocity control		Thrust 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.

△2.0 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: thrust 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 thrust control mode, set to 0000AF2Eh. Position ... 2Eh Velocity ... AFh Thrust... 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 △2.0
Negative direction over-travel inhibition input	NOT	02h	82h △2.0
External servo ON input	EX-SON	03h	83h
Forced alarm input	E-STOP	14h	94h
External latch input 1	EXT1	20h	A0h △2.0
External latch input 2	EXT2	21h	A1h △2.0
Near home input	HOME	22h	A2h △2.0
External latch input 3	EXT3	2Bh	ABh △2.0
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".
- 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.
- When latch correction pins (SI5/SI6/SI7) are used, only a-contact can be specified. If b-contact is specified, the Err33.8 "Latch input allocation error protection" occurs.
  If a latch correction pin is assigned to the over-travel inhibit input (POT/NOT), a-contact is specified. So, the over-travel inhibit input does not work when cable is broken. Be sure to secure safety using another method (e.g. installing a mechanical stopper).
- 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.
- The SI-MON1 and EXT1, SI-MON2 and EXT2, SI-MON3 and EXT3, SI-MON4 and EX-SON, and SI-MON5 and 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".

Safety precautions:

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

2-4-2 Assignment of output signal

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

(1) Using the default setting

The table below shows default signal allocation.

Note: Default settings of certain model will differ from those shown below. If the default settings shown in Reference specification SX-DSV02308 are different from values shown below, the settings described in SX-DSV02308 become valid standard default values.

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

(2) [Reallocation of output signal].

To change the allocation of output signal, change the following parameters.

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

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

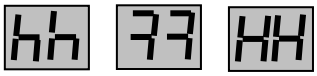
Function number table

Title of signal	Symbol		Setup value
	External output	RTEX status	
Invalid	—	—	00h
Alarm output	ALM	Alarm	01h
Servo-Ready output	S-RDY	Servo_Ready	02h
External brake release signal	BRK-OFF	—	03h
Positioning complete output	INP	In_Position	04h
At-velocity output	AT-SPEED	—	05h
Thrust in-limit signal output	TLC	Thrust _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
Estimated pole position output	CS-CMP	CS_Complete	12h

*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. However, the output logic setting must be the same. In addition, when using the same function for multiple control modes, the same output logic must be set. If different output logic was set, the output signal state will become unstable.
- 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 external brake release signal (BRK-OFF), the signal should be set in all control modes. If not applied to all control modes, Err 33.4 “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 amplifier 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.

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, SX-DSV02310 ”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 2.0</td><td>・Cycle to transfer the RTEX frame of a command and response.
・In general, the servo amplifier processes the command and response at this cycle.
▪ If the communication cycle is 0.0833 [ms], the pulse regeneration will be automatically invalid.
▪ If the communication cycle is 0.0833 ms (Pr7.20=0), please set an adaptive filter invalid. (Pr2.00=0).</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 amplifier:
<table>
<tr><td>Communication cycle 0.0833[ms]</td><td colspan="2">・The command and response are processed at 0.1666 [ms] cycle.
・Set the command update cycle to 0.1666 [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 amplifier 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-A5N series support the communication cycle/command update cycle, control mode, and data size listed in the table below.

(1) 16 byte mode

○: supported, –: unsupported

Communication cycle [ms]	Command update cycle [ms]											
	0.1666				0.5				1.0			
	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT
0.0833	–	○	○	○	–	–	–-	–	–	–	–-	–
0.1666	–	○	○	○	–	–	–-	–	–	–	–-	–
0.5					○	○	○	○	○	○	○	○
1.0									○	○	○	○

(2) 32 byte mode

○: supported, –: unsupported

Communication cycle [ms]	Command update cycle [ms]											
	0.1666				0.5				1.0			
	PP	CP	CV	CT	PP	CP	CV	CT	PP	CP	CV	CT
0.0833	–	–	–-	–	–	–	–-	–	–	–	–-	–
0.1666	–	–	–-	–	–	–	–-	–	–	–	–-	–
0.5					○	○	○	○	○	○	○	○
1.0									○	○	○	○

3) Relevant parameter

Class	No.	At-trib-ute	Title	Range	Unit	Description
7	20	R	RTEX communication cycle	0–12	△2.0	Set the communication cycle of the RTEX communication. 0 : 0.0833[ms] 1 : 0.1666[ms] 3 : 0.5[ms] 6 : 1.0[ms] Otherwise: Reserved for manufacturer's use (do not set this) ▪ If the communication cycle is 0.0833 [ms], the pulse regeneration will be automatically invalid. ▪ If the communication cycle is 0.0833 ms (Pr7.20=0), please set an adaptive filter invalid. (Pr2.00=0).
7	21	R	RTEX command update cycle ratio	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 (valid only for communication cycle = 0.0833, 0.5 [ms])
7	22	R	Extended RTEX function 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.

Note:
Make sure to set the same cycle as the upper equipment for the RTEX communication cycle (Pr7.20) 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:

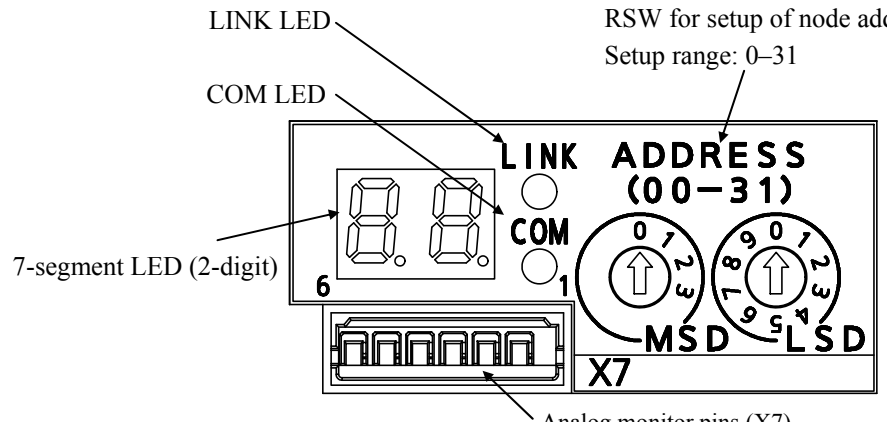
- Pr7.20 = 3 (communication cycle: 0.5 [ms])
- Pr7.21 = 2 (command updating cycle: 1.0 [ms] = 0.5 [ms] × 2)
- Pr7.22 = 0 (16 byte mode, semi-synchronous mode between axes)

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 condition of Pr7.20 (RTEX communication cycle) and Pr7.21 (RTEX command updating cycle) is not supported, Err93.5 (Parameter setting error protection 4) occurs.

3. Front panel display specification

3-1 Appearance of front panel



Pin No.	Symbol	Description
1	AM1	Analog monitor 1
2	AM2	Analog monitor 2
3	GND	Signal ground
4, 5, 6	-	Reserved (Do not use)

3-2 7-segment LED

Node address value set with RSW will be displayed at 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.

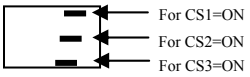
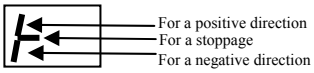
■ Relevant parameters

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

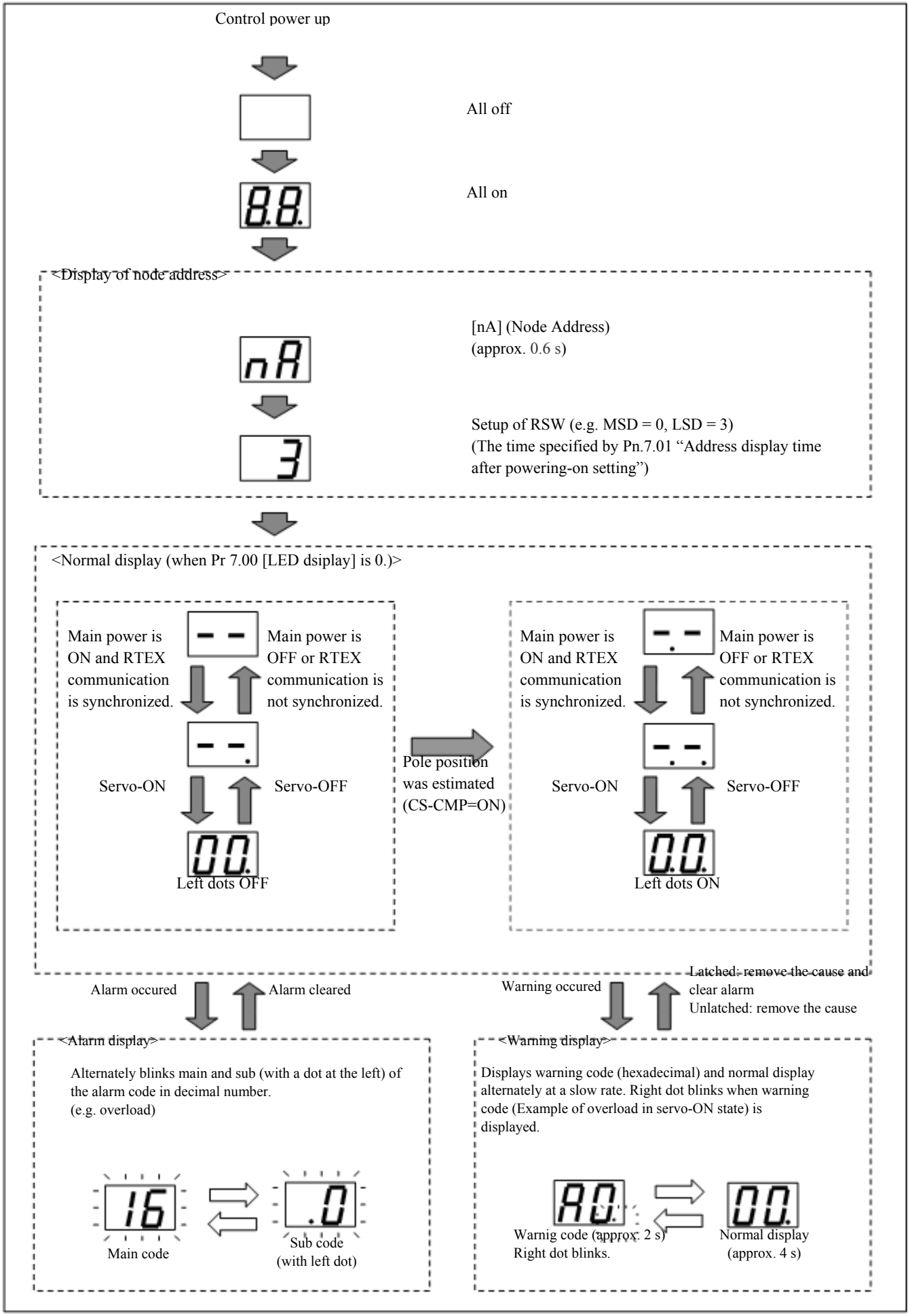
*1) For parameter attribute, refer to Section 9-1.

Pr 7.00	Information on display	Remarks
0	Normal display	[-]: servo OFF, [00]: servo ON
1	Mechanical angle	Range: 0 to FFF hex. 0: zero position of 1 revolution data of encoder. Data increments as motor turns CCW. When the displayed value exceeds [FF], the count is reset to [0] and restarted. When the incremental encoder is used, upon turning ON of the control power, [nF] (not Fixed) is displayed until zero position of the encoder is detected.
2	Electrical angle	Display range: 0 to FF [hex]. 0: the position where U phase induced voltage reaches the positive peak. Data increments as motor turns CCW. When the displayed value exceeds [FF], the count is reset to [0] and restarted.
3	RTEX Accumulated communication error counts	Display range: 0 to FF [hex]. Max. accumulated communication error counts: FFFF [hex]. Only the least significant byte is displayed. When the displayed value exceeds [FF], the count is reset to [00] and restarted. ▪ Accumulated communication error counts will be cleared upon turning OFF of the control power source.
5	Encoder Accumulated communication error counts	
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	Z phase counter	When the incremental feedback scale is used , displays the value of Z phase counter read from feedback scale: 0–F [hex]. ▪ This displayed value is not affected by the value of Pr 3.26 “Feedback scale & CS reversal”.
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, ‘ 0’ 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.
Otherwise	Reserved for manufacturer's use (unavailable)	—

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



3-3 Network status LED

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

■ COM LED

Display status	Description				
	RTEX communication status	Bit 4 of Pr 7.23 = 0		Bit 4 of Pr 7.23 = 1	
		MNM1221 status *1)	State of synchronization between communication and servo	MNM1221 status *1)	State of synchronization between communication and servo
Not lit	Not established	• INITIAL	Independent	• INITIAL	Not established
Blinking green	Established In process	• RING_CONFIG • READY		• RING_CONFIG • READY • RUNNING	Not established
Lit green	Established	• RUNNING		• RUNNING	Established
Blinking red	RTEX communication-related clearable alarm occurs.				
Lit red	RTEX communication-related unclearable alarm occurs.				

*1) MNM1221 is an ASIC for RTEX communication control

■ 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 amplifier, not due to an error.
- The state of the bit 4 of Pr.7.23 (RTEX function enhancement setting 2) can change the condition for turning on COM LED.

3-4 Monitor signal output function

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

■ Relevant parameters

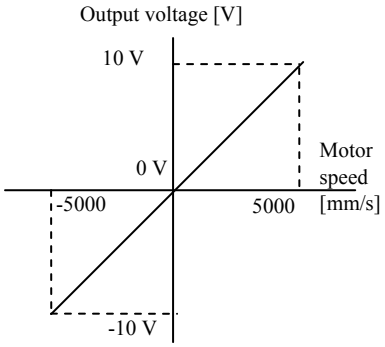
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	16	A	Type of analog monitor 1	0–24	—	Select the type of monitor for analog monitor 1. * See the next page.
4	17	A	Analog monitor 1 output gain	0–214748364	[Monitor unit in Pr 4.16] / V	Set up the output gain of analog monitor 1. For Pr 4.16 = 0 Motor velocity, 1 V is output at the motor velocity [mm/s] = Pr 4.17 setup value.
4	18	A	Type of analog monitor 2	0–24	—	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 Thrust command, 1 V is output at the thrust 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.

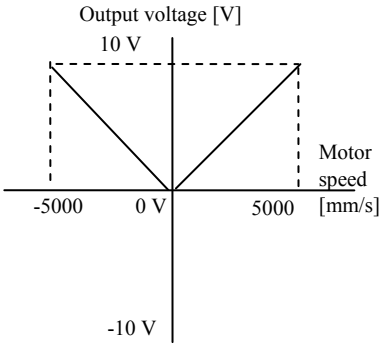
(1) Pr 4.21 “Analog monitor output setup”:

The figure below shows output specification when Pr 4.21 is 0, 1 or 2.

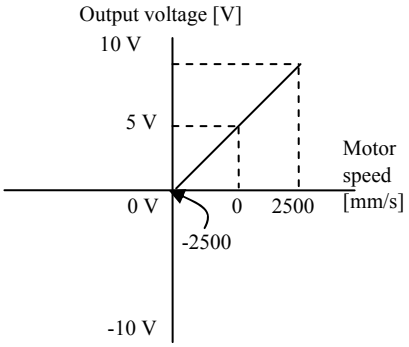
Pr 4.21 = 0, signed data output (output range –10 to 10 V)



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)



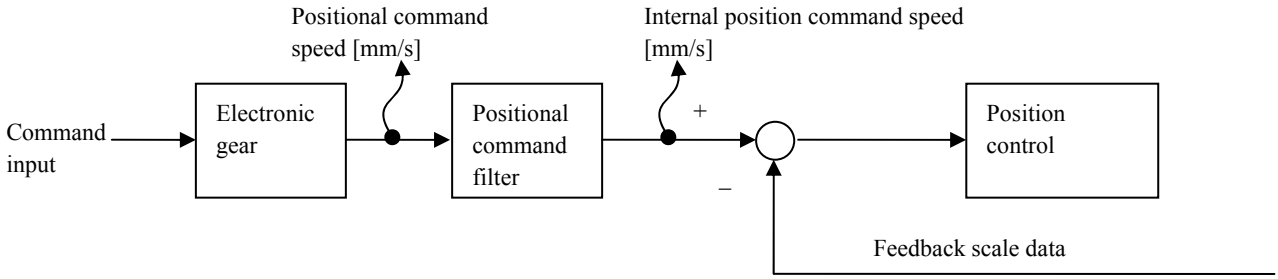
• When monitor type is motor speed, and conversion gain is 500 (1 V = 500 mm/s).

(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.

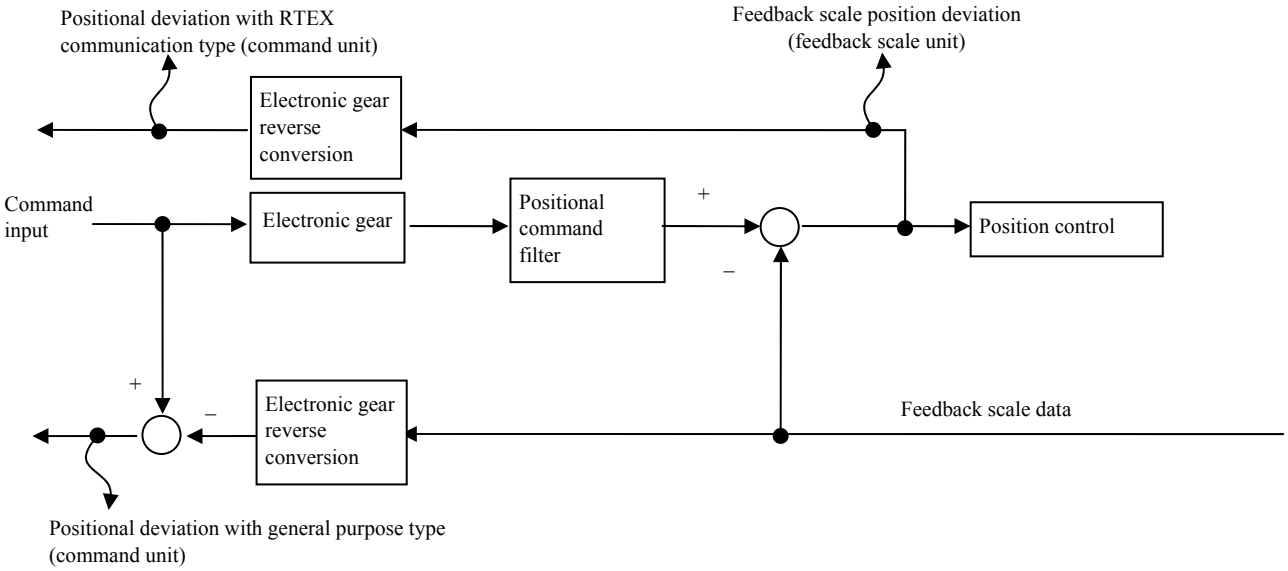
Pr 4.16/Pr 4.18	Type of monitor	Unit	Output gain for setting Pr 4.17/Pr 4.19 = 0 [1/V]
0	Motor velocity	mm/s	500
1	Positional command velocity *2	mm/s	500
2	Internal positional command velocity *2	mm/s	500
3	Velocity control command	mm/s	500
4	Thrust command	%	33
5	Command positional deviation *3	pulse (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 thrust limit	%	33
13	Negative direction thrust limit	%	33
14	Speed limit value	mm/s	500
15	Mass ratio	%	500
16	Reserved	—	—
17	Reserved	—	—
18	Reserved	—	—
19	Reserved	—	—
20	Driver temperature	°C	10
21	Reserved	—	—
22	Reserved	—	—
23	Moving command status *4	—	—
24	Gain selection status *4	—	—

*1 The direction of monitor data is basically as defined in Pr 0.00 “Operation direction”.

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



*3 Computation method (reference) of positional deviation (command unit) for RTEX communication type (MINAS-A5N series) is different from that for general purpose type ((MINAS-A5 series). With the general purpose type, the deviation is with respect to the command input before the positional command filter. With RTEX communication type, it is the deviation (feedback scale position deviation is reverse converted to a command unit) with respect to the instruction input after the positional command filter.
The feedback scale position deviation is the deviation at the input section of positional control.
The figure below shows details.



*4 For the monitor types No.23 and 24, digital signals are monitored using an analog monitor. So, set the Pr4.17 “Analog monitor 1 output gain” and the Pr4.19 “Analog monitor 2 output gain” to 0 or 1, and set the Pr4.21 “Analog monitor output setting” to 1. In this case, the output gain is as follows:

Analog output setting

- Pr4.17, Pr4.19 = 0 or 1
- Pr4.21 = 1

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 thrust control (CT)	Thrust command ≠ 0	Thrust command = 0
24	Gain selection status		2nd gain (Including 3rd gain)	1st gain

4. Basic function

4-1 Operation direction setup

When the positional command, velocity command or thrust command is applied, the 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.

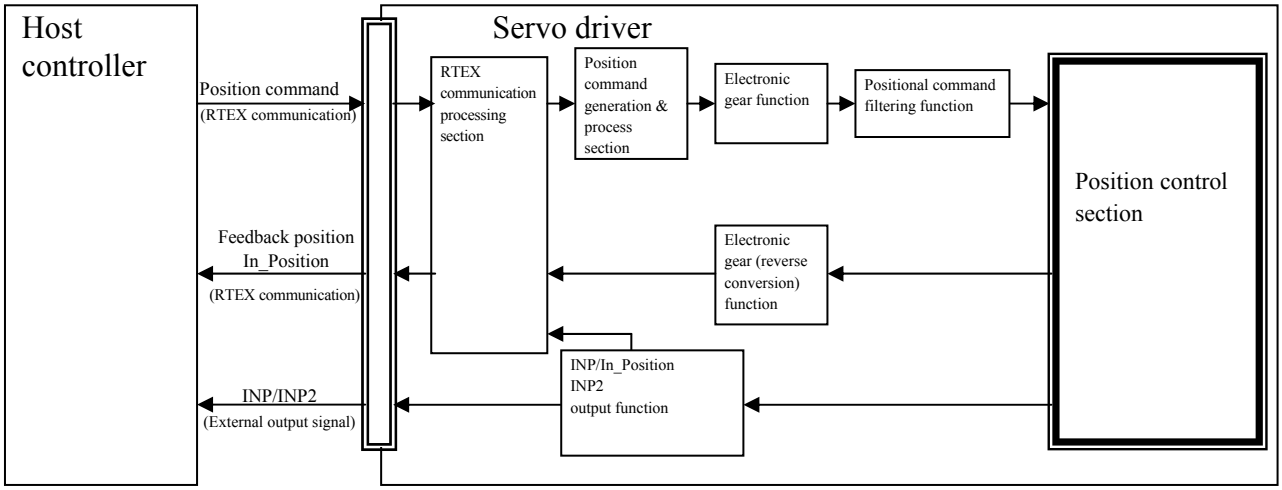
The positive/negative direction in these specifications is the direction configured here. As an example, the table below lists the relationship with the positive/negative drive inhibit input.

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.

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.



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 amplifier; 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, SX-DSV02310”Section 5-3,5-4”, RTEX communication.

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, moving amount of the motor per command can be set to the desired value.

■ Relevant parameters

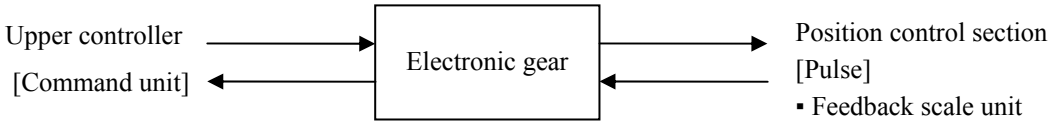
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	09	C	Numerator of electronic gear ratio	1–1073741824	—	Set the numerator of electronic gear ratio *2)
0	10	C	Denominator of electronic gear ratio	1–1073741824	—	Set the denominator of electronic gear ratio *2)

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

*2) In the range from 1/1000 to 1000: 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
1–1073741824	1–1073741824	**Position command input** → [Pr0.09 setting value] / [Pr0.10 setting value] → **Position command**

4-2-3 Positional command filtering function

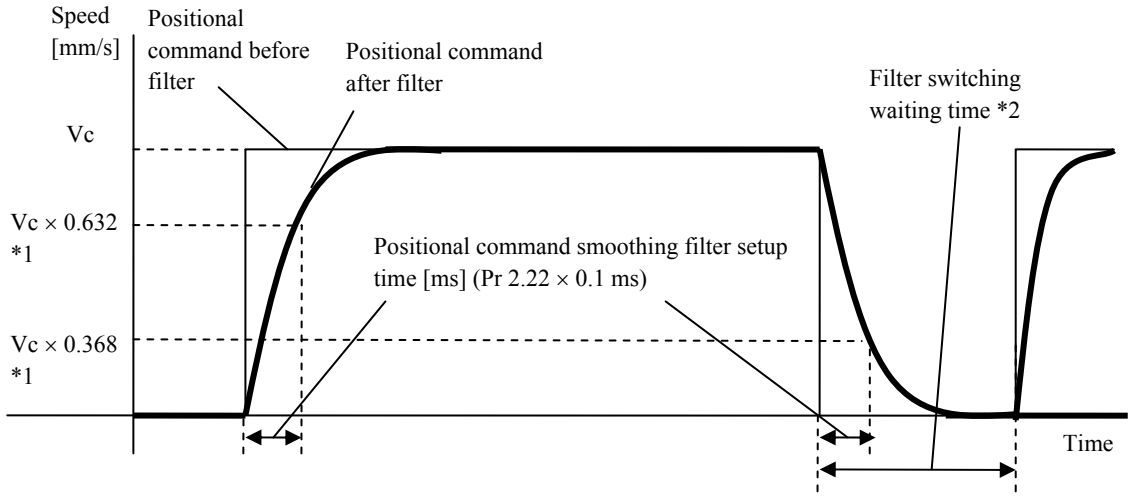
To make the positional command divided or multiplied by the electronic gear smooth, set the command filter.
For details of, such as restrictions, refer to Technical Reference, SX-DSV02310”Section 7-6-2”, RTEX communication.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	22	B	Positional command smoothing filter	0–10000	0.1 ms 2.0	Set up the time constant of the 1st delay filter in response to the positional command. Set to the time constant of the command response filter for 2 degrees of freedom control. The maximum value is 2000 (=200.0ms). (This restriction is imposed not on parameters themselves, but on values applied inside the driver. The damping is set in Pr6.49 "Command response/tuning filter damping setting." For details , refer to ”Section 5-2-3”.
2	23	B	Positional command FIR filter	0–10000	0.1 ms	Set up the time constant of the 1st delay filter in response to the positional command

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

• Pr 2.22 “Positional 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.



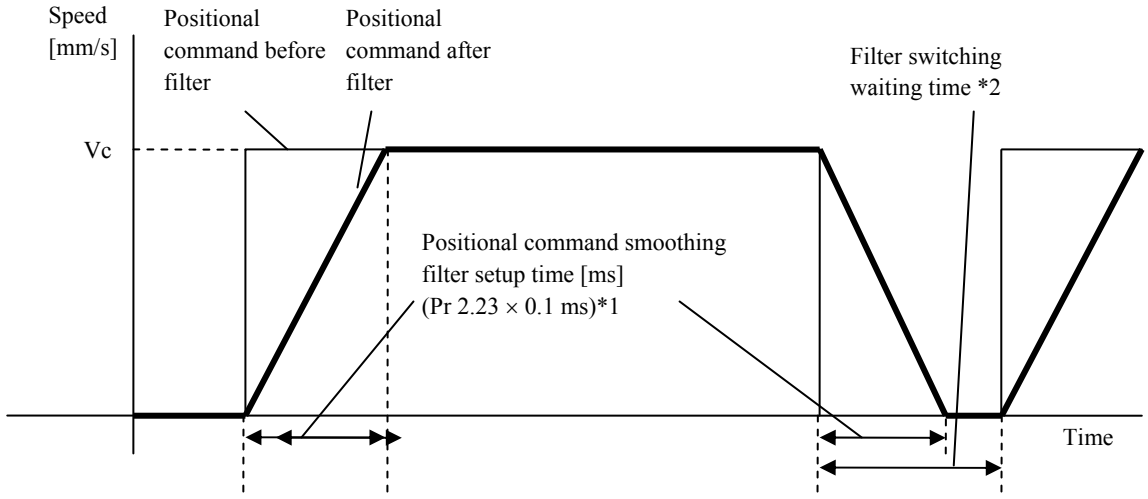
*1 Actual filter time constant (setup value × 0.1 ms) has the maximum absolute error of 0.4 ms for a time constant below 100 ms and the maximum relative error of 0.2% for a time constant 20 ms or more.

*2 Switching of Pr 2.22 “Positional command smoothing filter” is performed on the rising edge of the command with the number of command pulses/0.166 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 “Positional command smoothing filter” setting is changed during velocity control or thrust 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 “Positional 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 “Positional 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.

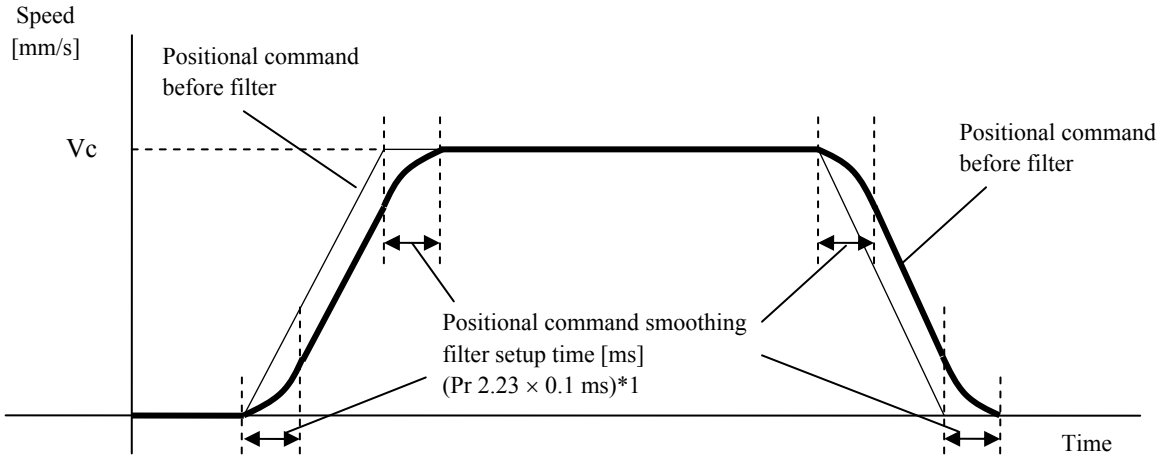


*1 The actual average travel time (setup value × 0.1 ms) has the maximum absolute error of 0.2 ms for a time constant below 10 ms and the maximum relative error of 1.6% for a time constant 10 ms or more.

*2 When changing the setting of Pr2.23 “Positional 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 “Positional 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, SX-DSV02310”Section 4-3-3”, RTEX communication.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	31	A	Positioning complete (In-position) range	0–262144	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 “Positioning unit selection”. Note that when the encoder unit is used, unit of Pr 0.14 “Positional deviation excess setup” is also changed. Note: This setting value is also used as the detection threshold of positioning complete of RTEX communication status (In_Position). △2.0 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	0–4	—	Select the condition to output the positioning complete signal (INP1). 0: The signal will turn on when the positional deviation is smaller than Pr 4.31 “Positioning complete range” 1: 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: 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: 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: Positioning completion decision starts in a delay time specified by Pr4.33 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. Note: This setting value is also used in the condition for detecting positioning completion (In_Position) of RTEX communication status.
4	33	A	INP hold time	0–30000	1 ms	Set up the hold time when Pr 4.32 “Positioning complete output setup” = 3. 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 is 4. 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.

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
4	42	A	Positioning complete (In-position) range 2	0–262144	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 "Positioning unit selection". Note that when the encoder unit is used, unit of Pr 0.14 "Positional deviation excess setup" is also changed 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.
6	10	B	Function expansion setup	0–1023	- (2.0)	bit7: INP output limit 0: Invalid 1: Valid
7	24	C	RTEX function extended setup 3	-32768 –32767 (2.0)	-	bit 2: Setting condition to output the positioning complete signal during servo-off 0: Compulsive ON Invalid 1: Compulsive ON Valid bit 3: Setting condition for In_Position(positioning complete signal) of RTEX communication 0: Unit is set up by Pr5.20. 1: Command unit

(2.0)

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

- The positional command is detected based on the command after the positional command filter. For positional command filter, refer to 4-2-3 Positional command filtering function.

Note: If Pr9.20 "Pole detection method" = 2 (Pole position estimation) and bit7 = 1 for Pr6.10 "Function enhancement setup", the positioning complete signals 1 (INP1) and 2 (INP2) **are turned OFF forcibly** until the pole position estimation is finished.

Note: When an electronic gear ratio is larger than 1/1, even if it is servo-off, the remainder on operation may occur and a feedback scale position deviation may not be set to 0. If it sets up per feedback scale by Pr5.20 " Position setup unit select ", the completion outputs 1/2 (INP/INP2) of positioning may turn off during servo-off (2.0)

4-2-5 Pulse regeneration function [Under preparation]

The information on the amount of movement can be sent to the host controller in the form of A- and B-phase pulses from the servo driver. The resolution of information, B phase logic can be set up by using parameters.
Z phase signal is not compatible with pulse regeneration.
If the communication cycle is 0.0833 ms (Pr7.20=0), the pulse regeneration function is automatically disabled.

2.0 If the communication cycle is 0.0833 [ms], the pulse regenerationwill be automatically invalid.

■ Relevant parameters

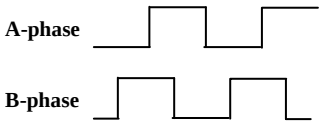
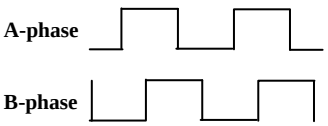
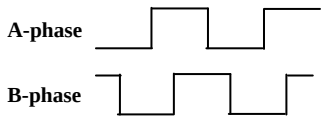
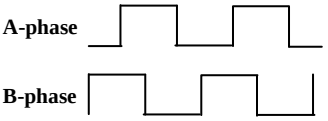
Class	No.	At-trib-ute *1)	Parameter	Range	Unit	Function
0	11	R	Pulse output numerator	1–262144	pulse/r	The division ratio can be set by using Pr0.11 as a division numerator and Pr5.03 as a division denominator. Therefore, if the pulse count is multiplied by 4 in the upper side: Pulse output resolution per distance = (Pr0.11 value / Pr5.03 value) × Feedback scale resolution per distance
5	3	R	Pulse output denominator	1–262144	-	
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.
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 motor revolution” and Pr5.03 “Denominator of pulse output division”.

Pr 0.11	Pr 5.03	Regenerative pulse output process
1–262144	1–262144	Feedback scale pulse [pulse] → [Pr0.11setting value] / [Pr5.03 setting value] → Output pulse [pulse]

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

Pr0.12	B-phase logic	Output source	Positive direction operation	Negative direction operation
0, 2	Nonreversal	Feedback scale		
1, 3	Reversal	Feedback scale		

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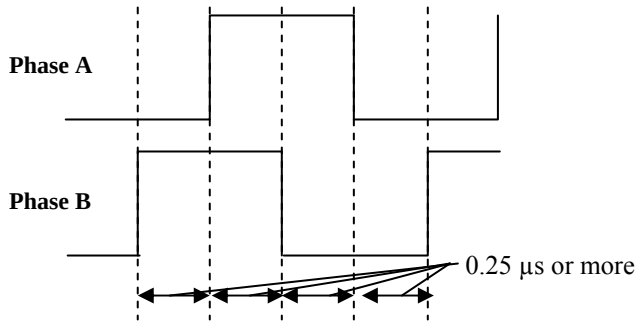
■ Command on pulse regeneration function

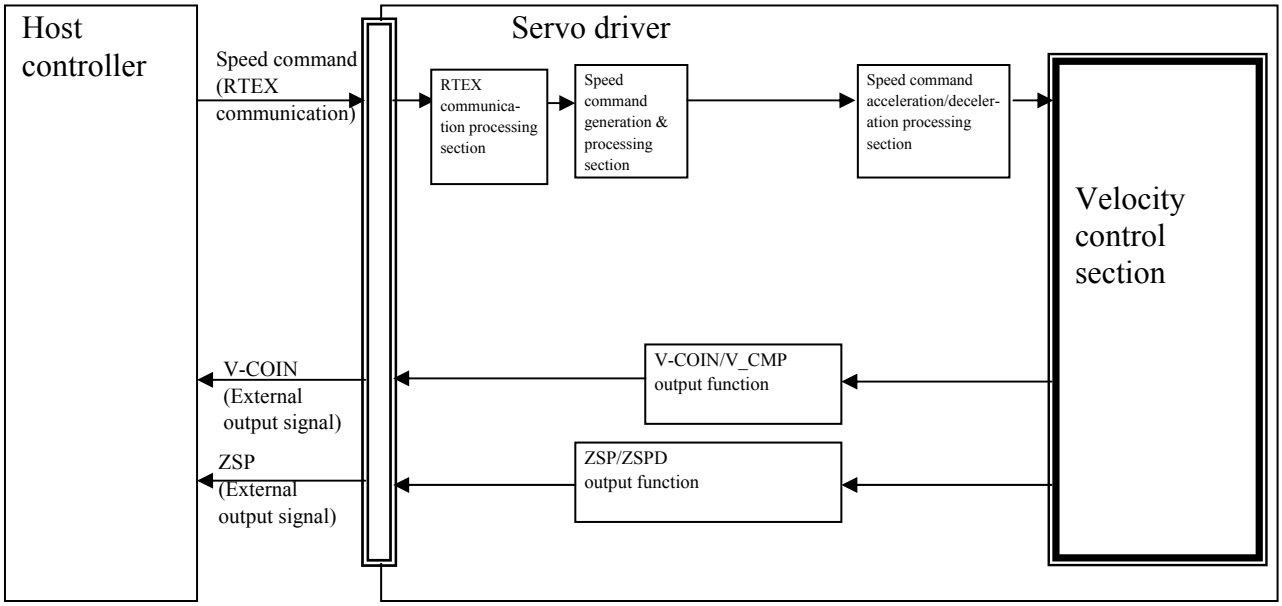
• Maximum frequency of regenerated pulse output is 4 Mpps (after multiplied by 4), If the movement speed exceeds this frequency, the regeneration will not function correctly. That is, correct pulse is not returned to the host controller, causing positional deviation.



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 the motor state (irregular speed).

4-3 Velocity Control [Under preparation]

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, SX-DSV02310”Section 5-5”, RTEX communication.



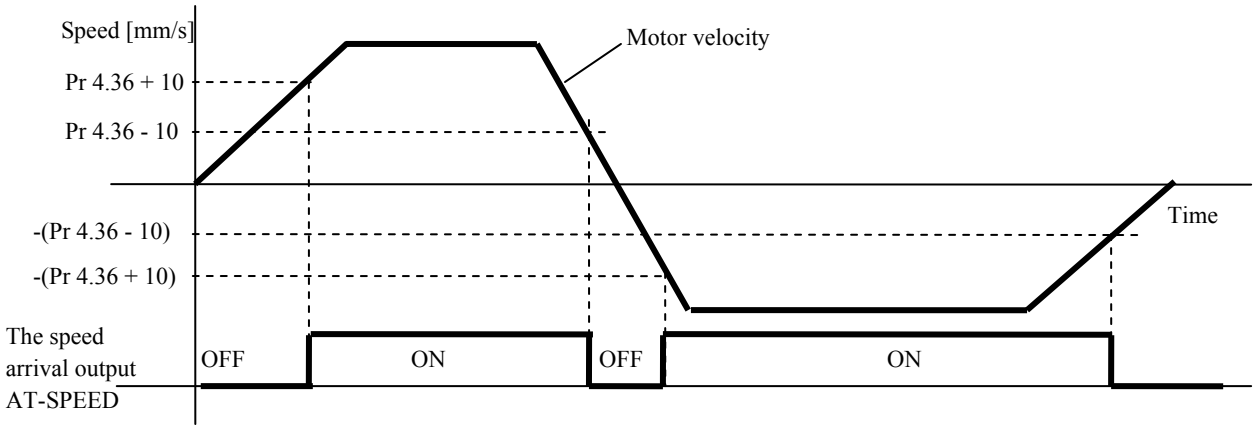
4-3-1 Attained speed output (AT-SPEED)

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	mm/s	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 mm/s hysteresis.

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



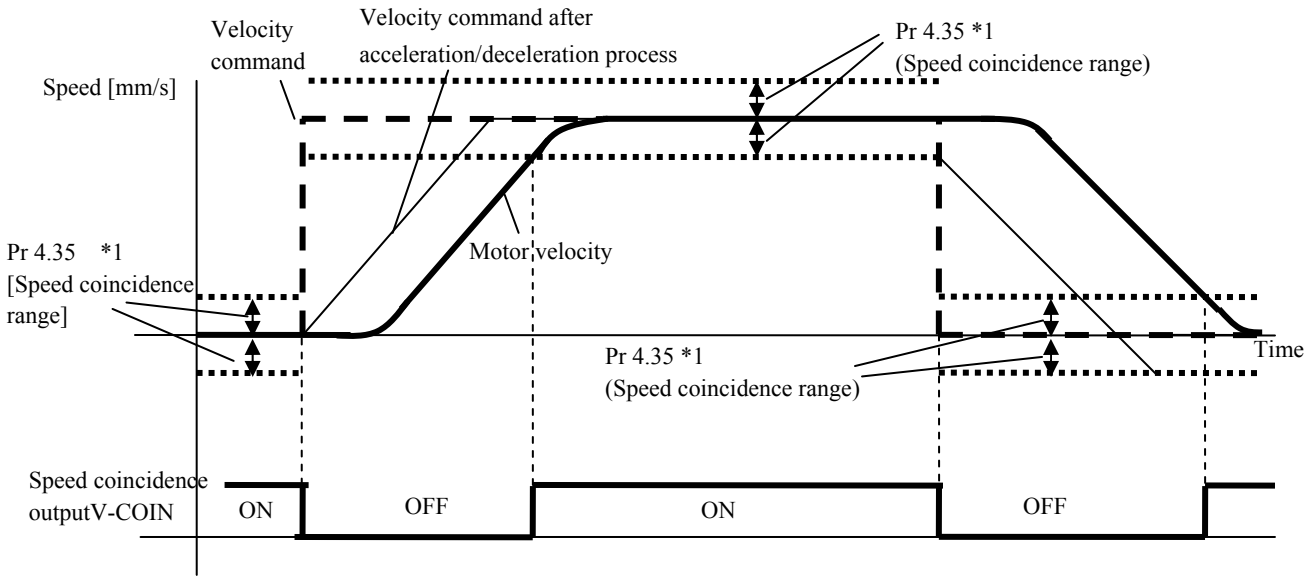
4-3-2 Speed coincidence output (V-COIN)

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	mm/s	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 mm/s hysteresis.

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



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

Speed coincidence output OFF ON timing (Pr 4.35 – 10) mm/s
Speed coincidence output ON OFF timing (Pr 4.35 + 10) mm/s

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, you can use the soft start when inputting stepwise velocity command or when using internal velocity setup. You can also 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 mm/s)	Set up acceleration processing time in response to the velocity command input.
3	13	B	Deceleration time setup	0–10000	ms/ (1000 mm/s)	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.

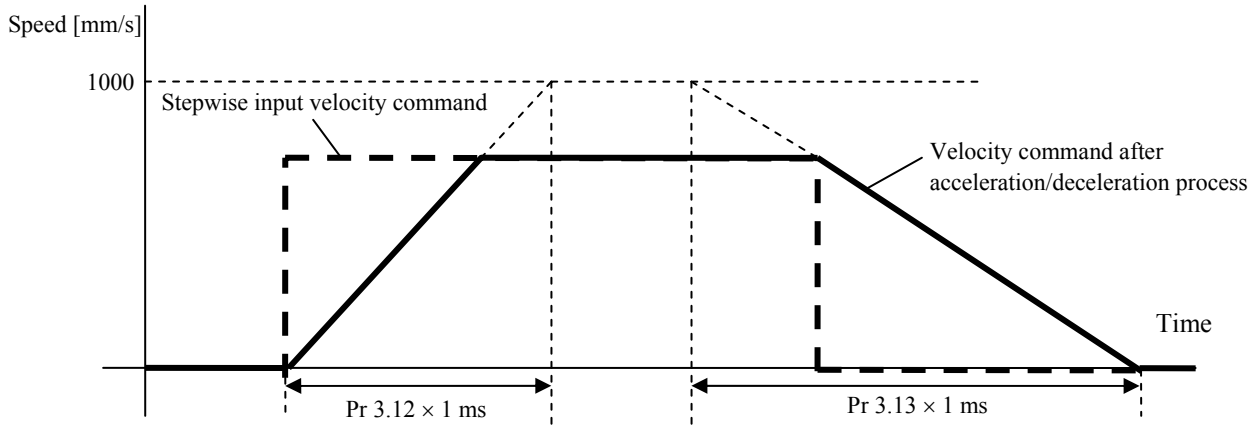
Note: When the position loop is external to the driver, do not use the acceleration/deceleration time setting. Set these values to 0.

• Pr 3.12 “Acceleration time setup”, Pr 3.13 “Deceleration time setup”

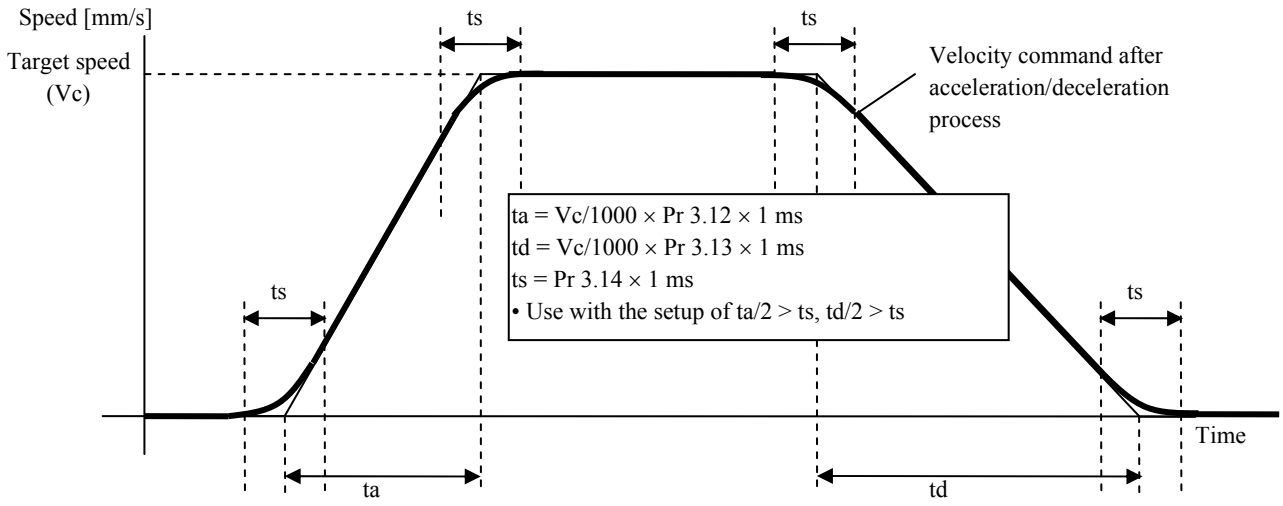
Set the time, elapsing before the velocity command (stepwise input) reaches 1000 mm/s after a stepwise velocity command is input, to Pr 3.12 “Acceleration time setup”. Also set the time, elapsing before the velocity command reaches 0 mm/s from 1000 mm/s, to Pr 3.13 “Deceleration time setup”. Assuming that the target value of the velocity command is Vc [mm/s], 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

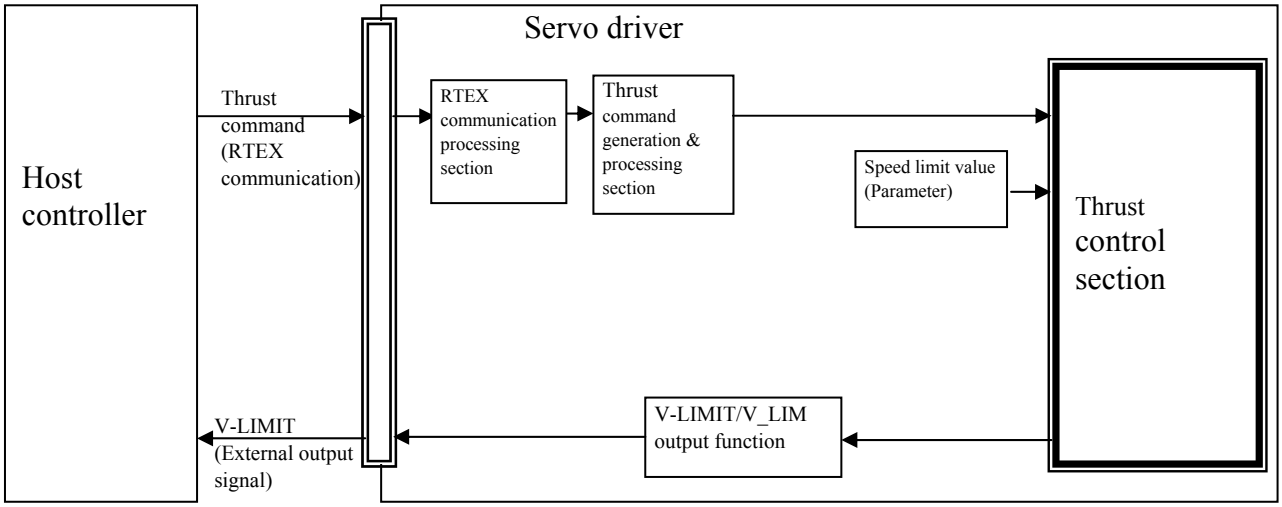


• Pr 3.14 “Sigmoid acceleration/deceleration time setup”
According to Pr 3.12 “Acceleration time setup” and Pr 3.13 “Deceleration time setup”, set up sigmoid time with time width centering the inflection point of acceleration/deceleration.



4-4 Thrust control [Under preparation]

This function performs thrust control based on thrust command of RTEX communication command sent from the host controller. Below describes basic setting of thrust control to be used. In addition to the thrust command, the speed limit command is required to maintain the motor at the working speed below the limited value.
Available thrust control mode is the cyclic thrust control mode (CT control mode) which updates the command thrust during communication period. The mode is selected by RTEX communication command. For details, refer to Technical Reference, SX-DSV02310"Section 5-6", RTEX communication.



4-4-1 Speed limit function

The speed limit is one of protective functions used during thrust control.
This function regulates the motor speed so that it does not exceed the speed limit while the thrust is controlled.
Note: While the speed limit is used to control the motor, the thrust command applied to the motor is not directly proportional to the analog thrust command. Thrust command should have the following result.: the motor speed is equal to the speed limit.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	17	B	Speed limit select	0–1	—	Set up the selection method of the speed limit used for thrust controlling. Setting value / SL_SW = 0 / SL_SW = 1 0 / Pr 3.21 1 / Pr 3.21 / Pr 3.22
3	21	B	Speed limit value 1	0–20,000	mm/s	Set up the speed limit used for thrust controlling. During the thrust controlling, the speed set by the speed limit value cannot be exceeded. Also, the internal value is limited to the setting speed of Pr5.13 "Overspeed level setup", Pr6.15 "2nd overspeed level setup", and Pr9.10 "Maximum overspeed level", whichever smaller.
3	22	B	Speed limit value 2	0–20,000	mm/s	When Pr 3.17 "Selection of speed limit" is set to 1, the speed limit selected with SL_SW 1 is set. Also, the internal value is limited to the setting speed of Pr5.13 "Overspeed level setup", Pr6.15 "2nd overspeed level setup", and Pr9.10 "Maximum overspeed level", whichever smaller.

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

4-5 Setting regenerative resistor

The table describes setup of regenerative resistor.
For details of regenerative resistor specification, refer to Technical Reference SX-DSV02308.

■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
0	16	C	External Regenerative resistor setup	0–3	—	With this parameter, you can select either to use the built-in regenerative resistor of the driver, or to separate this built-in regenerative resistor and externally install the regenerative resistor. 0: Use the built-in resistor and activate regenerative over-load protection. 1: Use the external resistor and activate regenerative over-load protection. 2: Use the external resistor but do not activate regenerative over-load protection. 3: Do not use regenerative resistor. (Do not use over-load protection.)
0	17	C	Selection of load factor of external regenerative resistor	0–4	—	When selecting the external regenerative resistor (Pr 0.16 = 1, 2), select the computing method of load factor of regenerative resistor. 0: Regenerative load factor is 100% when duty factor of external regenerative resistor is 10%. (Compatible with A4N series) 1–4: For manufacturer's use (do not setup)

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

4-6 Absolute setup

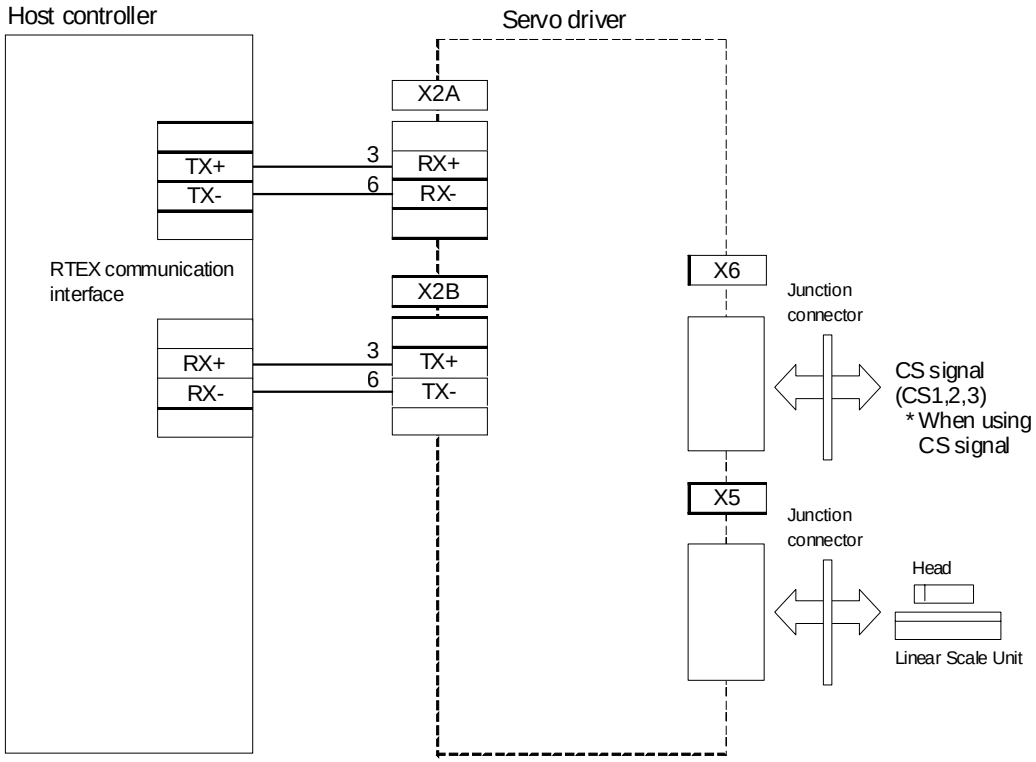
4-6-1 Feedback scale

An absolute system can be built which eliminates the home return operation after power-on by using the feedback scale of absolute type.

4-6-1-1 Absolute system configuration

Absolute system configuration using the RTEX communication interface (connecting example to a single servo amplifier)

The absolute data is transferred to the upper controller as a current position for the RTEX communication response (from amplifier to upper controller).



4-7 Linear motor/feedback scale setting

The MINAS-A5NL 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, thrust, etc.) Feedback scale (resolution, etc.)	Linear type		4-7-1-1
	Rotary type		4-7-1-2
(2) Feedback scale	A/B phase		4-7-1-3
	Serial increment		
	Serial absolute		
(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	4-7-1-4	(B) Use automatic setting tool	4-7-4
	CS signal	4-7-3-1		

■Cautions

- 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.
Two motor types are supported: “Linear type” and “Rotary type”.

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

4-7-1-1 Linear type motor

■Relevant parameter: Linear type

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	00	R	Motor type	0–2	—	Select the type of the motor to be connected. 1: linear type, 2: rotary type If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	01	R	Feedback scale resolution / number of scale pulses per revolution	0–16777216	0.001 µm	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/ motor inertia	0–32767	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/ motor rated torque	0–32767	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	0–32767	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 amplifier, Err60.1 “Motor combination error 1” occurs.
9	07	R	Motor maximum instantaneous current	0–32767	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 amplifier, Err60.1 “Motor combination error 1” occurs.
9	10	R	Maximum overspeed level	0–20000	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	0–1	—	Select the carrier frequency. 0: 6kHz, 1: 12kHz * The factory default of carrier frequency may vary according to the amplifier size. Sizes A, H: 12 kHz, sizes B to G: 6 kHz * When the carrier is set to 12 kHz in the sizes B to G, a delaying is necessary. For more information, refer to the delivery specifications.

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	02	R	Magnetic pole pitch	0–32767	0.01mm	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	0–327670000	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 parameter: Rotary type

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	00	R	Motor type	0–2	—	Select the type of the motor to be connected. 1: linear type, 2: rotary type If the setting value is zero, Err60.0 “Motor setting error protection” occurs.
9	01	R	Feedback scale resolution / number of scale pulses per revolution	0–16777216	pulse	Set the number of pulses of the feedback scale per revolution. The valid range is 10000 to 16777216. 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 126 M based on the Pr9.10 “Maximum overspeed level” value and this setting value, Err60.1 occurs. Example: Pr9.01=4194304 (22bit): Supported speed [r/min] = 60 × 126000000 / 4194304 = 1802.44 So, if Pr9.10 is not less than 1803, Err60.1 occurs.
9	03	R	Number of pole pairs per revolution	0–255	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 movable part mass/ motor inertia	0–32767	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 thrust/motor rated torque	0–32767	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	0–32767	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 amplifier, Err60.1 “Motor combination error 1” occurs.
9	07	R	Motor maximum instantaneous current	0–32767	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 amplifier, Err60.1 “Motor combination error 1” occurs.
9	10	R	Maximum overspeed level	0–20000	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 126 M based on the Pr9.01 “Number of scale pulses per revolution” value and this setting value, Err60.1 occurs.
9	11	R	Carrier frequency	0–1	—	Select the carrier frequency. 0: 6kHz, 1: 12kHz * The factory default of carrier frequency may vary according to the amplifier size. Sizes A, H: 12 kHz, sizes B to G: 6 kHz * When the carrier is set to 12 kHz in the sizes B to G, a delaying is necessary. For more information, refer to the delivery specifications.

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

4-7-1-3 Feedback scale type setting

Select the type of the feedback scale to be used.

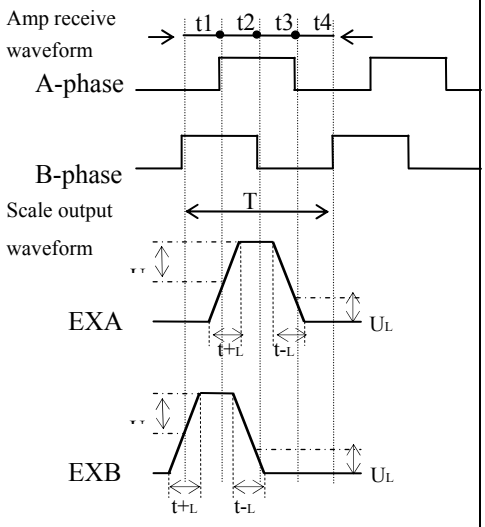
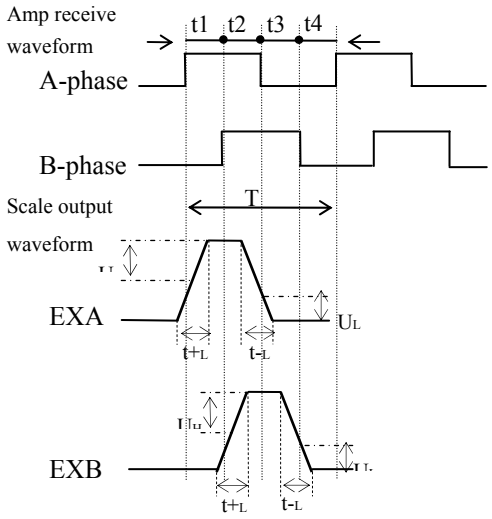
■ Relevant parameter

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	23	R	Feedback scale type	0–2	—	Set the feedback scale type. 0: A/B phase output type 1: serial communication type (increment specification) 2: serial communication type (absolute specification) When the value is set to 1 or 2 while the A/B phase output type is connected, Err50.0 “Feedback scale wiring error protection” occurs. Also, if the value is set to zero while the serial communication type is connected, Errs55.0 to 2 “A/B/Z phase wiring error protection” occurs.

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

Pr3.23	Feedback scale type	Supported scale	Acceptable speed *2
0	A/B phase output type *1	Feedback scale of A/B phase output type	Up to 4 Mpps (multiplied by 4)
1	Serial communication type (increment specification)	Magnescale SR75, SR85, SL700/PL101-RP *3	Up to 400 Mpps
2	Serial communication type (absolute specification)	Mitutoyo AT573A, ST770A, ST770AL *3 Magnescale SR77, SR87 *3	Up to 400 Mpps

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

Negative direction (count down)	Positive direction (count up)
B-phase is by 90° ahead of A-phase t1 t2 t3 t4> 0.25µs T > 1.0µs	A-phase is by 90° ahead of B-phase t1 t2 t3 t4> 0.25µs T > 1.0µs
	

*2 The acceptable speed represents the feedback speed [pps] of the feedback scale to be processed by amplifier.
For the supported range in the scale side, refer to the scale specifications.
For example, when using the feedback scale at 0.01 µm resolution in the serial communication type, the speed is up to 4 m/s. Also, to use the serial communication type at 5 m/s speed, select up to 0.0125 µm resolution for the feedback scale.

*3 For the supported feedback scales, contact us.

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

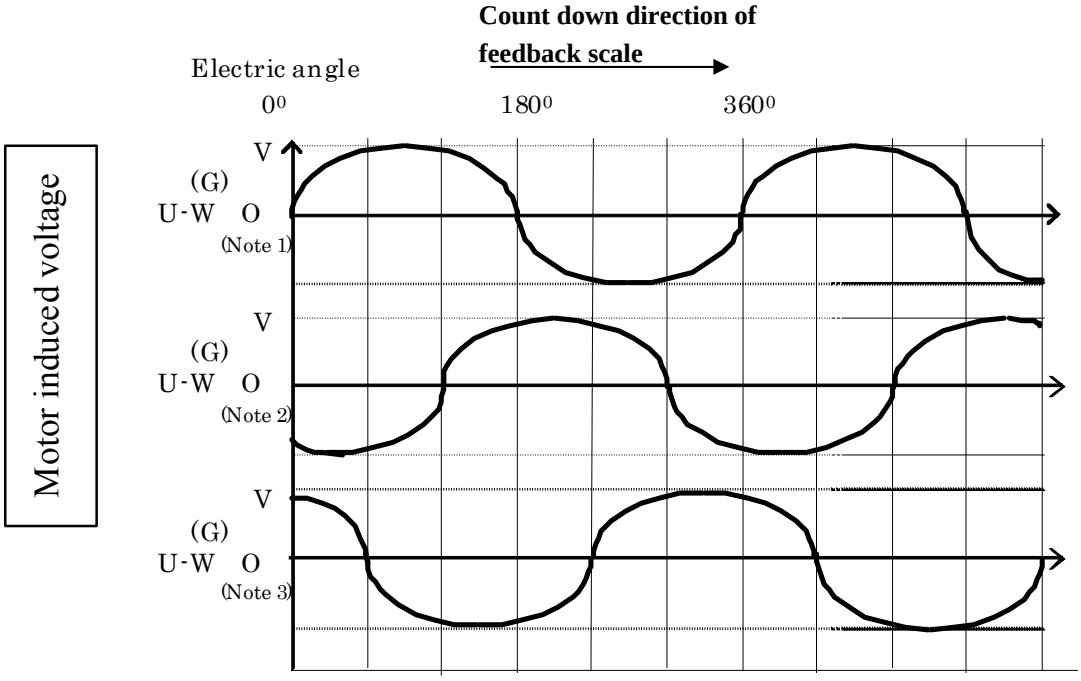
■ Relevant parameter

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
3	26	R	Feedback scale & CS reversal	0–3	—	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).

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

Set the direction so that the relationship can meet the figure below between the count direction of feedback scale and the phase sequence of the motor's induced voltage. 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: 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.



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.

4-7-2 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 parameter

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	08	R	Phase inductance	0–32767	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	0–32767	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	0–100	%	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.
9	13	B	Proportional current gain	0–32767	—	Set a proportional current gain. In general, use the theoretical value as is calculated using Pr9.12.
9	14	B	Integral current gain	0–32767	—	Set an integral current gain. In general, use the theoretical value as is calculated using Pr9.12.

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

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).

4-7-3-1 CS signal method

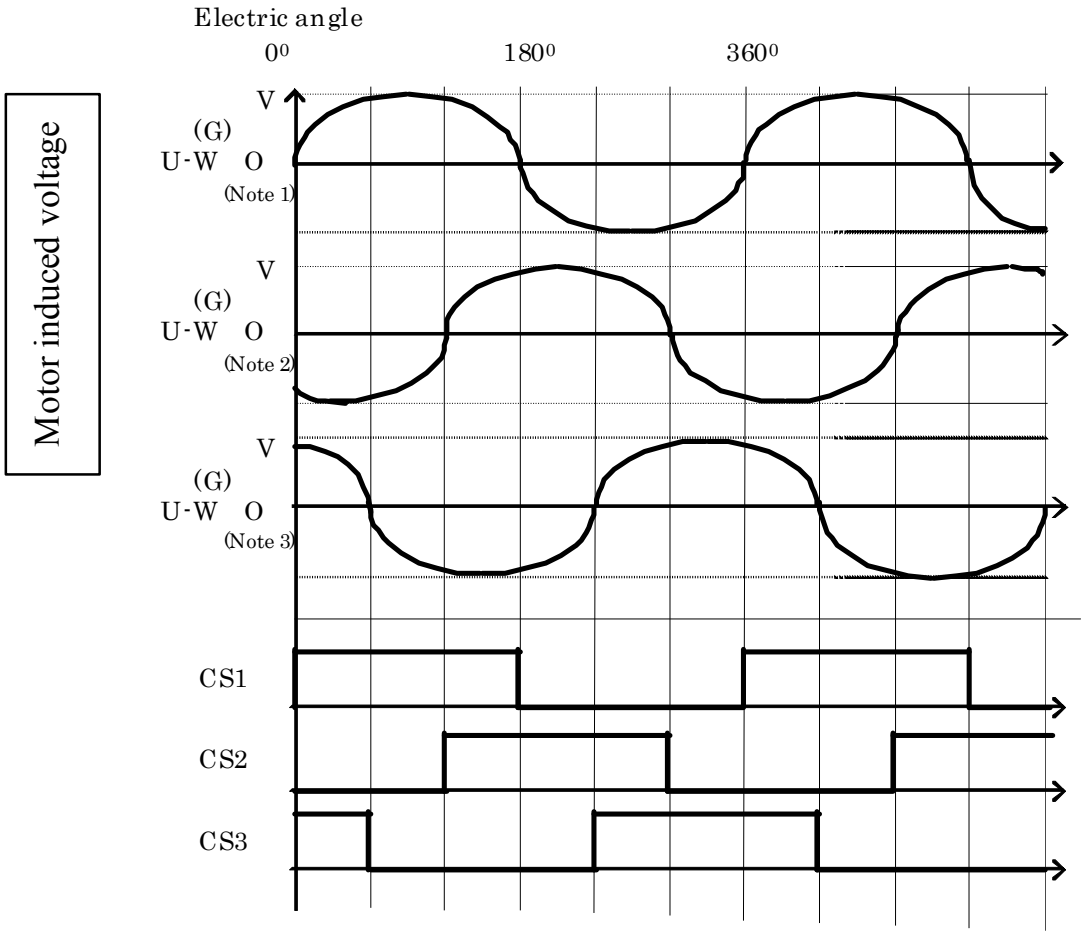
Detect a pole position by using the CS signals (CS1, CS2, CS3).
This section describes how to manually set the direction and phase of CS signal.
For information on the automatic setting with a tool, refer to the “Section 4-7-4”.

■ Relevant parameter

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	20	R	Pole detection method	0–3	—	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.
9	21	R	CS phase	0–360	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	0–3	—	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).

*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)

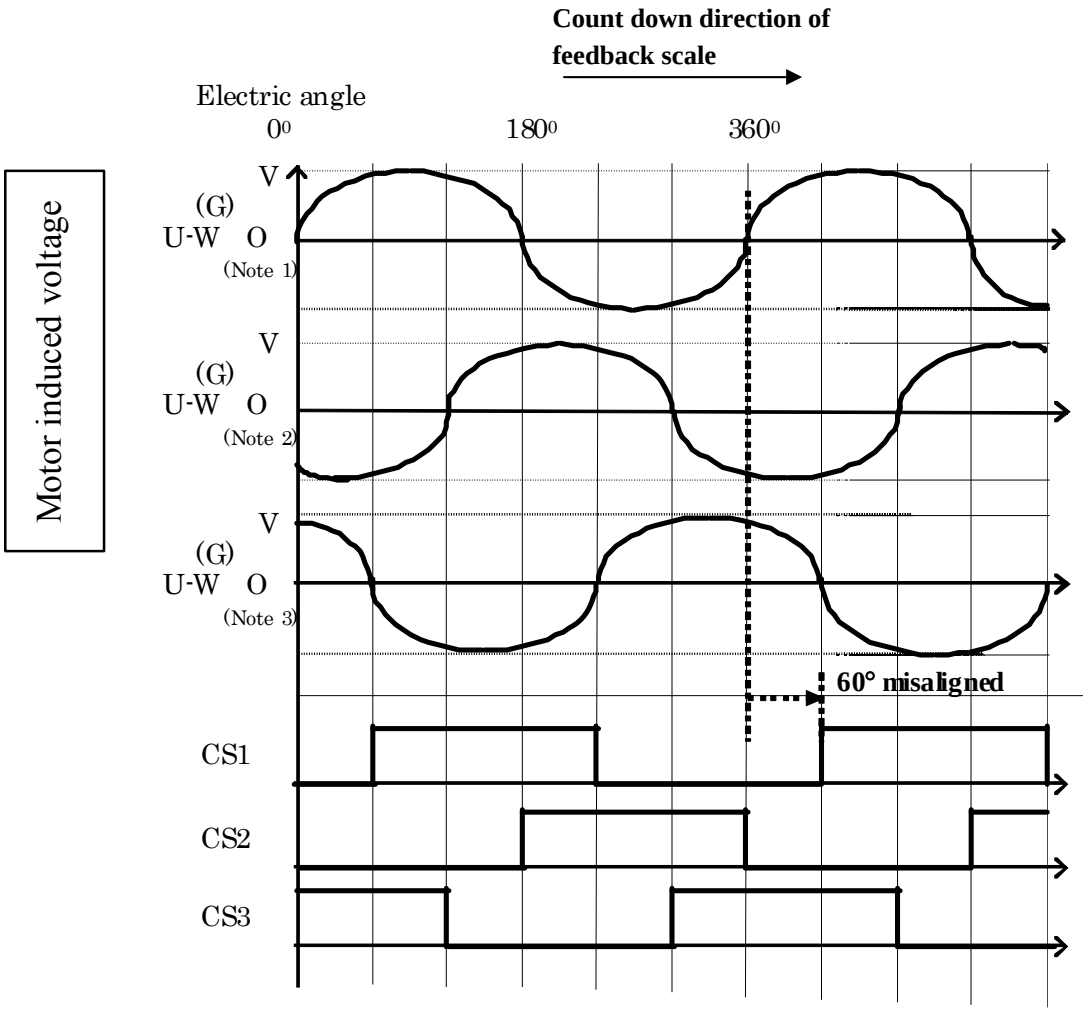


Note 1: It is a waveform generated when checking the induced voltage in the terminal U by connecting the terminal W with GND.
Note 2: It is a waveform generated when checking the induced voltage in the terminal V by connecting the terminal U with GND.
Note 3: It is a waveform generated when checking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

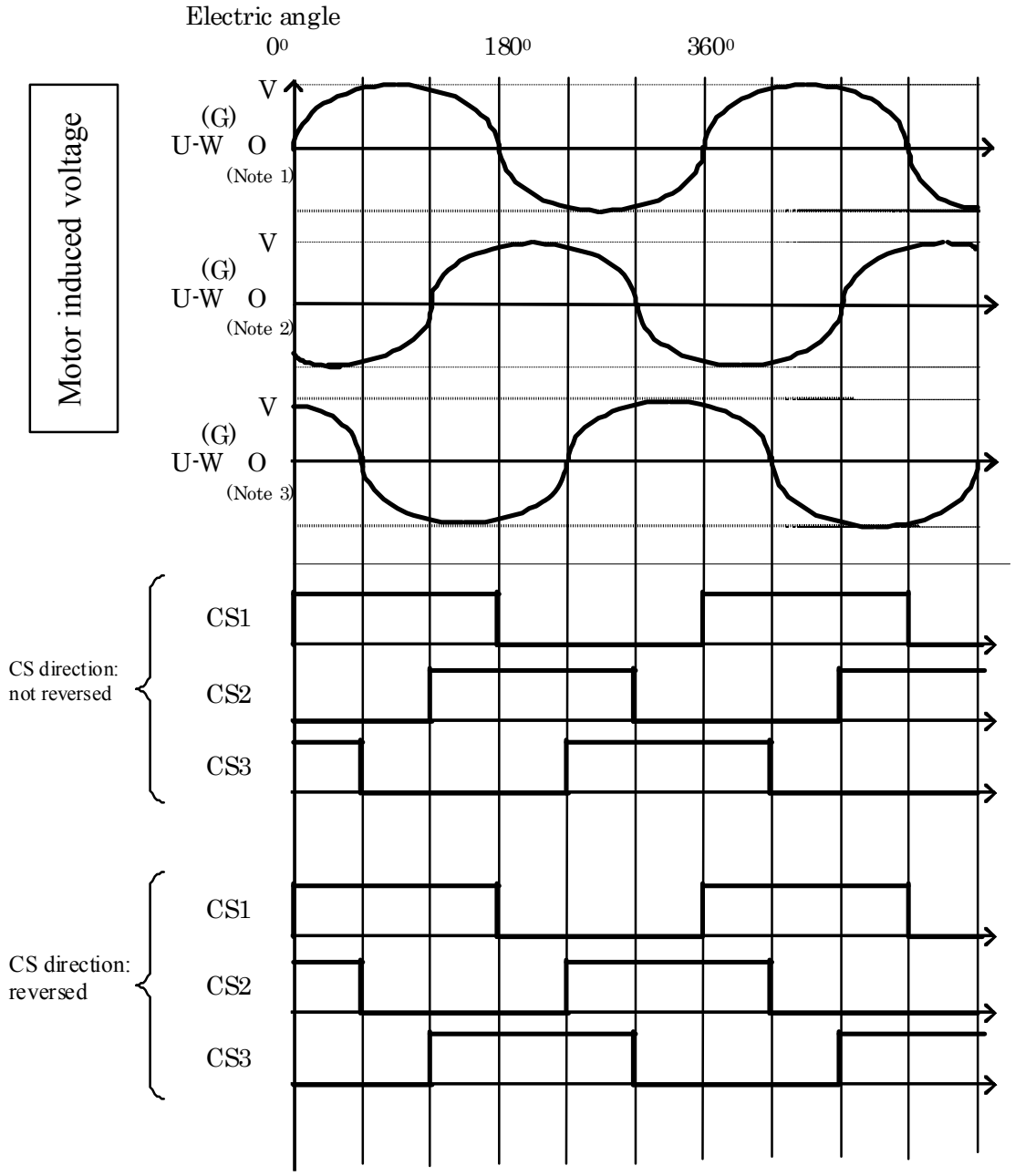


Note 1: It is a waveform generated when checking the induced voltage in the terminal U by connecting the terminal W with GND.

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.

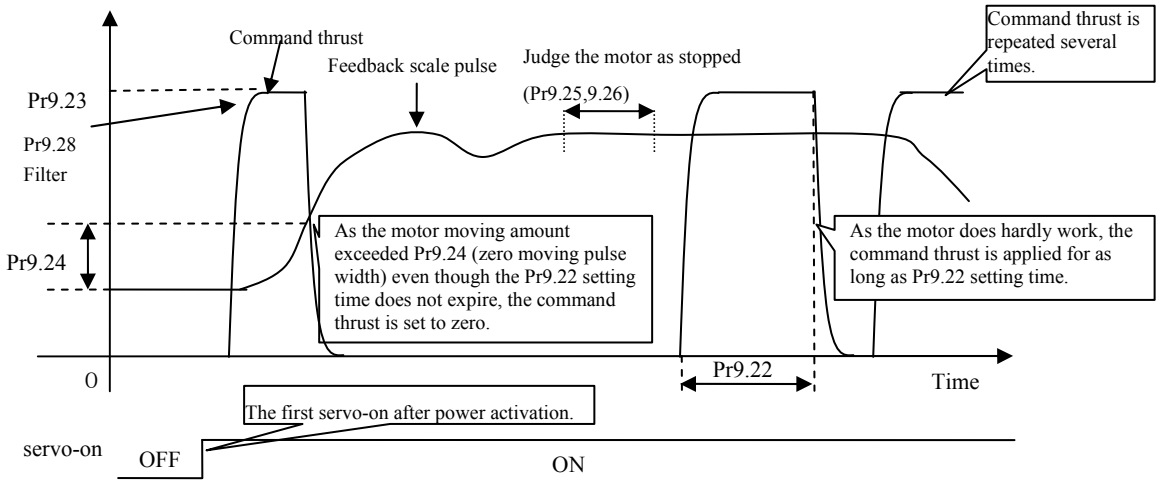
・How to set the CS signal direction by using Pr3.26 “Feedback scale & CS reversal”
There are two types of wiring patterns among CS1, CS2, and CS3 as shown in the figure below. In the figure above, the wiring among CS1, CS2, and CS3 is correct for the induced voltage, so set the CS signal direction to “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 amplifier, 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 parameter

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	20	R	Pole detection method	0–3	—	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.
9	22	B	Thrust command time for estimating pole position	0–200	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 thrust 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). Note: The actual time is about the setting value plus 4 ms.
9	23	B	Command thrust for estimating pole position	0–300	%	・ Set the thrust 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 thrust is limited by the maximum allowable thrust of the motor.
9	24	B	Zero moving pulse width for estimating pole position	0–32767	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 thrust 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).

(To be continued)

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	25	B	Stop pulse count for estimating pole position	0–32767	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 thrust 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	0–32767	ms	
9	27	B	Stop time limit for estimating pole position	0–32767	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	Thrust command filter for estimating pole position	0–2500	0.01ms	・ Set the time constant of the filter for the thrust 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.

■ Cautions

・ 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 amplifier 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:

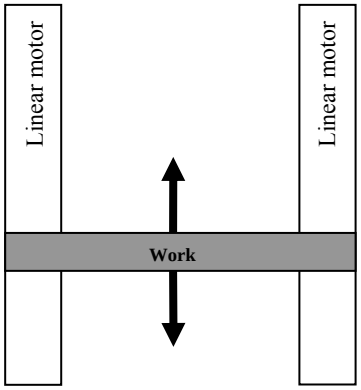
Do not run the pole position estimation (at the first servo-on after power-on) in the multiple axes at the same time.

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, SX-DSV02310”Section 7-1-2”, RTEX communication.

■ 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. Setting with this parameter will be prioritized (supersede setting with Pr 7.40-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/CS2) 6: Byte 3, bit5 (SI-MON3/EXT3/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.

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 parameter

Class	No.	Title	Range	Unit	Function
9	20	Pole detection method	0–3	—	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.

■ Procedures

(1) Set Pr9.20=2 and make an pole position estimation (see 4-7-3-2)
▪ The pole position estimation result is stored by the servo amplifier
(2) Set Pr9.20=3 and turn the control power OFF and ON again

■ Cautions

・ The estimation result of the pole position is stored in the amplifier. When the combination of the amplifier and linear motor is changed (exchange of amplifier, linear motor, or feedback scale), the pole position may change, thereby disabling you to control the motor properly.
In this case, because the amplifier 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.

・ 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	Range	Unit	Function
3	26	R	Feedback scale & CS reversal	0–3	—	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).
9	13	B	Proportional current gain	0–32767	—	Set a proportional current gain.
9	14	B	Integral current gain	0–32767	—	Set an integral current gain.
9	21	R	CS phase	0–360	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).

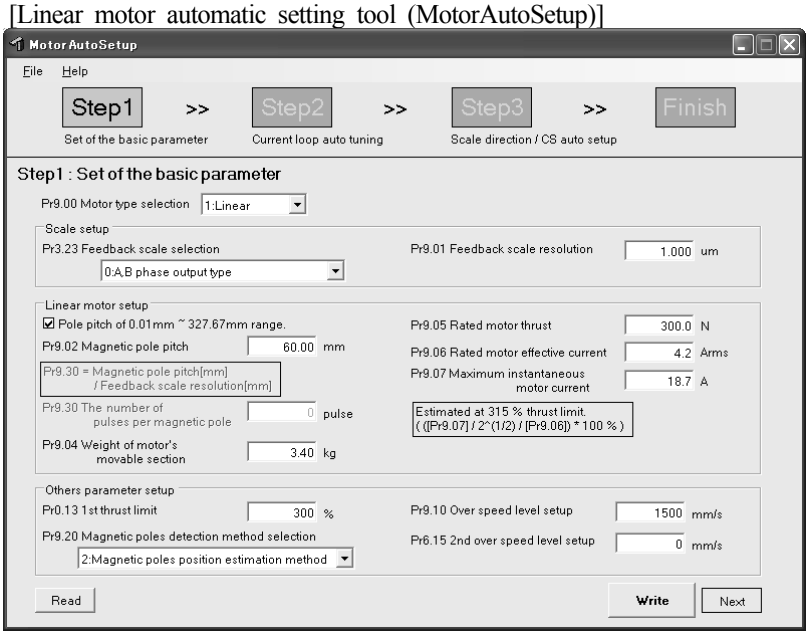
*1) For information on the parameter attribute, refer to the section 9-1.

▪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 amplifier finally.</u>

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

■ Cautions

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

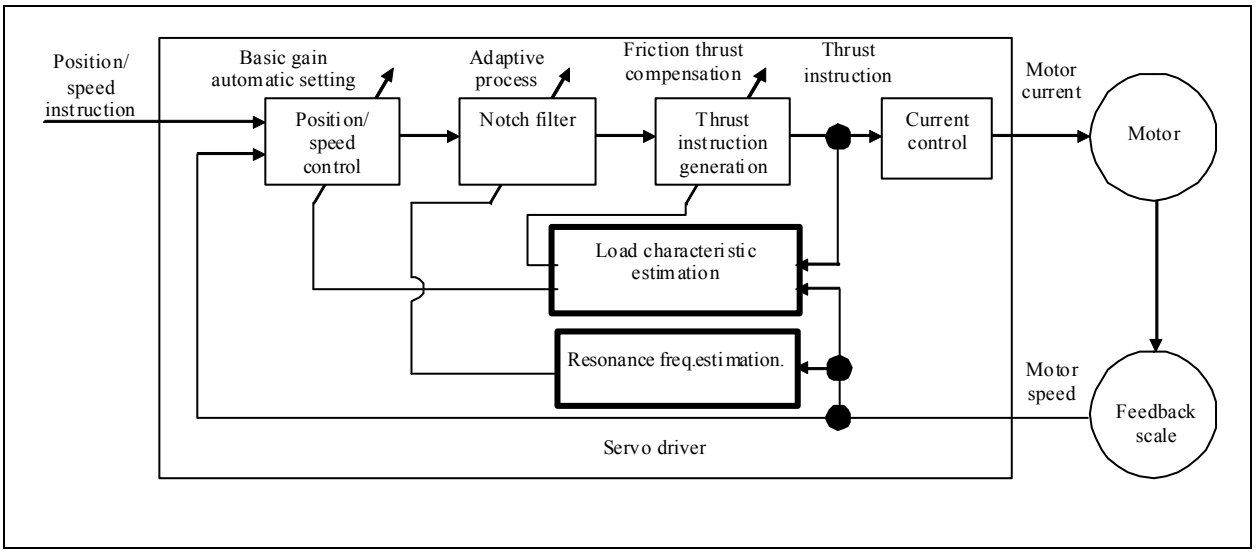
- When the external servo-on signal is allocated for input signal allocation, turn ON the external servo-on signal. If the external servo-on signal remains OFF, the servo cannot turn ON and the automatic setting cannot start.
  Also, if the external servo-on signal is turned OFF during the automatic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

- After the automatic setting is finished, make sure to reset the power supply of the servo amplifier 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 amplifier, 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-A5N series.



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

2) Adaptive filter
Estimates the resonance frequency based on the motor velocity and removes the frequency components from thrust 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.

2.0 For Real-Time Auto Tuning of Block Diagram of 2 Degrees of Freedom Mode(Standard type), 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-tuning setup”.
Others	• Should be in servo-on condition • Parameters except for controls such as thrust limit setup, 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) Caution

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 condition	• The load mass is too small or large compared to the movable mass. (Less than 3 times or more than 20 times). • The load mass 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 [mm/s] or lower. • Acceleration/deceleration is slow (2,000 [mm/s] per 1 [s] or low). • When the speed condition of 100 [mm/s] or more and acceleration/deceleration condition of 2,000 [mm/s] per 1 [s] are not maintained for 50 [ms]. • Acceleration/deceleration thrust is smaller than unbalanced massed/viscous friction thrust.

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>Attrib-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 setup support software.</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 thrust controls are the same as in the standard mode.
*2 Thrust control is the same as in the standard mode.
*3 Velocity control is the same as in the vertical axis mode. Thrust 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>
</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 support software, 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>Mass ratio update *3</td><td>Set up update to be made based on result of the load characteristics estimation of Pr 0.04 “Mass ratio”.
Setup value=0: Use current setup.
Setup value=1: Update by the estimated value.</td></tr>
<tr><td>6–4</td><td>Thrust compensation *4</td><td>Set up the update to be made according to the results of load characteristics estimation of Pr 6.07 “Thrust command additional value”, Pr 6.08 “Positive direction thrust compensation value” and Pr 6.09 “Negative direction thrust compensation value”.
Setup value=0: Use current setup
Setup value=1: Disable thrust compensation
Clear the parameters shown above to zero.
Setting value = 2: Vertical axis mode
Update Pr 6.07. Zero clear Pr 6.08 and Pr 6.09
Setting value = 3: Friction compensation (low)
Update Pr 6.07. Set low compensation to Pr 6.08 and Pr 6.09.
Setting value = 4: Friction compensation (middle)
Set middle compensation to Pr 6.08 and Pr.6.09.
Setting 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 mass ratio is updated according to the estimated value. When the thrust 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 “Real-time auto-tuning machine stiffness setup”.
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 mass ratio update is enabled, set bit 1–0 to 1(enable). If neither is effective, the mass ratio is not updated.
*4 If the thrust compensation is abled (setup value=2-5), set bit 3–2(Mass ratio update) to 1(enable). If neither is effective, the mass ratio is not updated. The thrust compensation alone cannot be updated.
*5 Set bit3–2(Mass ratio update) to 1(enable) when this setting is set excluding 0. At this time, you can be set whether to mass 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 setup support software 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 thrust compensation function is 4.
2) Multiply the setup value by power of 2 (LSB).
Example: To set the thrust 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, mass ratio update = enable, thrust 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-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	Mass ratio	0–10000	%	Updates this parameter when the real-time auto-tuning mass ratio update is enabled.
6	07	B	Thrust 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 thrust Compensation Value	-100–100	%	Update this parameter when the friction compensation mode for real time auto-tuning is valid.
6	09	B	Negative direction thrust 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 “Real-time auto-tuning machine stiffness setup”. 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 thrust 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 thrust 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	0–1000	0.1%	When fixed parameter setup is valid, set the parameter to 300 (30%).
1	11	B	Velocity feed forward filter	1–6400	0.01 ms	When fixed parameter setup is valid, set the parameter to 50 (0.5 ms).
1	12	B	Thrust feed forward gain	0–1000	0.1%	When fixed parameter setup is valid, set the parameter to 0.
1	13	B	Thrust 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 thrust control switching	0–3	—	Sets to 0 if the current setting is not maintained.
1	25	B	Delay time of thrust control switching	0–10000	0.1 ms	Sets to 0 if the current setting is not maintained.
1	26	B	Level of thrust control switching	0–20000	—	Sets to 0 if the current setting is not maintained.
1	27	B	Hysteresis at thrust control switching	0–20000	—	Sets to 0 if the current setting is not maintained.

The following settings are always set to invalid when Pr 0.02 “Real-time auto-tuning setup” is not 0. However, the parameter settings are not changed.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function expansion setup	△2.0 0–1023	—	Instantaneous velocity observer function enable bit (bit 0), disturbance observer function enable bit (bit 1) are internally disabled.
6	23	B	Disturbance thrust compensating gain	-100–100	%	Parameter setup can be changed, but disturbance observer is disabled.
6	24	B	Disturbance observer filter	10–2500	0.01 ms	Parameter setup can be changed, but disturbance observer is disabled.

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

5) How to Operate

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

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

When value of Pr0.03 “Real-time auto-tuning machine stiffness setup” 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 “Real-time auto-tuning machine stiffness setup”, 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 “Real-time auto-tuning machine stiffness setup”.
2) Set Pr 0.02 “Real-time auto-tuning setup” to 0 to disable the real-time auto-tuning.
3) Set Pr 0.04 “Mass ratio” to the calculational value of the equipment and set Pr 6.07 “Thrust command addition value”, Pr 6.08 “Positive direction thrust compensation value” and Pr 6.09 “Negative direction thrust compensation value” to 0.

[2] When abnormal noise and oscillation occur, Pr 0.04 “Mass ratio“ or Pr 6.07 “Thrust command additional value“, Pr 6.08 “Positive direction thrust compensation value“, Pr 6.09 “Negative direction thrust 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 “Mass ratio“ and Pr 6.07 “Thrust command additional value“, Pr 6.08 “Positive direction thrust compensation value“, Pr 6.09 “Negative direction thrust 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 “Real-time auto-tuning machine stiffness setup” 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				A4N Series stiffness setup (reference) *1
	Pr 1.00	Pr 1.01	Pr 1.02	Pr 1.04	Pr 1.05	Pr 1.06	Pr 1.07	Pr 1.09	
	Position [0.1/s]	Velocity [0.1 Hz]	Velocity loop integration [0.1 ms]	Thrust [0.01 ms]	Position [0.1/s]	Velocity [0.1 Hz]	Velocity loop integration [0.1 ms]	Thrust [0.01 ms]	
0	20	15	3700	1500	25	15	10000	1500	
1	25	20	2800	1100	30	20	10000	1100	
2	30	25	2200	900	40	25	10000	900	
3	40	30	1900	800	45	30	10000	800	
4	45	35	1600	600	55	35	10000	600	
5	55	45	1200	500	70	45	10000	500	
6	75	60	900	400	95	60	10000	400	
7	95	75	700	300	120	75	10000	300	
8	115	90	600	300	140	90	10000	300	0
9	140	110	500	200	175	110	10000	200	
10	175	140	400	200	220	140	10000	200	
11	320	180	310	126	380	180	10000	126	1
12	390	220	250	103	460	220	10000	103	2
13	480	270	210	84	570	270	10000	84	3
14	630	350	160	65	730	350	10000	65	4
15	720	400	140	57	840	400	10000	57	5
16	900	500	120	45	1050	500	10000	45	6
17	1080	600	110	38	1260	600	10000	38	7
18	1350	750	90	30	1570	750	10000	30	8
19	1620	900	80	25	1880	900	10000	25	9
20	2060	1150	70	20	2410	1150	10000	20	10
21	2510	1400	60	16	2930	1400	10000	16	11
22	3050	1700	50	13	3560	1700	10000	13	12
23	3770	2100	40	11	4400	2100	10000	11	13
24	4490	2500	40	9	5240	2500	10000	9	14
25	5000	2800	35	8	5900	2800	10000	8	
26	5600	3100	30	7	6500	3100	10000	7	15
27	6100	3400	30	7	7100	3400	10000	7	
28	6600	3700	25	6	7700	3700	10000	6	
29	7200	4000	25	6	8400	4000	10000	6	
30	8100	4500	20	5	9400	4500	10000	5	
31	9000	5000	20	5	10500	5000	10000	5	

*1 Stiffness setting of A4N series refers to the setup value (0–15) of A4N series parameter Pr 22 “Real-time auto-tuning machine stiffness selection”.

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 thrust command with adaptive filter, thus reduces the resonance vibration.

⚠2.0 If the communication cycle is 0.0833 ms (Pr7.20=0), please set an adaptive filter invalid. (Pr2.00=0).

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 thrust control.
Others	• Should be servo-on status. • Elements other than control parameters, such as deviation counter clear command inhibit and thrust limit are appropriately set, enabling the motor to operate normally. • No adaptive operation is performed during the execution of magnet pole position estimation.

2) Caution

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

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

3) Relevant parameters

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

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	00	B	Adaptive filter mode setup	0–4	—	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. 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.

(To be continued)

The adaptive filter automatically sets up the following parameters.

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

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

4) How to Operate

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

5) Other cautions

(1) Immediately after the first servo-on at start up; or after increasing stiffness setting with the real-time auto-tuning enabled, abnormal sound or oscillation may be generated until the adaptive filter stabilizes. If such abnormality lasts or repeats for 3 or more reciprocating operations, take the following countermeasures.
   1) Write the parameters which have given the normal operation into EEPROM.
   2) Lower the setting value of Pr0.03 “Real-time auto-tuning machine stiffness setup”.
   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 (2 Degrees of Freedom Control Mode Standard type)

2.0

This is an auto tuning function specifically for 2 degrees of freedom control mode(Standard type).

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

For Block Diagram of 2 Degrees of Freedom Mode (Standard type), refer to Section 5-2-13.

1) Scope of application

This function is enabled under the following conditions:

	Conditions for real-time auto tuning
Control mode	Position Control Pr6.47 bit0=1 : 2 degrees of freedom control mode
Other	· In Servo On status. · Parameters for other functions than control, such as deviation counter clearing, input signals such as command input prohibition, and torque limit settings, must be specified appropriately and normal rotation of motor must have no problems.

2) Cautions

Real-time auto tuning may not normally function in the following conditions. If that happens, change the load conditions/operation pattern or see the descriptions about manual tuning to manually configure relevant parameters.

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

3) Parameters controlling operation of real-time auto tuning

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

<table>
<tr><th>Category</th><th>No.</th><th>At-trib-ute *1).</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td rowspan="2">0</td><td rowspan="2">02</td><td rowspan="2">B</td><td rowspan="2">Real-time auto-gain tuning setup</td><td rowspan="2">0~6</td><td rowspan="2">–</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>0,6</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</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 setup support software.</td></tr>
</table></td></tr>
<tr><td>0</td><td>03</td><td>B</td><td>Selection of machine stiffness at realtime 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>
</table>

(Continued)

2.0

<table>
<tr><th>Category</th><th>No.</th><th>At-trib-ute *1)</th><th>Parameter</th><th>Setup 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 setup support software, 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 (Continued)</td><td>-32768~ 32767</td><td>–</td><td>Not available in 2 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

2.0

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."

Category	No.	At-trib-ute *1).	Parameter	Setup range	Unit	Function
0	04	B	mass ratio	0~10000	%	This parameter is updated if Pr0.02=1, 2 or 4.
6	07	B	Thrust command additional value	-100~100	%	This parameter is updated if the high responce mode 2 ,3 of real-time auto tuning are valid.
6	08	B	Positive direction torque compensation value	-100~100	%	This parameter is updated if the high responce mode 3 of real-time auto tuning is valid.
6	09	B	Negative direction torque compensation value	-100~100	%	This parameter is updated if the high responce mode 3 of real-time auto tuning is valid.
6	50	B	Viscous friction compensating gain	0~10000	%/(10000mm/s)	This parameter is updated if the high responce mode 3 of real-time auto tuning is valid.

The real-time auto tuning function updates the following basic gain setting parameters in accordance with Pr0.03 "Selection of machine stiffness at realtime auto-gain tuning" For details, refer to 7) Basic gain parameter settings table.

Category	No.	At-trib-ute *1).	Parameter	Setup range	Unit	Function
1	00	B	1st gain of position loop	0~30000	0.1/s	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	01	B	1st gain of velocity loop	1~32767	0.1 Hz	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	02	B	1st time constant of velocity loop integration	1~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	04	B	1st time constant of torque filter	0~2500	0.01 ms	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	05	B	2nd gain of position loop	0~30000	0.1/s	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	06	B	2nd gain of velocity loop	1~32767	0.1 Hz	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	07	B	2nd time constant of velocity loop integration	1~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
1	09	B	2nd time constant of torque filter	0~2500	0.01 ms	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
2	22	B	Positional command smoothing filter	0~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.
6	48	B	Tuning filter	0~2000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), update the setting values in accordance with hardness.

Specify fixed values for the following parameters for real-time auto tuning.

2.0 Category	No.	At-trib-ute *1).	Parameter	Setup range	Unit	Function
1	03	B	1st filter of speed detection	0~5	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	08	B	2nd filter of speed detection	0~5	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	10	B	Velocity feed forward gain	0~1000	0.1%	If real-time auto tuning is valid (Pr0.02=1~4), specify "1000" (100%).
1	11	B	Velocity feed forward filter	1~6400	0.01 ms	If real-time auto tuning is valid (Pr0.02=1~4), specify "0" (invalid).
1	12	B	Torque feed forward gain	0~1000	0.1%	If real-time auto tuning is valid (Pr0.02=1~4), specify "1000" (100%).
1	13	B	Torque feed forward filter	0~6400	0.01 ms	If real-time auto tuning is valid (Pr0.02=1~4), specify "0"(invalid).
6	10	B	1st filter of speed detection	0~1023	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "bit4=1."
6	49	B	Command / tuning filter damping	0~99	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "15."

Specify the following parameters for real-time auto tuning in accordance with Pr0.02 "Real-time auto-gain tuning setup."

Category 2.0	No.	At-tribute *1).	Parameter	Setup range	Unit	Function
1	14	B	2nd gain setup	0~1	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "1."
1	15	B	Mode of position control switching	0~10	–	If the standard responce mode is valid (Pr0.02=1)., specify "0." If the high responce mode 1~3 are valid (Pr0.02=2~4)., specify "7."
1	16	B	Delay time of position control switching	0~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), specify "10."
1	17	B	Level of position control switching	0~20000	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	18	B	Hysteresis at position control switching	0~20000	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	19	B	Position gain switching time	0~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), specify "10."
1	20	B	Mode of velocity control switching	0~5	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	21	B	Delay time of velocity control switching	0~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	22	B	Level of velocity control switching	0~20000	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	23	B	Hysteresis at velocity control switching	0~20000	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	24	B	Mode of torque control switching	0~3	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	25	B	Delay time of torque control switching	0~10000	0.1 ms	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	26	B	Level of torque control switching	0~20000	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
1	27	B	Hysteresis at torque control switching	0~20000	–	If real-time auto tuning is valid (Pr0.02=1~4), specify "0."
6	05	B	Position 3rd gain valid time	0~10000	0.1 ms	If the standard responce mode or the high responce mode 1 are valid (Pr0.02=1,2), specify "0"(invalid). If the high responce mode 2,3 are valid (Pr0.02=3,4)., specify "Pr2.22 x 20." (However a maximum value is limited to "10000.")
6	06	B	Position 3rd gain scale factor	50~1000	%	If the standard responce mode or the high responce mode 1 are valid (Pr0.02=1,2), specify "100"(100%). If the high responce mode 2,3 are valid (Pr0.02=3,4)., specify "200"(200%). *This setting value is valid if Pr6.47bit1=0. See section 5-2-11 "3rd Gain Switching" for detail.

The following settings are always invalid when a value other than "0" is specified for Pr0.02"Real-time auto-gain tuning setup" Note that parameter setting values are not changed.

Category	No.	At-tribute *1).	Parameter	Setup range	Unit	Function
6	10	B	Function expansion setup	0~1023	–	Instantaneous speed observer function permission bit (bit0), disturbance observer function permission bit (bit1) and mass ratio switching function permission bit (bit3) are made invalid internally.
6	23	B	Disturbance torque compensating gain	-100~100	%	Parameter settings may be changed, but disturbance observer compensation function is made invalid.
6	24	B	Disturbance observer filter	10~2500	0.01 ms	Parameter settings may be changed, but disturbance observer compensation function is made invalid.

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

5) Usage

Control parameters are specified automatically if a value other than "0" is specified for Pr0.02 "Real-time auto-gain tuning setup" in accordance with Pr0.03 "Selection of machine stiffness at realtime auto-gain tuning"

Input an operation command after the drive has been enabled by Servo On. If estimation load characteristic is successful, Pr0.04 "Mass ratio" is updated. In addition, some mode setting may cause changes of 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 compensating gain."

Specifying higher settings for Pr0.03 "Selection of machine stiffness at realtime auto-gain tuning" can increase response of motor. Adjust to the optimum value while monitoring the positioning stabilization time and vibration conditions.

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 realtime 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 realtime 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 "Mass 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 compensating gain."
2) After occurrence of strange noises or vibrations, values of Pr0.04 "Mass 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 compensating 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 "Mass 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 compensating 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 “Real-time auto-tuning machine stiffness setup” 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 settings table

2.0

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

*1 For Pr6.48 "Tuning filter," a value with 1 added is set in frames B to G.

5-2 Manual adjusting function

As explained previously, MINAS-A5N 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.

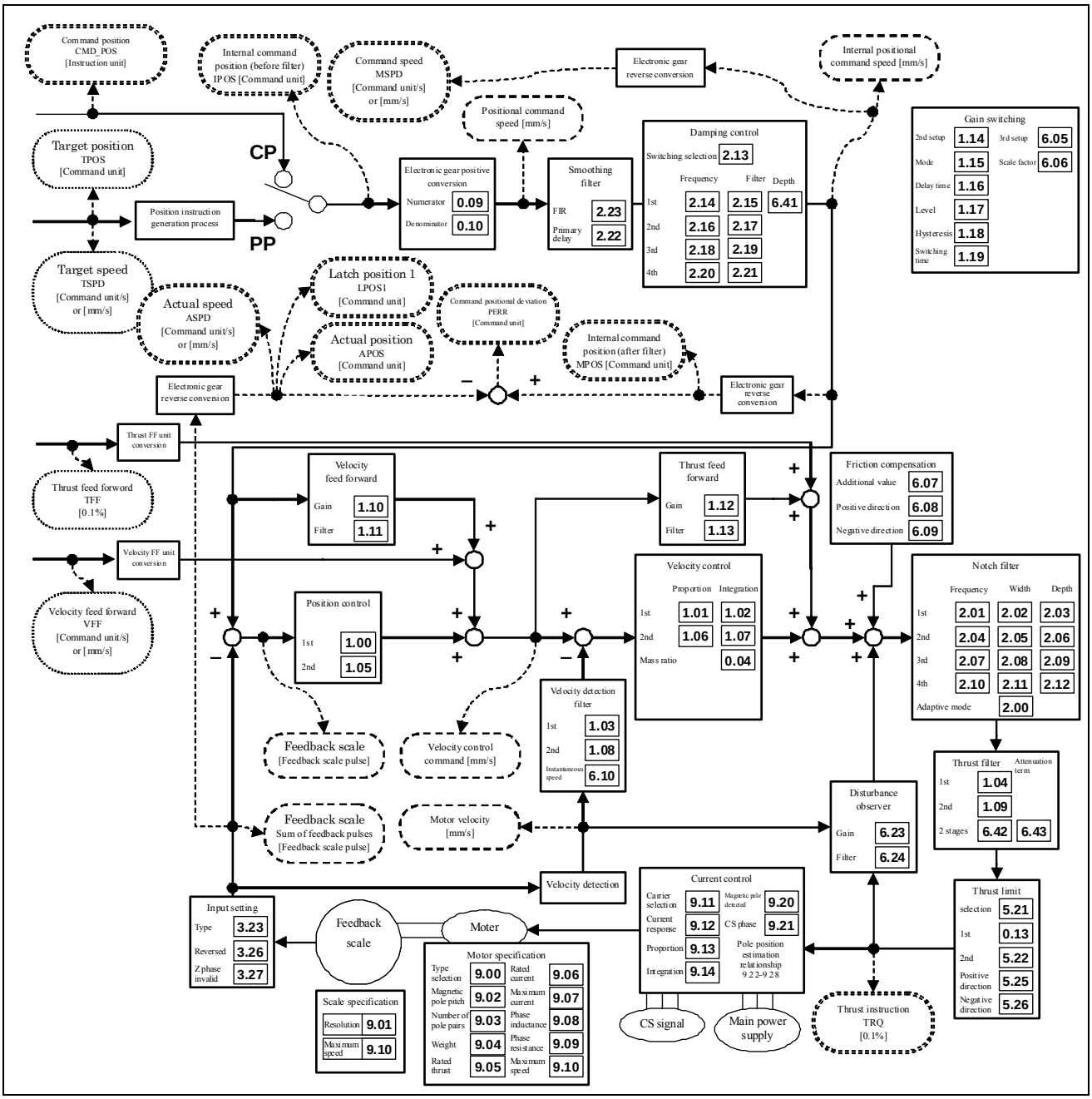
Here we explain this manual gain tuning method by each control mode and function.

1) Block diagram of position control mode (5-2-1)
2) Block diagram of velocity control mode (5-2-2)
3) Block diagram of thrust 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) Feed forward function (5-2-7)
8) Instantaneous velocity observer (5-2-8)
9) Disturbance observer (5-2-9)
10) 3rd gain switching function (5-2-10)
11) Friction thrust compensation (5-2-11)
12) 2-stage thrust filter (5-2-12)
13) Block Diagram of 2 Degrees of Freedom Mode (Standerd type) (5-2-13)

5-2-1 Block diagram of position control mode

The diagram below shows position control block of MINAS-A5N series.

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

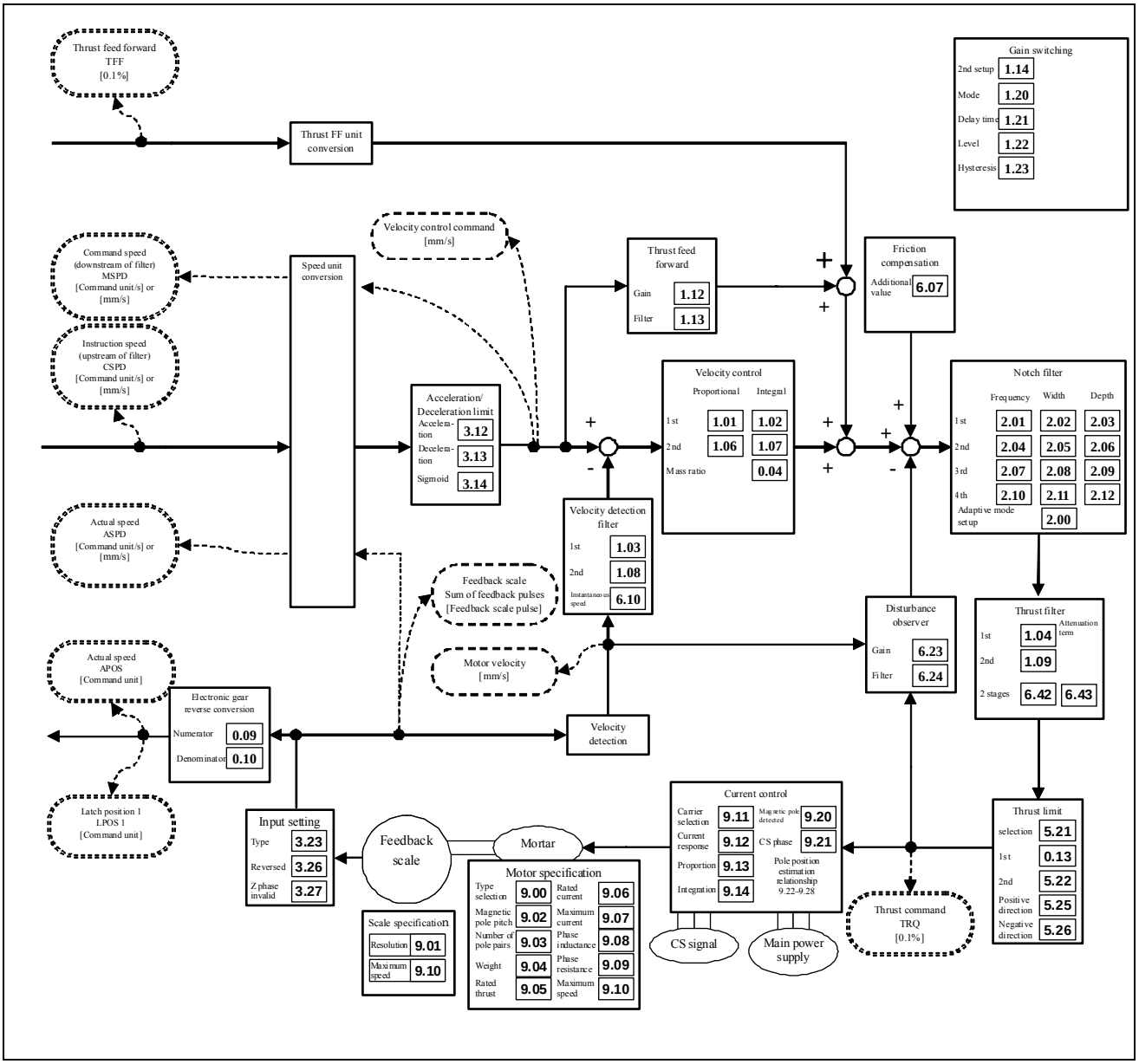


Block diagram of position control

5-2-2 Block diagram of velocity control mode

The diagram below shows velocity control block of MINAS-A5N series.

• Cyclic velocity control mode (CV)

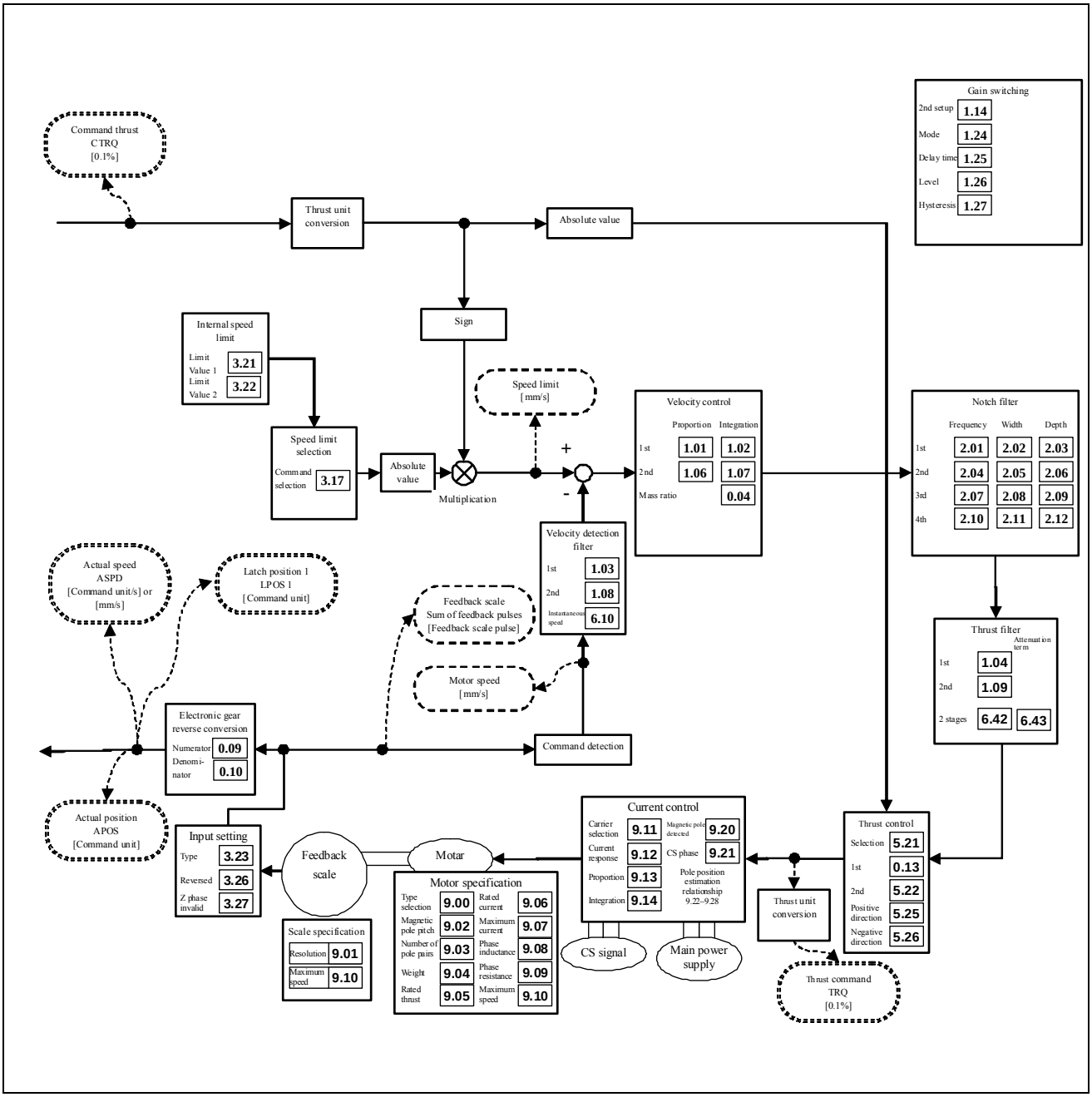


Block diagram of velocity control

5-2-3 Block diagram of thrust control mode

The diagram below shows the thrust control block of MINAS-A5N series.

• Cyclic thrust control mode (CT)



Block diagram of thrust control

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</td></tr>
<tr><td>3</td><td>Thrust 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 *2)</td></tr>
<tr><td>7</td><td>Position command exists</td></tr>
<tr><td>8</td><td>Not in positioning complete *2)</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</td></tr>
<tr><td>3</td><td>Thrust 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 thrust control switching</td><td>0–3</td><td>—</td><td>For thrust 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</td></tr>
<tr><td>3</td><td>Thrust command</td></tr>
</table></td></tr>
<tr><td>1</td><td>25</td><td>B</td><td>Delay time of thrust control switching</td><td>0–10000</td><td>0.1 ms</td><td>For thrust controlling: When shifting from the 2nd gain to the 1st gain with Pr 1.24 “Thrust 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 thrust control switching</td><td>0–20000</td><td>Mode dependent</td><td>For thrust controlling: Set up triggering level when Pr 1.24 Thrust 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 thrust control switching</td><td>0–20000</td><td>Mode dependent</td><td>For thrust controlling: Set up triggering hysteresis when Pr 1.24 Thrust 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) When an electronic gear ratio is larger than 1/1, even if it is servo-off, the remainder on operation may occur and a feedback scale position deviation may not be set to 0. For details refer to “Section 4-2-4”.

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	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	Thrust command is large	• Shift to the 2nd gain when the absolute value of the thrust command exceeded (level + hysteresis) (%) previously with the 1st gain. • Return to the 1st gain when the absolute value of the thrust command was kept below (level–hysteresis) (%) previously during delay time with the 2nd gain.
4	Velocity command variation is larger.	• Valid only during velocity control. • Shift to the 2nd gain when the absolute value of the velocity command variations exceeded (level + hysteresis) [10 mm/s/s] previously with the 1st gain. • Return to the 1st gain when the absolute value of the velocity command variations was kept below (level–hysteresis) [0 mm/s/s] during delay time previously with the 2nd gain. ▪ The 1st gain is fixed while the velocity control is not applied.
5	Velocity command is large	• Valid for position and velocity controls. • Shift to the 2nd gain when the absolute value of the velocity command exceeded (level +hysteresis) [mm/s] previously with the 1st gain. • Return to the 1st gain when the absolute value of the velocity command was kept below (level- hysteresis) [mm/s] previously during delay time with the 2nd gain.
6	Position deviation is large	• Valid for position controls. • Shift to the 2nd gain when the absolute value of the positional deviation exceeded (level +hysteresis) [pulse] previously with the 1st gain. • Return to the 1st gain when the absolute value of the positional deviation was kept below (level–hysteresis) [pulse] previously over delay time with the 2nd gain. ▪ Unit of level and hysteresis [pulse] is set with feedback scale resolution.

(To be continued)

Setup value	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) [mm/s] previously with the 1st gain. • Return to the 1st gain when the absolute value of the actual speed was kept below (level -hysteresis) [mm/s] 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 below (level–hysteresis) [mm/s] previously with the 2nd gain.

3) How to set

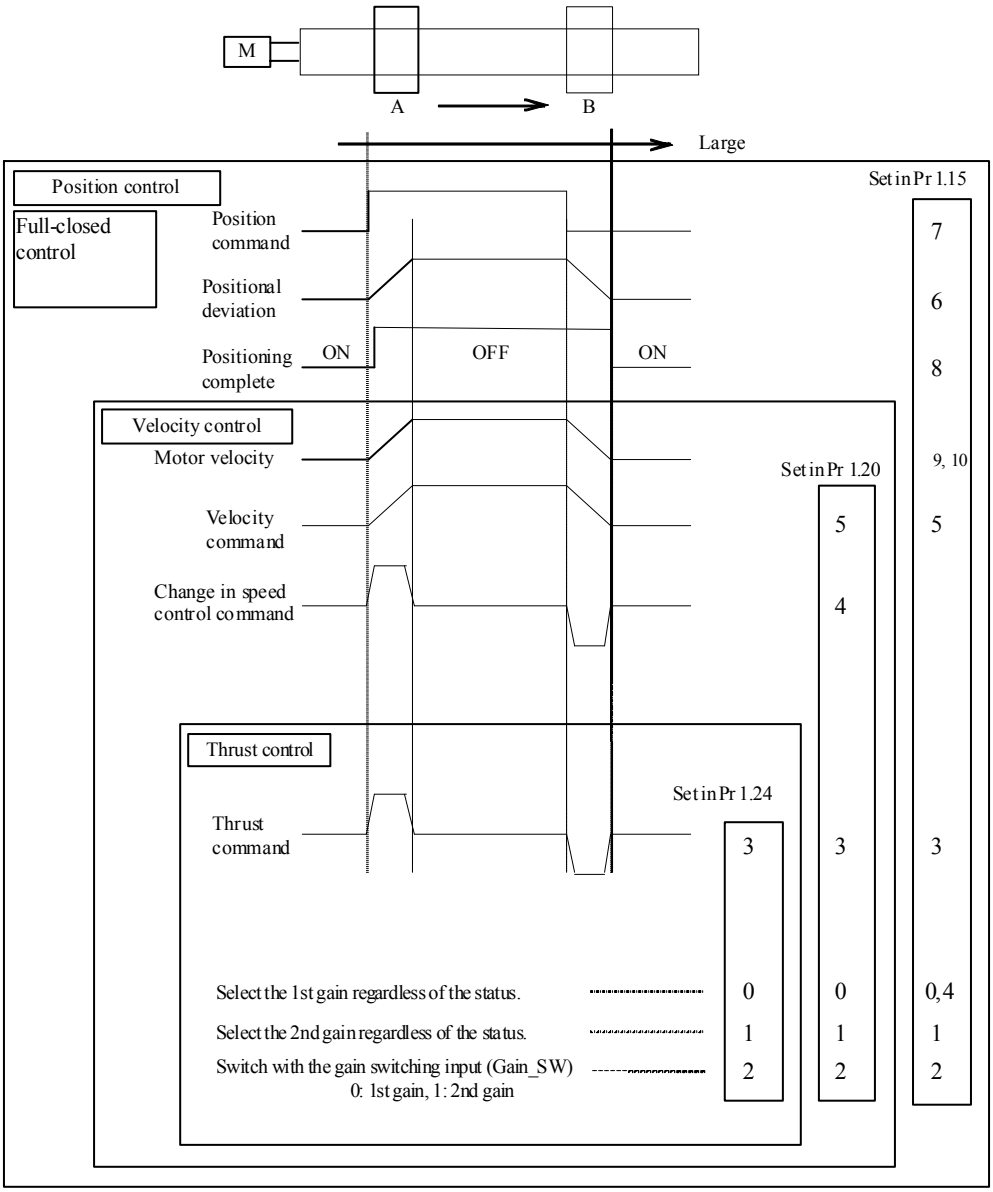
Suppose the load travels from A to B position and the internal status of the drive changes as the fig. below shows. Hereunder we explain how to set up the related parameters when you use the gain switching function.

1) Set up the conditions for gain switching with the following parameters.

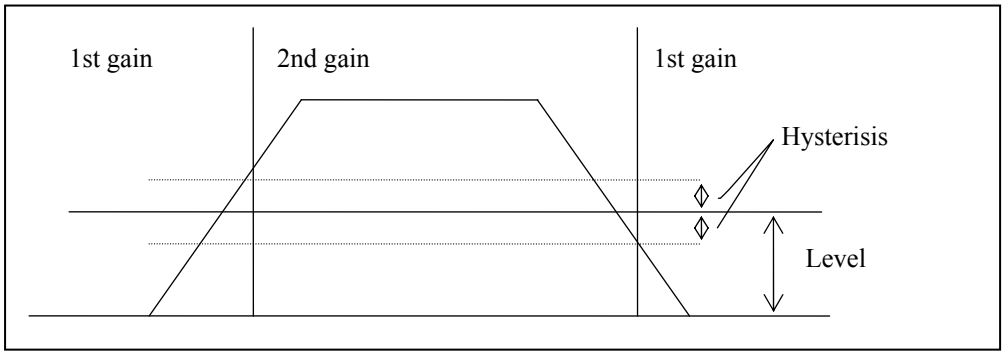
Pr 1.15 “Mode of position control switching”

Pr 1.20 “Mode of velocity control switching”

Pr 1.24 “Mode of thrust control switching”

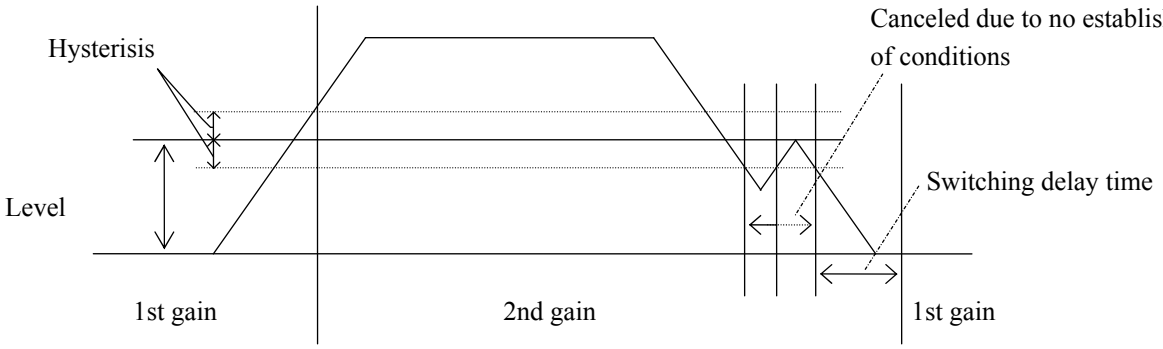


2) Set up the switching level and Hysteresis depending on the switching conditions.



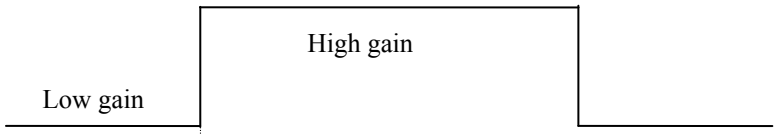
3) Set up the switching delay time.

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.

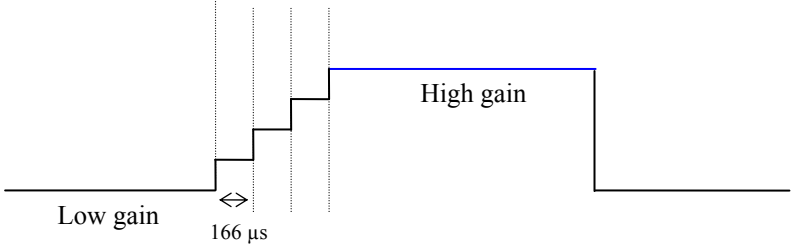


4) Set up the switching time of position gain.

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 Thrust filter can be switched instantaneously.
When Pr 1.19 “Position loop gain switching time” is 0,



When Pr 1.19 (Position loop gain switching time) is 5,



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-A5N series feature 4 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.

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

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

2) How to use

Determine the resonant frequency by using the frequency response measurement function of the setup support software, resonant frequency monitor or waveform graphics function and set it to the notch frequency.

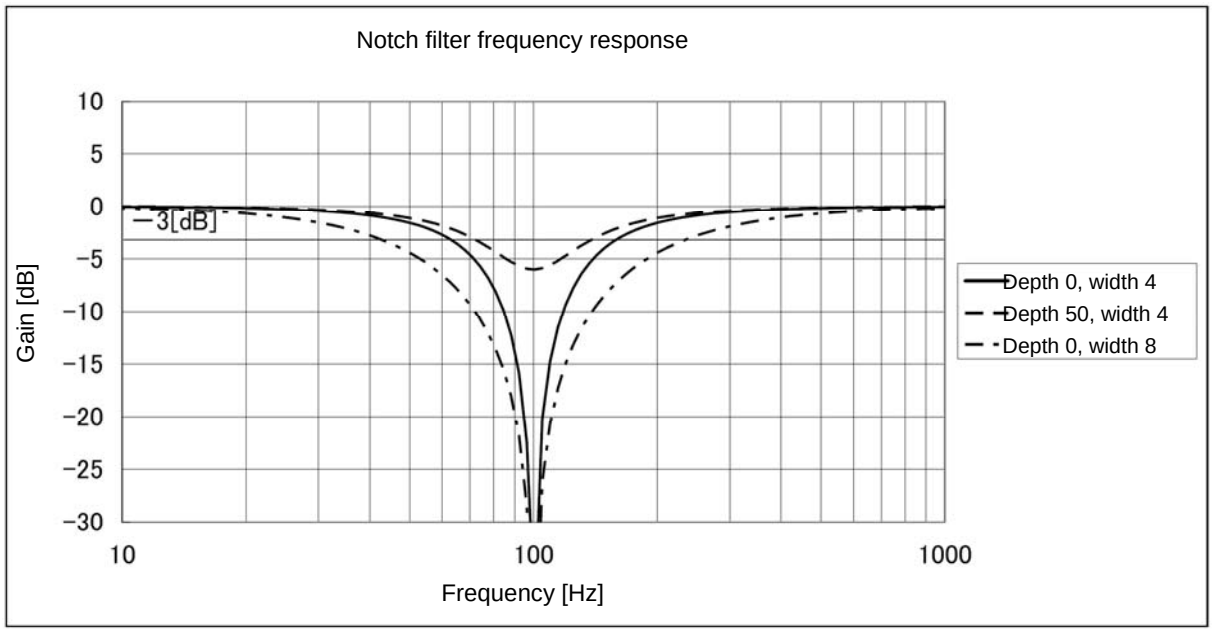
3) Notch width and depth

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.

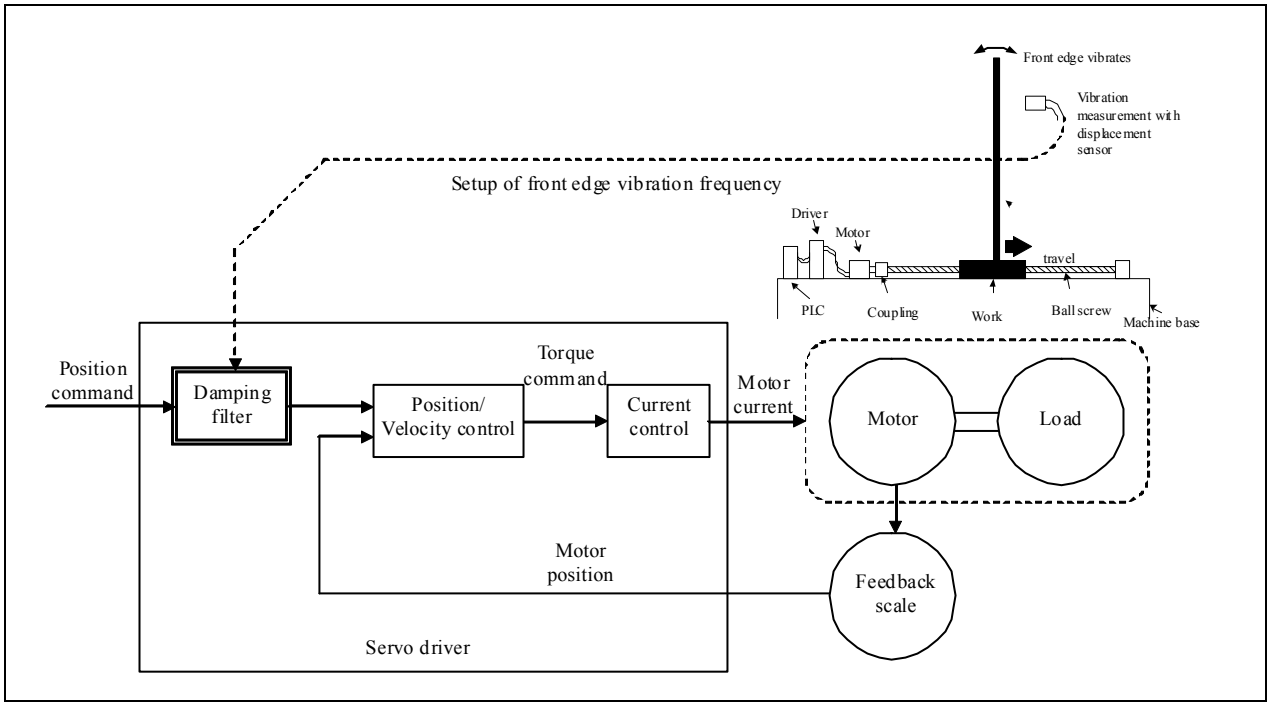
Notch width	Band width/center frequency	
	MINAS-A4N (reference)	MINAS-A5N Series
0	0.41	0.50
1	0.56	0.59
2	0.71	0.71
3	0.86	0.84
4	1.01	1.00
5		1.19
6		1.41
7		1.68
8		2.00
9		2.38
10		2.83
11		3.36
12		4.00
13		4.76
14		5.66
15		6.73
16		8.00
17		9.51
18		11.31
19		13.45
20		16.00

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



5-2-6 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 2 among 4 frequency settings can be used at the same time.



1) Applicable Range

Damping control is activated under the following conditions.

	Conditions under which the damping control is activated
Control mode	Control mode to be position control.

2) Caution

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

	Conditions which obstruct the damping control effect
Load	• Vibration is triggered by other factors than command (such as disturbance). • Ratio of resonance frequency and anti-resonance frequency is large. • Vibration frequency is out of the range of 1.0–200.0 [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>0–3</td><td>—
2.0</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: Maker use (Do not modify this parameter.)
• 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>
However, when the 2 degree of freedom control mode is enabled, this function is limited to the following (only one can be used at a time):
· 0: valid only 1st vibration suppression.
· 1 or 2: For manufacturer’s use
· 3: switched by 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</td><td>valid</td><td>Invalid</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td>Negative</td><td>Invalid</td><td>valid</td><td>Invalid</td><td>Invalid</td></tr>
</table></td></tr>
<tr><td>2</td><td>14</td><td>B</td><td>1st damping frequency</td><td>0–2000</td><td>0.1 Hz</td><td>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 1.0 to 200.0 [Hz]. Setup of 0 to 9 becomes invalid.</td></tr>
<tr><td>2</td><td>15</td><td>B</td><td>1st damping filter setup</td><td>0–1000</td><td>0.1 Hz</td><td>If thrust 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 2000–damping frequency, whichever is smaller.</td></tr>
<tr><td>6</td><td>41</td><td>B</td><td>1st damping depth</td><td>0–1000</td><td>—</td><td>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.</td></tr>
<tr><td>2</td><td>16</td><td>B</td><td>2nd damping frequency</td><td>0–2000</td><td>0.1 Hz</td><td>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 1.0 to 200.0 [Hz]. Setup of 0 to 9 becomes invalid.</td></tr>
<tr><td>2</td><td>17</td><td>B</td><td>2nd damping filter setup</td><td>0–1000</td><td>0.1 Hz</td><td>If thrust 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 2000–damping frequency, whichever is smaller.</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 (0.166 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 thrust 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.

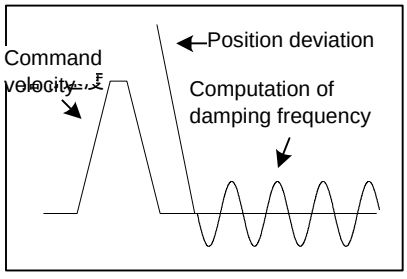
*2 There is delay from setting change of damping frequency or damping filter to internal computation and application of new setting values. If the switching described in *1 occurs during this delay time, application of new value will be suspended.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
2	18	B	3rd damping frequency	0–2000	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 1.0 to 200.0 [Hz]. Setup of 0 to 9 becomes invalid.
2	19	B	3rd damping filter setup	0–1000	0.1 Hz	If thrust 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 2000–damping frequency, whichever is smaller.
2	20	B	4th damping frequency	0–2000	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 1.0 to 200.0 [Hz]. Setup of 0 to 9 becomes invalid.
2	21	B	4th damping filter setup	0–1000	0.1 Hz	If thrust 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 2000–damping frequency, whichever is smaller.

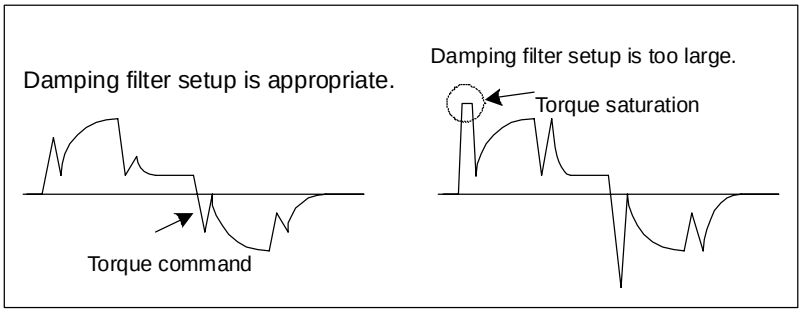
*1) For parameter attribute, refer to Section 9-1.

4) How to use

(1) Setup of damping frequency (1st: Pr 2.14, 2nd: Pr 2.16, 3rd: Pr 2.18, 4th: 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 or a waveform graphic function.



(2) Setup of damping filter (1st: Pr 2.15, 2nd: Pr 2.17, 3rd: Pr 2.19, 4th: Pr 2.21)
First, set to 0 and check the thrust waveform during operation.
You can reduce the settling time by setting up larger value, however, the thrust ripple increases at the command changing point as the right fig. shows. Setup within the range where no thrust saturation occurs under the actual condition. If thrust saturation occurs, damping control effect will be lost.



(3) Configuring damping depth setting (Pr 6.41)
*) Effective to only the 1st damping setting
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 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 thrust command necessary for operation based on the velocity control command and by adding thrust feed forward calculated by comparison with velocity feedback to the thrust command. In certain command, thrust 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-A5N series, the velocity feed forward and thrust feed forward can be used.

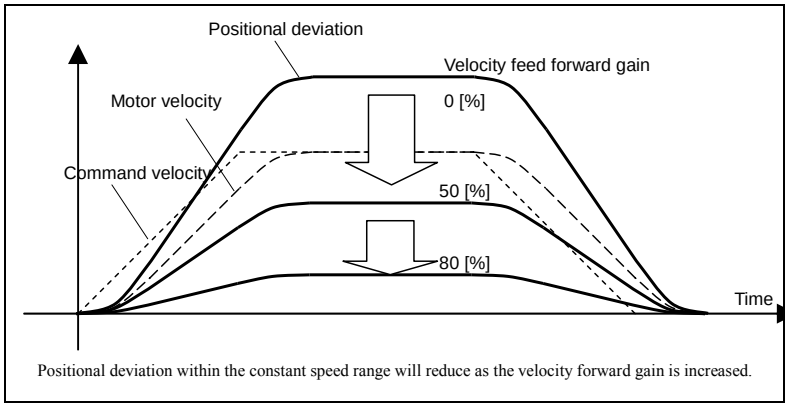
Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
1	10	B	Velocity feed forward gain	0–1000	0.1%	Multiply the velocity control command calculated according to the internal positional command by the ratio of this parameter and add the result to the velocity command resulting from the positional control process.
1	11	B	Velocity feed forward filter	0–6400	0.01 ms	Set the time constant of 1st delay filter which affects the input of velocity feed forward.
1	12	B	Thrust feed forward gain	0–1000	0.1%	Multiply the thrust command calculated according to the velocity control command by the ratio of this parameter and add the result to the thrust command resulting from the velocity control process.
1	13	B	Thrust feed forward filter	0–6400	0.01 ms	Set up the time constant of 1st delay filter which affects the input of thrust feed forward.

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

2) Usage example of velocity feed forward

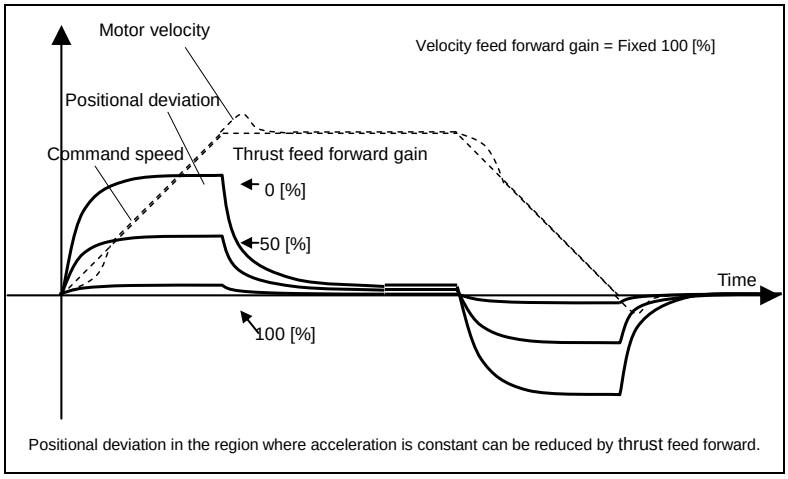
The velocity feed forward will become effective as the velocity feed forward gain is gradually increased with the velocity feed forward filter set at approx. 50 (0.5 ms). The positional deviation during operation at a constant velocity is reduced as shown in the equation below in proportion to the value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



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.

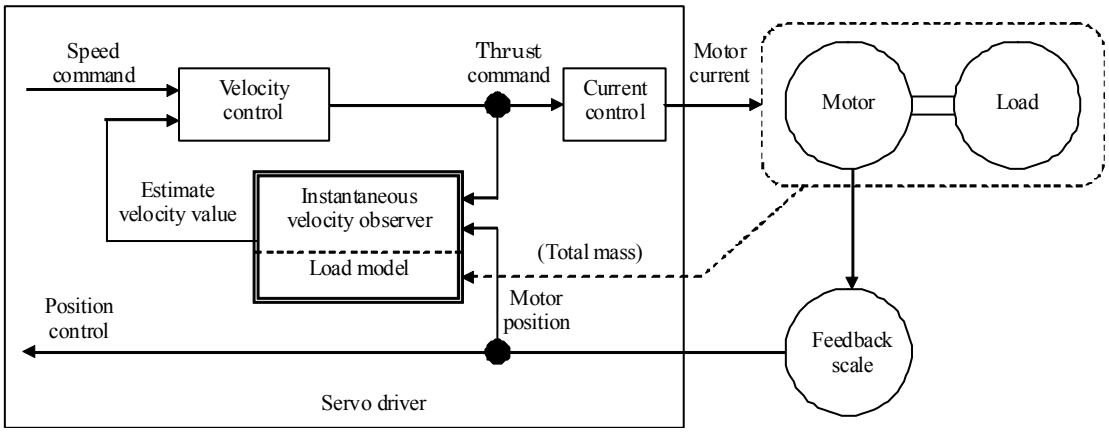
3) Usage example of thrust feed forward
To use the thrust feed forward, correctly set the mass ratio. Use the value that was determined at the start of the real time auto tuning, or set the mass ratio that can be calculated from the machine specification to Pr 0.04 “Mass ratio”.
The thrust feed forward will become effective as the thrust feed forward gain is gradually increased with the thrust 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 thrust 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 thrust is not active.



Zero positional deviation is impossible in actual situation because of disturbance thrust.
As with the velocity feed forward, large thrust 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.

5-2-8 Instantaneous Velocity Observer function

This function enables both realization of high response and reduction of vibration at stopping, by estimating the motor velocity using a load model, hence improving the accuracy of the velocity detection.



(1) Applicable Range

□ Following conditions have to be satisfied to apply this function.

	Conditions under which the instantaneous velocity observer is activated
Control mode	• Control mode to be position control or velocity control.
Others	• Should be in servo-on condition • Parameters except for controls such as thrust limit setup, are correctly set, assuring that the motor can operate normally. • Real-time auto-tuning should be disabled. (Pr 0.02=0) • The motor should be of a linear type. (Pr 9.00=1) • No velocity estimation operation is performed during the execution of magnet pole position.

(2) Cautions

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

	Conditions which obstruct instantaneous velocity observer action
Load	• Gap between the estimated total load mass (motor+load) and actual machine is large. e.g.) Large resonance point exists in frequency band of 300 [Hz] or below. Non-linear factor such as large backlash exists. • Load mass varies. • Disturbance thrust with harmonic component is applied.
Others	• Settling range is very small.

(3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function expansion setup	2.0 0–1023	—	Velocity observer enable bit (bit 0) valid/invalid the function. bit 0 0: Invalid 1: Valid * bit 0 = LSB

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

(4) How to Use

(1) Setup of mass ratio (Pr 0.04)

Set up as exact mass ratio as possible.

- When the mass ratio (Pr 0.04) is already obtained through real-time auto-gain tuning and is applicable at normal position control, use this value as Pr 0.04 “Mass value”.
- When the mass ratio is already known through calculation, enter this calculated value.
- When the mass ration is not known, execute the normal mode auto-gain tuning and measure the mass ratio.

(2) Adjustment at normal position control

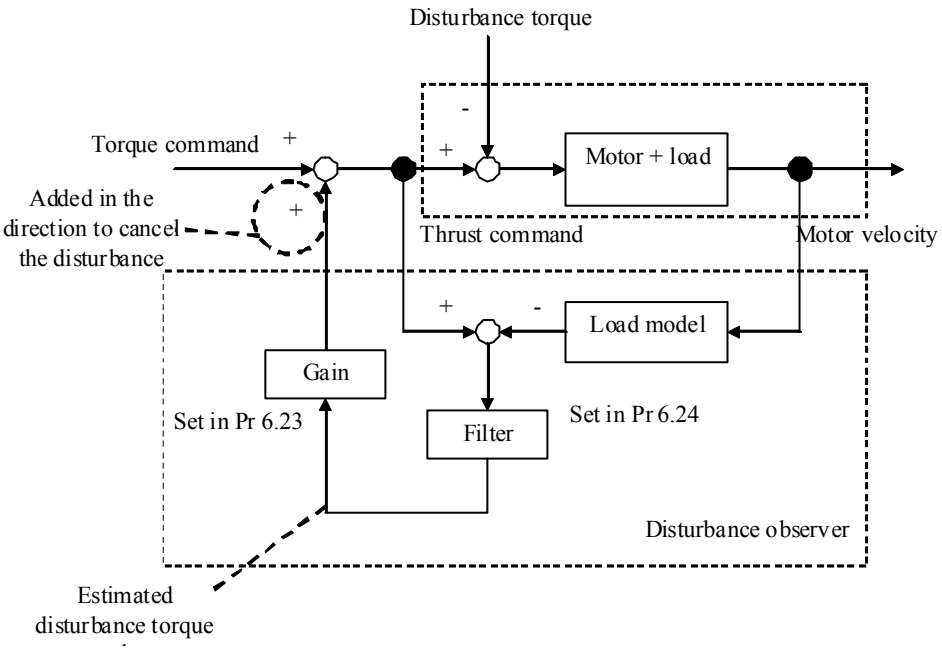
- Adjust the position loop gain, velocity loop gain, etc.

(3) Setup of function expansion setup (Pr 6.10)

- By enabling instantaneous velocity observer function through function expansion setup (Pr 6.10), the velocity detection method changes to the instantaneous velocity observer.
- When you experience a large variation of the thrust waveform or noise, return this to 0, and reconfirm the above cautions and (1).
- When you obtain the effect such as a reduction of the variation of the thrust waveform and noise, search an optimum setup by making a fine adjustment of Pr 0.04 [“Mass ratio] while observing the position deviation waveform and actual velocity waveform to obtain the least variation. If you change the position loop gain and velocity loop gain, the optimum value of Pr 0.04 [Mass ratio] might have been changed, and you need to make a fine adjustment again.

5-2-9 Disturbance observer function

This function uses the disturbance thrust determined by the disturbance observer to reduce effect of disturbance thrust and vibration.



(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	• Control mode to be either or both position control or/and velocity control.
Others	• Should be in servo-on condition • Parameters except for controls such as thrust limit setup, are correctly set, assuring that the motor operate normally. • Real-time auto-tuning should be disabled. (Pr 0.02=0) • Instantaneous velocity observer should be disabled. (Pr 6.10 bit0=0) • The motor should be of a linear type. (Pr 9.00=1) • No disturbance observer estimation operation is performed during the execution of magnet pole position estimation.

(2) Caution

□ Effect may not be expected in the following condition.

	Conditions which obstruct disturbance observer action
Load	• Resonant frequency is lower than the cutoff frequency estimated by the disturbance observer. • Disturbance thrust contains many high frequency components. • Scale resolution is low.

(3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	10	B	Function expansion setup	0–1023 △2.0	—	Sets bits related to disturbance observer. bit 1 0: Invalid 1: Valid bit 2 0: Always valid 1: Valid only when 1st gain is selected. * bit 0 = LSB Example: To use the disturbance observer in the enabled mode only when 1st gain is selected: Setup value = 6 To use the disturbance observer always in the enabled mode: Setup value = 2
6	23	B	Disturbance thrust compensating gain	-100–100	%	Set up compensating gain against disturbance thrust.
6	24	B	Disturbance observer filter	10–2500	0.01 ms	Set up the filter time constant according to the disturbance thrust compensation.
6	40	B	Disturbance thrust compensation phase setup	0–60	degree	Set up the phase advance compensation value respective to the disturbance thrust estimation value. Can compensate for a phase delay in filtering by the Pr 6.24 “Disturbance observer filter”. Disturbance control effect can improve by setting the setup value to a value between 45 and 50 degrees or so.

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

(4) How to use

1) With Pr 6.10 “Function enhancement setup”, set observer enable/disable and operation mode (always enable/enable only when 1st gain is selected).
2) Setup of Pr 6.24 “Disturbance observer filter”
   First, set up Pr 6.24 to a larger value and check the operation with Pr 6.23 “Disturbance thrust compensating gain” set to a low value, and then gradually decrease the setup value of Pr 6.24. A low filter setup value assures disturbance thrust estimation with small delay and effectively suppresses effects of disturbance. However, this results in larger operation noise. Well balanced setup is required.
3) Setup of Pr 6.23 “(Disturbance thrust compensating gain”
   After setting up Pr 6.24, increase Pr 6.23.
   The disturbance suppressing capability increases by increasing the gain, but it is associated with increasing volume of operation noise.
   This means that well balanced setup can be obtained by adjusting Pr6.24 and Pr6.23.
4) Setup of Pr6.40 “Disturbance thrust compensation phase setup”
   If the setup of Pr6.23 and Pr6.24 alone does not work well, set Pr6.40.
   The effect of disturbance control may improve by setting Pr6.24 based on the expression shown below and setting the Pr6.40 value to a value between 45 and 50 degrees.
   Pr6.24 “Disturbance observer filter”[0.01ms]
   = 100000/(2 π × disturbance frequency [Hz])

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	• Control mode to be position control
Others	• Should be in servo-on condition • Parameters except for controls such as thrust limit setup, are correctly set, assuring that the motor can operate 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

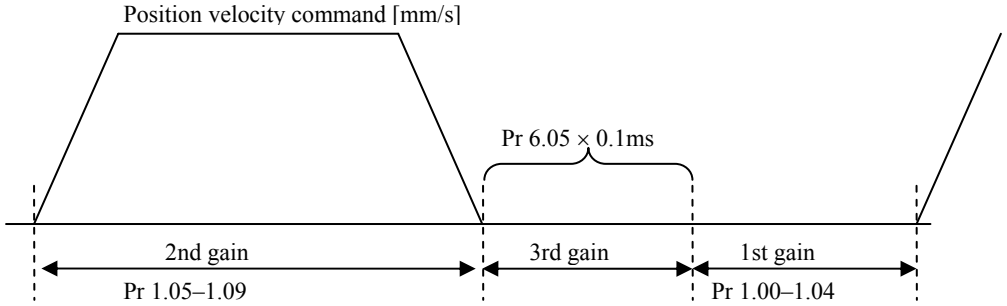
*1) For parameter attribute, refer to Section 9-1.

(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 enable time”, and set the 3rd gain (scale factor with reference to 1st gain) to Pr 6.06 “Position 3rd gain magnification ratio”.

- 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 thrust filter time constant directly use the 1st gain value.

5-2-11 Friction thrust compensation

To reduce effect of friction represented by mechanical system, 2 types of friction thrust compensation can be applied: offset load compensation that cancels constant offset thrust and the dynamic friction compensation that varies direction as the operating direction varies.

(1) Applicable Range

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

	Conditions under which the Friction thrust 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 thrust limit setup, are correctly set, assuring that the motor can operate normally.

(2) Relevant parameters

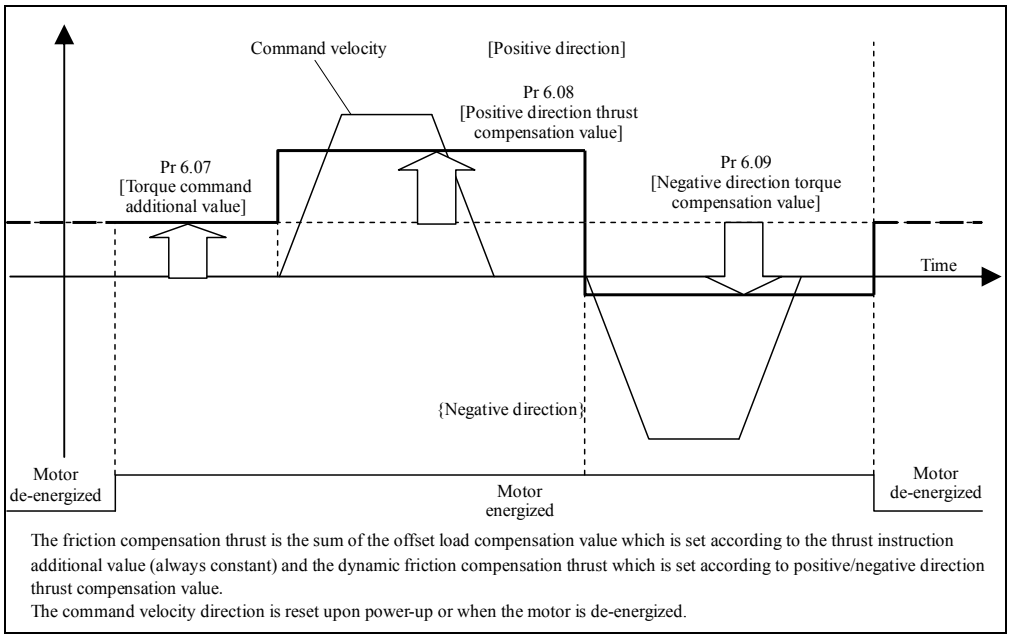
Combine the following 3 parameters to setup appropriate friction thrust compensation.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	07	B	Thrust command additional value	-100–100	%	Set up the offset load compensation value usually added to the thrust command in a control mode except for the thrust control mode.
6	08	B	Positive direction thrust compensation value	-100–100	%	Set up the dynamic friction compensation value to be added to the thrust command when forward positional command is fed at the time of position control.
6	09	B	Negative direction thrust compensation value	-100–100	%	Set up the dynamic friction compensation value to be added to the thrust command when negative direction positional command is fed at the time of position control.

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

(3) How to use

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



The friction compensation thrust is the sum of the offset load compensation value which is set according to the thrust instruction additional value (always constant) and the dynamic friction compensation thrust which is set according to positive/negative direction thrust compensation value.
The command velocity direction is reset upon power-up or when the motor is de-energized.

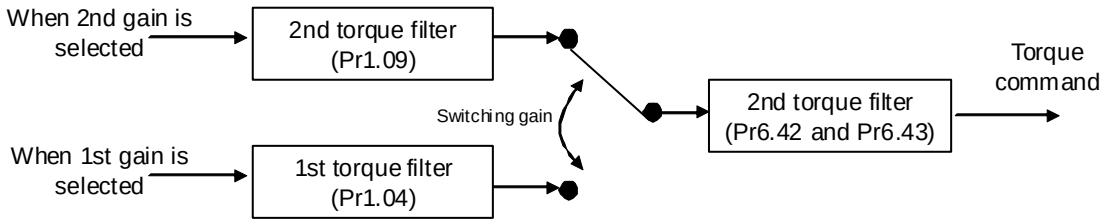
- Pr 6.07 “Thrust command additional value” reduces variations in positioning operation (performance is affected by direction of movement). These variations occur when constant offset thrust resulting from mass on vertical axis is applied to the motor.
- Certain loads such as belt driven shaft requires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

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

- For thrust 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 2-stage thrust filter

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



(1) Application range

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

	Conditions for operating 2-stage thrust 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 thrust limit, other than control parameter are set properly, and motor is running without any problem.

(2) Precautions

- If the setting value is increased excessively, the control may become unstable to produce vibration. Specify proper setting value while checking the status of the device.
- If Pr6.43 “2-stage thrust 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	2-stage thrust filter time constant	0–2500	0.01ms	Sets 2-stage thrust 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 5–159 (0.05–1.59 ms). (Equivalent to 100–3000 Hz in frequency) Setting values 1–4 works as 5 (3000 Hz), and 159–2500 works as 159 (100 Hz).
6	43	B	2-stage thrust filter attenuation term	0–1000	—	Sets attenuation term of 2-stage thrust filter. The filter degree of the 2-stage thrust 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.

(4) Usage

Set a 2-stage thrust filter if high-frequency vibration can’t be removed only using usual 1st and 2nd thrust filters. Setting Pr6.43 “2-stage thrust filter attenuation term” to 1000 (ζ=1.0), adjust Pr6.42 “2-stage thrust filter time constant”.

5-2-13 Block Diagram of 2 Degrees of Freedom Mode (Standerd type)

△2.0 Block Diagram of 2 Degrees of Freedom Mode is expanded function of the position control mode which aims at the improvement of a response by enabling a setup of the “Position command response measurement” and “Disturbance control measurement(Servo stiffness)” independently.

(1) Application range

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

	Conditions for operating 2-stage thrust filter
Control mode	• Control mode to be position control
Others	• Should be in servo-on condition • Parameters except for controls such as thrust limit setup, are correctly set, assuring that the motor can operate normally.

(2) Precautions

Please write EEPROM as Pr6.47” Function expansion setup 2”=1 first, Block Diagram of 2 Degrees of Freedom Mode is enabled by Control power supply reset

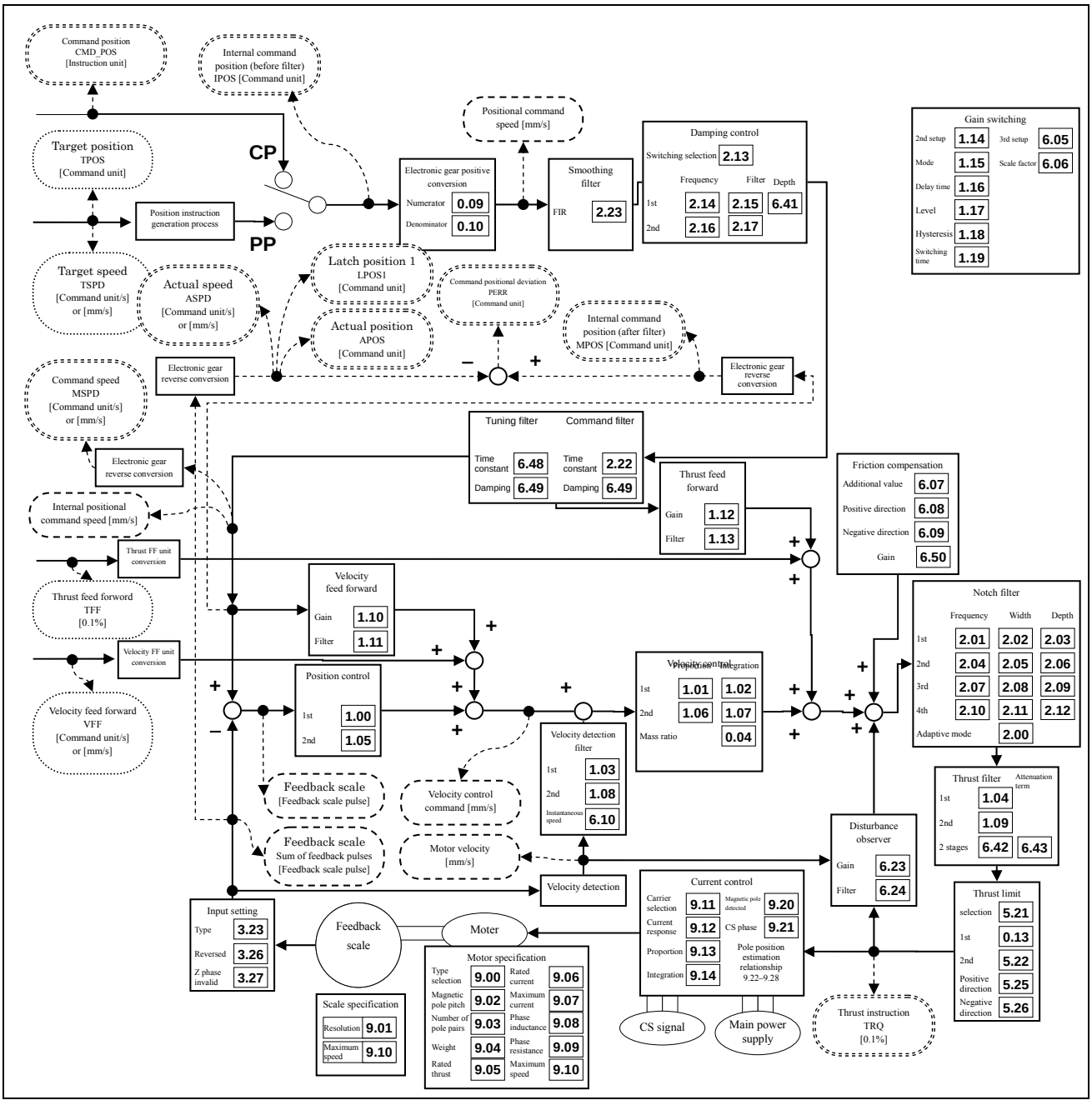
After this, please adjust in Real-time Auto Tuning. For adjustment, refer to Section 5-1-3.

Only when the further improvement is required, please tune the following parameter finely manually, checking a response.

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
6	47	R	Function expansion setup 2	0~1	-	Set various functions with bits. bit0 2 degrees of freedom control mode(Standerd type) (Position control) 0: Disabled 1: Enabled
2	22	B	Positional command smoothing filter	0~10000	0.1ms	To set the time constant of the 1st order filter for the position command. Set to the time constant of the command response filter for 2 degrees of freedom control. The maximum value is 2000 (=200.0ms). (This restriction is imposed not on parameters themselves, but on values applied inside the driver. The damping is set in Pr6.49 "Command response/tuning filter damping setting."
6	48	B	Tuning filter	0~2000	0.1ms	Set the time constant of the tuning filter.
6	49	B	Command / tuning filter damping	0~99	-	Set the damping of the command filter and tuning filter. The first digit is set for the command filter and the second digit is for the tuning filter in decimal notation. Effective digits 0 to 4: No damping (Operates as a primary filter) 5 to 9: Secondary filter (The damping ζ will be 1.0, 0.86, 0.71, 0.50 and 0.35 respectively.) Ex) To obtain ζ=1.0 for the command filter and ζ=0.71 for the tuning filter 1, set the value to 75 (1st digit=5 (ζ=1.0), 2nd digit=7(ζ=0.71)). Please note that for the time constant of the command filter, Pr2.22 "Positional command smoothing filter" will be applied.
6	50	B	Viscous friction compensating gain	0~10000	%/(10000 mm/s)	The command speed is multiplied by this set value to obtain a compensation amount that will be added to the torque command. The unit is [rated torque %/(10000mm/s)].

2.0 (3) Block Diagram of 2 Degrees of Freedom Mode(Stabderd type)

2 degrees of freedom mode has a structure shown in the following block diagram.



2 degrees of freedom mode block diagram

6. Application

6-1 Thrust limit switching function

This function changes the thrust limit value according to the operation direction or thrust limit switching command (TI_SW) of RTEX communication.
For details, refer to Technical Reference, SX-DSV02310”Section 4-2-3-3”, RTEX communication.

(1) Applicable range

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

	Conditions under which the thrust limit switching function is activated
Control mode	• Position control and velocity control. *1)
Others	• Should be in servo-on condition • Parameters except for controls are correctly set, assuring that the motor can operate normally.

*1) During thrust controlling, the switching function is disabled and only Pr. 0.13 “1st thrust 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 thrust limit</td><td>0–500</td><td>%</td><td>You can set up the 1st limit value of the motor output thrust. *2)</td></tr>
<tr><td>5</td><td>21</td><td>B</td><td>Selection of thrust limit</td><td>1–4</td><td>—</td><td>You can set up the thrust 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></td></tr>
<tr><td>5</td><td>22</td><td>B</td><td>2nd thrust limit</td><td>0–500</td><td>%</td><td>You can set up the 2nd limit value of the motor output thrust. *2)</td></tr>
<tr><td>5</td><td>25</td><td>B</td><td>Positive direction thrust limit</td><td>0–500</td><td>%</td><td>Set up positive direction thrust limit upon receiving thrust limit switching. *2)</td></tr>
<tr><td>5</td><td>26</td><td>B</td><td>Negative direction thrust limit</td><td>0–500</td><td>%</td><td>Set up negative direction thrust limit upon receiving thrust limit switching. *2)</td></tr>
</table>

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

*2) The maximum thrust limit [%] = 100 x Pr9.07 /(Pr9.06 x √2)
Pr 9.07 (Maximum instantaneous motor current [0.1A])
Pr 9.06 (Rated effective motor current [0.1 Arms])

6-2 Motor working range setup function

You can make an alarm stop of the motor with software limit protection (Err34.0) when the motor travels exceeding the movable range which is set up with Pr 5.14 “Motor working range setup” against the position command input range. You can prevent the work from colliding to the machine end caused by motor oscillation.

(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 thrust limit setup, are correctly set, assuring that the motor can operate normally.

(2) Caution

• This function is not a protection against the abnormal position command.

• When this software limit protection is activated, the motor decelerates and stops according to Pr 5.10 “Sequence at alarm”.
The work (load) may collide to the machine end and be damaged depending on the load during this deceleration, hence set up the range of Pr 5.14 including the deceleration movement.

• This motor working range setup protection will be disabled during the frequency response functioning of the communication.

• When changing the control mode (for the purpose of only to control velocity or thrust), do not use this function. Instead, use software limit function or drive inhibit input.

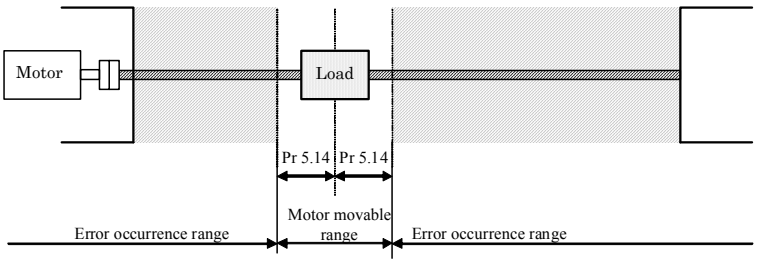
(3) Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
5	14	A	Motor working range setup	0–1000	0.1 magnet pole pitch	You can set up the movable range of the motor against the position command input range. When the motor movement exceeds the setup value, software limit protection will be triggered.

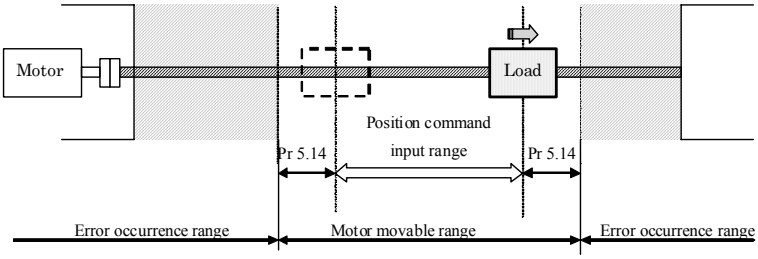
*1) For parameter attribute, refer to Section 9-1.

(4) Example of movement

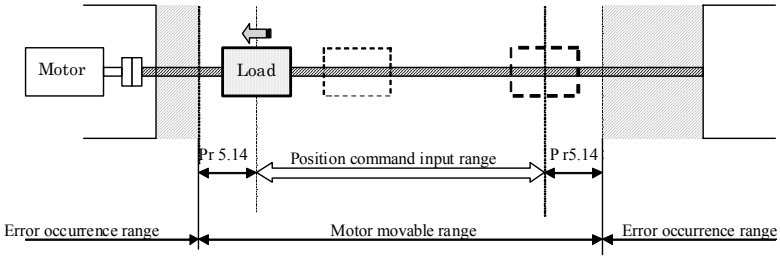
(1) When no position command is entered (Servo-ON status)
The motor movable range will be the travel range which is set at both sides of the motor with Pr5.14 since no position command is entered. When the load enters to the Err34.0 occurrence range (oblique line range), software limit protection will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



Condition under which the position command input range is cleared

The position command input range will be 0-cleared under the following conditions.

- When the power is turned on.
- While the position deviation is being cleared (servo OFF, deceleration/stop upon inputting of over-travel inhibition and positional deviation is cleared, etc.)
- At the beginning and ending of trial run via USB communication (PANATERM).
- Velocity or thrust is controlled.
- Position information is initialized.
  Upon returning to home position, etc.
- During the execution of magnet pole position estimation
- During the automatic setup of the linear motor through the use of tools.

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 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, thrust in over-travel inhibition direction is 0. *3) 1: POT and NOT are disabled, having no effect on operation. 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 inhibition” = 0, specify the status during deceleration and stop after application of the over-travel inhibition (POT, NOT).
5	11	B	Thrust setup for emergency stop	0–500	%	Set up the thrust limit at emergency stop. When setup value is 0, the thrust limit for normal operation is applied.
7	23	B	RTEX function Expansion 2	-32768 –32767	—	[bit 2] RTEX status response condition setting while POT/NOT function 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 Pr.5.04 (Setup of over-travel inhibit input) and Pr.5.05 (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 Pr.5.04 to 1.
For more information on profile home position return, refer to a technical document, SX-DSV02210 “Section 7-5-7,7-5-8,7-5-9 ”,RTEX communication.

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

(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 mm/s or below)	
		Stopping method	Deviation	Operation after stopping	Deviation
0	Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)	—	• Control mode depends on the command. *2)	—
	0	• Dynamic brake action	Clear *3)	• Thrust command=0 towards inhibited direction	Hold
	1	• Free run (DB OFF)	Clear *3)	• Thrust command=0 towards inhibited direction	Hold
	2	• Emergency stop *5) • Thrust limit=Pr 5.11	Clear *3)	• Thrust limit and thrust 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 enhancement setting 2 (Pr7.23) is set to 1 at this time, a command error is returned.
*3) During deviation clearing, the process that lets the internal command position to follow the feedback position is activated. At the instantaneous stopping and at the end of deceleration, position deviations/ feedback scale deviations accumulated during deceleration are cleared.
*4) When setting value of Pr 5.04 Over-travel inhibit input set up is 2, Err 38.0 “Run-inhibition input protection” 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 thrust command value is limited during this process by Pr 5.11 “Emergency stop thrust setup”.
*6) Deceleration period is the time required for the running motor to speed down to 30 mm/s. Once the motor speed drops below 30 mm/s, it is treated as in stop state regardless of its speed.

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	Thrust setup for emergency stop	0–500	%	Set up the thrust limit at emergency stop. When setup value is 0, the thrust 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 mm/s or below)	
	Stopping method	Deviation	Operation after stopping	Deviation
Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)	—	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)	—
0,4	• Dynamic brake action	Clear *2)	• Dynamic brake action	Clear *2)
1,5	• Free run (DB OFF)	Clear *2)	• Dynamic brake action	Clear *2)
2,6	• Dynamic brake action	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) *6) • Thrust limit =Pr 5.11	Clear *2)	• Dynamic brake action	Clear *2)
9	• Emergency stop *3) *6) • Thrust 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 t thrust command value is limited during this process by Pr 5.11 “Emergency stop thrust setup”.
*4) Deceleration period is the time required for the running motor to speed down to 30 mm/s. Once the motor speed drops below 30 mm/s, 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 during main power interruption”.
*6) During magnet pole position estimation and during the automatic setup of scale/CS directions, an immediate stop is disabled and deceleration is enabled with the operation of the dynamic brake (DB).

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	L/V trip selection upon 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. bit 1 0: Detect main AC power OFF alarm only when servo is in ON state. 1: Always detect main AC power OFF alarm.
5	09	C	Detection time of main power off	70-2000	ms	Set up main AC power alarm detection time. Main AC power OFF detection is disabled when the setting value is 2000. Resolution of setting is 2 ms. For example, when setting value is 99, processed in 100 ms.
5	11	B	Thrust setup for emergency stop	0–500	%	Set up the thrust limit at emergency stop. When setup value is 0, the thrust limit for normal operation is applied

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

(2) Contents

• Details of Pr 5.07 (Sequence at main power OFF)

Pr 5.07	During deceleration *4)		After stalling (Approx.30 mm/s or below)	
	Stopping method	Deviation	Operation after stopping	Deviation
Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)	—	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)	—
0,4	• Dynamic brake action	Clear *2)	• Dynamic brake action	Clear *2)
1,5	• Free run (DB OFF)	Clear *2)	• Dynamic brake action	Clear *2)
2,6	• Dynamic brake action	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) *6) • Thrust limit =Pr 5.11	Clear *2)	• Dynamic brake action	Clear *2)
9	• Emergency stop *3) *6) • Thrust 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 thrust command value is limited during this process by Pr 5.11 “Emergency stop thrust setup”.

*4) Deceleration period is the time required for the running motor to speed down to 30 mm/s. Once the motor speed drops below 30 mm/s, 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 with main power off “= 1, and the operation follows Pr 5.10 “Sequence at alarm”.

*6) During magnet pole position estimation and during the automatic setup of scale/CS directions, an immediate stop is disabled and deceleration is enabled with the operation of the dynamic brake (DB).

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 mm/s or below)	
	Stopping method		Deviation	Operation after stopping	Deviation
Common	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)		—	• Forcibly controls the position. *1) • Forcibly stops position command generation. *1)	—
0	• Dynamic brake action		Clear *2)	• Dynamic brake action	Clear *2)
1	• Free run (DB OFF)		Clear *2)	• Dynamic brake action	Clear *2)
2	• Dynamic brake action		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) *5) • Thrust limit =Pr 5.11	Clear *2)	• Dynamic brake action	Clear *2)
	Action B *3)	• Dynamic brake action	Clear *2)		
5	Action A *3)	• Emergency stop *3) *5) • Thrust limit =Pr 5.11	Clear *2)	• Dynamic brake action	Clear *2)
	Action B *3)	• Free run (DB OFF)	Clear *2)		
6	Action A *3)	• Emergency stop *3) *5) • Thrust limit =Pr 5.11	Clear *2)	• Free run (DB OFF)	Clear *2)
	Action B *3)	• Dynamic brake action	Clear *2)		
7	Action A *3)	• Emergency stop *3) *5) • Thrust 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 mm/s. Once the motor speed drops below 30 mm/s, and changes its status after stoppage, it is treated as in stop state regardless of its speed.

*5) During magnet pole position estimation and during the automatic setup of scale/CS directions, an immediate stop is disabled and deceleration is enabled according to the specifications for movement B.

6-3-5 Emergency stop upon occurrence of alarm

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

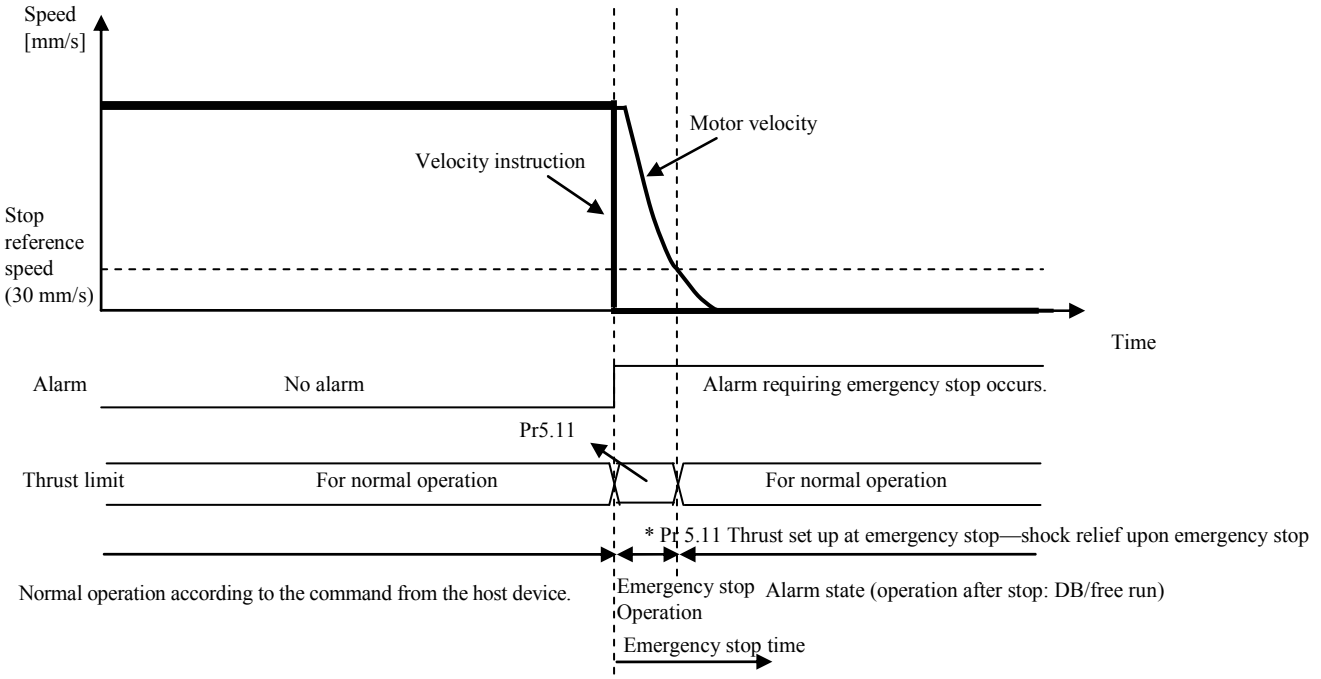
(1) Relevant parameters

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	Thrust setup for emergency stop	0–500	%	Set up the thrust limit at emergency stop. When setup value is 0, the thrust limit for normal operation is applied
5	13	A	Over-speed level setup	0–20000	mm/s	If the motor speed exceeds this setup value, Err 26.0 “Over-speed protection” occurs. 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 (Maximum over-speed level), the error will be saturated with Pr 9.10 (Maximum over-speed level).
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	A	2nd over-speed level setup	0–20000	△2.0 mm/s	When the motor speed exceeds this setup time, Err 26.1 “2nd over-speed protection” will be activated. 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 (Maximum over-speed level), the error will be saturated with Pr 9.10 (Maximum over-speed level).
9	10	R	Maximum over-speed level	0–20000	mm/s	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.



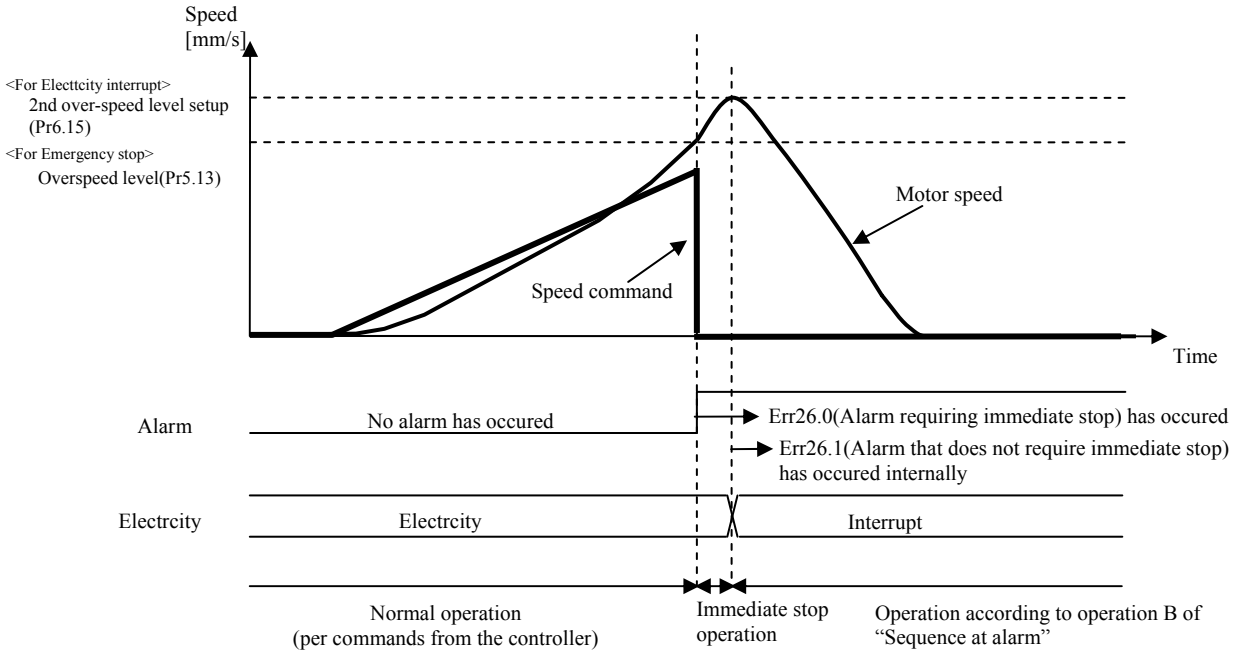
After occurrence of an alarm requiring emergency stop: when the speed has not dropped down to 30 mm/s after the elapse of time set by Pr 6.14 “Emergency stop time at alarm”, the system generates the alarm. The system also enters the alarm state if an alarm that does not require emergency stop occurs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

2.0

・About setting of Pr5.13 “Overspeed level” and Pr6.15 “2nd over-speed level setup”

A motor may not stop normally even if immediate stop function is used.
For example, in the following figure, motor speed is over the level in Pr5.13 “Overspeed level”, immediate stop function is executed. But motor speed may become fast without being able to control a motor normally.
As safety measures of such a case, Err26.1 "2nd over-speed protection" is arranged.
Because Err26.1 is the alarm that does not require immediate stop, electrcity is interrupted and motor operate according to operation B of “Sequence at alarm”. Set the allowable over-speed level in Pr6.15 “2nd over-speed level setup”

Set Pr5.13 in the low value with the margin enough for Pr6.15. When the margin is not enough or set value is same, both Err26.0 and Err26.1 is detected. In the case, Err26.0 will be displayed but an immediate stop will not be executed because Err26.1 is occuerred internally and the alarm that does not require immediate stop is given priority to.
And in the case of the value that Pr6.15 is lower in than Pr5.13, an immediate stop will not be executed because Err26.1 occure earlier from Err26.0.



When motor speed is over Pr6.15 “2nd over-speed level setup”, electrcity is interrupted and motor operate according to operation B of “Sequence at alarm”

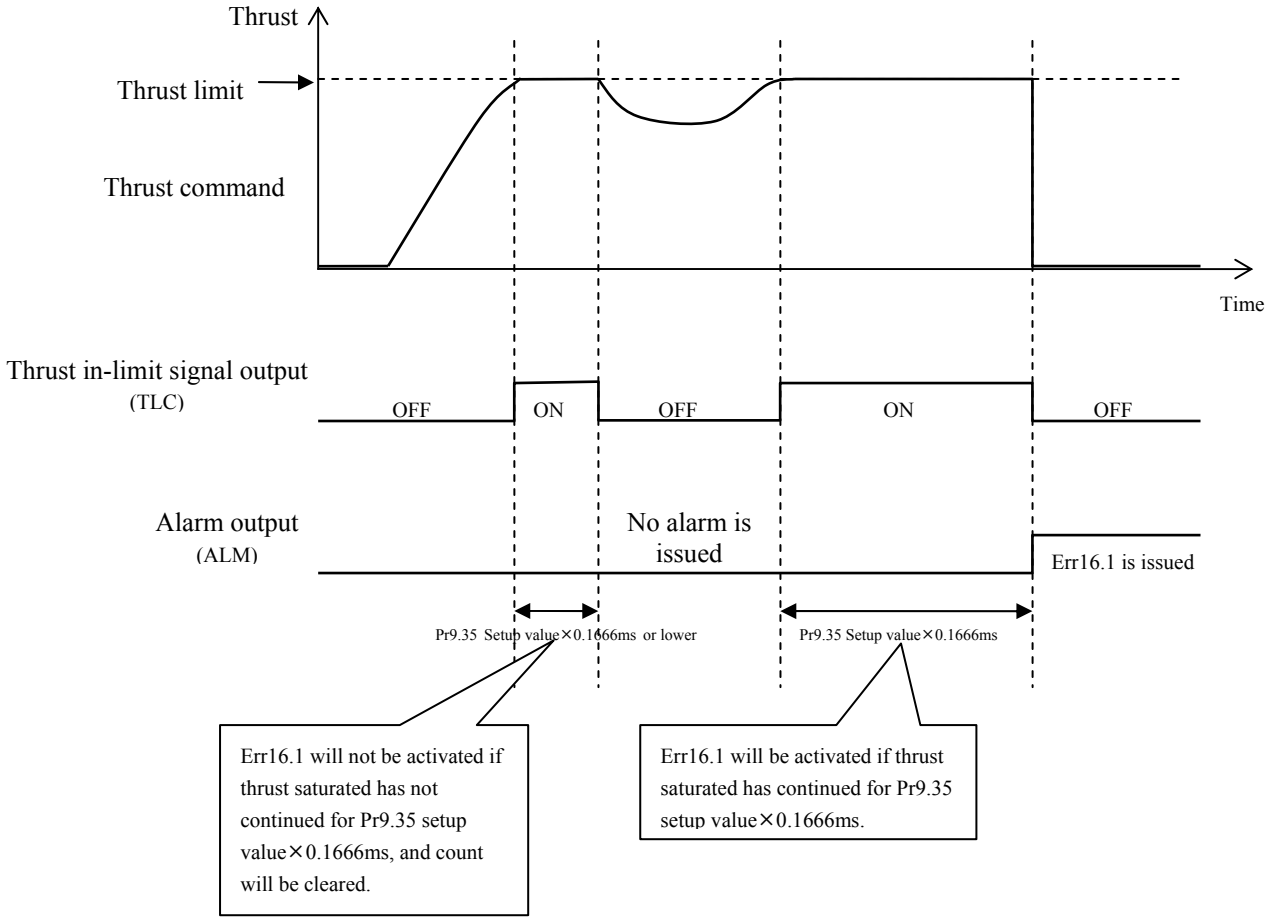
6-4 Thrust saturation protection function

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

■ Relevant parameters

Class	No.	Title	Range	Unit	Function
9	35	Frequency of thrust saturation protection	0–30000	time	If thrust saturated is continued during a preset frequency, Err 16.1 "Thrust saturation protection" will be activated. If the setup value is 0, this function is disabled and Err 16.1 will not be activated.

- For the frequency, the count increases by one for every 0.1666ms.
  For example, if the frequency is set to 30000, Err16.1 will be activated if thrust saturated has continued for about 5 seconds.
- When thrust 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.



7. Protective function/Alarm function

7-1 List of protective function

This servo driver incorporates various protective functions. When a protective function is enabled, the servo driver turns OFF the alarm signal (ALM) and displays the error number on 7-segment LED of the panel section at front surface.

Error No.		Alarm	Attribute		
Main	Sub		History	Can be cleared *2, *3	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	Thrust 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 1	○		○
	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	Deviation counter overflow protection 1	○		
	2	Deviation counter overflow protection 2	○		
30	0	Safety detection [Only special product supports this feature.]		○	
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	0–2	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	○		
51	0	Feedback scale status 0 error protection	○		
	1	Feedback scale status 1 error protection	○		
	2	Feedback scale status 2 error protection	○		
	3	Feedback scale status 3 error protection	○		
	4	Feedback scale status 4 error protection	○		
	5	Feedback scale status 5 error protection	○		

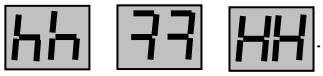
(To be continued)

Error No		Alarm	Attribute		
Main	Sub		History	Can be cleared *2, *3	Emergency stop *5
55	0	A-phase connection error protection	○		
	1	B-phase connection error protection	○		
	2	Z-phase connection error protection	○		
	3	CS signal logic error protection	○		
	4	AB-phase missing 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			
82	0	RTEX node addressing error protection	○		
83	0	RTEX communication error protection 1	○	○	○
	1	RTEX communication error protection 2	○	○	○
84	0	RTEX time out error protection	○	○	○
	3	RTEX sync and initialization error protection	○		
	5	RTEX communication cycle error protection	○	○	○
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		○	○
90	2	Multi-axis synchronization establishment error protection	○		
91	1	RTEX command error protection	○	○	
92	1	Feedback scale data 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	○	○	
98	1	RTEX hardware error protection 1	○		
	2	RTEX hardware error protection 2	○		
	3	RTEX hardware error protection 3	○		
Other		Other error	—	—	—

*1: When Err 16.0 “Overload protection” is triggered, you can clear it in 10 sec or longer after the error occurs. Recognized as alarm clear command and used for clearing process as the condition becomes ready for process.

*2: If the alarm cannot be cleared, remove the alarm cause, turn OFF power to reset.

*3: If the alarm can be cleared, clear it through the RTEX or USB communication (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.

7-2 Details of Protective function

Error No. Main	Error No. Sub	Protective function	Causes	Measures
11	0	Control power supply undervoltage protection	Voltage between P and N of the converter portion of the control power supply has fallen below the specified value. 1) Power supply voltage is low. Instantaneous power failure has occurred 2) Lack of power capacity...Power supply voltage has fallen down due to inrush current at the main power-on. 3) Failure of servo driver (failure of the circuit)	Measure the voltage between lines of connector and terminal block (L1C–L2C). 1) Increase the power capacity. Change the power supply. 2) Increase the power capacity. 3) Replace the driver with a new one.
12	0	Over-voltage protection	Power supply voltage has exceeded the permissible input voltage. = Voltage between P and N of the converter portion of the control power supply has exceeded the specified value. Source voltage is high. Voltage surge due to the phase-advancing capacitor or UPS (Uninterruptible Power Supply) have occurred. 1) Disconnection of the regeneration discharge resistor 2) External regeneration discharge resistor is not appropriate and could not absorb the regeneration energy. 3) Failure of servo driver (failure of the circuit)	Measure the voltage between lines of connector (L1, L2 and L3). Enter correct voltage. Remove a phase advancing capacitor. 1) Measure the resistance of the external resistor connected between terminal P and B of the driver. Replace the external resistor if the value is ∞. 2) Change to the one with specified resistance and wattage. 3) Replace the driver with a new one.
13	0	Main power supply undervoltage protection (PN)	Instantaneous power failure has occurred between L1 and L3 for longer period than the preset time with Pr 5.09 “Main power off detecting time” while Pr 5.08 “LV trip selection at the main power-off” is set to 1. Or the voltage between P and N of the converter portion of the main power supply has fallen below the specified value during Servo-ON. 1) Power supply voltage is low. Instantaneous power failure has occurred	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.
	1	Main power supply undervoltage protection (AC)	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)	2) Set up the longer time to Pr 5.09 (Main power off detecting time). Set up each phase of the power correctly. 3) Increase the power capacity. For the capacity, refer to Reference specification SX-DSV02308 “Driver and List of Applicable Peripheral Equipment” of Preparation. 4) Connect each phase of the power supply (L1, L2 and L3) correctly. For single phase, 100 V and 200 V drivers, use L1 and L3. 5) Replace the driver with a new one.
14	0	Over-current protection	Current through the converter portion has exceeded the specified value. 1) Failure of servo driver (failure of the circuit, IGBT or other components) 2) Short of the motor wire (U, V and W) 3) Earth fault of the motor wire 4) Burnout of the motor 5) Poor contact of the motor wire.	1) Turn to Servo-ON, while disconnecting the motor. If error occurs immediately, replace with a new driver. 2) Check that the motor wire (U, V and W) is not shorted, and check the branched out wire out of the connector. Make a correct wiring connection. 3) Measure the insulation resistance between motor wires, U, V and W and earth wire. In case of poor insulation, replace the motor. 4) Check the balance of resister between each motor line, and if unbalance is found, replace the motor. 5) Check the loose connectors. If they are, or pulled out, fix them securely.
	1	IPM error protection (IPM: Intelligent Power Module)	6) Welding of relay contact for dynamic braking due to frequent servo ON/OFF operations. 7) The motor is not compatible with the servo driver. 8) Timing of pulse input is same as or earlier than Servo-ON.	6) Replace the servo driver. Do not use servo ON/OFF during operation. 7) Check the nameplate on the servo drive for model and capacity. Use the motor as denoted on the nameplate. 8) Enter the pulses 100 ms or longer after Servo-ON.

(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	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	Thrust command value has exceeded the over-load level set with Pr 5.12 (Setup of over-load level) and resulted in overload protection according to the time characteristics (described later). 1) Load was heavy and actual thrust has exceeded the rated thrust and kept running for a long time. 2) Oscillation and hunching action due to poor adjustment of gain. Motor vibration, abnormal noise. Mass 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. ■ The over-load protection time characteristics are described on page 121.	Check that the thrust (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.
	1	Thrust saturation error protection	Thrust saturated has continued for the period set to Pr 9.35 “Thrust saturation error protection frequency”.	• Check the operating state of the amplifier. • Check to see if the motor wire is disconnected. • 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 mass, converter voltage has risen, and the voltage is raised 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 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 speed. Use an external regenerative resistor. 3) Set up Pr 0.16 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 the position command pulses. Check that the output thrust has not saturated in thrust monitor. Make a gain adjustment. Set up maximum value to Pr 0.13 “1st thrust limit setup“ and Pr 5.22 “2nd thrust limit setup“. 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 value 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 speed has exceeded the setup value of Pr 5.13 “Overspeed level setup”..	• 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 speed has exceeded the setup value of Pr 6.15 “2nd over-speed level setup”.	

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
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.
	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	FFT operated only by the driver: RTEX communication was established during trial run.	• During the test operation, FFT checks whether RTEX communication is establish.
	7	Position information initialization error protection	During validation mode of attribute C parameter of reset command of RTEX communication, servo was turned ON.	• Check to see that the servo is OFF during validation mode of attribute C parameter of reset command of RTEX communication.
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	After turning on of control power in absolute mode (absolute scale), after execution of attribute C parameter validation mode, after FFT or after trial run: during position information initialization process, absolute scale position (pulse unit)/electronic gear ratio exceeded $\pm 2^{31}$ (2147483648).	• Check the operation range at the position of absolute scale (absolute scale) and electronic gear ratio.
	2	Counter overflow protection 2	Position deviation in unit of pulse has exceeded $\pm 2^{29}$ (536870912). Or, position deviation in unit of command has exceeded $\pm 2^{30}$ (1073741824).	• Check that the motor follows the position command pulses. • Check that the output thrust has not saturated in thrust monitor. • Make a gain adjustment. • Set up maximum value to thrust limit setting. • Make a wiring connection of the feedback scale as per the wiring diagram.
30	0	Safety input protection [Only special product supports this feature.]	Input photocoupler of both or one of safety input 1 and 2 is OFF.	• Check wiring of safety input 1 and 2.
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) are assigned with undefined number.	• Allocate correct function to each connector pin.
	8 (2.0)	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.

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
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.	1) Check the gain (balance between position loop gain and velocity loop gain) and mass ratio. 2) Increase the setup value of Pr 5.14. Or, Set Pr 5.14 to 0 to disable the protective function.
36	0 1 2	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.
37	0 1 2	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.
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 (PANATERM). Or, POT or NOT is turned ON while the system is operating according to the command given through USB communication.	• 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. Main	Error No. Sub	Protective function	Causes	Measures
50	0	Feedback scale wiring error protection	Communication between the feedback scale and the driver has been interrupted in certain times, and disconnection detecting function has been triggered.	• Make a wiring connection of the feedback scale as per the wiring diagram. Correct the miswiring of the connector pins. • Check to see if the feedback scale type (AB-phase, serial incremental, serial absolute) coincides with Pr 3.23 “Feedback scale type selection”.
	1	Feedback scale communication data error protection	Communication error has occurred in data from the feedback scale. Mainly data error due to noise. Feedback scale cables are connected, but communication date has some error.	• Secure the power supply for the feedback scale of 5 VDC ±5% (4.75 to 5.25 V)...pay attention especially when the feedback scale scale cables are long. • Separate the feedback scale cable and the motor cable if they are bound together. Connect the shield to FG...refer to wiring diagram for feedback scale in Reference specification SX-DSV02308.
51	0	Feedback scale status 0 error protection	Bit 0 of the feedback scale error code (ALMC) has been turned to 1. Check the specifications of the feedback scale.	After removing the cause of the error, clear the feedback scale error. And then, shut off the power to reset.
	1	Feedback scale status 1 error protection	Bit 1 of the feedback scale error code (ALMC) has been turned to 1. Check the specifications of the feedback scale.	
	2	Feedback scale status 2 error protection	Bit 2 of the feedback scale error code (ALMC) has been turned to 1. Check the specifications of the feedback scale.	
	3	Feedback scale status 3 error protection	Bit 3 of the feedback scale error code (ALMC) has been turned to 1. Check the specifications of the feedback scale.	
	4	Feedback scale status 4 error protection	Bit 4 of the feedback scale error code (ALMC) has been turned to 1. Check the specifications of the feedback scale.	
	5	Feedback scale status 5 error protection	Bit 5 of the feedback scale error code (ALMC) has been turned to 1. Check the specifications of the feedback scale.	
55	0	A-phase wiring error protection	A-phase wiring in the feedback scale is defective, e.g. discontinued.	Check the A-phase wiring connection of feedback scale.
	1	B-phase wiring error protection	B-phase wiring in the feedback scale is defective, e.g. discontinued.	Check the B-phase wiring connection of feedback scale.
	2	Z-phase wiring error protection	Z-phase wiring in the feedback scale is defective, e.g. discontinued.	Check the Z-phase wiring connection of 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. Main	Error No. Sub	Protective function	Causes	Measures
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.	• 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.
	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 amplifier. • The setup value for Pr 9.07 “Maximum instantaneous motor current” is above the allowable maximum current for the amplifier. • A value of more than 126 Mpulses has been set to the number of pulses per unit second	• 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 framework for the amplifier needs to be enlarged. • Check the setup value for each of Pr 9.01 “Feedback scale resolution/number of scale pulse per rotation” and Pr 9.10 “Maximum over-speed level” and set a value of less than 126 M pulses to the number of pulses per unit second.
	2	Motor combination error 2 protection	• The rated motor current is too small as against the rated amplifier current. • A ratio of a movable-part mass (M) to the rated thrust (F) is too large. (The M-F 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 framework of the amplifier needs to be reduced. • Check the setup value for each of Pr 9.05 “Rated motor thrust” (Setting unit: 0.1 N) and Pr 9.04 “Moving portion mass of motor” (Setting unit: 0.01 kg). • 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.		Protective function	Causes	Measures
Main	Sub			
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.

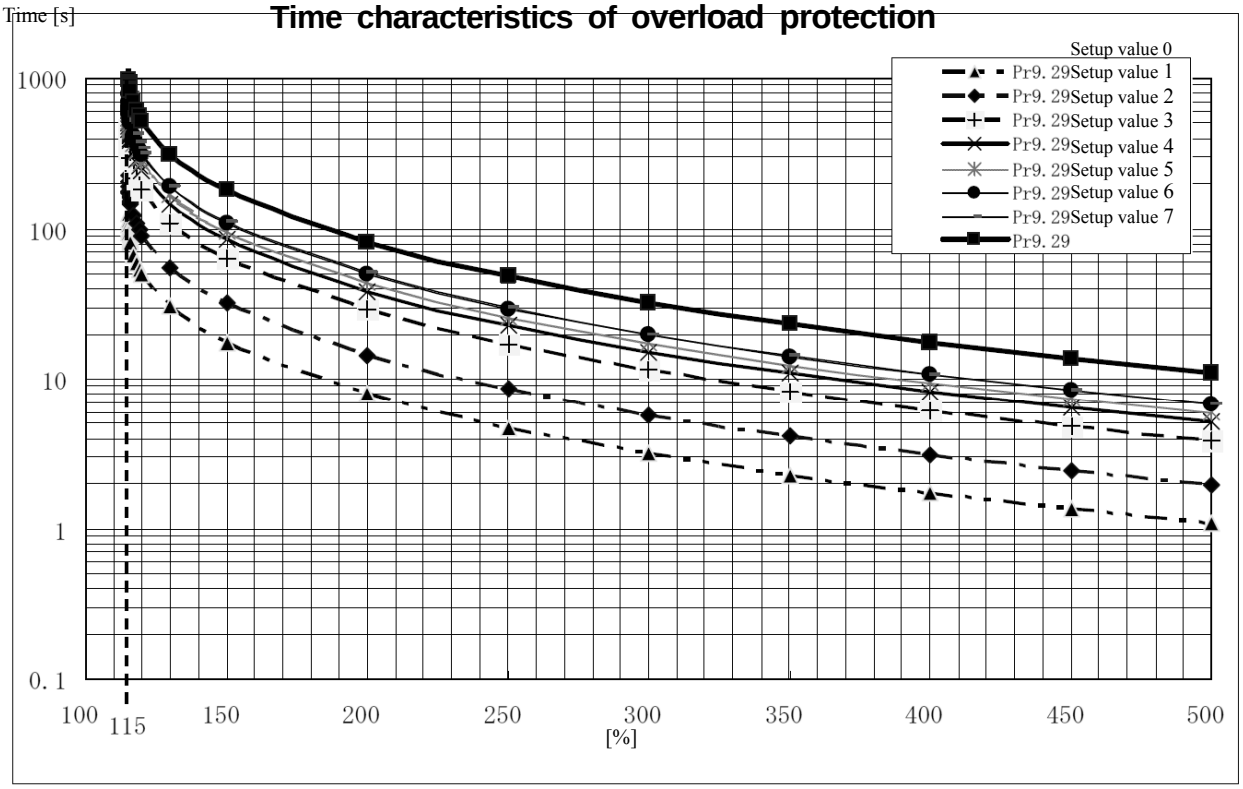
(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
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	An error (CRC error) with reading data received by a local node continued for a specified period.	• 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.
	1	RTEX continues communication error protection 2	An error with the reading data received by a local node continued for a specified period. Note: This alarm assumes an error if CRC error, receiving failure, or cyclic data error occurs.	
84	0	RTEX communication timeout error protection	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.	• 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 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.
	3	REX sync & initialization error protection	Error occurred during communication and servo sync and initialization process.	• 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	Although the NMNI221 (RTEX communication control ASIC) output a receive interrupt handling start signal, communication and servo went out of synchronization due to an output frequency problem with the signal.	• 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 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.
86	0	RTEX cyclic data error protection 1	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.	• Check the data in the cyclic command field (at location as described on the left column). • Check process performed on the host device.
	1	RTEX cyclic data error protection 2	A problem with cyclic command code continued for a specified period.	
	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. • Check if there is any problem in frequency setting in upper devise side and in amplifier side. • Increase the setup value for Pr 7.38. • When Update_Counter is not used with ratio of communication frequency and command renewal frequency being 1:1, this alarm is made invalid.
87	0	Forced alarm input protection	Forced alarm input (E-STOP) is applied.	Check the wiring of forced alarm input (E-STOP).

(To be continued)

Error No. Main	Error No. Sub	Protective function	Causes	Measures
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.
91	1	RTEX command error protection	• Inconsistency in communication frequency, and combination of 16/32 byte mode and control mode. • Control mode was switched at intervals shorter than 2 ms. △2.0 • Control mode was changed during profile position latch positioning/profile home position return (Type_Code = 12h, 13h, 31h, 32h, 33h,34h,35h). • Control mode was changed while non-cyclic command (Busy = 1) was processed. △2.0 • Home position return command (4h) was executed during profile position latch positioning/profile home position return (Type_Code = 12h, 13h, 31h, 32h, 33h,34h,35h). • Initialization mode (Type_Code = 1□h, 31h) for home position return command (4h) was performed during profile positioning/profile continuous rotation (Type_Code = 10h, 11h, 20h). • Type_Code was changed during profile position control (pp). • Type_Code = 1□h/2□h for home position return command (4th) was performed at the time of speed control (CV)/thrust control (CT). △2.0 • Control mode other than position control changed during block Diagram of 2 Degrees of Freedom Mode.	• Check the process of upper device for any problem.
92	1	Feedback scale data recovery error protection	When in the absolute mode (absolute scale), internal position data has not been correctly initialized.	• Regulate the power source of the feedback scale to 5 VDC ±5% (4.75−5.25 V)….Measure the voltage at the feedback scale connection cable end if it is long. • If the motor cable and feedback scale connection cable are bundled together, separated them. Connect the shield to FG.(See the feedback scale connection diagram in Reference specification SX-DSV2308.)
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 1000.
	3	Feedback scale connection error protection	The communication type of the connected feedback scale (serial communication model) does not match the type selected through Pr 3.23 Feedback scale selection.	• Set Pr 3.23 to the type of feedback scale connected.
	5	Parameter setup error protection 4	• The combination conditions of Pr 7.20 RTEX communication cycle setting, Pr 7.21 RTEX command updating cycle setting and bit1 RTEX communication data size of Pr 7.22 RTEX function extended setup 1 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, SX-DSV02203”Section 2-5”, RTEX communication.
94	2	Home position return error protection	• An error with profile home position return occurred.	• Check sensor installation status etc. for any problem.

Error No.		Protective function	Causes	Measures
Main	Sub			
98	1	RTEX hardware error protection 1	Fault is determined in RTEX communication related peripheral device.	• Turn off the power once, then re-enter. • If error repeats, this might be a failure. Stop using the products, and replace the motor and the driver. • Return the products to the dealer or manufacturer.
	2	RTEX hardware error protection 2		
	3	RTEX hardware error protection 3		
Other No.		Other error	Control circuit has malfunctioned due to excess noise or other causes. Some error has occurred inside of the driver while triggering self-diagnosis function of the driver.	• Turn off the power once, then re-enter. • If error repeats, this might be a failure. Stop using the products, and replace the motor and the driver. Return the products to the dealer or manufacturer.



■ Relevant parameters

Class	No.	At-trib-ute *1)	Title	Range	Unit	Function
9	29	R	Overload protection timing characteristic setup	0–7	—	Setup value: According to standard specifications Selects the overload protection timing characteristic from any of 8 types of characteristics illustrated above.

*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 setting): the warning non-latch mode in which the warning is automatically cleared 1 sec. after the cause of warning is removed, and the warning latch mode in which the warning is kept issued even after the cause of warning is removed. To clear the latched state, use the alarm clearing procedure described in previous alarm section.
Note that the battery warning is latched by the feedback scale: after unlatching at the feedback scale, the warning is cleared.

(1) Relevant parameters

Class	No.	At-trib-ute	Title	Range	Unit	Function
4	40	A	Selection of alarm output 1	0–14	—	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 below.
4	41	A	Selection of alarm output 2	0–14	—	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 below.
6	27	C	Warning latch state setting	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	38	C	Warning mask setting	-32768 –32767	—	Set the warning detection mask. To disable detection of a warning, place 1 to the corresponding bit.
7	14	C	Main power OFF warning detection time	0–2000	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] • Setting resolution is 2 ms.
7	26	A	RETEX continuous communication error warning setting	0–32767	times	WngC0H (RTEX accumulated 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	RETEX accumulated communication error warning setting	0–32767	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 setting	0–32767	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 Corresponding bit *3)
A0	Overload protection	Load factor is 85% or more the protection level.	○	1	bit 7
A1	Over-regeneration alarm	Regenerative load factor is 85% or more the protection level.	○	2	bit 5
A3	Fan alarm	Fan has stopped for 1 sec.	○	4	bit 6
A6	Oscillation detection alarm	Oscillation or vibration is detected.	○	7	bit 13
A7	Lifetime detection alarm	Life expectancy of capacitor or fan becomes short.	Latch fixed	8	bit 2
A8	Feedback scale error alarm	The feedback scale detects the alarm.	○	9	bit 8
A9	Feedback scale communication alarm	The number of successive feedback scale communication errors exceeds the specified value.	○	10	bit 14

■ 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 Corresponding bit *3)
C0	RETEX 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 communication error warning setting.	○	11	bit 9
C1	RETEX 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 communication error warning setting.	Latch fixed	12	bit 10
C2	RTEX_Update_Counter error warning	Accumulated amount exceeded the times specified by Pr7.28 (RTEX_Update_Counter error warning setting), so that Update_Counter was not updated.	Latch fixed	13	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	bit 12

*1) The mark circle indicates that the warning status can be maintained or cleared by the setting of Pr 6.27 (Warning latch state setting). The lifetime detection alarm will be in the lath mode only.

*2) Select the warning output signal 1 (WARN 1) or warning output signal 2 (WARN 2) through Pr 4.40 “Warning output select 1” or Pr 4.41 “Warning output select 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 setting”, 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-A5 series.

*4) Alarm can be cleared by alarm clear. If alarm cause is not resolved yet, once cleared alarm is issued again.

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 over-travel inhibit input (POT/NOT). Set the following parameters which are related to over-travel inhibit input.

Pr 5.04 Setup of over-travel inhibit input

Pr 5.05 Sequence at over-travel inhibit

2) Setup of thrust limit

By limiting motor maximum thrust, damage caused by failure or disturbance such as bite of the machine and collision will be minimized. To uniformly limit maximum thrust by using the parameter Pr 0.13 “1st thrust limit”, first set Pr 5.21 “Selection of thrust limit” to 0 or 1.

If the thrust 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 thrust in-limit output (TLC) of interface specification to the output signal, thrust 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 Over-speed level setup = Vmax × (1.2 to 1.5) Vmax: motor maximum speed [mm/s] 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 Setup of positional deviation excess. 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.

■ When Pr 5.20 = 0 (detection through command positional deviation)

Pr 0.14 (Setup of positional deviation excess) = Vc / Kp × (1.2 to 2.0) Vc: maximum frequency of positional command pulse [pulse (command unit)/s] Kp: position loop gain [1/s] Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection

■ When Pr 5.20 = 1 (detection through feedback scale positional deviation)

Pr 0.14 (Setup of positional deviation excess) = Ve / Kp × (1.2 to 2.0) Ve: maximum operation frequency [pulse/s] in feedback scale unit Kp: position loop gain [1/s] Factor in ( ) is margin to prevent frequent activation of excess positional deviation protection

Notes:

- When switching position loop gain Kp, select the smallest value for calculation.
- 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 amount of travel set to Pr 5.14 “Motor working range setup”, and issues Err 34.0 “Software limit protection”.

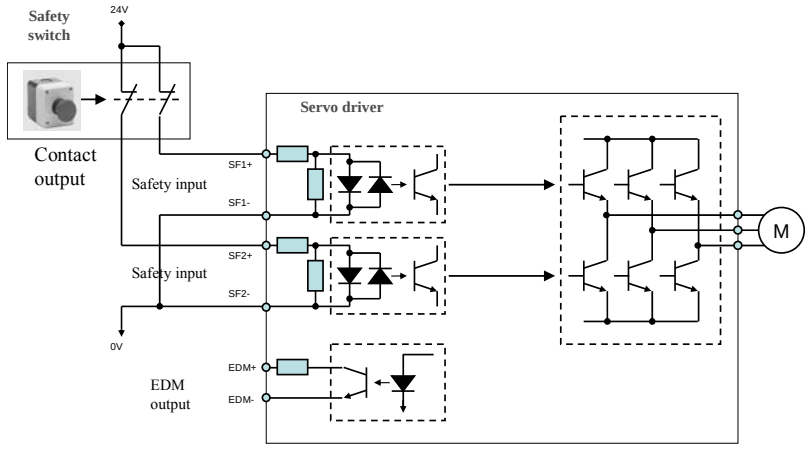
For details, refer to 6-2 Motor working range setup function.

8. Safety function [Supported only by specific model]

Standard specification parts (having part numbers ended with “A1”) can’t be used due to no safety function incorporated. This chapter deals with special specification parts (having part numbers ended with 2 numeric characters) with safety functions.

8-1 Outline description of safe thrust off (STO)

The safe thrust off (STO) function is a safety function that shuts the motor current and turns off motor output thrust 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 function operates, the servo driver turns off the servo ready output signal (S-RDY) and enters safety state. This is an alarm condition and the 7-seg LED on the front panel displays the error code number.

- PFH value of the safety function: 2.30×10^{-8}

8-2 Specifications of Input & output signals

8-2-1 Safety input/ signal

• Provided with 2 safety input channels to activate the STO function.

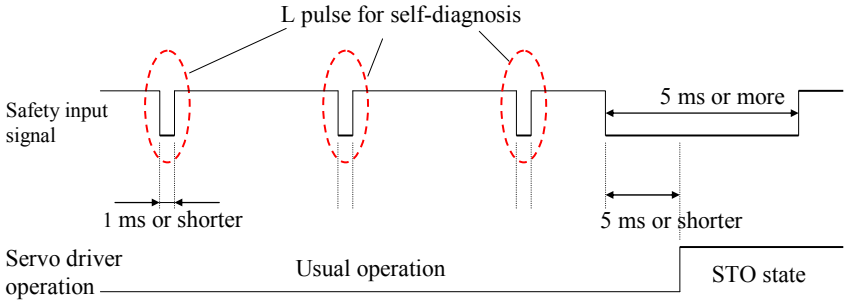
Type	Signal	Symbol	Pin No	Contents	Control mode		
					Position	Velocity	Thrust
Input	Safety input 1	SF1+	X3-4	• Input 1 that triggers STO function. This input turns off the upper arm drive signal of power transistor. • When using the function, connect this pin in a way so that the photocoupler of this input circuit turns off to activate STO function.	○		
		SF1-	X3-3				
	Safety input 2	SF2+	X3-6	• 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, causing motor output thrust to turn off.

Caution: Safety equipment self-diagnosis L pulse

Safety output signal from the 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 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. Connect the monitor output to the external device monitor terminal of the safety devices such as safety controller and safety sensor.

Type	Signal	Symbol	Pin No.	Contents	Control mode		
					Position	Velocity	Thrust
Out put	EDM output	EDM+	X3-8	Outputs monitor signal that is used to check the safety function. This output signal is not a safety output.	○		
		EDM-	X3-7				

• The table below shows the logical relationship between safety input signal and EDM output signal.
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	Symbol	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, when error occurs, the EDM output circuit does not turn ON the photocoupler even if both safety inputs 1 and 2 are OFF. Or, reversely, the EDM output circuit turns ON the photocoupler if one of or both of safety inputs 1 and 2 are ON.

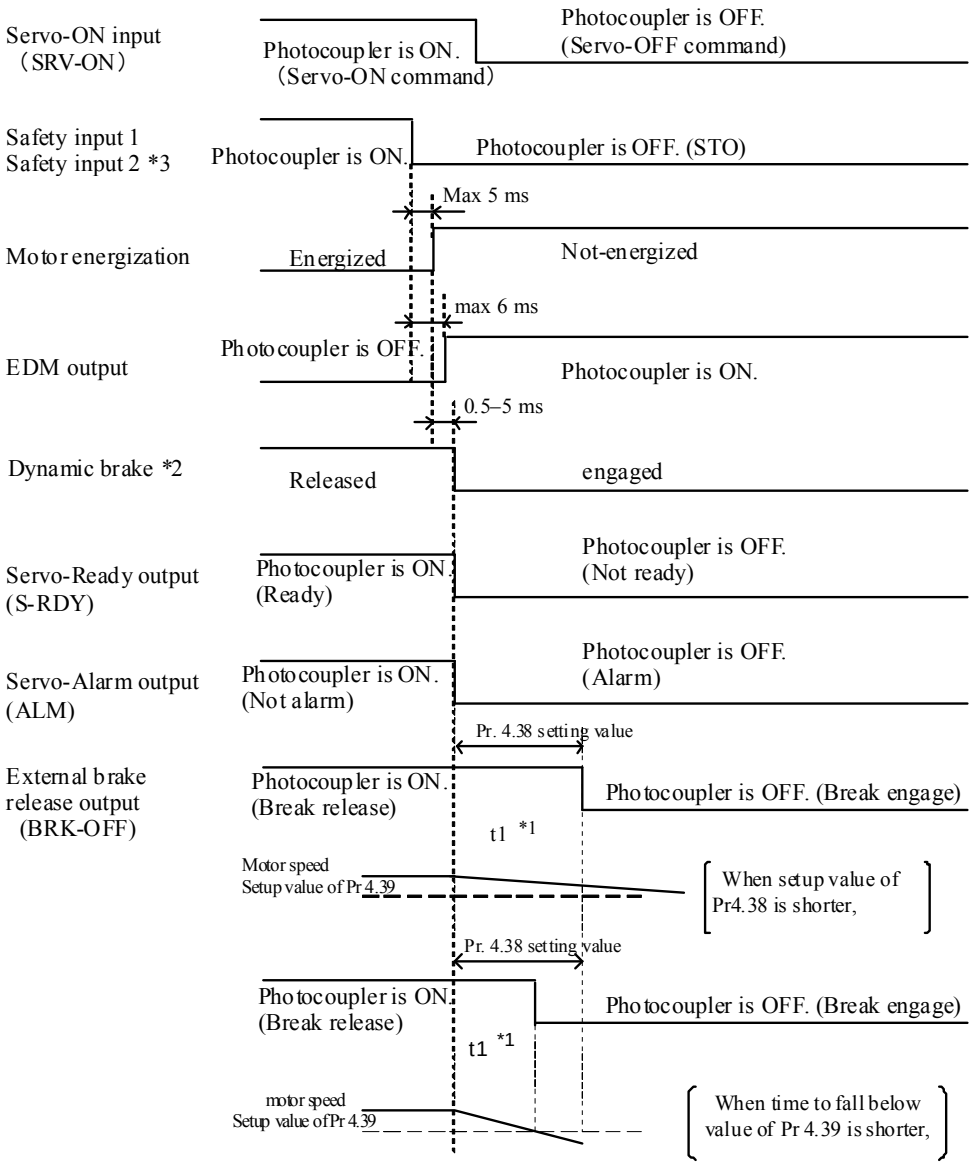
• Maximum delay time from input of safety 1 and 2 signals to output of EDM signal is 6 ms.

8-2-3 Internal signal circuit block diagram

See the safety circuit block diagram at the end of this book.

8-3 Detailed functional description

8-3-1 Operating timing for safety status

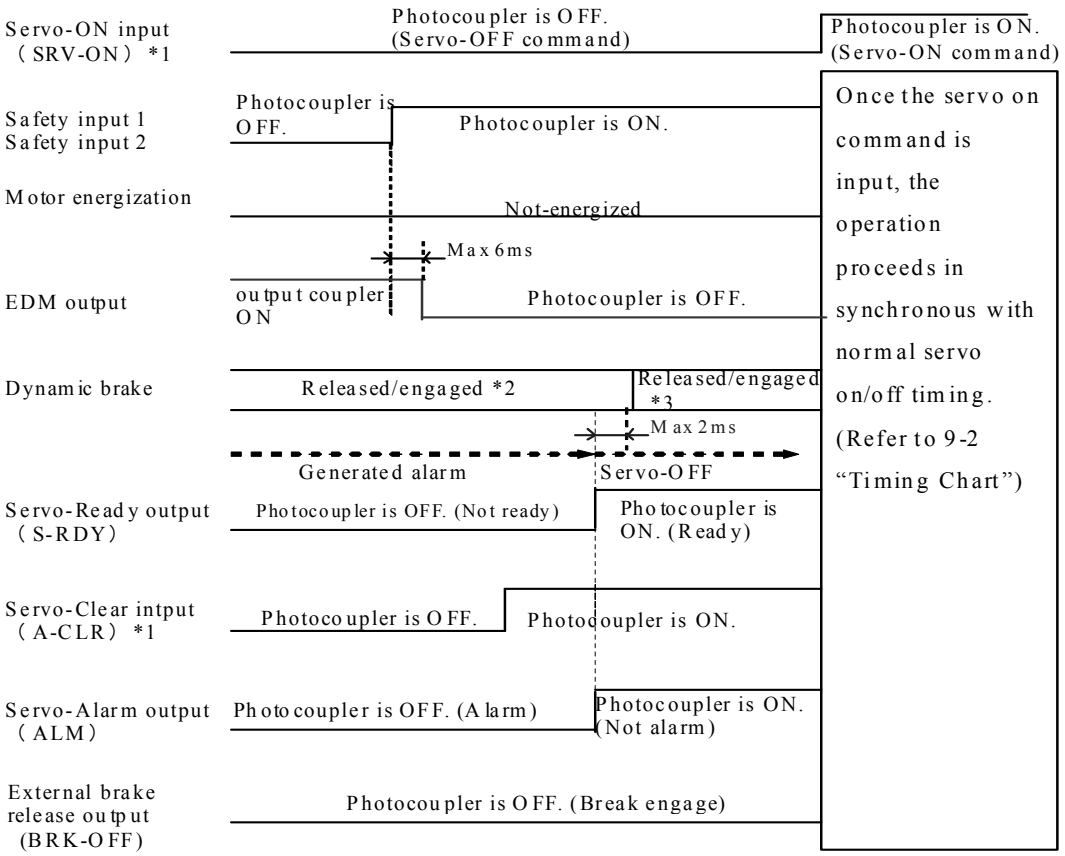


*1 t1 is the value set to Pr 4.38 “Setup of mechanical brake action at running” or the time at which the motor speed drops below the time set to Pr 4.39 “Brake release speed setup”, whichever comes first.

*2 Dynamic brake operates to the setting of Pr 5.10 “Sequence at alarm”.

*3 When safety input 1 or 2 turns off, the state changes to STO condition.

8-3-2 Return timing from safety state



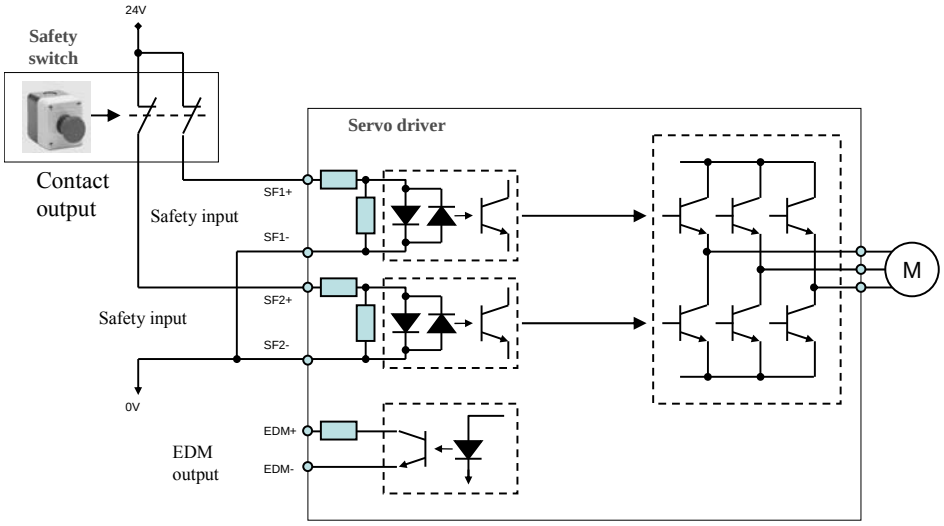
*1 Photocouplers for safety input 1 and 2 should be turned on again with servo-on input turned off. Otherwise, alarm occurs, and should be cleared.
Alarm clear should be performed after the safety input 1 and 2 have been turned back to on. Otherwise, alarm occurs.

*2 This is an alarm condition and the dynamic brake operates according to Pr 5.10 (Sequence at alarm).

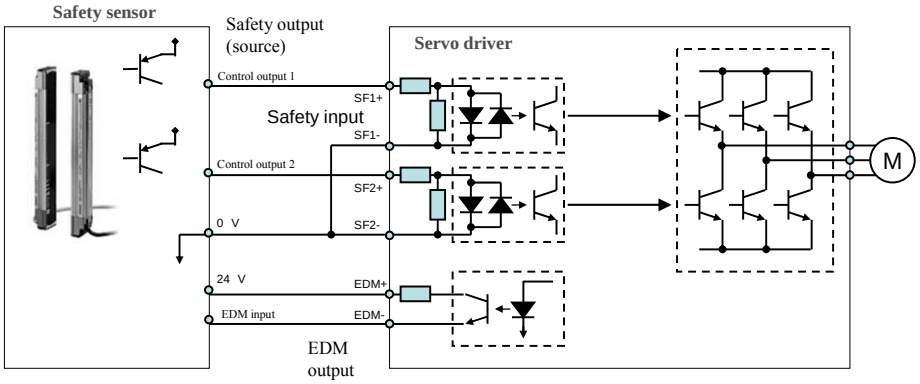
*3 This is normal servo-off condition and the dynamic brake operates according to Pr 5.06 (Sequence at servo-off).

8-4 Example of connection

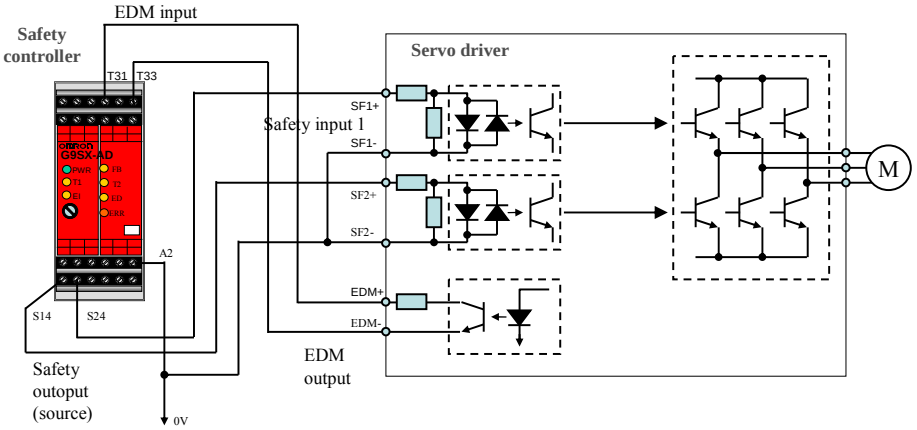
8-4-1 Example of connection to safety switch



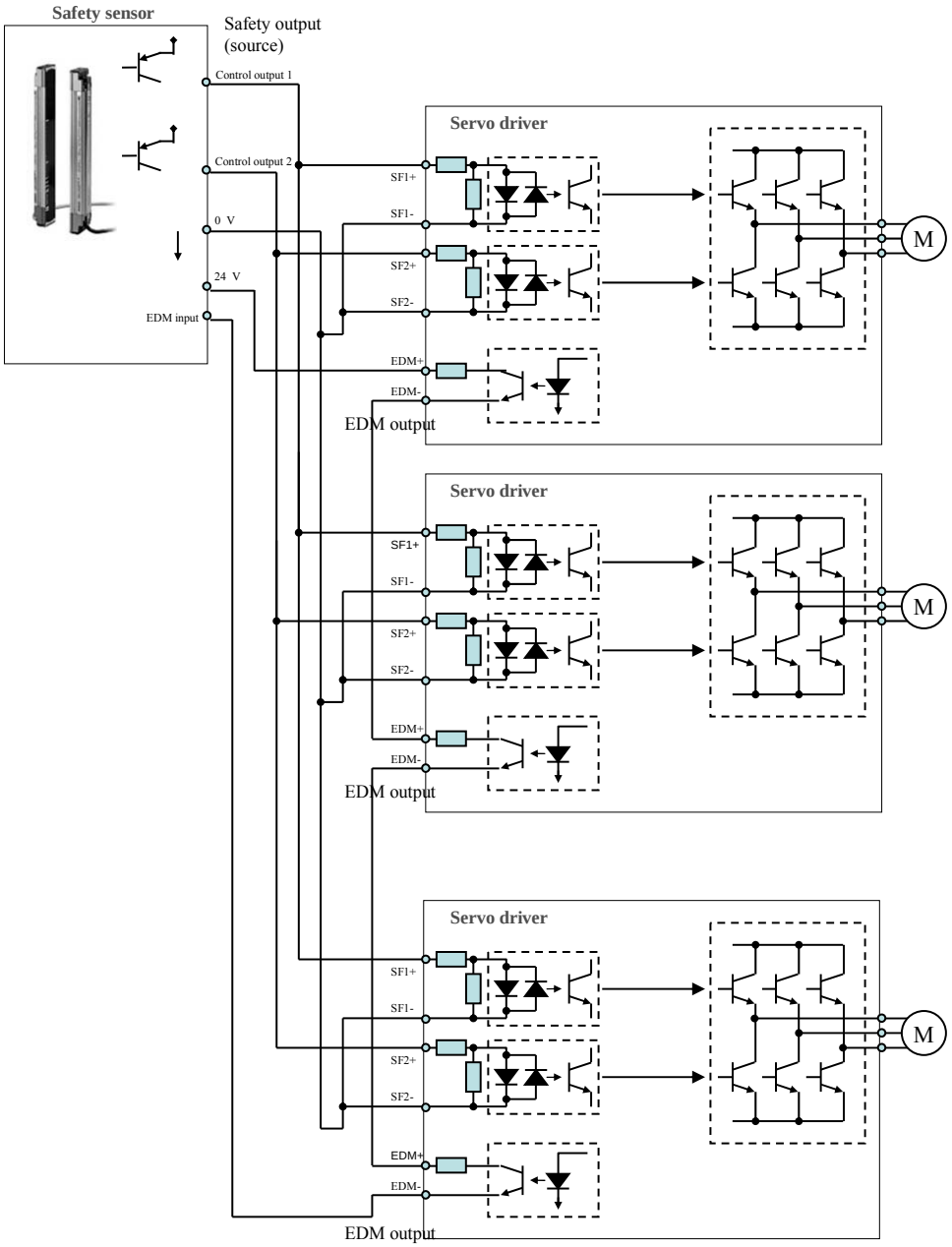
8-4-2 Example of connection to safety sensor



8-4-3 Example of connection to safety controller



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



- Capacity requirement per safety output (source) channel: 50 × No. of connected axes (mA)
- 24 VDC supply allowable voltage: 24 V±15%
- Maximum No. of connectable axes: 8

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.

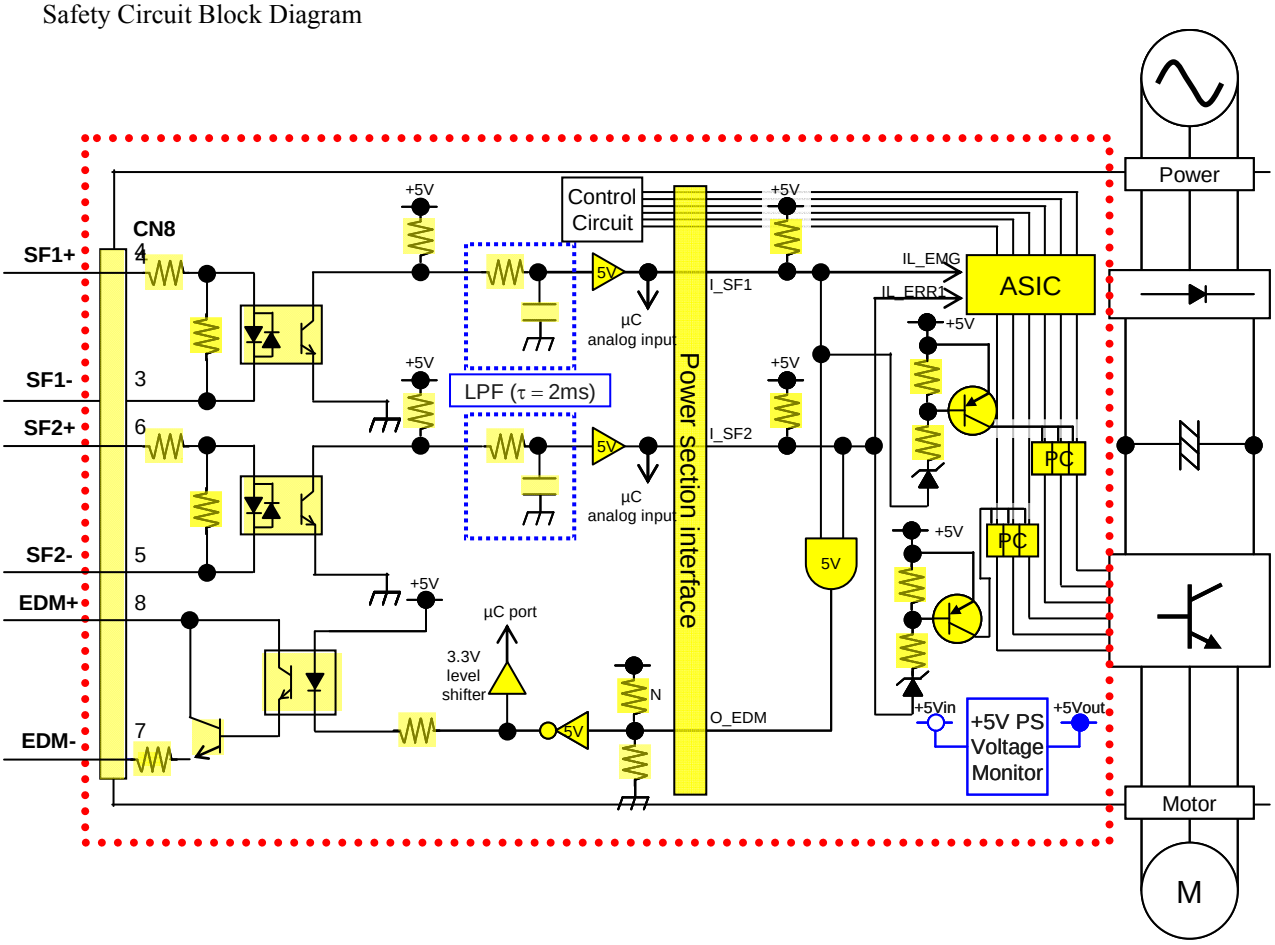
- Even while the STO function is working, the following potential safety hazards exist. Check safety in risk assessment.
  - The motor may move when eternal force (e.g. gravity force on vertical axis) is exerted on it. Provide an external brake, etc., as necessary to secure the motor. Note that the purpose of motor with brake is holding and it cannot be used for braking application.
  - When parameter Pr 5.10 “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.
  - 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.

- External device monitor (hereafter EDM) output signal is not a safety signal. Do not use it for an application other than failure monitoring.

- 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 condition does not result in danger condition.

- When using STO function, connect equipment conforming to the safety standards.

Safety Circuit Block Diagram



9. Other

9-1 List of parameters

The attribute of a parameter indicates the point at which the modified parameter setting becomes effective.

A : Always effective

B : Do not change while the motor is operating or command is transferred.

▪ Reflection timing of parameter change made during the motor operation or command transfer is not defined.

C : Becomes valid upon resetting of control power, in software reset mode of RTEX communication reset command, or after execution of attribute C parameter validation mode.

R : Becomes valid upon resetting of control power or execution of software reset mode of RTEX communication reset command.

▪ Does not become valid after execution of attribute C parameter validation mode of RTEX communication reset command.

RO: Read only - cannot be changed through the normal parameter change procedure.

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
	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
	03	Real-time auto-tuning machine stiffness setup	—	0–31	2	Set the machine stiffness after tuning real-time auto-gain.	B	All	5-1-1
	04	Mass ratio	%	0–10000	2	You can set up the ratio of the load mass against the moving portion's mass of the motor.	B	All	—
	09	Numerator of electronic gear	—	$1–2^{30}$	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	pulse /r	1–262144	4	Set the numerator of pulse output division.	R	All	4-2-5
	12	Reversal of pulse output logic	—	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 thrust limit	%	0–500	2	You can set up the 1st limit value of the motor output thrust. In addition, the actual thrust applied is limited with the maximum thrust limit for the motor applied. (The parameter value is not limited) Note that the maximum thrust limit for the motor applied can be calculated according to the expression given below. Maximum thrust limit [%] = 100x Pr 9.07/(Pr 9.06 x √2) Pr9.07 "Maximum instantaneous motor current [0.1A]" Pr9.06 "Rated effective motor current [0.1 Arms]"	B	All	6-1 7-4
	14	Position deviation excess setup	Command unit	$0–2^{27}$	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 "Positional unit selection".	A	Position	7-4
	16	External regenerative resistor setup	—	0–3	2	Set up items related to regenerative resistor.	C	All	4-5
	17	Selection of load factor for external regenerative resistor	—	0–4	2	Select the computation method of loading factor for external regenerative resistor.	C	All	4-5

Class1: Gain adjustment

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
1	00	1st gain of position loop	0.1/s	0–30000	2	Set up the 1st gain of position loop.	B	Position	5-2
	01	1st velocity loop gain	0.1 Hz	1–32767	2	Set up 1st velocity proportional gain.	B	All	5-2
	02	1st velocity loop integration time constant	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 thrust filter time constant	0.01 ms	0–2500	2	Set up the time constant of the 1st thrust 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 velocity loop gain	0.1 Hz	1–32767	2	Set up 2nd velocity proportional gain.	B	All	5-2
	07	2nd velocity loop integration time constant	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 thrust filter time constant	0.01 ms	0–2500	2	Set up the time constant of the 2nd thrust filter.	B	All	5-2
	10	Velocity feed forward gain	0.1%	0–1000	2	Set up the velocity feed forward gain.	B	Position	5-2-7
	11	Velocity feed forward filter	0.01 ms	0–6400	2	Set up the time constant of velocity feed forward filter.	B	Position	5-2-7
	12	Thrust feed forward gain	0.1%	0–1000	2	Set up the thrust feed forward gain.	B	Position, Velocity	5-2-7
	13	Thrust feed forward filter	0.01 ms	0–6400	2	Set up the thrust feed forward filter.	B	Position, Velocity	5-2-7
	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 thrust control switching	—	0–3	2	Set the condition of gain switching for thrust control	B	Thrust	5-2-4
	25	Delay time of thrust control switching	0.1 ms	0–10000	2	Set up the delay time when switching from 2nd to 1st gain.	B	Thrust	5-2-4
	26	Level of thrust control switching	—	0–20000	2	Set up the gain switching level.	B	Thrust	5-2-4
	27	Hysteresis at thrust control switching	—	0–20000	2	Set up the hysteresis at gain switching.	B	Thrust	5-2-4

Class 2: Damping control

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
2	00	Adaptive filter mode setup	—	0–4	2 2.0	Set up the operation of adaptive filter. If the communication cycle is 0.0833 ms (Pr7.20=0), please set an adaptive filter invalid. (Pr2.00=0).	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 notch width 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	5-2-5
	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	5-2-5
	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	5-2-5
	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	5-2-5
	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	5-2-5
	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	5-2-5
	13	Selection of damping filter switching	—	0–3	2	Select the filters to be used for damping control.	B	Position	5-2-6
	14	1st damping frequency	0.1 Hz	0–2000	2	You can set up the 1st damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 10 (= 1 Hz) or higher is valid.	B	Position	5-2-6
	15	1st damping filter setup	0.1 Hz	0–1000	2	Fine tune the 1st filter damping control. Decrease the setting value to avoid thrust saturation or increase the value to improve the response.	B	Position	5-2-6
	16	2nd damping frequency	0.1 Hz	0–2000	2	You can set up the 2nd damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 10 (= 1 Hz) or higher is valid.	B	Position	5-2-6
	17	2nd damping filter setup	0.1 Hz	0–1000	2	Fine tune the 2nd filter damping control. Decrease the setting value to avoid thrust saturation or increase the value to improve the response.	B	Position	5-2-6
	18	3rd damping frequency	0.1 Hz	0–2000	2	You can set up the 3rd damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 10 (= 1 Hz) or higher is valid.	B	Position	5-2-6
	19	3rd damping filter setup	0.1 Hz	0–1000	2	Fine tune the 3rd filter damping control. Decrease the setting value to avoid thrust saturation or increase the value to improve the response.	B	Position	5-2-6
	20	4th damping frequency	0.1 Hz	0–2000	2	You can set up the 4th damping frequency of the damping control which suppresses vibration at the load edge. Setting value of 10 (= 1 Hz) or higher is valid.	B	Position	5-2-6
	21	4th damping filter setup	0.1 Hz	0–1000	2	Fine tune the 4th filter damping control. Decrease the setting value to avoid thrust saturation or increase the value to improve the response.	B	Position	5-2-6

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
2	22	Positional command smoothing filter	0.1 ms	0–10000	2 ⚠2.0	Set up the time constant of the 1st delay filter in response to the positional command. Set to the time constant of the command response filter for 2 degrees of freedom control. The maximum value is 2000 (=200.0ms).	B	Position	4-2-3
	23	Positional 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

Class 3: Velocity/ Thrust

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 mm/s)	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 mm/s)	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	Thrust	4-4-1
	21	Speed limit value 1	mm/s	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	Thrust	4-4-1
	22	Speed limit value 2	mm/s	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	Thrust	4-4-1
	23	Feedback scale selection	—	0–2	2	Select the type of feedback scale. 0: A,B phase output type 1: Serial communication type (incremental version) 2: Serial communication type (absolute version)	R	Position	4-7-1-3
	26	Reversal of direction of feedback scale & CS	—	0–1	2	Set the polarity of feedback scale feedback pulse and the CS signal.	R	Position	4-7-1-4 4-7-3-1
	27	Feedback scale Z phase disconnection detection disable	—	0–1	2	Enable/disable Z phase open circuit detection when using feedback scale of AB phase output type. 0: Enable, 1: Disable	R	Position	—
2.0	29	For manufacturer's use	—	—	2	Fixed to 0.	—	—	—

Class 4: I/O monitor setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
4	00	SI1 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI1.	C	All	2-4-1
	01	SI2 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI2.	C	All	2-4-1
	02	SI3 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI3.	C	All	2-4-1
	03	SI4 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI4.	C	All	2-4-1
	04	SI5 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI5.	C	All	2-4-1
	05	SI6 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI6.	C	All	2-4-1
	06	SI7 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI7.	C	All	2-4-1
	07	SI8 input selection	—	0–00FFFFFFh	4	Set up function and logic of SI8.	C	All	2-4-1
	10	SO1 output selection	—	0–00FFFFFFh	4	Set up SO1 function allocation.	C	All	2-4-2
	11	SO2 output selection	—	0–00FFFFFFh	4	Set up SO2 function allocation.	C	All	2-4-2
	12	SO3 output selection	—	0–00FFFFFFh	4	Set up SO3 function allocation.	C	All	2-4-2
	16	Type of analog monitor 1	—	0–24	2	Select the type of monitor for analog monitor 1.	A	All	3-4
	17	Analog monitor 1 output gain	—	0–214748364	4	Set up the output gain of analog monitor 1.	A	All	3-4
	18	Type of analog monitor 2	—	0–24	2	Select the type of monitor for analog monitor 2.	A	All	3-4
	19	Analog monitor 2 output gain	—	0–214748364	4	Set up the output gain of analog monitor 2.	A	All	3-4
	21	Analog monitor output setup	—	0–2	2	Select output voltage format of the analog monitor.	A	All	3-4
	22	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	23	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	24	For manufacturer's use	—	—	2	Permanently set at 0.	—	—	—
	31	Positioning complete (In-position) range	Instruc-tion unit	0–262144	4 2.0	Set up allowable No. of pulses for positioning complete signal (INP). Use the unit specified by Pr 5.20 Position setup unit select. 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.	A	Position	4-2-4
	32	Positioning complete (In-position) output setup	-	0–4	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	mm/s	10–20000	2	Set up threshold for zero speed (ZSP) detection.	A	All	2-4-2
	35	Speed coincidence range	mm/s	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, Thrust	4-3-2
	36	At-speed (Speed arrival)	mm/s	10–20000	2	Set the detection timing of the speed arrival output (AT-SPEED).	A	Velocity, Thrust	4-3-1
	37	Mechanical brake action at stalling setup	ms	0–10000	2	Set up mechanical brake operating time at stalling. Set resolution in unit of 2 ms. For example, when setting value = 11, processed in 12 ms.	B	All	9-2-3
	38	Mechanical brake action at running setup	ms	0–10000	2	Set up mechanical brake operating time at running. Set resolution in unit of 2 ms. For example, when setting value = 11, processed in 12 ms.	B	All	9-2-4 9-2-5
	39	Brake release speed setup	mm/s	30–3000	2	Set up the speed timing of brake output checking during operation.	B	All	9-2-4 9-2-5
	40	Selection of alarm output 1	—	0–14	2	Select the type of alarm issued as the alarm output 1.	A	All	7-3
	41	Selection of alarm output 2	—	0–14	2	Select the type of alarm issued as the alarm output 2.	A	All	7-3
	42	Positioning complete (In-position) range 2	Instruc-tion unit	0–262144	4 2.0	Set up acceptable No. of pulses for positioning complete signal 2 (INP2). Use the unit specified by Pr 5.20 "Position setup unit select". 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.	A	Position	4-2-4

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	—	1–262144	4	Set up the denominator of pulse output division.	R	All	4-2-5
	04	Over-travel inhibit input setup	—	0–2	2	Set up the operation of the inhibit positive/ negative direction travel inputs.	C	All	6-3-1 7-4
	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 upon main power off	—	0–9	2	Set up the sequence while main AC power is OFF.	B	All	6-3-3
	08	L/V trip selection upon main power off	—	0–3	2	Select LV trip or servo OFF upon occurrence of main AC power alarm. Setup the condition to detect main AC power OFF alarm when the main AC power is kept interrupted for a time longer than the time set by Pr7.14. bit 0 0: Select servo OFF according to the setting of Pr 5.07 and then return to servo ON by turning ON main AC power. 1: Trip with Err 13.1 “Main power undervoltage protection”. bit 1 0: Detect main AC power OFF alarm only when servo is in ON state. 1: Always detect main AC power OFF alarm.	B	All	—
	09	Detection time of main power off	1 ms	70–2000	2	Set up main AC power alarm detection time. Main AC power OFF detection is disabled when the setting value is 2000. Resolution of setting is 2 ms. For example, when setting value is 99, processed in 100 ms.	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
	11	Thrust setup for emergency stop	%	0–500	2	Set up the thrust limit at emergency stop. When setup value is 0, the thrust 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	mm/s	0–20000	2	Set up the detection level of Err.26.0 “Over-speed protection”. When the setting value is 0, Err 26.0 is activated with the setup value for Pr 9.10 “Maximum over-speed level”. If the setup value exceed Pr 9.10 “Maximum over-speed level“, the error will be enabled with Pr 9.10 “Maximum over-speed level”.	A	All	6-3-5
	14	Motor working range setup	0.1 magnet pitch	0–1000	2	Set up motor over-travel limit to the position command.	A	Position	6-2 7-4
	15	Control input signal reading setup	—	0–3	2	Select reading period of the control input signal: 0: 0.166 ms, 1: 0.333 ms, 2: 1 ms and 3: 1.666 ms Exception: external latch input 1/2/3 (EXT1/2/3)	C	All	—
	20	Position setup unit select	—	0–1	2	Specify the unit to determine the range of positioning complete and excessive positional deviation. 0: Command unit 1: 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	4-2-4 7-4

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
5	21	Selection of thrust limit	—	1–4	2	Select positive direction or negative direction thrust limit.	B	Position, Velocity	6-1 7-4
	22	2nd thrust limit	%	0–500	2	You can set up the 2nd limit value of the motor output thrust. In addition, the actual thrust applied is limited with the maximum thrust limit for the motor applied. (The parameter value is not limited)	B	Position, Velocity	6-1
	25	Positive direction thrust limit	%	0–500	2	With Pr 5.21 “Selection thrust limit” set to 4, set the positive direction thrust limit when TL_SW is at 1. In addition, the actual thrust applied is limited with the maximum thrust limit for the motor applied. (The parameter value is not limited)	B	Position, Velocity	6-1
	26	Negative direction thrust limit	%	0–500	2	With Pr 5.21 “Selection thrust limit” set to 4, set the negative direction thrust limit when TL_SW is at 1. In addition, the actual thrust applied is limited with the maximum thrust limit for the motor applied. (The parameter value is not limited)	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	Fixed to 4.	—	—	—

Class 6: Special setting

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	02	Speed deviation excess setup	mm/s	0–20000	2	Set threshold of Err 24.1 “Speed over deviation protection”. This protection is not detected when the setup value is 0.	A	Position	—
	05	Position 3rd gain valid time	0.1 ms	0–10000	2	Set up 3rd gain valid time of 3 gain level adjustment.	B	Position	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	Thrust command additional value	%	-100–100	2	Set up the offset thrust to be added to the thrust command.	B	Position	5-2-11
	08	Positive direction thrust compensation value	%	-100–100	2	Set up the value to be added to the t thrust command for positive direction operation.	B	Position	5-2-11
	09	Negative direction thrust compensation value	%	-100–100	2	Set up the value to be added to the thrust command for negative direction operation.	B	Position	5-2-11
	10	Function expansion setup	2.0 —	0–1023	2	Set up the function in unit of bit. bit0 Velocity observer 0:Invalid 1:Valid bit1 Disturbance observer 0:Invalid 1:Valid bit2 Disturbance observer operation setup 0: Always valid 1:Valid only when 1st gain is selected. 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: Current response improvement 0: Invalid 1: Valid bit7: INP output limit 0: Invalid 1: Valid bit9: For manufacturer’s use. Always se to 0. ▪ bit 0 = LSB	B	All	5-2-8 5-2-9
	14	Emergency stop time at alarm	ms	0–1000	2	Set up the time allowed to complete emergency stop in an alarm condition. Set resolution in unit of 2 ms. For example, when setting value = 11, processed in 12 ms.	B	All	6-3-5
	15	2nd over-speed level setup	mm/s	0–20000	2	When the motor speed exceeds this setup time during emergency stop sequence in an alarm condition, Err 26.1 “2nd overspeed protection” will be activated. If the setup value is 0, Err 26.1 will be activated with Pr 9.10 “Maximum over-speed level”. If the setup value exceeds Pr 9.10 (Maximum over-speed level), the error will be saturated with Pr 9.10 (Maximum over-speed level).	A	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
	20	For manufacturer’s use	—	—	2	Fixed to 0.	—	—	—
	21	For manufacturer’s use	—	—	4	Fixed to 0.	—	—	—
	22	AB phase feedback scale pulse outputting method selection	—	0–1	2	Select regeneration method of OA and OB pulse output when using AB phase output type feedback scale. 0: Signal is not regenerated 1: Signal is regenerated ▪ When signal regeneration is selected, the driver reproduces duty of OA and OB, minimizing waveform distortion.	R	Position	4-2-5

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	23	Disturbance thrust compensating gain	%	-100–100	2	Set up the compensation gain against disturbance thrust.	B	Position, Velocity	5-2-9
	24	Disturbance observer filter	0.01 ms	10–2500	2	Set up the filter time constant according to the disturbance thrust compensation.	B	Position, Velocity	5-2-9
	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
	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
	32	Real time auto tuning custom setup	—	-32768–32767	2 2.0	Set up details of real time auto tuning customize mode. Set to 0 during block Diagram of 2 Degrees of Freedom Mode.	B	All	5-1-1
	37	Oscillation detecting level	0.1%	0–1000	2	Set up the oscillation detecting level. Upon detection of a thrust vibration whose level is higher than this setup value, the oscillation detection alarm will be issued.	B	All	7-3
	38	Alarm mask setup	—	-32768–32767	2	Set up the alarm detection mask. Placing 1 to the corresponding bit position disables detection of the alarm condition.	C	All	7-3
	39	For manufacturer's use	—	—	2	Fixed to 0.	—	—	—
	40	disturbance thrust compensation phase setup	degree	0-60	2	The phase is advanced by the set amount respective to the disturbance thrust value.	B	Position, Velocity	5-2-9
	41	1st damping depth	—	0–1000	2	Specifies the damping depth of the 1st damping function.	B	Position	5-2-6
	42	2-stage thrust filter time constant	0.01 ms	0–2500	2	Specifies the filter time constant for the thrust 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	2-stage thrust filter attenuation term	—	0–1000	2	Specifies the attenuation term of the 2-stage thrust filter.	B	All	5-2-12
2.0	47	Function expansion setup 2	-	0~1	2	Set various functions with bits. bit0 2 degrees of freedom control mode (Position control) 0: Disabled 1: Enabled	Power reset	Depend on bit	5-2-13
2.0	48	Tuning filter	0.1ms	0~2000	2	Set the time constant of the tuning filter.	Always valid	Position	5-2-13
2.0	49	Command / tuning filter damping	-	0~99	2	Set the damping of the command filter and tuning filter. The first digit is set for the command filter and the second digit is for the tuning filter in decimal notation. Effective digits 0 to 4: No damping (Operates as a primary filter) 5 to 9: Secondary filter (The damping ζ will be 1.0, 0.86, 0.71, 0.50 and 0.35 respectively.) Ex) To obtain ζ=1.0 for the command filter and ζ=0.71 for the tuning filter 1, set the value to 75 (1st digit=5 (ζ=1.0), 2nd digit=7(ζ=0.71)). Please note that for the time constant of the command filter, Pr2.22 "Positional command smoothing filter" will be applied.	Always valid	Position	5-2-13

Class 2.0	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
6	50	Viscous friction compensating gain	%/(10000r/min)	0~10000	2	The command speed is multiplied by this set value to obtain a compensation amount that will be added to the torque command. The unit is [rated torque %/(10000r/min)].	Always valid	Position	5-2-13

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	00	Display on LED	—	0–32767	2	Select type of data displayed on front panel 7-seg LED.	A	All	3-2
	01	Display time setup upon power-up	100 ms	-1–1000	2	Set up the node address display time upon turning ON of control power. When the setting 0 to 6, it is processed in 600ms. When the setup value is -1, the node address is displayed until RTEX communication is established (completion of synchronization of communication and servo) after the turning ON of the control power supply.	R	All	3-2
	03	Output setup during thrust limit	—	0–1	2	Set up judgment condition of output while thrust is limited by thrust control. 0: Turn ON at thrust limit including thrust command value 1: Turn ON at thrust limit excluding thrust command value	A	Thrust	—
	04	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	05	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	06	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	07	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	08	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	09	For manufacturer's use	—	—	2	To be fixed to 360.	—	—	—
	10	Profile 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 (Profile positive side software limit) and Pr 7.12 (Profile negative side software limit). 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	Profile positive side software limit value	Command unit	-1073741823 –1073741823	4	[Under review] 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	Profile negative side software limit value	Command unit	-1073741823 –1073741823	4		A	Position (PP)	RTEX
	13	Absolute home position offset	Command unit	-1073741823 –1073741823	4	Set up the offset value on feedback scale position (external scale position) when using absolute feedback scale (absolute external scale) and mechanical coordinate system position.	C	All	RTEX
	14	Main power off warning detection time	1 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] * Setting resolution is 2 ms. Note: Set this parameter so that Pr.7.14 becomes smaller than Pr.5.09 in order for the warning detection is performed before shut-down detection. If the voltage between P and N of the main power convertor is decreased to below a specified value before the warning is detected because the setting value is long, the main power low voltage error (Err13.0) occurs before the warning.	C	All	7-3 RTEX
	15	Profile 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 (PP)	RTEX

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	20	RTEX communication cycle setup	—	0–12	2 2.0 2.0	Set up the RTEX communication cycle. 0: 0.0833[ms] 1: 0.1666 [ms] 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. ▪ With communication cycle 0.0833[ms], pulse regeneration is automatically disabled. ▪ 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 ▪ If the communication cycle is 0.0833 ms (Pr7.20=0), please set an adaptive filter invalid. (Pr2.00=0).	R	All	2-5, RTEX
	21	RTEX command updating cycle ratio setting	—	1–2	2	Setup the ratio of RTEX communication cycle and command update cycle. 1: 1 [time] 2: 2 [times] (can be set only when communication cycle = 0.0833 [ms] and 0.5 [ms]) ▪ 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 guaranteed.	R	All	2-5, RTEX
	22	RTEX function extended setup 1	—	-32768 –32767	2	bit 0: Set up RTEX communication data size 0: 16-byte mode, 1: 32-byte mode bit 1: Specifies synchronization mode among multiple axes using TMG_CNT. 0: Semi-synchronization among axes, 1: Full synchronization among axes Bit2: For manufacturer's use. Always set to 0. Bit3: For manufacturer's use. Always set to 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, RTEX

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	23	RTEX function extended setup 2	—	-32768 –32767	2	bit 0: Parameter writing through RTEX communication: 0: Enable, 1: Disable bit 1: Alarm code sub number setup 0: Fixed to 0, 1: Sub number enabled bit 2: RTEX status response condition setup with function of P0T/N0T disabled (Pr.5.04 = 1). 0: Status enabled, 1: Fixed to 0 bit 3: RTEX status bit arrangement setup of P0T/N0T 0: P0T is bit 1, N0T is bit 0 1: N0T is bit 1, P0T 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 P0T/N0T 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 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: For manufacturer's use. Always set to 0.	B	All	6-3-1, RTEX
	24	RTEX function extended setup 3	—	-32768 –32767	△2.0 2	bit 0: 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.) bit 1: 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.) bit 2: Setting condition to output the positioning complete signal during servo-off 0: Compulsive ON Invalid 1: Compulsive ON Valid bit 3: Setting condition for In_Position(positioning complete signal) of RTEX communication 0: Unit is set up by Pr5.20. 1: Command unit bit 4: Setting condition for Servo_Active (servo-on state signal) of RTEX Communication 0: Not dependent on charge + offset measurement 1: ON after the completion of charge + offset measurement Note:Pr7.40" RTEX function extension setup 4"bit0 can be set up simultaneous,refer to it.	C	All	2-2, RTEX
	25	RTEX speed unit setup	—	0–1	2	Set up the unit of speed data used in RTEX communication. Set up the unit both for both command data such as command speed and for response data such as actual speed. 0: mm/s 1: Command unit/s	C	All	RTEX

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	26	RTEX continuous error warning setup	No. of times	0 –32767	2	Generates WngC0h (RTEX continuous communication error warning) when the No. of continuous errors reaches the setting of this parameter. When the setting value is 0, this function is disabled and no warning is issued.	A	All	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	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	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	[Under review] 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, thrust (TRQ) is monitored.	A	All	RTEX
	32	RTEX monitor select 4	—	0–32767	2	Selects a monitor type of Sub_Response_Data1 in 32-byte mode when sub command is 0h. Please set up Type Code (8 bits) of a RTEX monitor command. If the setup value is 0, 0 is returned.	A	All	RTEX
	33	RTEX monitor select 5	—	0–32767	2	Selects a monitor type of Sub_Response_Data2 in 32-byte mode. Please set up Type Code (8 bits) of a RTEX monitor command. If the setup value is 0, 0 is returned.	A	All	RTEX
	34	RTEX monitor select 6	—	0–32767	2	Selects a monitor type of Sub_Response_Data3 in 32-byte mode. Please set up Type Code (8 bits) of a RTEX monitor command. If the setup value is 0, 0 is returned.	A	All	RTEX
	35	RTEX command setting 1	—	0–2	2	Specifies the Command_Data3 of non-cyclic command. However, this setting is invalid for non-cyclic command using Command_Data3 area. 0: Invalid 1: Velocity feedforward [Command unit/s] or [mm/s] 2: Thrust 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 [mm/s] 2: Thrust 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 [mm/s] 2: Thrust feedforward [0.1%]	C	All	RTEX

Class 7: Special setting 2

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
7	38	RTEX_Update_Counter error protection setup	No.of times	0–32767	2	If the Update_Counter exceeds the setup value for this parameter and is not updated correctly, Err 86.2 “RTEX_Update_Counter error protection” will be activated. If the setup value is 0 or 1, this function will be disabled and an alarm will not be activated.	A	All	RTEX
	39	For manufacturer’s use	—	—	2	Always set to 0.	—	—	—
	40	RTEX function extension 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-MONI/EXT1 to SI-MOn3/EXT3 1: CS1 to CS3	C	All	9-2-1 RTEX
	41	RTEX function extension 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)	R	All	2-2 RTEX
	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. Setting with this parameter will be prioritized (supersede setting with Pr 7.40-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/CS2) 6: Byte 3, bit5 (SI-MON3/EXT3/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.	B	All	RTEX
	52	For manufacturer’s use	—	—	2	Fixed to 0.	—	—	—

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	To be fixed to 0.	—	—	—
	01	Profile linear acceleration constant	10000 Command unit /s^2	1–65535	4	Specifies acceleration during profile position control (PP). Be sure to set before starting operation.	B	Position (PP)	RTEX
	02	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	03	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—
	04	Profile linear deceleration constant	10000 Command unit /s^2	1–65535	4	Specifies deceleration during profile position control (PP). Be sure to set before starting operation.	B	Position (PP)	RTEX
	05	For manufacturer's use	—	—	2	To be fixed to 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, 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 mm/s	0– 2147483647	4	Specifies a velocity for high-speed operation during profile home position return. Unit is specified with Pr7.25 (RTEX velocity unit setting). Maximum velocity is internally limited using Pr 9.10 "Maximum over-speed level setup". * When velocity setting is in mm/s, it is converted to command unit/s through internal computation and the equivalent value is limited within the range as shown below: –80000001h to 7FFFFFFFh (–2147483647 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 mm/s	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 velocity unit setting). Maximum velocity is internally limited using Pr 9.10 "Maximum over-speed level setup". * When velocity setting is in mm/s, it is converted to command unit/s through internal computation and the equivalent value is limited within the range as shown below: –80000001h to 7FFFFFFFh (–2147483647 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	To be fixed to 0.	—	—	—
	19	For manufacturer's use	—	—	2	To be fixed to 0.	—	—	—

Class 9: Linear-related

Class	No.	Title	Unit	Range	Size [byte]	Function / Contents	Attribute	Related control mode	Reference
9	00	Motor type selection	—	0–2	2	Select the type of a motor that will be connected.	R	All	4-7-1-1 4-7-1-2 4-7-4
	01	Feedback scale resolution/ Number of scale pulses per rotation	0.001 µm /pulse	0–16777216	4	[Motor type: Linear] Set up the resolution for the feedback scale. [Motor type: Rotary] Set the number of pulses of the feedback scale per revolution.	R	All	4-7-1-1 4-7-1-2 4-7-4
	02	Magnet pole pitch	0.01mm	0–32767	2	[Motor type: Linear] Set up the magnet pole pitch. * For the rotary type, no settings are required.	R	All	4-7-1-1 4-7-4
	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, no settings are required.	R	All	4-7-1-2
	04	Mass of motor's movable section/ Motor inertia	0.01kg /0.00001 kgm^2	0–32767	2	[Motor type: Linear] Set up the moving portion's mass of motor. [Motor type: Rotary] Set up the motor inertia.	R	All	4-7-1-1 4-7-1-2 4-7-4
	05	Rated motor thrust/rated motor torque	0.1N /0.1Nm	0–32767	2	[Motor type: Linear] Set up the rated thrust for the motor. [Motor type: Rotary] Set up the rated torque for the motor.	R	All	4-7-1-1 4-7-1-2 4-7-4
	06	Rated effective motor current	0.1 Arms	0–32767	2	Set up the rated effective current for the motor.		All	4-7-1-1 4-7-1-2 4-7-4
	07	Maximum instantaneous motor current	0.1A	0–32767	2	Set up the maximum instantaneous current for the motor.	R	All	4-7-1-1 4-7-1-2 4-7-4
	08	Motor phase inductance	0.01mH	0–32767	2	Set up the phase inductance for the motor.		All	4-7-1-1 4-7-1-2
	09	Motor phase resistance	0.01Ω	0–32767	2	Set up the phase resistance for the motor.	R	All	4-7-1-1 4-7-1-2
	10	Maximum over-speed level	(mm/s) /(r/min)	0–20000	2	Set up the maximum over-speed for the motor.	R	All	4-7-1-1 4-7-1-2 4-7-4
	11	Carrier frequency selection	—	0–1	2	Select the carrier frequency. 0: 6 kHz 1: 12 kHz	R	All	4-7-1-1 4-7-1-2
	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	4-7-2
	13	Proportional current gain	—	0–32767	2	Set up the proportional current gain.	R	All	4-7-2
	14	Integral current gain	—	0–32767	2	Set up the integral current gain.	R	All	4-7-2

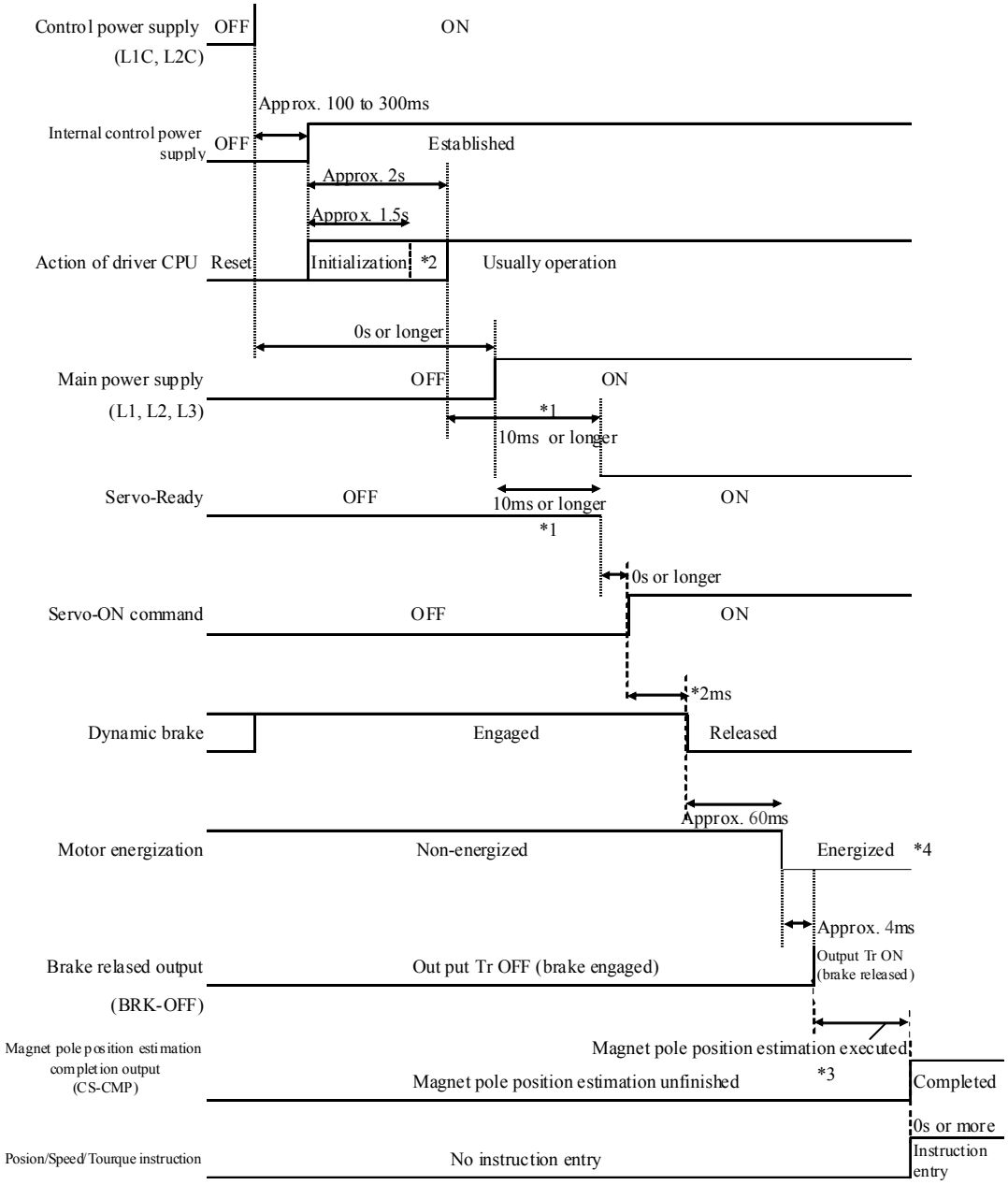
Note) Depending on motor types, different parameter names and setup units are used.

Class 9: Linear-related

Class	No.	Title	Unit	Range	Size [byte]		Attribute	Related control mode	Reference
9	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.	—	—	—
	20	Magnet pole detection scheme selection	—	0–3	2	Select the detection scheme for magnet pole position.	R	All	4-7-3-1 4-7-3-2 4-7-3-3
	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	4-7-3-1
	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	4-7-3-2
	23	Magnet pole position estimation command thrust	%	0–300	2	Set up the command thrust for magnet pole position estimation.	B	All	4-7-3-2
	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	4-7-3-2
	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	4-7-3-2
	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	4-7-3-2
	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	4-7-3-2
	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	4-7-3-2
	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	4-7-1-1 4-7-4
	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.	—	—	—
	35	Thrust saturation error protection frequency	time	0–30000	2	If thrust saturated is continued during a preset frequency, Err 16.1 "Thrust saturation protection" will be activated. If the setup value is 0, this function is disabled and an alarm will not be activated.	B	Position, Velocity	6-4

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/thrust 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”.

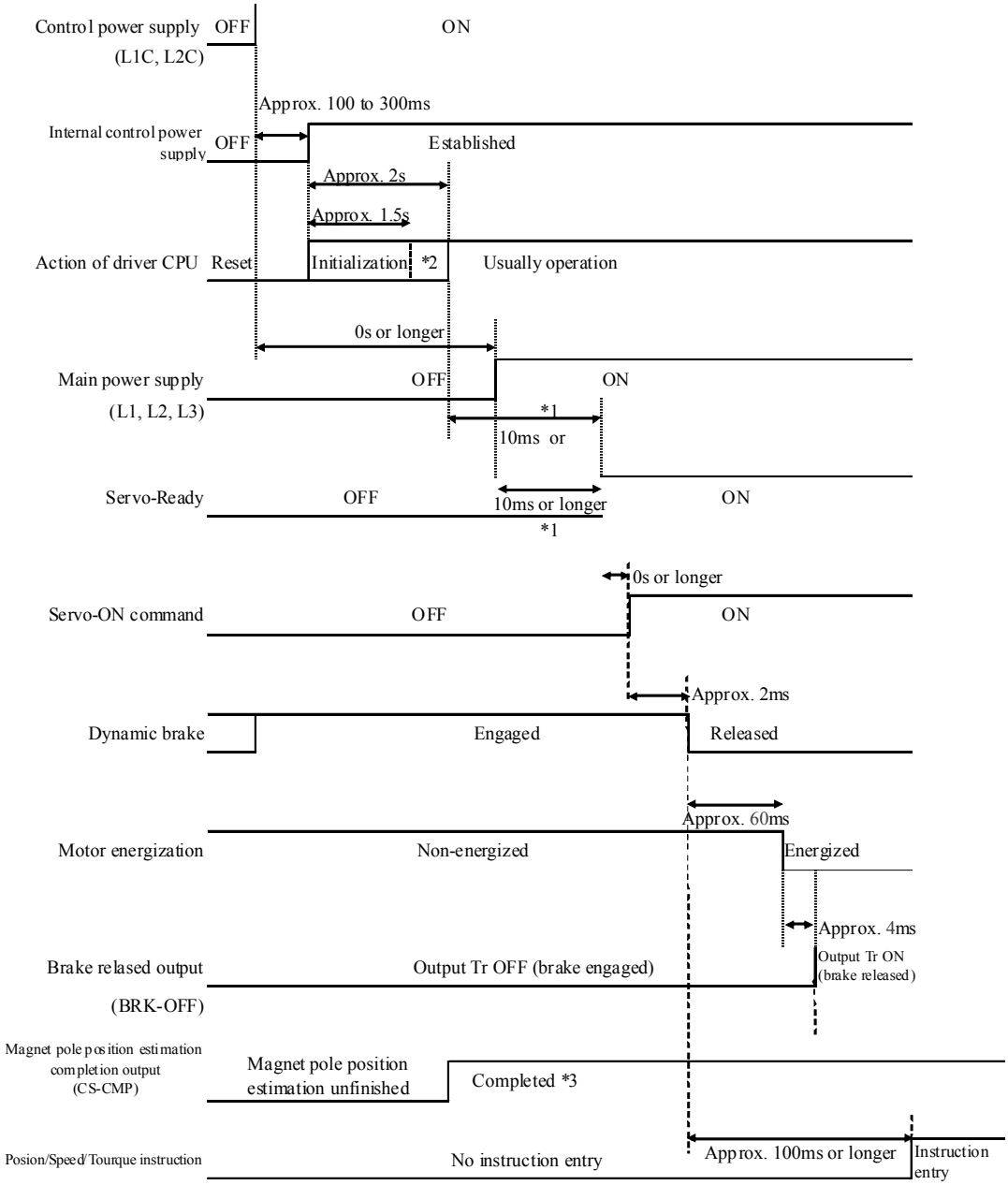
*2. After Internal control power supply, protective functions are active from approx. 1.5 sec after the start of initializing microcomputer. Please set the signals, especially for protective function, for example over-travel inhibit input (POT, NOT) or feedback scale input, so as to decide their logic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

*3. Time for magnet pole position estimation depends on parameter settings. Check that the magnet pole position estimation completion output will turn ON and then apply the command. If magnet pole position estimation has not completed correctly, the magnet pole position estimation completion output will not turn ON.

*4. 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/thrust commands according to the above timing chart.

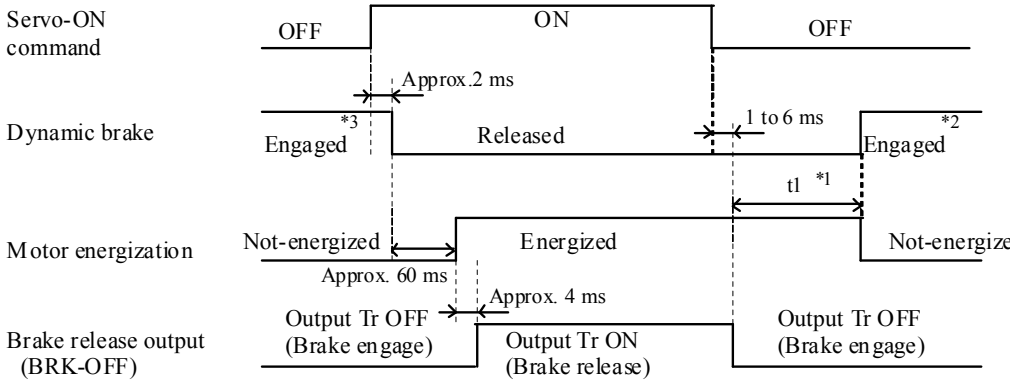
*1. The servo ready is turned on when all the following conditions are satisfied: “Initialization of microcomputer is completed”, “Main power supply is established”, “No alarm is issued”, and “Synchronization (phase matching) between RTEX communication and servo is completed and RTEX communication is 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 “Wait time after power-up”.

*3. 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.)



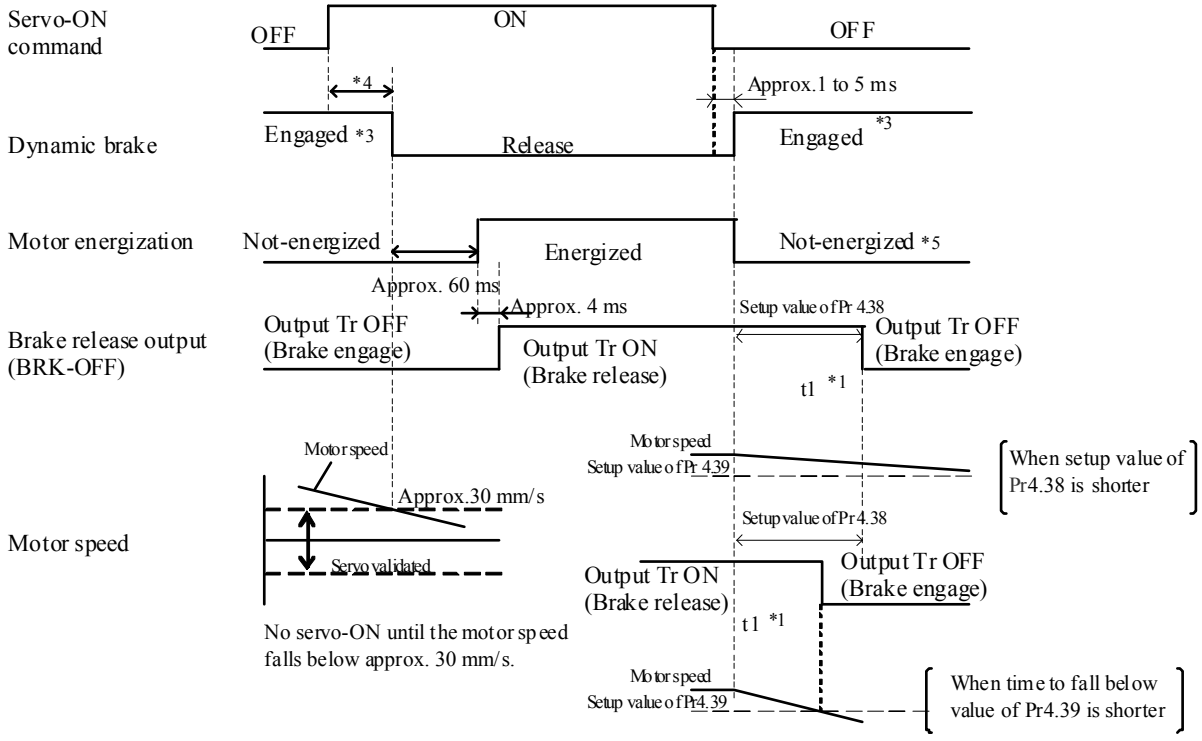
*1. t1 depends on the setup value of Pr 4.37 Setup of mechanical brake action at stalling.

*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 mm/s.

9-2-4 Servo-ON/OFF action while the motor is in operation

(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”.

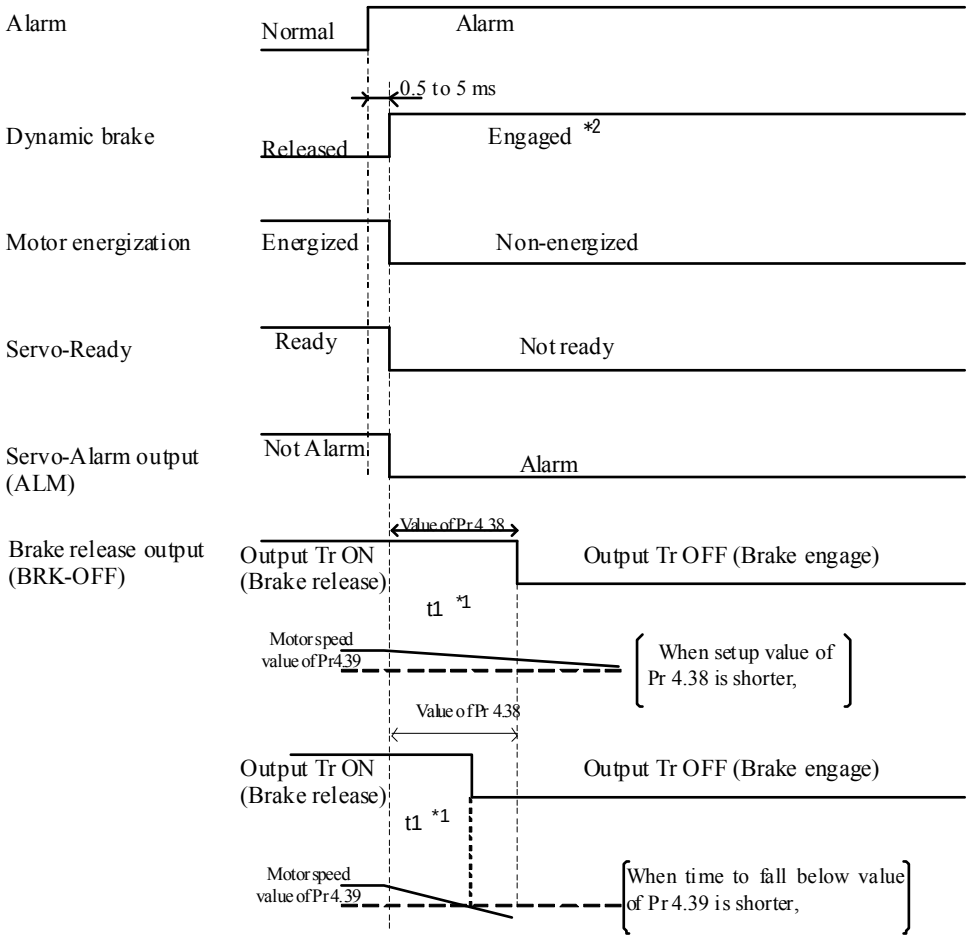
*2. Even when the servo-ON command is turned on again while the motor is decelerating, transition to servo-ON is not performed until the motor stops.

*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 mm/s.

*5. For the motor energization during deceleration at Servo-OFF depends on the setup value of Pr .5.06 (Sequence at Servo-OFF).

9-2-5 When an error (alarm) has occurred (at Servo-ON command)



*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”.

9-2-6 When an alarm has been cleared (at Servo-ON command)